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THE RELATIONSHIP BETWEEN SOIL STRUCTURE, SOIL CULTIVATION, NITROGEN UPTAKE, AND CROP GROWTH. I.—A Review of the Literature

By KHAZAN SINGH and A. G. POLLARD

Zakharov[1] defined soil structure as the nature of the fragments or clods into which the soil breaks up. The effects of cultural operations such as ploughing, cultivating, harrowing and hoeing on soil structure include the breaking up of soil into such fragments (soil aggregates) thus increasing the volume/weight and porosity. Henin[2] affirmed this and gave a mathematical expression to such an increase. Nekrassov in 1928, 1929, 1934[3–5] and Apsits in 1936[6] studied the effects of ploughing, cultivating, harrowing, rolling and hoeing on the capillary and non-capillary porosity of the soil (according to whether the pores are of such size that water does or does not drain under gravitational forces). They found that the major influence of tillage was on the non-capillary porosity. Doyarenko and his co-workers (Krause[7]) have investigated the relationship of non-capillary porosity to various soil properties including aeration and nitrate formation. The oxygen content of the soil air, and nitrate formation were closely related to the non-capillary porosity, which in turn was associated with the proportion of larger aggregates in the soil. Other recent experimental results have shown rather definite relationships between non-capillary porosity and soil permeability (permeability to water under gravity), as well as the root development of crops. Salter[8] has specially stressed the importance of pore space in root–soil relationships. Page, Willard & McCuen[9] studied the non-capillary porosity and compactness of soil resulting from different methods of seed-bed preparation. Ploughed plots were the most porous and mellow. Hoed and disced plots were quite compact and were the most poorly aerated. Chizhersky & Kolobova[10] found that plots which had been worked with a cultivator contained 14% of aggregates smaller than 0·25 mm., while ploughed ones contained only 3%. Keen[11] compared the aggregation of a soil following cultivation with a ridging plough, an ordinary plough and a rotary cultivator and found the ridging plough to be the best in this respect, a relatively small amount of disintegration of aggregates being caused by the ordinary plough. Dreibelbis & Nair[12] also found in the 0–4-in. layer greater pore space and better aggregation after discing than after ploughing, but in the 4–7-in. layer the relationship was reversed. Maize plants were better but thinner in the stand on disced than on the ploughed plots, but yields were not affected.

Poletaef[13] studied the effect of tillage on soil fertility. The nitrogen nutrition of crops appeared to be related to the physical conditions of the upper soil layers at sowing time. A cloddy structure in deeper (20–22 cm.) ploughed plots caused greater leaching of nitrates in winter than did a fine structure in shallow-ploughed (12–14 cm.) plots; mobilization of nitrates in spring was more active in the former than in the latter. Wheat grown on the shallow-ploughed plots showed signs of lack of nitrogen, but was much better on the deep-ploughed plots; weight of grain, number of ears and length of the straw were greater in the deeper ploughed plots. Gainey[14] noted differences in the rate at which organic matter decomposes in deep and shallow cultivated soils, ammonification and nitrification being much greater in the former, whilst Fedulaev[15] found much more available nitrogen, phosphate and potassium in thoroughly cultivated soil than that receiving a bare minimum of cultivation. Nitrifying power was greater in the former than in the latter.

Rynasiewicz[16] observed that onion yields in different rotations increased with the degree of aggregation (% of aggregates >0·5 mm.) in both the 0–4- and 4–8-in. soil layers. There was a high positive correlation between the degree of aggregation and the organic matter content.

Although the effects of ploughing and cultivation with other types of implements of light draft (e.g., disc) on soil porosity and aggregation vary with the soil conditions (Keen,[11] Page, Willard & McCuen,[9] and others) the plough has been found to leave the soil in a better structural condition than do the lighter types of implements. Williams[17] and Papazov[18] state that by inverting the top layer (10 cm.) completely by ploughing, its structure was restored and subsoil with better structure was brought to the surface. Apart from this, the soil-inverting plough, by

virtue of its mechanical action, granulates the soil, as the furrow slice moves along the length of the mould board. However, the beneficial effects of ploughing on soil structure are limited by the type of soil and its moisture content. The soil-inverting plough may do more harm than good to the structure in soils having a very high clay content in the sub-surface layer. After being turned up, the sub-surface soil does not crumble but forms hard clods. Singh* experienced such a case in Scotland at Turnhouse, where the sub-surface soil contained 52% clay. In this case, soil prepared by a tine-cultivator (single operation) was in a better condition of tilth than that prepared by ploughing even with additional rolling and discing operations. Harper & Brensing[19] also reported similar effects.

More detailed information on this subject will be found in the two monographs on soil structure by Russell[20] and by Krause[7] and in a review by Torstensson[21] of British, German and other work on soil cultivation with special reference to changes in physical properties.

The second aspect of the subject is the response of the plants to the changed structural conditions of the soil due to cultivation, e.g., soil aeration, water capacity of the soil. Root development may be taken first. Soil porosity has been much studied in relation to root development (e.g., Weaver,[22, 23] Carlson,[24] Hole,[25] Salter[8]). This work has been reviewed by Singh,[26] who also shows that soil cultivation affected primarily the non-capillary porosity of the soil. Both root spread and the development of the main and branch roots were affected by cultivation, but the main effects were on the branch roots, which are mostly concerned with the absorption of water and nutrients. However, nutritional benefits due to greater root development following appropriate cultivation did not occur in a rich soil or in one suitably manured; nor did any differences exist between the cultivation treatments with respect to nitrogen uptake and crop growth.

Grandeau[27] was one of the earliest investigators of the effects of cultivation on the physical conditions of the soil and on crop yields, although his methods were empirical. He assumed increased nitrification to result from enhanced aeration of the soil by ploughing. Continental and Russian workers continued to support this view of the beneficial effects of cultivation, on soil aeration, and water conservation. However, in England Russell and his associates (Keen,[28, 29] Russell & Keen,[30] Russell[31]) discarded this view and maintained that the principal effect of cultivation was on weed control, the crop being more sensitive to weed competition than to soil tilth. Crop yields, obtained from plots prepared by implements other than the plough, e.g., rotocultivator, approached the level of those obtained from the ploughed plots under fairly clean conditions. These results together with those obtained previously in America in comparisons of deep and shallow ploughing and subsoiling (Chilcott *et al.*,[32] Chilcott & Cole[33]) added much support to the view that changed physical conditions under cultivation are of less significance than weed control.

Singh[26, 34–37] studied the effects of soil cultivation on the growth and yield of winter wheat in Scotland using six different types of soil under varying climate conditions. Weeds were kept down in the experimental plots to eliminate the weed factor. Differences existed between the cultivation treatments; ploughing giving higher yields than did 2- and 4-in. tine-cultivations. Greater nitrogen deficiency occurred in the cultivated plots than in the ploughed plots causing lower yields in the former. Greater compactness and consequently poorer soil aeration seemed to be associated with poor development of root systems and less nitrification in these plots. Applications of nitrogen fertilizer made up for the deficiency of nitrogen in the cultivated plots and the yields were brought to the level of those obtained from the ploughed plots. However, only fertile and well-drained soils responded to nitrogen in this way; in poor soils the differences between the cultivation treatments persisted. In the latter type of soils, both the physical and chemical conditions of the soil determined the intensity of nitrogen deficiency and its amelioration by the application of nitrogen fertilizer.

Work at the Iowa Agricultural Experiment Station[38, 39] and that by Lawton & Browning[40] showed that tillage practices causing greatest aeration were the best for the nutrition of the plant in poor soils having less favourable physical conditions. In such soils nutritional deficiencies occurred and yields were lowered on plots prepared by implements of light draft, e.g., disc.

* Private communication.

The method of tillage had little effect on nutritional deficiencies or on yields in rich soils or those receiving suitable manurial treatment.

Singh's work in Edinburgh and the Iowa work seem to establish the fact that cultivation does influence the physical conditions of the soil, particularly its structure, but the response of the crop (growth and yield) to cultivation is limited to poor soils with less favourable physical conditions. In these soils weed control cannot be eliminated altogether from the list of advantages derived from ploughing.

The effects of cultivation on crop growth are many-sided, and factors concerned are both physical and chemical as well as physiological. The literature on the physiological aspects is voluminous and has been summarized and reviewed by Russell,[41] Singh,[26, 34–37] Swell,[42] Chilcott, Cole & Burr,[32] Chilcott & Cole,[33] Cole & Mathews,[43] Torstensson,[21] and in *Soils and Fertilizers*.[44] Fewer references are available to research on the physical and chemical aspects of the problems either separately or together (some of this has been referred to in the text), while very few papers have appeared in which all the three aspects of the problem have been examined simultaneously. Work in Edinburgh was begun in this direction (see Singh[37]) and the present investigations are a development of the same.

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THE RELATIONSHIP BETWEEN SOIL STRUCTURE, SOIL CULTIVATION, NITROGEN UPTAKE, AND CROP GROWTH. II.*—Effects of Cultivation on Aggregation of Soil

By KHAZAN SINGH and A. G. POLLARD

The effects of depth of cultivation on aggregation of the Harlington field station soil, during 1949 and 1950, are examined, the crops studied being swedes in 1949 and spring wheat in 1950.

The type of cultivation influenced the size distribution of aggregates, mainly in the surface 4 in. of soil. The larger aggregates >0·5 mm., particularly those of 4–2 mm. diam., were more especially affected. Both deep- and shallow-ploughed plots contained a higher percentage of larger aggregates >0·5 mm. than did the tine-cultivated plots. The plough by inverting the slice brought the better structured sub-surface soil to the surface and thus increased the percentage of larger aggregates >0·5 mm. in the 0–4-in. layer. This effect of ploughing lasted for about 4 to 5 months.

Except in one instance, the type of cultivation did not affect the ' degree ' of aggregation of particles <0·05 mm.; both deep- and shallow-ploughed soils showed a greater degree of aggregation than did the tine-cultivated soil.

With all three types of cultivation the horizon A_1 of the soil contained a higher proportion of larger aggregates >1·0 mm. than did horizon A_2. The reverse was true of the smaller aggregates <1·0 mm., particularly those of 0·25–0·05 mm. diam. Differences between the proportion of very fine particles (<0·05 mm.) in the two horizons were small. The higher content of clay and lower content of organic matter in horizon A_2 than in horizon A_1 were probable factors in these differences.

Seasonal variations were apparent in both the size distribution of aggregates and the degree of aggregation of soil during two years. Soil moisture played the major part in these variations, lower moisture content being associated with higher content of aggregates >0·05 mm. and vice versa.

Disruption of aggregates occurred throughout the two growing seasons, which demonstrates the unstable nature of the structure of this soil. The order of stability among aggregates of different sizes was 0·25–0·05, 0·5–0·25, 2·0–1·0 mm. > 1·0–0·5 mm. > 4·0–2·0 mm. $\gg$ 4·0 mm., and that among individual layers in the soil profile was: 0–2-in., 8–12-in. layers < 2–4-in., 4–8-in. layers.

Seasonal variation in the stability of the aggregates was in the order: August > September, January > October, July.

No significant differences existed between the cultivation treatments in regard to disruption of aggregates or in their stability.

No experimental evidence was obtained that finer material (particles <0·05 mm.) became leached from the upper to lower depths.

Introduction

Published work has already been reviewed in the first paper of this series. The experimental work on this problem, which began in 1949 at Harlington and continued in 1950, included a study of the relations between depth and type of cultivation and

(*a*) aggregation in soil;
(*b*) porosity and compactness;
(*c*) nitrate accumulation in soil;
(*d*) root development in wheat;
(*e*) nitrogen uptake and crop growth.

Section (*a*) constitutes the subject of this paper.

Experimental

Experimental site and layout

A cultivation experiment was set up at the Imperial College Field Station, Harlington. The experiments began in the spring of 1949 and included three types of cultivation: deep-ploughing (PA) to 8-in. depth; shallow-ploughing (PB) to 4-in. depth; tine-cultivation (C) to

* Part I: preceding paper

2-in. depth. The layout was in four randomized blocks. A three-factorial manurial experiment was superimposed on the cultivation experiment with a randomized layout (split plot technique). Final arrangement of the treatments within each block is shown in Fig. 1.

←24′→												←24′→
21′	PA^0	PB^0	Cm^0	PB^0	PAm^0	Cm^0	PA^0	C^0	PBm^m	C^0	PB^0	PAm^0	21′
21′	PAm^m	PBm^0	Cm^m	PBm^0	PAm^m	Cm^m	PAm^m	Cm^m	PBm^0	Cm^0	PBm^m	PAm^m	21′
21′	PAm^0	PBm^m	C^0	PBm^m	PA^0	C^0	PAm	Cm^0	PB^0	Cm^m	PBm^0	PA^0	21′
←24′→												←24′→	

^{0} No manure
m^0 Manured for previous crop (swedes) and not manured for the crop following (wheat)
m^m Manured for the previous crop (swedes) as well as for the crop following (wheat)

FIG. 1.—*Arrangement of the main cultivation and superimposed manurial treatments within each block*

There were 12 main plots and 36 sub-plots; each main plot had an area of about 1/30th acre and each sub-plot about 1/90th acre.

Treatment of the plots.—The plots of the 'standard' deep-ploughing treatment were ploughed in the ordinary way with a mould board plough to a depth of about 8 in., for the shallow-ploughing to about 4 in., and for the cultivation treatment the tine-cultivator operated at about 2 in. All the plots were levelled by harrowing after those operations and the crop was sown.

The swede crop followed a potato crop which was heavily manured with mixed fertilizer and was lifted in January, 1949. The land was prepared for swedes in the last week of May, 1949, and for spring wheat in the third week of March, 1950.

The crops were sown across the plots and the drills ran at right angles to the ridge and furrow. The crops were sown with a hand seed-drill, the swedes on 31 May, 1949, at the rate of about 40 oz. per acre with rows 2½ ft. apart and at a depth of about ½ in., and the spring wheat on 24 March, 1950, at the rate of three bushels per acre with drills 6 in. apart and at a depth of about ¾ in. A 4-ft. border on each side of the field was left unsown.

Varieties: Swedes—Laing's Garden Swedes.
Spring wheat—Atle.

The plots received a dressing of 8 cwt. of a 2 : 4 : 1* fertilizer (N 6%, P_2O_5 10·3%, K_2O 7·1%) per acre in August, 1949, for swedes, and 4 cwt. of a 1 : 2 : 1 fertilizer (N 5·3%, P_2O_5 9·0%, K_2O 12·5%) per acre for wheat in May, 1950. The plots were tine-harrowed after manuring.

Climate conditions.—The year 1949 was exceptionally dry, but 1950 was a wetter one, total rainfall being 19·60 in. in 1949, as compared with 25·29 in. in 1950. The drier period from June to September, 1949, and the wetter one from July to September, 1950, were of much significance from the point of view of crop growth and the changes in the physical state of soil. Practically the whole growing season of the swedes was dry and yields were adversely affected. In these years also wide differences in soil structure were apparent. The two years of rather extreme weather conditions provided special features in the investigation on the unstable silt loam soil of Harlington (Singh[1]).

Soil.—The soil contains a high proportion of fine sand and silt and a low proportion of clay, the proportions being 52% of fine sand, 21% of silt and only 12% of clay. It is substantially neutral at both horizons, with pH 6·2 to 6·5. Field capacity for moisture ranges from 20 to 22% of the oven-dry soil.

Field sampling.—Three random samples of soil were taken from each plot and bulked to form a composite sample for aggregate analysis. The same layout of the plots and sampling technique were followed in each year.

* Ammonium sulphate : superphosphate : potassium sulphate

In the statistical interpretation of the results, wherever the experimental data for several months, seasons or soil depths have been pooled in one analysis of variance, the standard error has been calculated on the original number of replications, i.e., four, and split plot technique was employed in the analysis of the data.

Analysis of covariance has been used to assess the influence of an independent variable in the complex experimental data, involving soil heterogeneity, cultivation, season and other factors.

Tables of ' t ' and those for significance of Corr. Coeff. V-B (Fisher[2]) and ' f ' (Snedecor[3]) have been used for the interpretation of the statistical significance of the experimental data.

Effects of cultivation on aggregation of soil

A preliminary study of the aggregate analysis of the soil made by Singh[1] showed that it had an unstable structure. The present study has been extended to a detailed examination of different aspects of aggregation of this soil. Size distribution of aggregates, disruption and stability of aggregates and the degree of aggregation have been studied over two seasons, one relatively dry (1949) and the other wet (1950), at four depths, i.e., 2, 4, 8 and 12 in. The experiments were confined to the main cultivation experiment with three depths of cultivation. The samples from each sub-manurial plot were bulked into one composite sample for each cultivation plot and for each of the four depths, 0–2 ; 2–4 ; 4–8 ; and 8–12 in., respectively. The first three of these soil layers constituted horizon A_1 and the last one horizon A_2.

Aggregate analysis of the samples was made for seven sizes of aggregates, namely >4·0 ; 4·0–2·0 ; 2·0–1·0 ; 1·0–0·5 ; 0·5–0·25 ; 0·25–0·05 and <0·05 mm. The first five sizes were determined by the wet sieving method described by Singh.[1] Fractions smaller than 0·25 mm. diameter were estimated by the sedimentation method, using the liquid in the containers after wet sieving, which then contained all particles less than 0·25 mm. diameter. First the particles from 0·25 to 0·05 mm. diameter were separated from the smaller fractions <0·05 mm. by repeated sedimentation and decantation and then the remaining fraction <0·05 mm. was obtained by difference, a few checks being made on the direct determination of this fraction.

The amount of water-stable aggregates of each size in the sample was expressed as the percentage of the weight of oven-dried soil.

The degree of aggregation is recorded as the percentage of primary particles <0·05 mm., which are aggregated into secondary particles >0·05 mm. (aggregates) in the sample, i.e., difference in the amount of particles <0·05 mm. before and after dispersion (as for mechanical analysis), expressed as percentage of the latter value. The lower limit of 0·05 mm. in the estimation of the degree of aggregation was chosen because aggregates and mechanical separates <0·05 mm. are indistinguishable from each other. Baver[4] states that curves for aggregate analysis and mechanical analysis cross near this point. Some investigators (e.g., Middleton[5]) have used the dispersion ratio as a measure of aggregation.

Results and discussion

A. *Size distribution of water-stable aggregates in the soil profile*

The experimental data given in Table I include two seasons, four depths and three cultivation treatments. A survey of the results shows that aggregates of sizes between 0·25 and 0·05 mm. formed 40–50% of the total weight of the soil, and finer material (<0·05 mm.) another 30–40%, while only a small percentage (10–20%) consisted of particles of other denominations, i.e., >4·0 mm., 4·0–2·0 mm., 1·0–0·5 mm. and 0·5–0·25 mm. The percentage of aggregates of each of the latter four sizes ranged from 4 to 5% of the total weight of the soil. The soil therefore contains a large proportion of small pores, thus giving the compactness and caking and unfavourable structure for maximum growth of most agricultural crops (see Doyarenko,[7] Kvasnikov,[8] Yodder,[9] Dittrich[10] for relations between the size of aggregates and crop growth).

The low proportion of aggregates >0·25 mm. in this soil is probably due to the low stability of the larger aggregates, noted in a previous communication (Singh[1]). It is seen from the bottom of Table I that this soil contains a high proportion of fine sand and silt and a low proportion of organic matter and these are probably the chief factors contributing to the low stability

of the larger aggregates (see also Alderfer & Merkle[11]). Alderfer & Merkle state that soils containing much fine sand and silt disperse to a considerable degree under cultivation. They also found the organic matter content to be related to the stability of aggregates.

Cultivation effects

It is seen from Table I that some significant differences existed between the cultivation treatments with respect to the size distribution of aggregates in the soil profile, but these differences seemed to be limited to larger aggregates >2·0 mm. diameter, except in August, 1949, when these differences also extended to aggregates 2·0–1·0 mm. and 1·0–0·5 mm. diameter. Both the deep- and shallow-ploughed plots contained a greater percentage of aggregates of these sizes than did the tine-cultivated plots at 2-, 4- and 12-in. depths in August, 1949, at 12-in. depth in October, 1949, and at 2-, 4- and 8-in. depths in July, 1950. No significant differences existed between the three cultivation treatments in September of the season 1950, while in January of the season 1949 the tine-cultivated plots contained a greater percentage of aggregates (4·0–2·0 mm.) than did the deep-ploughed plots at 4- and 8-in. depths.

Thus the effects of cultivation on water-stable aggregates were temporary and lasted for about 4 to 5 months in each season. Soil cultivation affected mostly the aggregates >2·0 mm. diameter and these effects were influenced considerably by season and depth. In the drier month of August in 1949, the effects extended to lower depths, i.e., 12 in., and to aggregates <2·0 mm. size, while in the wetter month of July in 1950 to 2-, 4- and 8-in. depths and were limited to aggregates >4·0 mm. and those between 4·0 and 2·0 mm. diameter.

Depth

It is evident from Table I that soil from 2-, 4- and 8-in. depths (horizon A_1) contained a greater percentage of aggregates >1·0 mm. than did that at 12-in. depth (horizon A_2). The reverse was true of the aggregates 0·25–0·05 mm. and to a lesser extent of those between 1·0–0·5 and 0·5–0·25 mm. No significant differences existed between the two horizons in regard to finer material <0·05 mm. or between the three layers of horizon A_1, i.e., 0–2, 2–4 and 4–8 in. with respect to aggregates >1·0 mm. As seen in Table I the clay content of the soil is significantly higher and the organic matter lower in horizon A_2 than in horizon A_1. These two factors might have contributed to the differences in the composition of aggregates in the two horizons. Clarke & Marshall[12] associated the clay content more with the smaller than with the larger aggregates and also found that organic matter was more conducive to the formation of relatively larger stable aggregates. Baver[13] reached similar conclusions.

Season

No significant differences existed between the three layers of horizon A_1 (0–2-, 2–4- and 4–8-in. layers) in regard to the size distribution of aggregates in the soil profile, and the data of Table I have been calculated for the two horizons A_1 (0–8 in.) and A_2 (8–12 in.) for 5 months and are set in Table II (deep-ploughed plots only), to examine seasonal effects.

It is seen from Table II that seasonal variations are apparent in the 1949 as well as in the 1950 season. In 1949 the soil contained a higher percentage of aggregates >0·05 mm. in August; the percentage of these aggregates fell in October and rose again in January at the end of the growing season of the swedes. Similarly, in 1950, the soil contained a higher percentage of aggregates >0·05 mm. in September at the end of the growing season of spring wheat as compared to the percentage in July at the bloom stage. The same trend of results is shown for both horizons A_1 and A_2.

Further, if the two three-monthly early periods of the two crops (swedes and spring wheat) i.e., August, 1949, and July, 1950, respectively, are compared, it is seen that the soil showed a higher percentage of aggregates >0·05 mm. in August, 1949, than in July, 1950. The month of August was drier (1·04-in. rainfall) than July (3·62-in. rainfall). The soil moisture conditions as well as the nature of the crop might have contributed to this kind of difference between the early periods of the two crops in regard to the percentage of aggregates in the soil.

Table I

Effects of cultivation on the size distribution of water-stable aggregates of Harlington soil

Aggregates in % on oven-dry soil—means

SWEDES—1949–50

Size of aggregates (mm.)	Ploughed								Tine cultivated (C)				S.E. of mean	Significance
	Deep (PA)				Shallow (PB)									
	Soil depth—inches													
	0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12		
							August, 1949							
>4·0	5·4	4·3	3·7	2·0	5·7	4·9	2·6	1·2	5·8	4·8	3·2	1·4	0·33	Cultivation insignificant 2, 4, 8 in. > 12 in.** 2, 4 in. > 8 in.**
4·0–2·0	5·5	4·6	3·9	2·5	5·5	4·6	4·3	1·9	5·0	5·1	4·0	1·7	0·26	PA > C* (12 in.) 2, 4, 8 in. > 12 in.** 2 in. > 8 in.**
2·0–1·0	4·8	3·8	3·6	2·9	5·1	3·9	3·9	2·6	3·9	4·0	3·7	1·8	0·25	PA, PB > C* (2, 12 in.) 2, 4, 8 in. > 12 in.** 2 in. > 8 in.**
1·0–0·5	3·6	4·2	3·4	4·4	3·1	3·2	3·0	4·0	3·0	3·6	3·3	2·6	0·18	PA > PB*, C* (2, 4 in.) PA, PB > C* (12 in.) 4, 12 in. > 8 in.*
0·5–0·25	7·0	4·4	4·6	5·5	6·8	3·6	5·6	5·6	6·4	4·0	5·3	5·2	0·27	Cultivation insignificant 2 in. > 4,** 8,** 12 in.** 8, 12 in. > 4 in.**
0·25–0·05	37·7	43·5	44·7	48·6	38·5	44·5	43·9	50·4	39·1	43·8	44·0	50·6	0·66	Cultivation insignificant 12 in. > 2,** 4,** 8 in.** 4, 8 in. > 2 in.**
<0·05	36·0	35·2	36·1	34·1	35·3	35·3	34·7	34·3	36·8	34·7	36·6	36·7	0·88	Cultivation insignificant Depth insignificant
							October, 1949							
>4·0	2·8	3·5	1·8	0·2	2·9	3·4	1·8	0·2	2·7	3·4	1·6	0·3	0·18	Cultivation insignificant 2, 4, 8 in. > 12** in. 4 in. > 2,** 2, 4 > 8** in.
4·0–2·0	2·7	3·6	3·3	1·7	3·1	3·5	3·3	1·3	3·1	3·4	3·6	1·2	0·12	PA > PB,* C* (12 in.) PB, C > PA** (2 in.); 2, 4, 8 in. > 12 in.** 4, 8 in. > 2 in.**
2·0–1·0	2·6	2·6	2·9	1·9	2·7	3·1	2·7	1·8	2·6	2·7	2·9	1·7	0·17	Cultivation insignificant 2, 4, 8 in. > 12** in.
0·1–0·5	2·1	2·9	2·0	2·7	2·1	2·8	2·2	3·1	2·1	2·8	2·1	3·1	0·13	Cultivation insignificant 4, 12 in. > 2,** 8** in.
0·5–0·25	4·3	3·9	4·0	4·0	4·0	3·9	4·5	4·3	3·1	4·0	4·3	4·1	0·28	Cultivation insignificant Depth insignificant
0·25–0·05	44·8	45·0	46·1	48·6	45·9	45·3	46·5	48·7	44·6	44·7	46·2	48·6	1·10	Cultivation insignificant 12 in. > 2,* 4* in.
<0·05	40·7	38·5	39·9	40·9	39·3	38·0	39·0	40·6	41·8	39·0	39·4	40·9	1·13	Cultivation insignificant Depth insignificant
							January, 1950							
>4·0	3·7	2·8	2·8	0·4	3·4	3·9	3·2	0·7	4·2	3·3	2·7	0·9	0·34	Cultivation insignificant 2, 4, 8 in. > 12 in.**
4·0–2·0	3·8	3·8	4·2	2·9	4·4	4·9	5·1	2·6	3·8	4·8	5·0	3·1	0·22	PB, C > PA* (4, 8 in.) 2, 4, 8 in. > 12 in.**
2·0–1·0	3·7	3·4	4·1	2·8	4·4	4·4	4·7	2·8	4·2	5·1	4·8	3·2	0·29	Cultivation insignificant 2, 4, 8 in. > 12 in.**
1·0–0·5	2·5	3·6	2·9	3·2	2·7	3·6	2·6	2·7	2·2	3·7	3·1	2·6	0·25	Cultivation insignificant 4 in. > 2,** 8,** 12** in.
0·5–0·25	4·8	4·6	5·4	4·6	5·2	5·0	4·5	4·2	4·7	4·7	4·7	4·7	0·26	Cultivation insignificant Depth insignificant
0·25–0·05	37·8	38·9	40·4	44·7	37·4	36·4	38·2	44·6	37·2	36·6	39·6	44·6	0·90	Cultivation insignificant. 12 in. > 2,** 4,** 8** in.
<0·05	43·7	42·9	40·2	41·4	42·5	41·8	41·7	42·4	43·7	41·8	40·1	40·9	1·00	Cultivation insignificant 2 in. > 8 in.

* Significant at 5% point
** Significant at 1% point

Table I—*contd.*

SPRING WHEAT—1950

Size of aggregates (mm.)	Ploughed								Tine cultivated (C)				S.E. of mean	Significance
	Deep (PA)				Shallow (PB)									
	Soil depth—inches													
	0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12		
July, 1950														
>4·0	4·2	4·0	1·5	0·4	4·5	3·9	1·6	0·3	4·3	3·0	1·6	0·2	0·19	PA, PB > C* (4 in.) 2 in. > 4 in.** 2, 4, 8 in. > 12 in** 2, 4 in. > 8 in.**
4·0–2·0	3·7	4·1	3·7	1·0	3·5	4·3	3·5	1·1	2·4	3·2	2·6	0·7	0·25	PA, PB > C** (2, 4, 8 in.) 2, 4, 8 in. > 12 in.**
2·0–1·0	3·6	3·9	3·3	1·5	4·0	4·2	3·8	1·8	3·4	3·7	3·6	1·3	0·19	Cultivation insignificant 2, 4, 8 in. > 12 in.**
1·0–0·5	2·4	3·3	3·0	2·5	2·6	3·6	2·8	2·5	2·4	3·2	2·2	2·2	0·24	Cultivation insignificant 4 in. > 2,** 8,** 12 in.**
0·5–0·25	4·9	5·1	4·7	4·2	5·1	5·2	4·6	4·1	4·2	4·1	4·8	3·8	0·27	Cultivation insignificant 2, 4, 8 in. > 12 in.**
0·25–0·05	36·7	37·9	41·8	43·2	36·0	37·7	41·6	43·8	39·7	40·1	42·5	43·8	1·38	Cultivation insignificant 12, 8 in. > 2,** 4 in.**
<0·05	44·5	41·7	42·0	47·2	44·3	41·1	42·1	46·4	43·6	42·7	42·7	48·0	1·07	Cultivation insignificant 12 in. > 4 in,** 8 in.**
September, 1950														
>4·0	3·5	3·2	2·4	1·1	3·2	2·8	2·6	0·7	3·7	2·2	2·4	0·8	0·33	Cultivation insignificant 2 in. > 8 in.* 2, 4, 8 in. > 12 in.**
4·0–2·0	2·8	2·8	2·9	1·5	3·0	2·7	3·2	1·7	3·3	2·0	2·8	1·6	0·32	Cultivation insignificant 2, 4, 8 in. > 12 in.**
2·0–1·0	5·0	5·2	4·2	2·8	5·3	5·2	4·5	2·7	4·9	4·2	4·4	2·6	0·45	Cultivation insignificant 2, 4, 8 in. > 12 in.**
1·0–0·5	3·3	2·9	4·7	5·0	3·1	2·8	5·2	4·9	2·8	3·3	5·3	4·4	0·33	Cultivation insignificant 8 in. > 2,** 4 in.**
0·5–0·25	6·0	5·4	4·4	5·9	5·4	5·4	4·7	4·8	5·7	6·0	4·9	5·4	0·66	Cultivation insignificant Depth insignificant
0·25–0·05	40·1	39·4	43·3	45·1	42·2	41·8	40·9	45·2	41·3	42·0	42·4	44·8	1·15	Cultivation insignificant 12 in. > 2,** 4 in.**
<0·05	39·4	41·1	38·8	38·6	37·9	40·3	38·9	40·1	38·7	40·3	39·9	40·5	0·94	Cultivation insignificant Depth insignificant

	0–2-in. layer	2–4-in. layer	4–8-in. layer	8–12-in. layer		
<0·05 (after dispersion)	58·2	58·5	57·3	62·7	0·45	Cultivation insignificant 12 in. > 2,* 4,* 8 in.*
Carbon†	1·90	1·76	1·67	1·46	0·033	2, 4, 8 in. > 12 in.* 2 in. > 4,* 8 in.*
Fine sand and silt	73·08	72·46	72·56	72·0	1·44	Depth insignificant
Clay %	12·13	12·32	12·94	15·57	0·244	12 in. > 2,*, 4,* 8 in.*

* Significant at 5% point
** Significant at 1% point
† Carbon content was determined by the semi-micro method of McCready & Hassid[6]

Table II

The influence of season on the size distribution of water-stable aggregates in Harlington soil in 1949–50 and 1950

Aggregates in % on oven-dry soil—means

Size of aggregates (mm.)	Horizon A_1 (0–8-in. layer)					Horizon A_2 (8–12-in. layer)				
	Aug. 1949	Oct. 1949	Jan. 1950	July 1950	Sept. 1950	Aug. 1949	Oct. 1949	Jan. 1950	July 1950	Sept. 1950
>4·0	4·5	2·7	3·1	3·2	3·0	2·0	0·2	0·4	0·4	1·1
4·0–2·0	4·7	3·2	3·9	3·8	2·8	2·5	1·7	2·9	1·0	1·5
2·0–1·0	4·1	2·7	3·7	3·6	4·8	2·9	1·9	2·8	1·5	2·8
1·0–0·5	3·7	2·3	3·0	2·9	3·6	4·4	2·7	3·2	2·5	5·0
0·5–0·25	5·3	4·1	4·9	4·9	5·3	5·5	4·0	4·6	4·2	5·9
0·25–0·05	42·0	45·3	39·0	38·8	40·9	48·6	48·6	44·7	43·2	45·1
<0·05	35·7	39·7	42·4	42·8	39·6	34·1	40·9	41·4	47·2	38·6

Disruption and stability of aggregates during the growing season of the crop

Disruption of aggregates during the growing season of the crop has been measured by the differences in the amounts of the different-sized aggregates each month from those in August, 1949. August was chosen as a basis for comparison because it was a relatively dry period and very little rain fell between the preparation of land for the seed-bed and the date of sampling for August, i.e., from June to middle of August, 1949. The crop was not hoed until the middle of August. Hence August values were least affected by the disruptive agencies such as rainfall and inter-cultivation of the crop. Such comparisons have been made in Table III (*a*) and (*b*) for October, January, July and September.

A general survey of the data of Table III (*a*) shows negative and positive differences for all sizes of aggregates. In the case of aggregates >4·0 mm. and (except in January) those 4·0–2·0 mm., all differences are negative. Thus the larger aggregates (>4·0 mm. and 4·0–2·0 mm.) show greater breakdown than do those of other sizes in all the four months and at all the four depths with deep- and shallow-ploughings and tine-cultivation respectively. Next to these in order of instability are 1–0·5 mm., then 0·5–0·25 and 2·0–1·0 mm. and lastly 0·25–0·05 mm.

A greater disruption of aggregates is shown in the 0–2-in. and 8–12-in. layers than in the 2–4- and 4–8-in. layers under all the three cultivation treatments. Disruption of aggregates is greater in the 8–12-in. layers with ploughing than with tine-cultivation. If the total losses of aggregates, derived from the algebraic sum of minus and plus differences of aggregates of each size, are compared with the gains in the <0·05 mm. particles, the totals balance [e.g., in Table III (*a*) total minus (−) difference for aggregates >4·0 to 0·5–0·25 mm. is −11·8, and plus (+) differences for aggregates 0·25–0·05 mm. is +7·1. Then the balance is −4·7, equivalent to +4·8 for <0·05 mm. Similarly for other differences]. Thus the gains in smaller aggregates are not due to further aggregation of the soil, but to disruption of larger aggregates. Two types of disruption, ' complete ' and ' intermediary stage ',* are of great significance in soil structure relationships. Intermediary disruption may not reduce the aggregates to such small units so as to block the larger pores, whereas in ' complete ' disruption larger pores are always blocked. Samples for the four months can be distinguished on this basis. Disruption of aggregates was more of an ' intermediary stage ' type in September and October, but more of a ' complete ' type in July and January. A study was made of the compactness and porosity of this soil and the results will be reported in a later paper. One result may be anticipated here, viz., the soil was more compact in January, 1950, than in October, 1949.

The absolute figures of Table III (*a*) have also been converted into % of the August values, so as to give a comparative basis and a statistical interpretation to the results in regard to the stability of aggregates of each size. The significance of the results is given in Table III (*b*). Increases in the amounts of smaller aggregates due to disruption of larger aggregates, as shown in Table III (*a*), must be eliminated if the stability of aggregates of each size is to be estimated. This has been done by assuming the disruption of the aggregates to be nil where increases are shown in Table III (*a*).

It is seen that the component ' soil depth ' of the analysis of variance is significant, but the

* ' Complete ' = breakdown of aggregates to primary particles. ' Intermediary ' = breakdown of aggregates into smaller ones.

Table III

Effects of cultivation on disruption of aggregates and leaching of finer material from the soil at Harlington during 1949–50 and 1950–51

(*a*) *Differences from the values of aggregates* in August (as % of oven-dry soil)*

Size of aggregates (mm.)	Month	Ploughed								Tine cultivated (C)			
		Deep (PA)				Shallow (PB)							
		0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12
>4·0	Oct. 49	−2·6	−0·8	−1·9	−1·8	−2·8	−1·5	−1·8	−1·0	−3·1	−1·4	−1·6	−1·1
	Jan. 50	−1·7	−1·5	−0·9	−1·6	−2·3	−1·0	−0·4	−0·5	−1·6	−1·5	−0·5	−0·5
	Jul. 50	−1·2	−0·3	−2·2	−1·6	−1·2	−1·0	−2·0	−0·9	−1·5	−1·8	−1·6	−1·2
	Sept. 50	−1·9	−1·1	−1·3	−0·9	−2·5	−2·1	−1·0	−0·5	−2·1	−2·6	−0·8	−0·6
4·0–2·0	Oct. 49	−2·8	−1·0	−0·6	−0·8	−2·4	−1·1	−1·0	−0·6	−1·9	−1·7	−0·4	−0·5
	Jan. 50	−1·7	−0·8	+0·3	+0·4	−1·1	+0·3	+0·8	+0·7	−1·2	−0·3	+1·0	+1·4
	Jul. 50	−1·8	−0·5	−0·1	−1·5	−2·0	−0·3	−0·8	−0·8	−2·6	−1·9	−1·4	−1·0
	Sept. 50	−2·7	−1·8	−1·0	−1·0	−2·5	−1·9	−1·1	−0·2	−1·7	−3·1	−1·2	−0·1
2·0–1·0	Oct. 49	−2·2	−1·2	−0·7	−1·0	−2·4	−0·8	−1·2	−0·8	−1·3	−1·3	−0·8	−0·1
	Jan. 50	−1·1	−0·4	+0·5	−0·1	−0·7	+0·5	+0·8	+0·2	+0·3	+1·1	+1·1	+1·4
	Jul. 50	−1·2	+0·1	−0·3	−1·4	−1·1	+0·3	−0·1	−0·8	−0·5	−0·3	−0·1	−0·5
	Sept. 50	+0·2	+1·4	+0·6	−0·1	+0·2	+1·3	+0·6	+0·1	+1·0	+0·2	+0·7	+0·8
1·0–0·5	Oct. 49	−1·5	−1·3	−1·4	−1·7	−1·0	−0·4	−0·8	−0·9	−0·9	−0·8	−1·2	+0·5
	Jan. 50	−1·1	−0·6	−0·5	−1·2	−0·4	+0·4	−0·4	−1·3	−0·8	+0·1	−0·2	−0·0
	Jul. 50	−1·2	−0·9	−0·4	−1·9	−0·5	+0·4	−0·2	−1·5	−0·6	−0·4	−1·1	−0·4
	Sept. 50	−0·3	−1·3	+1·3	+0·6	−0·0	−0·4	+2·2	+0·9	−0·2	−0·3	+2·0	+1·8
0·5–0·25	Oct. 49	−2·7	−0·5	−0·6	−1·5	−2·8	+0·3	−1·1	−1·3	−3·3	−0·0	−1·0	−1·1
	Jan. 50	−2·2	+0·2	+0·8	−0·9	−1·6	+1·4	−1·1	−1·4	−1·7	+0·7	−0·6	−0·5
	Jul. 50	−2·1	+0·7	+0·1	−1·3	−1·7	+1·6	−1·0	−1·5	−2·2	+0·1	−0·5	−1·4
	Sept. 50	−1·0	+1·0	−0·2	+0·4	−1·4	+1·8	−0·9	−0·8	−0·7	+2·0	−0·4	+0·4
0·25–0·05	Oct. 49	+7·1	+1·5	+1·4	+0·0	+7·4	+0·8	+2·6	−1·7	+5·5	+0·4	+2·2	−2·0
	Jan. 50	+0·1	−4·6	−4·3	−3·9	−1·1	−8·1	−5·7	−5·8	−1·9	−7·2	−4·4	−6·0
	Jul. 50	−1·0	−5·6	−2·9	−5·4	−2·5	−6·8	−2·3	−6·5	+0·6	−3·7	−1·5	−6·8
	Sept. 50	+2·4	−4·1	−1·4	−3·5	+3·7	−2·7	−3·0	−5·2	+2·2	−1·8	−1·6	−5·8
<0·05	Oct. 49	+4·8	+3·2	+3·9	+6·8	+4·1	+2·6	+3·3	+6·3	+5·3	+4·9	+2·8	+4·5
	Jan. 50	+7·8	+7·7	+3·9	+7·4	+7·3	+6·4	+6·0	+7·9	+7·1	+7·3	+3·5	+4·3
	Jul. 50	+8·6	+6·3	+5·8	+13·1	+9·0	+5·6	+6·3	+12·0	+7·1	+8·1	+6·3	+11·5
	Sept. 50	+3·3	+5·7	+2·5	+4·5	+2·5	+4·8	+3·1	+5·7	+2·0	+5·6	+3·3	+3·8

* Data of Table I are used in these calculations

(*b*) *Significance of the data, calculated as % of August values (disruption of aggregates)*

Cultivation—insignificant. (C)

Depth**—2, 12 in. > 4,** 8** in. (D)

Aggregate size (A) >4·0 mm. > 2·0,* 1·0,* 0·5,* 0·25,* 0·05* mm.; Season*—Oct., July > Jan.,* Sept.* (S)

2·0 mm. > 1·0, 0·05 mm.

C × D; C × A; C × S; C × A × D × S—insignificant.

* Significant at 5% point
** Significant at 1% point

interaction between cultivation and depth is insignificant, showing that differences between soil depths with respect to disruption of aggregates were not affected by cultivation as was indicated by the general survey of the results. In general, aggregates broke down more at 2- and 12-in. depths than at 4- and 8-in. depths. Probably the more disruptive force of the impacts of raindrops on the surface particles than on the sub-surface particles broke down aggregates at 2-in. depth to a greater extent than it did at lower depths. Stability of aggregates itself and other factors must be responsible for the differences between the 12-in. and the upper depths. Aggregates of sizes 4·0–2·0 mm. and >4·0 mm. were disrupted to a greater extent than were smaller aggregates. Those >4·0 mm. broke down more than those 4·0–2·0 mm. No significant differences in % disruption existed between any groups of smaller aggregates. The order of stability of aggregates was:

0·25–0·05 mm.
0·5 –0·25 mm.
2·0 –1·0 mm. } > 1·0–0·5 mm. > 4·0–2·0 mm. ⩾ 4·0 mm.

This is in agreement with the results of the principal data of Table V and with previous findings of Singh[13a] on this soil. The two smaller aggregate sizes, 0·25–0·05 mm. and 0·5–0·25 mm., were not included in his earlier work, but as seen from Table V they show no greater stability than do the aggregates of 2·0–1·0 mm. diam.

Seasonal variations are also apparent. Significant differences existed between the four months in regard to the breakdown of aggregates. On the basis of total breakdown of aggregates (complete and intermediary), aggregates broke down to a greater extent in October, 1949, and July, 1950, than in January and September, 1950. No significant differences existed between October and July or between January and September. On the other hand, if only complete breakdown of aggregates is considered, i.e., increase in the proportion of particles <0·05 mm., aggregates broke down to a greater extent in July and January than in October and September (see Tables III *a* and IV).

Henin & Turc[14] reported that under continental conditions soil structural stability decreased in autumn and winter and increased in spring, owing probably to an increase in microbiological activity followed by period of desiccation.

In the present investigations the method of cultivation had no effect on the disruption of aggregates nor on their stability. All the components of interactions in the analysis of variance with cultivation are insignificant.

Leaching of finer material from the soil

Schefer[15] in reviewing the German work on this problem states that under German climatic conditions much leaching of colloid particles and nutrients occurs and that phosphate is removed with colloid particles. In some soils the formation of a plough sole is brought about by repeated ploughing to the same depth and also by the leaching of finer material from the surface and sub-surface layers to lower depths.

The balancing of the losses of aggregates and the gains of the particles <0·05 mm. for each soil depth as shown in Table III (*a*) has lent support to the view that finer material did not leach from the upper to lower depths. The data for the particles <0·05 mm. in the sample is examined further in Table IV to throw light on this point. It is seen that the only significant component in the analysis of variance is season; soil depth and interactions are insignificant. Thus, seasonal variations existed in the amount of particles <0·05 mm. present in the soil. However, this amount is the same at all the four depths of sampling at any one time. No experimental evidence was obtained of the leaching of finer material from the upper to the lower layers of soil.

Table IV

Effects of cultivation, soil depth and season on the finer material (<0·05 *mm.*) *of Harlington soil in* 1949 *and* 1950

Percentage of finer material <0·05 mm.

Month		Ploughed								Tine cultivated (C)			
		Deep (PA)				Shallow (PB)							
		Soil depth—inches											
		0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12
Aug.	1949	36·1	35·4	36·3	34·1	35·4	35·5	35·8	34·4	36·7	34·7	36·6	36·7
Oct.	1949	40·9	38·6	40·2	40·9	39·5	38·1	39·1	40·7	42·0	39·6	39·4	41·2
Jan.	1950	43·9	43·1	40·2	41·5	42·7	41·9	41·8	42·3	43·8	42·0	40·1	41·0
July	1950	44·7	41·7	42·1	47·2	44·4	41·1	42·1	46·4	43·8	42·8	42·9	48·2
Sept.	1950	39·4	41·1	38·8	38·6	37·9	40·3	38·9	40·1	38·7	40·3	39·9	40·5
S.E. of a mean		± 1·19											

Significance:
Cultivation (Clt)—insignificant; Season**—Oct., Jan., Sept., July > Aug.**
Depth (D) — ,, (SS) Jan., July > Sept.,** Oct.**

Clt × D; Clt × SS; Clt × D × SS—insignificant

** Significant at 1% point

The pattern of the seasonal variation in the amounts of particles <0·05 mm. is that the proportion was least in August and greater in January and July than in September or October.

No significant differences existed between January and July or between September and October. It would appear that January and July are the periods in which aggregates disrupted more extensively.

B. *Degree of aggregation of soil*

From the results shown in Table V, it is seen that the degree of aggregation was greater in the subsoil layer (8–12 in. depth) than in the surface layer (0–2 in. depth). No significant differences existed between the sub-surface soil (2–4 and 4–8 in. depth) and the subsoil (8–12 in. depth). The higher percentage of clay in the subsoil than in the sub-surface or surface layers might have caused a greater aggregation of soil in the former than in the two latter layers. Baver[13] found a high correlation between the amount of clay present in the soil and the percentage of finer particles <0·05 mm. present in the form of aggregates >0·05 mm.

Table V

Effects of cultivation, soil depth and season on the degree of aggregation of soil

Percentage of primary particles <0·05 mm. in aggregates > 0·05 mm.

Month		Ploughed								Tine cultivated (C)			
		Deep (PA)				Shallow (PB)							
		Soil depth—inches											
		0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12	0–2	2–4	4–8	8–12
Aug.	1949	38·0	39·6	36·6	45·6	39·2	39·3	37·6	45·2	37·0	40·7	36·1	41·4
Oct.	1949	29·7	34·0	29·9	34·7	32·2	34·8	32·0	35·1	27·9	32·3	31·2	34·4
Jan.	1950	24·7	26·4	29·8	33·8	26·6	28·3	27·0	32·5	24·8	28·3	30·0	34·6
July	1950	23·3	28·8	26·5	24·8	23·8	29·7	26·5	26·0	24·8	26·9	25·2	23·2
Sept.	1950	32·3	29·7	32·4	38·3	35·0	31·1	32·1	36·1	36·0	31·1	30·4	35·4

S.E. of a mean ± 1·70

Significance :
Cultivation (Clt)—insignificant ; Season**—Aug. > Oct.,** Jan.,** July,** Sept.**
Depth (D)** —12 in. > 2* in. (SS) Sept., Oct. > July,* Jan.*

Clt × D ; Clt × SS—insignificant ; Clt × D × SS*—PA, PB > C* (Aug., 12 in.)
PB > C* (Oct., 2 in.)

* Significant at 5% point
** Significant at 1% point

Only in one instance had cultivation affected the degree of aggregation, i.e., at 12-in. depth and in August, 1949, sample ; in this a higher percentage of particles <0·05 mm. was present in the form of aggregates in the deep- and shallow-ploughed plots than in the tine-cultivated plots.

Seasonal variations in the aggregation and moisture content of soil

It is seen from Table VI that of the five observations the degree of aggregation was minimum in January and July and at its maximum in August. It is further seen that a close negative relationship existed between the moisture content of soil and the percentage of aggregates >0·05 mm., the correlation coefficient being −0·6884 (0·5487, significant at 1% point). A lower moisture content was associated with a higher percentage of aggregates >0·05 mm. and *vice versa*.

The percentage of aggregates >0·05 mm. and the degree of aggregation were closely associated with each other as shown by a high correlation coefficient of +0·7799 (0·6614, significant at 1% point) and a significant regression. Hence the moisture content affected the percentage and degree of aggregation. A higher aggregation followed a lower moisture content and *vice versa*. Gish & Browning[16] reported that on a silt loam aggregation was greater at lower and less at higher moisture contents.

Table VI

Influence of soil moisture, rainfall and crop on the % of aggregates >0·05 mm. and the degree of aggregation

(% of primary particles <0·05 mm. in aggregate form)†

Period	Crop	% of aggregates >0·05 mm.	% of primary particles <0·05 mm. in aggregate form	Moisture content of soil at the end of the period (in % of oven-dry soil)	Rainfall during the period (in inches)
June to mid-Aug. 1949	Swedes	64·6	40·0	8·8	2·84
mid-Aug. to Oct. 1949	Swedes	59·9	32·1	13·7	2·34
Nov. 1949 to Jan. 1950	Swedes	57·9	28·7	19·0	7·94
April to mid-July 1950	Spring wheat	56·1	25·8	14·0	8·24
mid-July to Sept. 1950	Spring wheat	60·7	33·2	15·5	5·01

Correlation coefficient of % of aggregates and moisture content — 0·6884**
Correlation coefficient between % of aggregates >0·05 mm. and % of primary particles in aggregates + 0·7799**

** Significant at 1% point
† Data from ploughed plots and average for 0–2-, 2–4-, 4–8-, 8–12-in. depths

As soil moisture is associated with rainfall, the two together or each one separately affected the proportion of aggregates and degree of aggregation during the two years. The effects of the crop on aggregation cannot be distinguished from those of soil moisture and rainfall.

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ROLE OF pH IN THE CANNING OF JACK FRUIT (*ARTOCARPUS INTEGRIFOLIA*): EFFECT OF ADDING ACID OR OTHER FRUITS TO THE CANNED PRODUCT

By B. S. BHATIA, G. S. SIDDAPPA and GIRDHARI LAL

In the canning of jack fruit, pH plays an important part. Addition of 0·75 to 1% citric acid to the canning syrup has been found necessary for safe processing in boiling water. Canning of jack fruit in combination with more acidic fruits like *Bangalora* mango and pineapple achieves the same purpose and provides acceptable products.

Introduction

Fruits generally have a pH below 4·5 and can, therefore, be easily processed in boiling water, but higher temperatures must be used when the pH is higher, as is the case with most vegetables and some fruits. Jack fruit has a high pH value of 5·0–5·8 and has, therefore, to be processed under pressure unless the pH of the canned product is brought below 4·5 by adding acid or by canning it in combination with more acidic fruits like mangoes, pineapples and oranges. Processing under pressure is not always desirable because the texture and flavour of the fruit are adversely affected by higher processing temperatures.[1] In the case of jack fruit, processing at 10 pounds steam pressure for about 30 minutes makes the product very soft and imparts a cooked taste and flavour. It is, therefore, necessary to add extra acid in some form or other to lower the pH adequately so that the canned product can be processed in boiling water.

Adam has reported a pH of 4·3–4·8 in a few cans of jack fruit examined by him,[2] but the conditions of canning are not known. In the present investigation a study was made of the changes in pH as a result of different treatments.

Experimental and results

Materials and methods

The jack fruit was obtained from the local Mysore market, and the bulbs were prepared for canning as described in a previous paper.[3] Total titratable acidity was estimated by titrating a known weight of sample with standard NaOH. The pH was determined with a Beckman pH meter using the glass electrode.

Change in pH by the addition of different quantities of citric acid to jack fruit pulp

To 25 g. of the pulp in 50-ml. beakers different amounts of 1% (w/v) citric acid solution were added and mixed thoroughly. The pH of the resulting mixtures are given in Table I.

Table I

Change in pH with increase of citric acid content of jack fruit pulp

Series no.	Citric acid solution (1%) added ml.	Added citric acid in mixture (calculated) %	pH of the mixture
1	0·0	0·00	5·15
2	2·5	0·09	4·95
3	5·0	0·17	4·80
4	7·5	0·20	4·65
5	10·0	0·31	4·55
6	12·5	0·33	4·45
7	15·0	0·38	4·40
8	17·5	0·41	4·30
9	20·0	0·44	4·25
10	22·5	0·47	4·10
11	25·0	0·50	4·05
12	27·5	0·52	4·00
13	30·0	0·55	3·95
14	32·5	0·57	3·95
15	35·0	0·58	3·90

In the canned product, the covering sugar syrup added is about one-third of the contents. In order to have a similar medium to that found in a can, the above experiment was repeated using pulp and 50° Brix sugar syrup in the ratio of 2 : 1. The results are given in Table II.

Table II

Change in pH with increase of citric acid content of jack fruit pulp and 50° Brix syrup (2 : 1)

Series no.	*Citric acid added (ml. of 5% solution)	Added citric acid in mixture (calculated) %	pH of the mixture
1	0·0	0·00	5·60
2	1·0	0·16	4·75
3	2·0	0·31	4·45
4	3·0	0·46	4·25
5	4·0	0·59	4·20
6	5·0	0·71	3·90
7	7·5	1·00	3·55
8	10·0	1·25	3·40

* Citric acid was added to 20 g. of pulp + 10 g. of 50° Brix sugar syrup.

These experiments gave an idea of the amount of acid to be added to canned jack fruit. In order to confirm these results further, actual canning trials on similar lines were carried out using 35° and 50° Brix syrups. Using jam size (301 × 309) plain cans, 227 g. of fruit and 128 g. of hot syrup, different amounts of citric acid were added as 20% solution (w/v). The cans were exhausted in boiling water until the centre of the can reached 175° F, and then sealed and processed in boiling water for 30 minutes followed by immediate cooling in running cold water. They were stored at room temperature (24–30°) and opened after 9 and 25 months of storage and examined for pH and acidity. The results are given in Table III.

It is evident from Tables I, II and III that for obtaining a pH below 4·5 the amount of citric acid to be added to the contents of the can should be 0·25 to 0·33%. Since the ratio of fruit to syrup in a can is about 2 : 1, the acidity of syrup used should be 0·75–1·0%. Although the addition of a still higher percentage of acid may be desirable from the point of view of safe canning, there is a limit to this as the final product may not be acceptable on account of the high acidity.

Over a period of three years, a large number of cans were prepared using covering syrup with acid content varying from 0·15 to 1% and the pH of cut-out syrups were recorded during storage. The following general conclusions were drawn :

(1) Addition of 0·15% citric acid to syrup is not safe for ordinary processing (pH 4·80–4·95) ;
(2) 0·5% acidity in syrup is better but still not safe for general use (pH 4·50–4·65) ;
(3) 0·75% or 1% acid in syrup is safe for processing in boiling water (pH 4·15–4·45) ;
(4) in order that the product may not taste acid, the strength of sugar syrup used should be 40–50° Brix.

Canning of jack fruit in combination with other fruits

Jack fruit was canned in combination with mangoes, pineapples, oranges and bananas with a view to obtain better flavour blends and to lower the final pH of the pack by introducing more acidic fruits. This principle has been adopted by Graham[4] and Cruess & Chong[5] for the canning of vegetable juices. Table IV summarizes the combinations packed and pH of the cut-out syrup during storage.

It will be seen that jack fruit (pH 5·0–5·8) can be combined with acidic fruits like *Bangalora* mango (pH 3·1) without the addition of extra acid. Further, the amount of acid to be added will depend on the ratio in which jack fruit is mixed with other fruits and also on the acidity of the fruit with which it is blended. When jack fruit forms more than 50% of the combined fruit packed, it will be necessary to add extra acid. Similarly when combining jack fruit with banana, which is low in acidity, addition of acid becomes necessary.

Table III

Changes in acidity and pH of canned jack fruit containing different amounts of added citric acid after storage for 9 and 25 months at room temperature (24–30°)

Series no.	Added citric acid in contents %	Canned in 50° Brix sugar syrup: Total titratable acidity † After 9 months' storage	Total titratable acidity † After 25 months' storage	pH After 9 months' storage	pH After 25 months' storage	Taste
1	0·00	0·40*	—*	3·95*	—*	—
2	0·03	0·12*	0·18*	5·12	4·82	Sweetish
3	0·06	0·17	0·20	4·85	4·75	Good
4	0·11	0·19	0·24	4·75	4·62	Good
5	0·17	0·25	0·29	4·50	4·50	Good
6	0·22	0·30	0·32	4·40	4·35	Good
7	0·28	0·33	0·35	4·25	4·25	Very slightly acidic
8	0·33	0·38	0·38	4·18	4·20	Very slightly acidic
9	0·39	—	—	—	—	—

Series no.	Added citric acid in contents %	Canned in 35° Brix sugar syrup: Total titratable acidity † After 9 months' storage	Total titratable acidity † After 25 months' storage	pH After 9 months' storage	pH After 25 months' storage	Taste
1	0·00	0·13	0·20	5·00	4·95	Sweetish
2	0·03	0·18	0·21	4·92	4·85	Good
3	0·06	0·21	0·24	4·75	4·75	Good
4	0·11	0·29	0·28	4·56	4·60	Good
5	0·17	0·30	—	4·56	—	Good
6	0·22	0·37	0·33	4·45	4·42	Good
7	0·28	0·40	0·38	4·35	4·35	Slightly acidic
8	0·33	0·46	0·42	4·23	4·25	Slightly acidic
9	0·39	0·50	0·49	4·15	4·18	Acidic

* Can showing pressure
† Expressed as anhydrous citric acid

Table IV

pH of jack fruit canned in combination with other fruits

Combination packed	°Brix of canning syrup	Citric acid added to syrup %	pH of the cut-out syrup	Remarks
Jack fruit	50	0·5	4·55	Control
Jack + pineapple (2 : 1)	50	0·0	4·52–4·62	Good blend as to colour and flavour
,, ,,	50	0·5	4·10–4·22	,,
,, ,, (1 : 1)	40	0·15	4·02–4·05	,,
Jack + *Bangalora* mango (1 : 3)	50	0·0	4·02	,,
Jack + *Bangalora* mango + pineapple (1 : 3 : 1)	50	0·0	4·0	,,
Jack + *Raspuri* mango (2 : 1)	50	0·5	4·42	Good blend, jack fruit flavour predominant
,, (1 : 1)	35	0·15	4·12	Good blend, mild flavour of both fruits
,, (2 : 1)	35	0·0	4·71	Good blend, jack fruit flavour predominant
Jack + *Nanjangud* banana (3 : 1)	50	0·5	4·58	Good blend: banana and jack fruit have their characteristic flavour
Jack + Salem banana (1 : 1)	40	0·15	4·32	Banana slightly acidic to taste

Conclusions

As a result of systematic study, it has been shown that addition of 0·75 to 1% citric acid to the canning syrup is necessary to bring the pH of the canned jack fruit below 4·5, thus making it safe for processing in boiling water for 30 minutes. This object can also be achieved by canning the fruit in combination with more acidic fruits like *Bangalora* mango, *Raspuri* mango and pineapple.

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THE COLOUR OF COOKED CURED PORK. I.—Estimation of the Nitric oxide–Haem Pigments

By H. C. HORNSEY

A simple and rapid method is described for extracting and measuring the nitric oxide–haem pigments present in cooked cured meat.

Selective extraction as a nitric oxide–haem–acetone complex is achieved by the use of an acetone/water solvent. Other meat pigments are not extracted under the conditions used.

The acetone/water ratio is shown to be critical, maximum extraction being obtained with a ratio of 4 : 1, due allowance being made for the moisture present in the meat. After filtration, the optical density is measured spectrophotometrically.

With the inclusion of hydrochloric acid in the solvent, the method can be adapted to measure the *total* pigments present.

Introduction

The concentration and the stability of the cured meat pigments nitroso-myoglobin and nitroso-haemoglobin are of great importance to all concerned with cured meat products, and particularly is this so in the case of cooked cured pork products.

Generally, the assessment of the depth and stability of colour is determined visually, and comparisons made at the same time by an expert can provide useful information. However, in order to determine the factors affecting the cause and rapidity of fading, an objective measurement became necessary. The rate of fading of cooked meat pigments can only be studied if a fairly rapid estimation is used, in which no further oxidative changes take place during the determination.

Anderton & Locke[1] have recently published a note on the extraction of these pigments by first wetting the meat with acetone, and then extracting with ether. In these laboratories, a method of extracting the pigment by means of 75% acetone in water has been in use for several years, chiefly to assess the degree of conversion of fresh meat pigments to those of the cured meat. This method is simple and reasonably accurate, and its use has been adopted for the study of the distribution and fading of colour in cooked gammons which will form the subject of subsequent papers.

Experimental

Extraction of colour

During the routine examination of imported cooked meat products for the presence of synthetic colouring materials, interference was frequently found when the natural nitric-oxide pigments were present. These colours appeared to be extracted when acetone was used as a solvent, and also to some extent when alcohol was used. This observation led to a closer examination of the possibility of using acetone for estimating the amounts of cured meat pigments present.

When the minced lean portion of cooked cured meat was triturated with acetone, it was found that some extraction of colour was achieved. This did not appear to be complete, however, and some colour still remained in the tissues. Further, the degree of extraction did not appear to be constant, as variable results were obtained when different ratios of acetone to meat were used. Exhaustive extraction was tried, and was also found to give incomplete and variable results. It appeared, however, when smaller amounts of acetone were used, that less residual colour was left in the tissues. Lean meat contains 65–70% of water, and it was therefore thought that this effect was due to different acetone/water ratios. This point was therefore investigated, due allowance being made for the moisture present in the sample.

Experiment I.—Minced lean meat was first mixed to a smooth paste with approximately 10 ml. of the solvent. The remainder of the solvent was then added, and after 5 minutes, with intermittent mixing, and then filtering, the intensities of the colours of the resulting solutions were measured in a 1-cm. cell at a wavelength of 540 mμ using a Unicam S.P. 600 spectrophotometer. The results are shown in Table I and graphically in Fig. 1.

Table I

Optical densities of extracts from lean meat using different concentrations of acetone

Lean meat		Solvent		Acetone concentration, %	Optical density
Wt., g.	Water present, ml.	Acetone, ml.	Water, ml.		
5	3·5	96·5	0	96·5	(× 4) 0·324
5	3·5	46·5	0	93	(× 2) 0·330
10	7	43	0	86	0·360
10	7	40	3	80	0·370
10	7	37·5	5·5	75	0·360
10	7	35	8	70	0·308
10	7	32·5	10·5	65	0·270
10	7	30	13	60	0·225

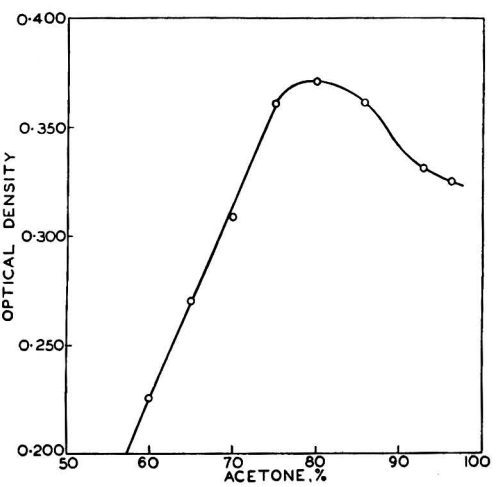

FIG. 1.—*The effect of varying the strength of an aqueous acetone solution, on the extraction of colour from cooked cured pork gammon*

From these results (Table I, Fig. 1) it can be seen that there is a fairly critical acetone/water ratio for maximum extraction of the colour, i.e., between 75 and 85% acetone. Exhaustive extraction with this strength of acetone gave a colour-free residue with those lean meats which showed complete conversion of pigment, i.e., which did not contain any denatured haemoglobin/myoglobin which was uncombined.

Experiment II.—To confirm that only the nitroso derivative of the blood and muscle pigments was being extracted, and that the other forms of the pigments, viz., reduced haemoglobin, oxyhaemoglobin, and methaemoglobin, were not contributing some colour also. Solutions of these were obtained in the following manner.

Equal aliquot parts of a haemolysed blood solution were treated with sodium hydrosulphite, air, ferricyanide, and hydrosulphite with sodium nitrite, respectively, and half of each were denatured by boiling for 1 min. All were then diluted to 50 ml. with acetone and water to give a final concentration of 80% acetone. After filtering, the optical densities were measured at 540 mμ in a 1-cm. cell.

Table II shows that little or no interference occurred with these pigments. Methaemoglobin gave a trace of haematin in solution, but the optical density at 540 mμ was <2% of that of the nitrosohaemochrome.

Table II

Optical densities of extracts of blood pigments

Pigment	Optical density of acetone extract
Reduced haemoglobin	0·003
,, ,, (denatured)	0·005
Oxyhaemoglobin	0·003
,, (denatured)	0·005
Methaemoglobin	0·010
,, (denatured)	0·010
Nitroso-haemoglobin	0·302
,, (denatured)	0·600

Experiment III.—Comparison of this method of extraction by 80% acetone with the procedure outlined by Anderson & Locke,[1] who do not recommend any specific amounts of acetone and ether, gave the results shown in Table III.

Table III

Optical densities of extracts of 10 g. of lean meat containing 7 ml. water prepared with acetone and with acetone + ether

Lean meat	Solvent	Acetone : total water ratio	Optical density at 540 mμ in 1-cm. cell
	40 ml. acetone + 3 ml. water	4 : 1	0·360
	8 ml. acetone + 35 ml. ether	1·14 : 1	0·215
	14 ml. acetone + 35 ml. ether	2 : 1	(× 1·12) = 0·291
	28 ml. acetone + 35 ml. ether	4 : 1	(× 1·4) = 0·350

The above values, which are corrected for the extra dilution introduced by the ether, show that this procedure gives variable and lower extraction unless the ratio of acetone used to the water present (in the meat) reaches 4 : 1, i.e., the same critical value which was found necessary in the absence of the ether. The other ratios give values which lie on the same curve as in Fig. 1. This suggests that the ether is only acting as a diluent and does not affect the extractions.

Stability and nature of extracted colour

The bright red acetone extracts were stable for at least an hour, then gradually faded to a yellow-brown colour. This process was accelerated in very strong light, and in the presence of air, but was never rapid enough (when using cooked meats) to cause interference with the determination. Ample time, therefore, is available for making the measurements, before any fading commences.

The typical wavelength/absorption curve for the extracted colour before fading is shown in Fig. 2 together with that of the same extract after standing 24 hours in the laboratory under normal lighting conditions.

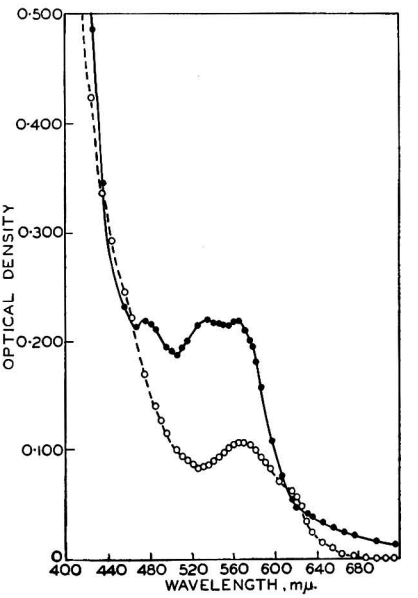

FIG. 2.—*Optical densities of*

●—●—●—● (*a*) *An extract of cooked cured pork gammon (nitroso-haem–acetone complex) with 80% acetone (on acetone + total water present)*

o--o--o--o (*b*) *The same extract after standing for 24 hours under normal lighting conditions in the laboratory*

The curve for the extracted pigment showed absorption maxima at 476, 535 and 563 mμ. This is somewhat similar to the curve of aqueous nitroso-haemoglobin but has the double peaks rather flattened and at slightly shorter wavelengths, with an additional peak at 476 mμ. The minimum at approximately 500 mμ tends to be flattened and moved slightly to longer wavelengths by this additional peak of the acetone complex.

A similar curve to that of the 80% acetone extract was obtained when haematin was reduced with sodium hydrosulphite, a trace of sodium nitrite added, and diluted with four parts of acetone.

The curve in Fig. 2 of the yellow-brown pigment left in solution after exposure of the acetone extract had an absorption maximum at 566 mμ and a minimum at 525 mμ. A solution of alkaline haematin in 80% acetone was found to give an identical absorption curve. Hunter's data[2] give a somewhat similar curve for an alcoholic solution of alkaline haematin, which is of identical shape but moved 30 mμ towards the longer wavelengths.

Hamsik[3] has described the acetone and alcohol complexes of haem, and the evidence, which is also confirmed by Anderton & Locke,[1] indicates that the extracted pigment is the acetone complex of nitric oxide haem. In acetone solution the decomposition product appears to be alkaline haematin, as distinct from the acid haematin which Anderton & Locke[1] have found in their ether/acetone extracts, and which we also have been able to confirm.

It had been noticed that *uncooked* cured meat which contains the undenatured nitroso pigments, although readily yielding its colour in 80% acetone, gave an extract which was much more susceptible to rapid fading. This rate varied with each individual sample of uncooked meat examined. Some samples gave almost as good a stability as is found with the extracts of cooked meats, whereas others showed some signs of fading after a few minutes. Again, when experiments were attempted using solutions prepared from pure (thrice recrystallized) haemoglobin and myoglobin, almost instantaneous fading to haematin occurred on dilution of the aqueous solutions with acetone.

These results indicate that reducing substances present to a varying degree in the uncooked meats, and to a greater degree in the cooked meats, are also extracted into the 80% acetone,

and confer stability for some time on the acetone–nitroso-haem complex by acting as a ' buffer ' against the light-catalysed air oxidation.

Consideration of the possible substances present indicate that free SH compounds such as cysteine and reduced glutathione are the most likely compounds to produce this effect. Both are capable of reducing the ferric haem pigments to the corresponding ferrous compounds.[4] With pure pigments they would be absent, and in uncooked meats would probably exist partly in the oxidized and partly in the reduced forms, depending on the conditions within the meat, whereas in cooked meats, at the low oxidation–reduction potentials and low oxygen tensions of denatured tissue, it appears likely that they would be present entirely in the reduced form.

If this is indeed the explanation, then the addition of cysteine to solutions of pure pigments should result in stabilization. Accordingly, 1 ml. of a fresh 0·5% solution of neutralized cysteine hydrochloride was added to 9 ml. of a solution of nitroso-myoglobin prepared from crystalline myoglobin. On dilution of this with 40 ml. of acetone, no fading of the red colour occurred for several hours, whereas in the absence of the cysteine, oxidation to haematin was almost instantaneous.

The addition of cysteine, in the extraction process, although not necessary when examining cooked meats, may, however, be advantageous when uncooked meat is being investigated.

This effect of cysteine and glutathione is also of importance in the stability of the pigments within the meat, and this aspect is further considered in work on the fading of hams, which will be published later.

Method of measurement in cooked meats

The lean meat, after trimming off the fatty tissue, is minced, mixed and then repassed through the mincer. This operation should be carried out in a darkened room, and with the minimum of delay, as it will be shown in a later paper that even a short exposure to light will lead to a slow reaction with air afterwards, even if it is then stored in the dark.

Ten g. of the minced sample, in a tall beaker to prevent undue evaporation, are first mixed to a smooth paste with approximately 10 ml. of a mixture containing 40 ml. of acetone and 3 ml. of water. The remainder of the acetone solution is then added, and after five minutes with intermittent mixing, the solution is filtered. The light absorption of the filtrate is measured at a wavelength of 540 mμ using a 1-cm. cell, with an 80% acetone/water solution as a blank. The values so obtained may be used directly as a comparative measure of the pigment concentration.

The addition of a known volume of liquid, i.e., 40 ml. of acetone + 3 ml. of water + 7 ml. of water derived from 10 g. of meat, was adopted in preference to dilution to 50 ml. in a graduated flask, for the following reasons:

1. Correction for the volume of the insoluble meat tissues was avoided.
2. Calculation of the required proportions of acetone and water was simpler.
3. Transference from one vessel to another, leading to increased aeration of the extract, was avoided.

Adaptation to measurement of total pigments

Replacement of 1 ml. of water by 1 ml. of concentrated hydrochloric acid in the solvent used, and keeping for 1 hour before filtering, gave a solution of acid haematin in the 80% acetone. This is composed of haematin derived from any uncombined pigments present, together with that resulting from the oxidation of the nitric oxide pigments. The optical density of this filtrate at 640 mμ is then a measure of the *total* haem pigments present in the meat.

Standardization

Conversion to units of the concentration of pigment involves the preliminary standardization of a nitroso-myoglobin solution. This is not a simple procedure, and as comparisons and not absolute values were of primary importance for the future work envisaged, the following method was adopted:

The absorption at 540 mμ of an 80% acetone extract of nitroso-haemoglobin (derived from whole blood) was measured. To this solution was added one drop of concentrated hydrochloric acid, and after setting aside for 2 hours to complete the oxidation, the absorption was again

measured at the peak wavelengths of acid haematin in 80% acetone, i.e., 640 mμ and 512 mμ. Measurement of the absorption of a standard acid haematin solution in 80% acetone (Fig. 3) then enabled both the total pigments and the extracted nitric oxide pigments to be expressed in terms of parts per million of haematin.

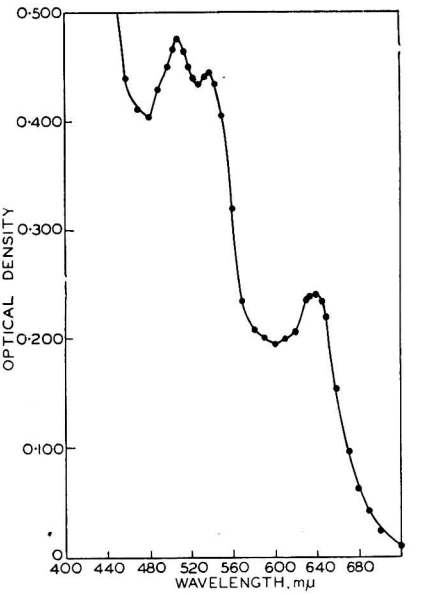

FIG. 3.—*Optical density of a 0·05mM-solution of haematin hydrochloride in 80% acetone containing 2% hydrochloric acid*

Triplicate standardization of haematin hydrochloride (Fe 8·46%) dissolved in 0·1N-sodium hydroxide, then diluting to 0·05M with acetone, conc. hydrochloric acid and water to give a final concentration of 80%, 2%, 18%, respectively, gave the following results:

$E^{1\%}_{512}$ of acid haematin in 80% acetone = 9·52
$E^{1\%}_{640}$ of acid haematin in 80% acetone = 4·80

From this it can be calculated that when using 10 g. of meat and a total fluid volume of 50 ml., the absorption at 640 mμ in a 1-cm. cell, multiplied by the factor 680 gives the concentration of total pigments in the meat as p.p.m. of haematin.

Standardization of the nitroso-haem extracts derived from blood, cooked cured pork, and cooked cured beef, by the above method, all gave identical results, i.e.,

$E^{1\%}_{540}$ of acetone–nitroso-haem in acetone 80%, water 20% = 11·3 (blood)
= 11·3 (pork)
= 11·3 (beef)

Under the recommended conditions, therefore, using 10 g. of meat, and a total fluid volume of 50 ml., the absorption of the acetone–nitroso-haem at 540 mμ in a 1-cm. cell multiplied by the factor 290 gives the concentration of nitroso pigments in the meat as p.p.m. of haematin.

In the estimation of total pigments, readings at both 512 mμ and 640 mμ should be made, and the ratio should not be greater than 2·0 if oxidation of the nitroso-haem to haematin is complete, as the following data shows:

	Acid haematin in 80% acetone	Nitroso-haem–acetone in 80% acetone
Ratio $\frac{E_{512}}{E_{640}}$	1·9	>5·0

Solutions in 80% acetone of both acid haematin and acetone–nitroso-haem were found to conform with Beer's Law, straight lines passing through the origin being obtained in both cases.

Conclusions

In cooked lean meat, both the total and nitroso pigments, expressed as parts per million of haematin, can be quickly assessed, and the amount of uncombined pigment obtained by difference. The degree of conversion of the original pigments to the nitric-oxide derivatives can also be obtained.

The proposed method for measuring nitroso-haemochromogen is rapid (<10 minutes after weighing), and is therefore very suitable for following the sequence of events in fading experiments, allowing samples of exposed meats to be withdrawn for analysis at short time intervals.

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SOME EFFECTS OF A SOIL CONDITIONER ON A HEAVY AND A LIGHT SOIL IN ABERDEENSHIRE

By JOYCE PRINGLE and W. T. H. WILLIAMSON

The remarkable effect of a soil conditioner on the germination of wheat in pot experiments with a heavy soil of the Cruden Bay Association is described. A field experiment was also carried out resulting in no effect on the crop but in a significant increase in the amount of water-stable aggregates in the soil. On a light soil, improvement in growth of carrots was observed.

Introduction

Numerous experiments with soil conditioners have been carried out in widely separated localities with very varied results. For instance, the use of a soil conditioner has been reported to give no increase of yield with potatoes in Hertfordshire,[1] with field beans in New South Wales[2] and with ground nuts in Jamaica.[3] On the other hand, marked improvements in crop yield have been found with vegetables such as radishes,[4] tomatoes[5] and carrots.[6] In the course of studies on soil structure in this department, one of the soils concerned, an extremely intractable one varying in texture from a silty clay loam to a sandy clay loam, seemed eminently suitable for testing the effects of a soil conditioner. Pot experiments to test the effect on germination were carried out during winter under artificial daylight in the laboratory. These were followed by field trials laid down in the following spring.

Experimental

The soil used is derived from Old Red Sandstone drift and is situated at Cruden Bay on the east coast of Aberdeenshire. After a period in arable cultivation it becomes exceedingly difficult

to work, forming large angular clods which are not easily broken down. Under grass it develops a good crumb structure. For the pot experiments use was made of soil (*a*) from a field which had been under arable cultivation for 12 years, the crops being mostly cereals, and (*b*) from a field which had been under timothy grass for 16 years, i.e., an arable and a ley soil. The ley soil is a silty clay loam containing 26·4% of clay (pH 5·4), whilst the arable soil is slightly lighter in texture, being a sandy clay loam with 21·9% of clay (pH 5·5). They are therefore two types of the same soil series. The soil conditioner used was a vinyl acetate–maleic anhydride polymer known as CRD-186.

In the pot experiments, use was made of the large monthly samples taken in the course of the studies referred to above. In order to get sufficient soil for the experiment, it was found necessary to use samples taken in three different months. The soils were air-dried and passed through a 3-mm. sieve before potting. The content of water-stable aggregates was determined on samples of each of the original soils by means of the rapid method of Williamson, Pringle & Coutts.[7] As variations in the figure obtained for this value occur from month to month, due partly to season and partly to weather conditions before sampling, the samples showing the lowest content of water-stable aggregates were used to fill the pots which were to receive treatment with CRD-186.

Two varieties of winter wheat were used, viz., Jubilégem and Bersée. Three series of pots were set up with each soil and each variety of wheat:

1. Treated with CRD-186 and sown with 50 wheat seeds.
2. Untreated and sown with 50 wheat seeds.
3. Treated with CRD-186 and uncropped.

The CRD-186 was applied at the rate of 0·05 g. per 100 g. of soil and the two thoroughly mixed together. Throughout the experiment the moisture content of the soil was made up daily to 25%. The average air temperature of the room was 18°. The time of year was December and during the first week of the experiment the pots were placed near the windows, but during the second week the period of exposure to light was extended to 16 hours per day by means of a bank of fluorescent tubular lamps as used by Low.[8] A time switch put the lamps on from 4 a.m. to 10 a.m. and again from 2 p.m. to 8 p.m. On dull days the daylight was supplemented by switching on the lamps by hand from 10 a.m. to 2 p.m.

The water loss from each cropped pot was measured every 24 hours during the second week. Two marked plants in each pot were measured every 24 hours for rate of growth. At the end of the second week the content of water-stable aggregates was determined on samples of the soil from the pots.

In the following spring a field experiment was laid down on the arable soil at Cruden Bay using a randomized 4 × 4 Latin square with four untreated plots as controls. The CRD-186 used in this case was the commercial product 'Merloam', which contains 25% of the vinyl acetate–maleic anhydride polymer. This was applied at three rates so as to give 0·02%, 0·05% and 0·1%, respectively, of the actual polymer per acre-three-inch of soil. The Merloam was applied in April and raked in by hand just after the crop (wheat) was sown. The plots were then harrowed and rolled by tractor. Weather conditions at the time were dry and, unfortunately, the dry weather continued for five weeks, so that the optimum moisture content for the soil conditioner was not realized. The crop was also slow in germinating and no difference in the rate of germination could be observed between the treated and the control plots. Soil samples were taken from the plots in June and again in September for the determination of the content of water-stable aggregates.

Results

Pot experiments

Referring to Table I, it will be noted that there were marked differences both in the rate of germination and in the rate of the succeeding plant growth. With the arable soil treated with CRD-186 (Treatments 1 & 2), germination was complete (100%) in 48 hours after sowing, while in the untreated soil (Treatments 3 & 4) it had barely commenced and two weeks later it was only

30%. This was the case with both varieties of wheat, although overall germination was later with Bersée. It was noticeable that in all cases the Jubilégem grew more rapidly than the Bersée. The difference in growth between the treated and untreated arable soil (Treatments

Table I

Treatment in pot experiments and observations one week after sowing

No.	Soil and treatment	Crop	Germination†		Average height of plants, cm.	Soil condition
			No. of seeds germinated	%		
1	Arable, treated*	Jubilégem	50	100	6·0	Granular
2	,, ,,	Bersée	50	100	3·0	Granular
3	Arable, untreated	Jubilégem	Just beginning		—	Showing hexagonal cracking
4	,, ,,	Bersée	,, ,,		—	Showing hexagonal cracking
5	Ley, treated	Jubilégem	38	76	3·5	Granular
6	,, ,,	Bersée	15	30	1·4	Granular
7	Ley, untreated	Jubilégem	46	92	4·3	Granular
8	,, ,,	Bersée	41	82	2·8	Granular
9	Arable, treated	None	—	—	—	Granular
10	Ley, treated	None	—	—	—	Granular

* 0·05% CRD-186 † All seed sown on 28 November

2 & 4) with Bersée, 12 days after sowing, is shown in Fig. 1, while the rate of growth in the second week from measurements of two marked plants in each of the Treatments 2, 4, 6 and 8 is given in Fig. 2.

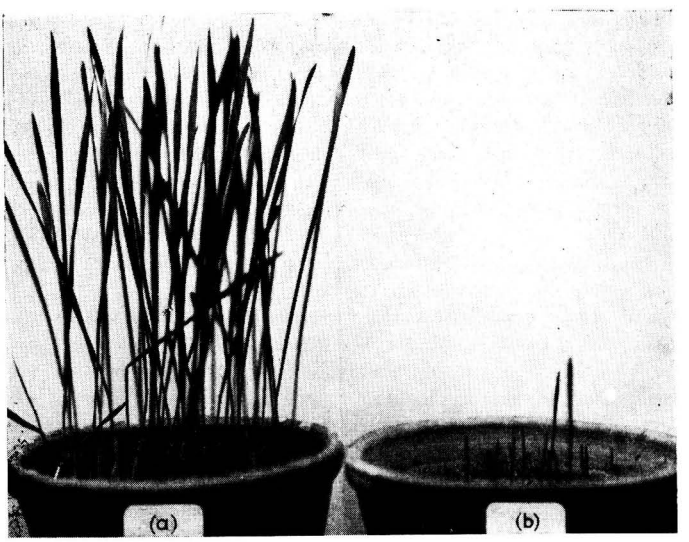

FIG. 1.—*Difference in growth of Bersée wheat 12 days after sowing on treated (a) and untreated (b) arable soil*

In the ley soil, whether treated or not, both the germination and the rate of growth were less than in the treated arable soil, while the untreated ley soil gave better results than the same soil with treatment.

There were striking differences in the water losses in the eight cropped pots as shown by daily measurements in the second week of growth (Table II). The loss from the untreated arable soil (Treatments 3 & 4) was more than double that from any of the other cropped pots. Since no water was observed draining from any of the pots, the losses could have taken place only by means of transpiration and evaporation. Since the amount of plant growth in the untreated arable soil was very small in comparison with that in the other treatments, the loss in this case

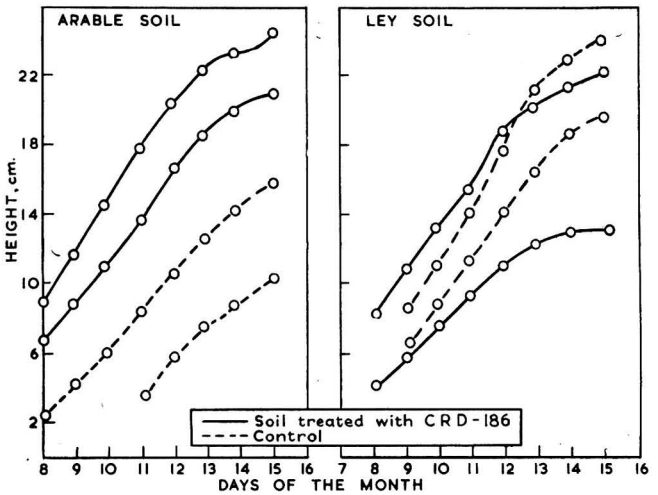

FIG. 2.—*Growth curves of two marked plants of Bersée wheat on treated and untreated arable and ley soils*

must have occurred mainly through direct evaporation from the soil. It may therefore be presumed that the increased water loss was caused by the greater surface area of soil exposed in the deep cracks which developed in the untreated arable soil (Fig. 3).

Table II

Daily water losses (in g.) from cropped pots from 10 to 15 December

Date	Treatment number							
	1	2	3	4	5	6	7	8
10	24	21	54	56	22	20	22	20
11	24	22	52	58	25	20	22	20
12	26	20	52	56	24	21	22	20
13	22	23	46	50	24	20	22	19
14	24	22	43	48	24	17	22	20
15	26	23	46	52	26	23	26	22
Average	24·3	21·8	48·8	53·3	24·2	20·2	22·7	20·2

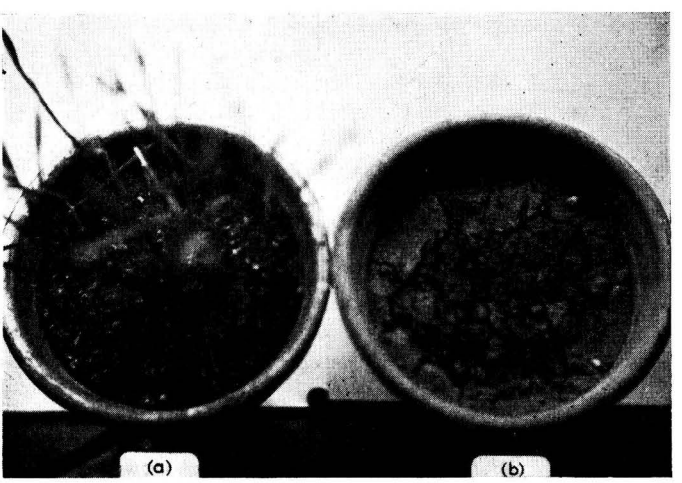

FIG. 3.—*Structural difference between treated (a) and untreated (b) arable soil*

The increase in the content of water-stable aggregates (Table III) is most marked in the case of the treated arable soil whether it was cropped or not, the percentage increase being of the same order in each case. With the ley soil, treatment with the conditioner produced a greater increase on the uncropped soil than on the cropped.

Table III

Content of water-stable aggregates in soils

	A			B		C		
	Before expt.	Treated and cropped		Before expt.	Treated and uncropped	Before expt.	Untreated and cropped	
		with Jubilégem	with Bersée				with Jubilégem	with Bersée
% water-stable aggregates <3 mm. in arable soil	7·2	31·2	31·5	9·9	50·0	16·0	16·5	13·5
% water-stable aggregates <3 mm. in ley soil	33·1	38·8	38·7	40·0	53·0	39·6	40·2	35·3

Field experiment and observations

When soil samples were taken from the field plots both in June and September, it was apparent ffom visual examination that the conditioner had had some effect on the surface three or four inches of soil. Clods from the treated plots crumbled readily in the hand, while those from the controls did not, but maintained the hard angular formation previously referred to. There was no evidence, however, of any increase in growth on the treated plots over that on the controls. The data for water-stable aggregates are shown graphically in Fig. 4. Applying Fisher's z-test,[9] the effect of an application of 0·05% CRD-186 on the content of water-stable aggregates is highly significant, while that produced by 0·02% is not and the increase effected by raising the dosage from 0·02% to 0·05% is just significant. Further, there is no appreciable advantage to be gained by using dressings higher than 0·05%, although the optimum effect is probably produced by a quantity somewhere between 0·05% and 0·1%.

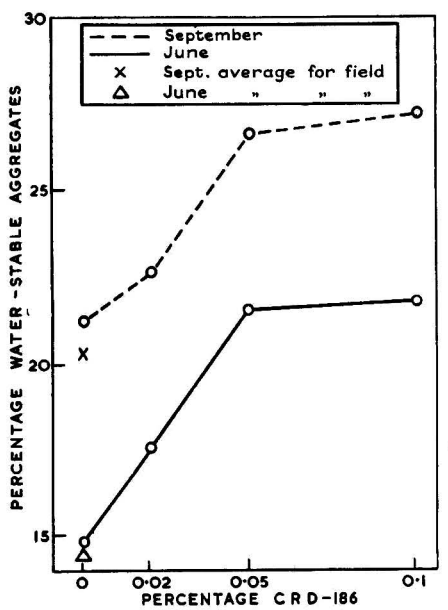

FIG. 4.—*Water-stable aggregates in soil from plots in field experiment*

(Isolated points—△ and ×—show the values for composite samples from surrounding field in June and September, respectively)

Although no increase in yield was obtained by the use of the conditioner in the above experiment, one case of improved crop growth due to its use under local conditions may be reported here. Fig. 5 shows samples of carrots grown in 1954 in a garden on light soil well supplied with fertilizers. The samples are typical of plants grown in two adjacent rows, the soil in one case being treated with approximately 0·05% CRD-186. The plants on the treated soil germinated earlier and showed consistently better growth throughout the whole season than those on the untreated soil. It will be seen from Fig. 5 that the roots were of better size and showed none of the forking exhibited by those from the untreated soil. A repetition of this trial in 1955 gave similar results in spite of the very dry season.

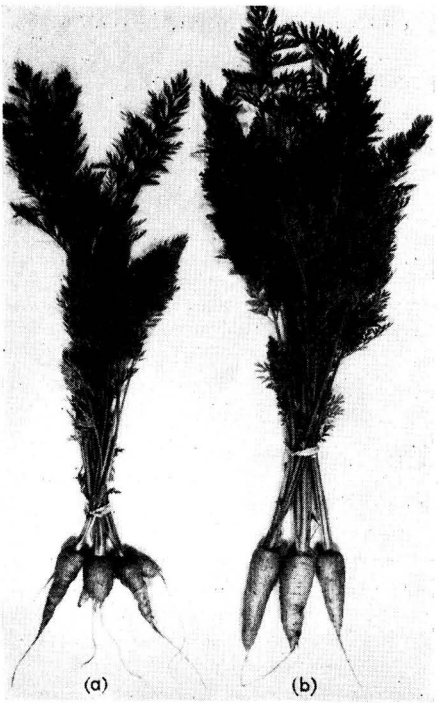

FIG. 5.—*Difference in growth of carrots on light soil untreated (a) and treated (b)*

Acknowledgments

We wish to thank Mrs. M. J. Garden, Cruden Bay, for granting facilities for carrying out the field experiment on her farm and Messrs. Monsanto Chemicals Ltd. for supplying the CRD-186 and the Merloam. One of us (J. P.) is indebted to the University of Aberdeen for a Post-graduate Studentship during the period when this work was in progress. We are also indebted to the Agricultural Research Council for a grant, which enabled us to carry this and related work to a later stage. We are obliged to Mr. J. McC. Brown for providing the plants shown in Fig. 5. Finally, thanks are due to our colleagues, Dr. J. R. H. Coutts for much useful help and criticism; Dr. E. A. FitzPatrick and Mr. A. Smith for taking the photographs; and Mr. Brian Bruce for preparing the prints and drawing the diagrams.

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BONE-TAINT IN BEEF

By LORNA S. COSNETT, D. J. HOGAN, N. H. LAW and B. B. MARSH

In a study of twenty-four sides of bone-tainted beef, large numbers of Gram-positive rods were observed in every case. At least twelve different organisms, including anaerobes, sporing aerobes and non-sporing aerobes, were isolated from fourteen of the sides. Evidence is presented to suggest that neither bone marrow nor synovial fluid is the centre from which the tainting organisms spreads.

The ischiatic and popliteal lymph nodes of freshly-killed cattle frequently contain bacteria, many of them Gram-positive rods. The incidence of nodes containing these rods appears to be related to the rainfall during the two months preceding slaughter.

It is suggested that Gram-positive rods enter abrasions in the skin of the cattle and are localized in the lymph nodes. After death, given suitable temperature and pH requirements, the organisms multiply and spread outwards to the neighbouring muscles producing taint.

Introduction

Bone-taint, defined as ' the development of putrid or sour odours and tastes in the deep-seated parts of meat, usually near the bone ',[1] is a problem of some concern to New Zealand, for although its incidence is not high, it causes over all a considerable loss to a country so dependent on its agricultural products. Previous workers[2, 3] have suggested that certain organisms of the genus *Clostridium* are responsible, while aerobic bacilli have been isolated from a few cases of taint.[4, 5] The mode of entry of the organisms, whatever their nature, to the deep-seated areas of beef carcasses is still uncertain : Callow & Ingram[1] repeat the alternatives of Moran & Smith[6] that the bacteria (i) may pass from the gut to the muscles in life, or (ii) might be introduced into the carcass at death.

During the past three years we have had an opportunity to study tainted beef, synovial fluid, bone marrow and lymph nodes from cattle killed in a large nearby meat-works. Due perhaps to the relatively high efficiency of its chillers, this works has a low incidence of taint, but in all, and including occasional samples from other sources, 24 tainted carcasses were examined and 14 of the causative organisms studied in some detail.

Experimental

Materials, preparation and examination

Tainted carcasses.—It was sometimes possible to be present during the cutting-up of a suspected side of beef, in which case a large sample, including femur, acetabulum (hip-joint), part of the ileum, and much of the adhering meat, was removed in one piece. On other occasions, however, taint was not reported to us until the side was largely dismembered, and it was possible only to collect several small samples of meat and sometimes of bone. In the laboratory the outer layers of meat were removed and the new surfaces seared, and samples were then taken from the interior with sterile instruments. Marrow samples were taken after cutting the bone and discarding with sterile instruments a one-centimetre plug of marrow immediately adjacent to the saw cut. Smears of meat and marrow were examined immediately, and samples were incubated in Robertson's meat medium at 37° for 2–3 days.

Synovial fluid.—About 30 minutes post-mortem, and immediately following the longitudinal halving of the carcass, a sample of the synovial fluid of the acetabulum was taken by probing with a long wide-bore sterile veterinary needle and sterile syringe. The fluid, usually of volume 3–4 ml., was taken to the laboratory in a sterile tube, and within an hour of the death of the animal was added to either Robertson's meat medium or liver broth medium and incubated for 2–3 days at 37°.

Lymph nodes.—Ischiatic nodes were removed about 30 minutes post-mortem without aseptic precautions with a clean knife ; any which were slit or damaged in the process of extraction were rejected. In the laboratory, within an hour post-mortem, the entire surface of each node was removed with a sterile scalpel to a depth of 1–2 mm., and the newly-exposed surfaces were seared with a hot spatula. From the interior a sample of about $\frac{1}{5}$–$\frac{1}{10}$ of the original weight of the entire

Table I

Characteristics of Gram-positive rods isolated from beef

	From tainted beef														From lymph nodes		
	Anaerobes				Sporing aerobes				Non-sporing aerobes						Sporing aerobe	Non-sporing aerobes	
Reference number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Motility	−	−	−	+	+	+			−	−	+	−	+	+		+	
Haemolysis		+	+	+	−	−	−	+	+	+	−			−	+		+
Litmus milk	Stormy clot	Stormy clot	Stormy clot		clot	clot	o	clot	clot	clot	clot	thin clot	o	clot	clot	clot	clot
Gelatin liquefaction	+	+	+	+	+	−	−	slow	+	+	−	−	−	−		−	
Dextrose	+	+	+	+	+	−	+	+	+	+	+	−	+	+	−	+	+
Sucrose	+	+	+	+	+	−	−	+	+	+	+	+	+	+	+	+	+
Lactose	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	−
Galactose	+?	+?	+		+	+		+	+	+	+	+	+	+	+	−	−
Maltose				+	+	+	−	+	+	+	+	+	−	+	+	+	+
Mannitol	−	−	+		+	+	−	+	+	−	+	+	+	+	+	−	+
Salicin	−	−	+	+	+	+	−	+	+	+	+	+	+	+	−	−	−
Nitrate reduction	+	+	+	−?	+	+	weak	weak	+	+	+	+	+	+		+	
Indole	−			weak	+	+	+	+	weak	+	+	−	+	+	+	−	−
Voges–Proskauer					−	−	−	−	−	−	−	−	−	−		−	
Methyl red					+	+	+		−	−	+	+		+		+	
H_2S	+	+	+	slow	+	slow	−		+	+	+	slow	−	+		+	

gland was removed with sterile scalpel and forceps, and was incubated in Robertson's meat medium for 3 days at 37°.

Only a few popliteal nodes were available since they could not be removed without some damage to the hot carcass.

Results

Tainted carcasses

In the course of this project, bone-taint was reported to us on 21 separate occasions, and samples were obtained from 24 different carcasses. In every case, direct smears made within one hour of sampling showed the presence of large numbers of Gram-positive rods, sometimes sporing. In a few samples other organisms were also present in fair numbers, but usually the rods alone appeared to be present, and it was clear that these were responsible for the taint observed. Isolation of the rod was not achieved in every case, but pure cultures of 14 of the organisms were obtained by plating on nutrient agar, blood agar, or blood–thioglycollate agar, and/or by heating for ten minutes at 80° when spores were present. Cultural characteristics of these organisms are shown in Table I, which also includes the properties of three Gram-positive rods isolated from lymph nodes of freshly-killed cattle which did not develop bone-taint (see later).

It is not our purpose to identify organisms which can cause bone-taint, but rather to indicate their nature and wide variety. It appears from Table I that taint may be due to any one of at least 12 different organisms, which include anaerobes, sporing aerobes and non-sporing aerobes.

The pair of apparently similar organisms, 1 and 2, were isolated from the meat of animals killed two months apart, while the pair, 11 and 14, were found in the meat of animals killed four days apart in different meat-works. Conversely, the different organisms, 6, 12 and 13, came from the meat of animals killed in the same works within minutes of each other. These latter results lend no support to the commonly held view that a source of contamination within the meat-works is responsible when several carcasses develop taint at the same time.

Eight of the isolated organisms were inoculated into meat to ensure that they were capable of causing taint. Nine cubes of meat, each of side about 3 cm., were cut from one of the long uniform neck muscles of a freshly killed ox. Within forty minutes of the death of the animal the cubes were dipped in alcohol and flamed twice, and a ' pocket ' was cut in each with a sterile scalpel. Into each pocket were introduced two loops of a culture of one of the organisms, and one cube remained uninoculated. After 20 hours at 37° the cubes were examined by a panel of six members, who agreed that the eight inoculated samples gave off odours indistinguishable from that characteristic of bone-taint, while the control was untainted. Organism numbers 4, 10, 11, 12 and 13 produced very intense taints, while numbers 5, 6 and 14 caused fairly intense odours. This result, coupled with the findings of large numbers of Gram-positive rods in all samples of tainted meat, indicates that the organisms isolated were indeed those responsible for the production of taint.

In seven tainted sides, including five of those studied in detail (numbers 1, 3 5, 6 and 14), the marrow of the femur was examined. In three cases the marrow proved sterile even after three days' enrichment in Robertson's meat medium, and in a fourth a few Gram-positive cocci appeared on enrichment. Of the remaining three, one showed a few Gram-positive rods in the only sample of marrow examined, one contained Gram-positive rods in marrow 20 cm. from the hip-joint, but none in marrow 7 cm. from the hip-joint, while the marrow of the remaining femur was sterile 3 and 7 cm. from the hip-joint but contained a few Gram-positive rods 10 cm. from the hip-joint. No taint or bad odour of any kind was detected in any of the marrows of these seven femurs.

Synovial fluid

The synovial fluids (pH 7·30–8·25) of the hip-joints of 29 sides of beef, taken within half an hour of death, were examined in this investigation. No organisms could be detected microscopically when fluid was examined immediately, but following incubation at 37° for 2–3 days, three of the 29 samples were found to contain Gram-positive rods. The sides from which these fluids had been taken were entirely free of taint.

The synovial fluid of another side was sterile after three days' incubation, while the side itself was found to be badly tainted only 24 hours post-mortem. The meat along the femur was heavily contaminated with a Gram-positive rod, and part of the shaft of the femur was slightly green, but the hip-joint itself and the meat immediately adjacent to it were neither tainted nor discoloured. This was the only tainted side of a large number of animals killed on that day; the side was slightly below average dressed weight, and the chiller had been working efficiently during the period. Thus a fairly rapid chilling must be assumed, and consequently the number of organisms present at the time of death must have been appreciable in order to reach such an advanced state by next day (compare Haines & Scott[3]). In these circumstances, if the hip-joint were the centre of spread, it seems most improbable that no organisms would be contained in the sample of 3 ml. of synovial fluid. It should be added that the rod isolated from the tainted meat (No. 2, Table I) was maintained and grown in ordinary media at 37° without difficulty, so there is little likelihood that it was present in the initial sample of fluid yet failed to survive incubation.

These results suggested that synovial fluid is not the centre from which the tainting organism spreads, and this line of investigation was not pursued.

Lymph nodes

During the examination of direct smears of tissue from several positions within a tainted side, it was noticed that the largest number of morphologically distinct organisms occurred in and immediately around a lymph node, probably the popliteal. This observation suggested the nodes as possible centres from which the tainting bacteria might spread, and a study of the organisms of the ischiatic nodes of freshly-killed cattle, eventually extending over two years, was commenced. Usually four nodes were collected each week, and in all 307 ischiatics and 18 popliteals of healthy animals were examined.

Since the study of tainted meat described above had indicated an association of bone-taint with large numbers of Gram-positive rods, the investigation of nodes was confined for the most part to demonstrating the existence of Gram-positive rods in the nodes shortly after death.

Of the 307 ischiatics, 191 (62%) contained organisms of one or more morphologically different types; 141 (46%) contained cocci, 79 (26%) Gram-positive rods, and 16 (5%) Gram-negative rods. Of the 18 popliteals, 15 (83%) contained at least one type of contaminant; 10 (56%) contained cocci, and 6 (33%) Gram-positive rods. No Gram-negative rods were detected. These results suggest a similarity in the nature and distribution of the organisms found in popliteals and ischiatics, and partly justify our examination of the more accessible ischiatic instead of the probably more important popliteal.

A more detailed study of the Gram-positive rods isolated from three of the fresh nodes was undertaken, the results appearing in Table I. Organisms 15 and 16 were found in popliteals, and 17 in an ischiatic. None of the three appears identical with any of the tainting rods, but in view of the diversity of reactions among the latter, this point is not surprising; it is most unlikely that the 14 cases of taint included all possible tainting organisms.

The proportion of nodes containing organisms varied widely from month to month; thus no rods were detected in the whole of one month, while at the other extreme 45% of all nodes examined in another month contained Gram-positive rods. No correlation existed between the extent of this contamination and either time of year or temperature, but a relation became apparent when rainfall was considered. In Fig. 1, the percentage of nodes containing Gram-positive rods each month is compared with the mean rainfall of the two preceding months for the observation points Waingawa and Palmerston North, representative of the farming districts Wairarapa and Manawatu from which almost all the cattle had come. It should be added that cattle remain outdoors throughout the year in these districts. Months in which fewer than 12 nodes were examined have been omitted from the figure.

The number of nodes in each monthly group was low (12–20), and individual variations are therefore not unexpected; on the other hand the investigation was continued over a sufficient period to show a significant trend despite appreciable monthly variations. Analysis of the data of Fig. 1 reveals a significant correlation: $r = -0{\cdot}65$, equivalent to a value of P of less than 0·01. Statistical treatment also shows significant correlations when the percentage of nodes containing Gram-positive rods is compared with rainfall in the last, and the second to last,

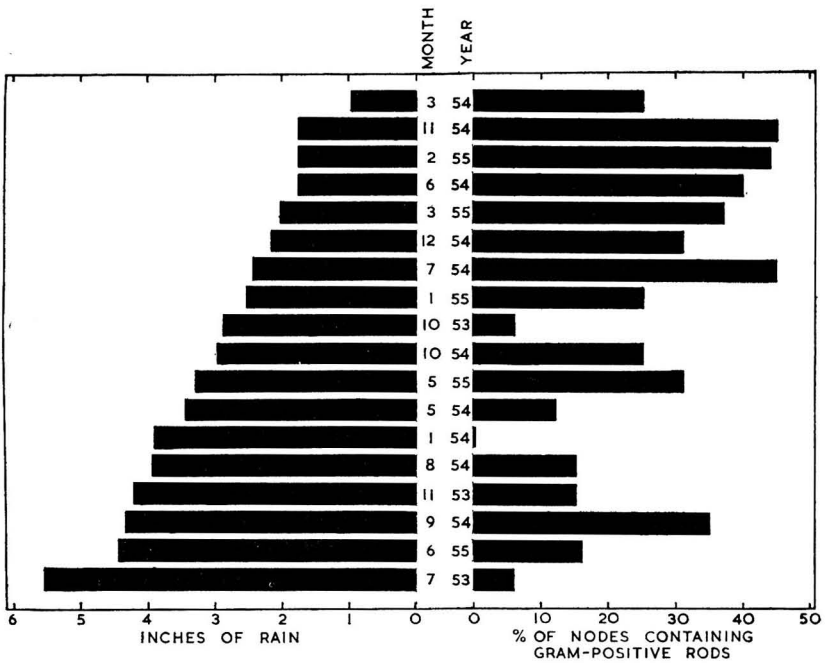

FIG. 1.—*The relation between the percentage of nodes containing Gram-positive rods and the mean rainfall during the two preceding months*

complete months of life ; r and P values are respectively — 0·54 and 0·02, and — 0·52 and less than 0·05. No correlation exists, however, between contamination and the rainfall of the third to last complete month of life (r = + 0·05).

Discussion

Because of its infrequent or sporadic occurrence, bone-taint is not an easy subject for investigation. The present study, though undertaken with the co-operation of a large meat-works and extended over a long period, has been hampered by this difficulty, and we are still unable to draw any definite conclusions concerning the mode of entry and spread of tainting organisms. We are convinced, however, that the trouble can be caused by any of a considerable number of Gram-positive rods, both aerobes and anaerobes, and that in the present work only Gram-positive rods were responsible.

The finding of Gram-positive rods in the synovial fluid of freshly-killed cattle at first encouraged the view that tainting organisms spread outward from the hip-joint. This theory, however, was discarded with the discovery of a sterile synovial fluid from a side which not only developed bone-taint quickly, but also had a normal untainted hip-joint. Similarly, the present work lends no support to the view that the organisms spread from the marrow of the femur ; four of the seven marrows of tainted sides contained no Gram-positive rods, and in none of the seven was any off-odour detectable. The three cases where rods were found within the marrow could as well be explained by an *inward* spread of organisms from the meat as by an *outward* spread from the marrow.

On the other hand, the view that the lymph node may be the centre of spread of the tainting organisms cannot be so readily rejected. Bacteria at least superficially resembling taint-producers have been found in a quarter of the nodes, and since only a small part of the node was examined, the extent of contamination may have been higher. Indeed, bacteria are perhaps to be expected there in view of the filtering functions of the nodes in the living animal. Furthermore, we have not seen a single tainted side that did not include a lymph node within the area of taint.

A variety of organisms was found in the lymph nodes of corpses of apparently healthy human beings by Adamson,[7] who presented evidence to show that these had been present for some considerable time before death. Adamson also quoted the results of Ørskov, who found that bacteria of low virulence injected into living mice could be demonstrated in the nodes two months after application. While our examination of nodes was in progress, our attention was drawn to the work of Lepovetsky, Weiser & Deatherage,[8] who extended Adamson's work to cattle, finding that 15 of 23 lymph nodes, 3 of 23 marrow samples, and 2 of 23 muscle samples contained bacteria, 12 genera in all being isolated. The authors suggested that the lymph node might be the point from which deep spoilage in beef arises.

The present results support this view, and the correlation between presence of Gram-positive rods and low rainfall may provide an indication of the source of contamination. There is apparently no relation between these variables except the effect of rainfall on the numbers of air- and dust-borne organisms. Neill & Armstrong[9] found that rain within the previous twelve hours greatly reduced the aeroscope catch of ascospores of blind-seed disease of rye grass, the count dropping to zero if rain fell during the run. Similarly far fewer bacteria would be expected to be present in the atmosphere during and after rain than in dry spells. Infection of the numerous cuts and abrasions to which cattle are liable—small wounds from fences, gates, horns, etc.—would thus appear much more likely during periods of low rainfall. Without an explanation postulating the entry of bacteria from *outside* the animal, no explanation can be offered of the significant correlation between rainfall and the presence of Gram-positive rods in the lymph nodes.

Once having gained access, the organism may spread through part of the lymphatic system and become localized in a node, where it might survive for some time. After the death of the host animal the organism can multiply because of the post-mortem depletion of leucocytes, and possibly because of the onset of *rigor mortis*.[10] Provided cooling is not too rapid and the lowering of the pH of the muscle not too fast or appreciable, proliferation might reach the degree at which taint is detectable.

Acknowledgments

The authors acknowledge the co-operation and assistance provided by the management and staff of the Wellington Meat Export Co., from whose meat-works all samples of synovial fluid and lymph nodes and some of the tainted meat samples were taken; the meat inspectors, Department of Agriculture, stationed at this works, who greatly facilitated the study; the Gear Meat Co., and also members of the Master Butchers' Federation, who permitted the collection of material from some of the tainted sides; Mr. R. R. Russell of the Wallaceville Animal Research Station, Department of Agriculture, for technical advice, and Dr. M. Ingram of the Low Temperature Research Station, Cambridge, for constructive criticism of the results. This paper is published by permission of the Director, Dominion Laboratory, Wellington.

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PHYSICO-CHEMICAL STUDIES ON THE APPLICATION OF INSECTICIDES TO SHEEP FLEECE. VIII.*—Reactions between Natural Fleece and Anionic Wetting Agents

By C. C. ADDISON and C. G. L. FURMIDGE

The paper describes variations in the interfacial activity of aqueous solutions of anionic wetting agents which occur on addition of natural fleece. The results are compared with those already described for cationic wetting agents. The influence of concentration, chain length and positive ion of the anionic compound, and time of immersion of the fleece, has been studied. Differences between anionic and cationic systems can be attributed mainly to the greater solubility of the long-chain complex C^+A^- formed by reaction between the soluble constituents of suint and the wetting agent.

In Parts II–VII,[1b–1g] the chemical reactions and consequent physical changes taking place in systems involving fleece, emulsion and cationic wetting agent have been fully explored, and an attempt has been made to define the physico-chemical principles which control the take-up of emulsion by fleece. It was not necessary to study anionic wetting agents in the same detail; the work described in this and the following paper was carried out to compare anionic with cationic systems, and to provide data which might help to explain the widely variable results obtained using anionic wetting agents in field trials.[2] Because of their simple structure (and to aid comparison) the long-chain alkyl sulphates have been used. Their solubility at room temperature is small, and it is for this reason that the lithium alkyl sulphates have been employed to a large extent. The present paper describes the influence of natural fleece on the interfacial activity of these anionic wetting agents.

Experimental

Materials and methods

Wetting agents.—Three mol. of concentrated sulphuric acid were added slowly to 1 mol. of the long-chain alcohol dissolved in the minimum quantity of carbon tetrachloride at room temperature, with stirring and cooling. The mixture was left to stand in a desiccator for several hours, then poured into water containing a sufficient quantity of the appropriate hydroxide to effect complete neutralization. The resulting paste was recrystallized three times from water at 0°; the wet crystals were dried by washing with acetone, and finally recrystallized from ethanol. The products gave stable solutions in water. Very occasionally (e.g., when it was desired to study a full range of metal ions or carbon chain lengths) it was necessary to employ slightly super-saturated solutions. These crystallize very slowly; crystallization is not induced by the introduction of fleece, and did not occur during the course of any experiment described below.

Wool samples.—The whole of the flank fleece from a Scotch Blackface ewe (born 1950, sheared 1953) was used. This was divided into root and tip samples,[1b] which had the following properties:

Sample	% Grease[1b]	% Suint[1b]	Surface Area[1d] (cm.²/g.)
Root flank	9·5	24·4	480
Tip flank	1·7	8·6	525

Interfacial tensions.—These were determined against xylene by the drop volume method.[1b] Using an orifice directed vertically upwards, drops of xylene were expelled into the aqueous solution.

Inactivation of solution.—This was measured as already described;[1b] whereas inactivation could be determined using only 2 ml. of the cationic agent solution obtained after treatment with fleece, it was necessary to use 25 ml. of anionic agent solution because the drop pipette is used in the reverse direction.

* Part VII: *J. Sci. Fd Agric.*, 1956, **7**, 281

Results and discussion

Inactivation isotherms

The variation in inactivation (expressed as the apparent loss of wetting agent per g. of wool immersed in 50 ml. of solution for 30 minutes) with grease and suint content is illustrated in the isotherms for ammonium tetradecyl sulphate (Fig. 1). The isotherm for cleaned wool (no grease or suint—curve C) shows slight inactivation due to direct adsorption at the fibre surface, and is of the order required for an adsorbed monolayer (compare[3]). The activation in more concentrated solutions is the result of interaction between protein chains and wetting agent to give interfacially active products. When the fleece carries grease and suint, the mechanisms for inactivation resemble broadly those for cationic wetting agents. In the concentration range below the critical concentration for micelles (the α range, Fig. 1), inactivation is the result of three main factors:

(*a*) Adsorption to, and absorption by, the grease layer; this should increase in a regular manner with concentration.

(*b*) Solution of long-chain anions from the suint; this will decrease inactivation, but since the mean chain length $(C_{10})^4$ of these anions is shorter than those of the wetting agent, their influence will only be noticeable at low concentrations of wetting agent.

(*c*) Reaction between long-chain cations (C^+) and long-chain anions (A^-) in solution to give a complex C^+A^-, the surface activity of which may vary widely with chain length. This process played a major role in solutions of cationic agents, but is less significant in anionic solutions. The soluble nitrogenous bases in suint have no pronounced long-chain character, and the formation and precipitation of the complex C^+A^- is slow and incomplete.

These factors can give rise to irregular isotherms in the α concentration range (curve A, Fig. 1) although this is not normally the case (Fig. 2). With cationic wetting agents the inactivation varied linearly with concentration in this range.

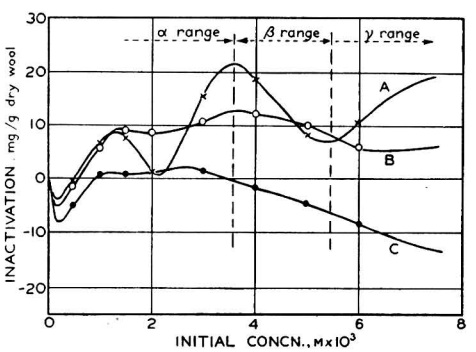

FIG. 1.—*Inactivation isotherms for ammonium tetradecyl sulphate solutions*

A Root fleece. B Tip fleece. C Cleaned fleece

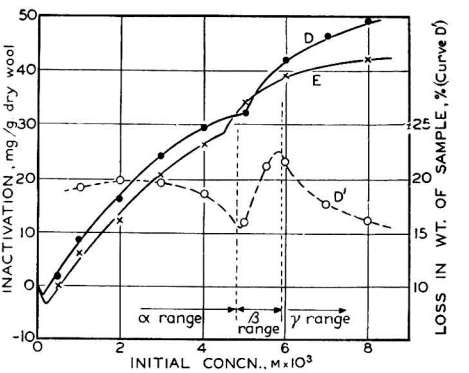

FIG. 2.—*Lithium tetradecyl sulphate solutions*

D Root fleece isotherm
E Tip fleece isotherm
D¹ Loss in weight of root fleece samples (% of original dry weight)

Above the critical concentration for micelles (the β range, Fig. 1), grease is removed from the fibres; this leads to a decrease in inactivation, and this process is precisely the same as for cationic wetting agents.[1c] The inactivation which occurs at the beginning of the γ range (curve A, Fig. 1) is again the result of flocculation of the dispersed grease particles at higher wetting agent concentrations. However, this flocculation process is much less pronounced in anionic than in cationic solutions. In the latter, it results from the formation of double adsorbed layers, which destroy the electrical repulsion of suspended particles; long-chain anions do not form such double layers to any comparable degree. With lower grease and suint content (curve B) the effects shown by curve A are much less evident.

Fig. 2 shows isotherms for lithium tetradecyl sulphate. Inactivation is regular in the α concentration range, and there is relatively little variation in the position of the isotherms with change in grease content. Each curve D and E shows only one slight break, although the operation of the different processes referred to above in the α, β and γ concentration ranges is quite clear from curve D[1], which shows the corresponding changes in weight of the root fleece samples.

Variation of inactivation with chain length

This is illustrated by the isotherms in Fig. 3. (To facilitate comparison, inactivation is expressed as change in molar concentration ΔM of the solution.) The chain length effect with anionic compounds is small compared with that found in solutions of long-chain cations (cf. Fig. 1, Part V[16]) ; this results from the different properties of the complex C^+A^- formed between suint and wetting agent in the two systems. With cationic wetting agents, each of the ions C^+ and A^- possesses a long chain, so that the solubility (and hence the interfacial activity) of the complex varies widely with chain length. Using anionic wetting agents, the cation C^+ is provided by the nitrogenous bases in suint, which have no definite long-chain character. They are therefore more soluble as a whole, and the isotherms are not so greatly influenced by change in chain length. The degree of separation of the isotherms in Fig. 3 can therefore be related more closely with the adsorption of wetting agent, which increases with increasing chain length. Similar observations were made with tip fleece.

Influence of positive ion

The isotherms in Fig. 4 show that variation in the alkali metal ion makes only a small difference to inactivation of dodecyl sulphate solutions. This is in sharp contrast to the behaviour of solutions of cationic wetting agents, where change in halide ion produced considerable variations in the inactivation of dodecyl pyridinium salts (see Fig. 5, Part V[16]). In the α concentration range the inactivation is independent of the metal ion used ; the choice of positive ion is only of importance in micellar solutions, since it is only at concentrations above the critical value for micelles (the β range) that changes in inactivation are observed.

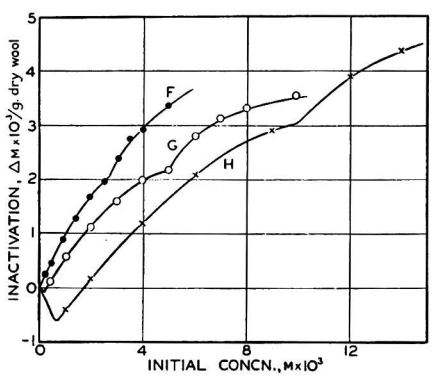

FIG. 3.—*Influence of chain length on isotherms for root fleece*

F Lithium cetyl sulphate
G Lithium tetradecyl sulphate
H Lithium dodecyl sulphate

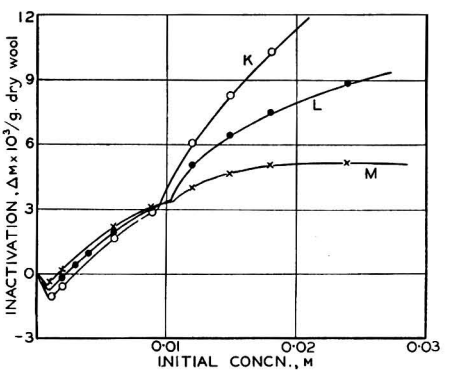

FIG. 4.—*Influence of alkali metal ion on isotherms for root fleece*

K Potassium dodecyl sulphate
L Sodium dodecyl sulphate
M Lithium dodecyl sulphate

Variation of inactivation with immersion time

The type of variation observed is illustrated by results in Fig. 5. It is of interest that a close similarity exists between these curves and those obtained with cationic wetting agents which gave a soluble C^+A^- complex (Figs. 2 and 3, Part VI[1f]). The suint which dissolves on immersion of fleece in an anionic wetting agent solution gives a C^+A^- complex which is at first soluble and

highly surface active. This causes activation of the solution, whereas the simple adsorption process causes inactivation. The curves in Fig. 5 represent the balance between these two opposing processes, which of course varies with wetting agent concentration. Some of C^+A^- complex does, in fact, separate slowly from aqueous solution. An aqueous suint extract from the fleece was added to aqueous solutions of several of the anionic wetting agents employed here ; the solutions gradually became turbid, but up to an hour was required before crystallization was complete. The solid dissolved on warming, and recrystallized on cooling again. This slow separation of complex probably accounts for the gradual increase in inactivation at the longer immersion times.

Successive addition of fleece samples

One-g. samples of wool were added successively to 50 ml. of wetting agent solution. Each sample was immersed for one minute, withdrawn, and the inactivation of the solution was then measured. Typical results are shown in Figs. 6(*a*) and 6(*b*). In general, when equilibrium is established within one minute (Fig. 5) there is little change in inactivation after addition of the

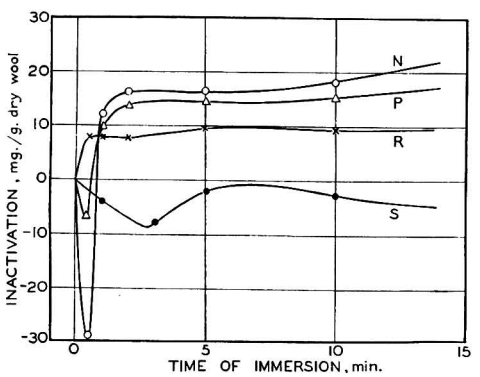

FIG. 5.—*Variation in inactivation of lithium dodecyl sulphate solutions with period of immersion*

N 0·009M solution, using root fleece
P 0·006M ,, ,, ,, ,,
R 0·003M ,, ,, ,, ,,
S 0·006M ,, using cleaned fleece

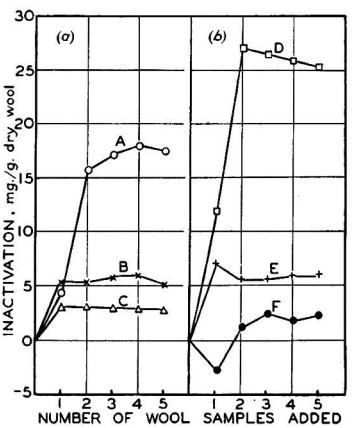

FIG. 6.—*Successive addition of fleece samples*

A 0·009M-sodium dodecyl sulphate : root fleece
B 0·003M- ,, ,, ,, ,, ,,
C 0·00025M-lithium cetyl sulphate : root fleece
D 0·009M-lithium dodecyl sulphate : root fleece
E 0·003M- ,, ,, ,, ,, ,,
F 0·003M- ,, ,, ,, tip fleece

first sample. When equilibrium is not established within one minute (curves A and D, Fig. 6), two additions are required before a steady state is reached. It is clear that inactivation by fleece is largely balanced by the activation produced as a result of solution of long-chain anions from the suint.

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PHYSICO-CHEMICAL STUDIES ON THE APPLICATION OF INSECTICIDES TO SHEEP FLEECE. IX.*—The Uptake of Oil Phase from Anionic Emulsion by Natural Fleece

By C. C. ADDISON and C. G. L. FURMIDGE

Comparison is made of the stability of anionic and cationic emulsions in the absence and presence of fleece. The quantity of oil phase removed by fleece from anionic emulsions under various conditions has been measured. Anionic wetting agents are attractive for the formulation of emulsion dips in that the uptake of oil phase on fleece samples added successively is regular and of suitable magnitude, and is largely independent of the positive ion, chain length and concentration of the wetting agent. They suffer, however, from the serious disadvantage that the uptake of oil phase varies with time of immersion, which is likely to render difficult the control of insecticide deposits.

Introduction

The experiments described here were carried out for comparison with similar experiments on emulsions prepared using cationic wetting agents.[1] Deposition of oil phase on to fleece immersed in a cationic emulsion is so heavy that such emulsions have no practical use as dips, and the instability is a direct consequence of the presence of a long-chain cation in solution. The present experiments show that although emulsion stability is considerably enhanced when anionic wetting agents are used, some undesirable features still remain. The instability of cationic emulsions was attributed to four main factors ; these will now be considered again in the light of the modifications introduced by change in the sign of the charge on the long-chain ion.

(a) *Adsorption and redeposition effects.*—Adsorption of anions to the very large fleece surface occurs (for comparable chain length) to a similar extent as for cations. In each case such adsorption competes with adsorption to the oil–water interface of the emulsion, but the solution of long-chain anions from suint will prevent the bath becoming denuded of wetting agent. The long-chain cation–anion complexes (often insoluble), which form by reaction of suint with solutions of cationic agents, are formed to a smaller extent in solutions of anionic agents (see preceding paper). Again, anionic wetting agents are comparatively poor flocculating agents, so that the effects listed under this heading as contributing to the instability of cationic emulsions have little significance in anionic emulsions.

(b) *Electric charge on the oil droplets.*—Neutralization of this charge is not possible in anionic solutions ; the droplets and suspended solids are negatively charged and there are no cations present in suint which have an adsorptive power comparable with the long-chain anions. Thus the major cause of instability in cationic emulsions is entirely removed.

(c) *Effect of wool protein.*—A negatively-charged emulsion may be flocculated by protein when the pH of the emulsion is less than the isoelectric point of the protein (pH 4 to 5 for wool protein). Anionic wetting agents usually give a slightly alkaline aqueous solution, and addition of fleece does not greatly modify this. Conditions are therefore not appropriate for flocculation of the emulsion by protein, whereas the reverse is the case for cationic emulsions.

(d) *Oil-fleece contact angle.*—Adsorption of long-chain cations to a solid surface renders the surface more easily wetted by oils than by water, but anionic wetting agents produce an opposite effect. The oil-fleece contact angle will be much higher, in general, than in cationic solutions, and the uptake of oil droplets from an anionic emulsion will be lower.

From the above it is clear that the processes which cause heavy deposition of oil phase on fleece in cationic emulsions are either not operative, or operate to a small extent only, in anionic emulsions. The following experiments were carried out to determine the extent to which these general conclusions apply in practice.

Experimental

The wetting agents and wool samples used were those referred to in the preceding paper. Emulsions were prepared as described in Part VII,[1] 1 ml. of xylene being emulsified in 25 ml. of

* Part VIII : preceding paper

solution. The quantity of oil phase taken up by the fleece was again measured using an oil-soluble, water-insoluble dyestuff in place of the insecticide. On removal of the 1-g. sample of fleece from the emulsion it was dried, and the dye extracted with 20 ml. of xylene. The colour of the solution was compared against standards, using a Spekker absorptiometer. The tetrabromoindigo used in the study of cationic emulsions was found to fade in the anionic emulsions used, but the azo dyestuff, Oil Yellow ATS, was satisfactory for this purpose.

Emulsion stability in the absence of fleece

The influence of chain length is shown diagrammatically in Fig. 1. The lithium salts were used because of their higher solubility. Fig. 1 may be compared directly with the corresponding diagram for cationic emulsions (Fig. 1, Part VII[1]). Although the concentration range for complete stability is rather narrower with anionic emulsions, their general stability is greater. This is indicated by the general observation that the anionic emulsions cream more readily, but break much less readily, than do cationic emulsions. Upper and lower concentration limits for stability arise for similar reasons in both systems. At the lower concentration, insufficient wetting agent is available to stabilize the emulsion; the upper limit is set by the

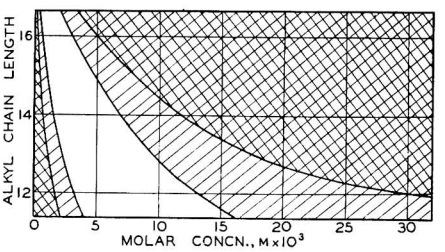

FIG. 1.—*Stability of xylene–water emulsions in presence of lithium alkyl sulphates*
Unshaded area: emulsion stable after 3 hours
Light shading: emulsion showed pronounced creaming after 3 hours
Heavy shading: emulsion broke within 3 hours

flocculating power of the wetting agent, which accounts for the greater stability of anionic emulsions at high wetting agent concentrations. As far as their solubilities permit measurement, the sodium and potassium alkyl sulphates gave stability diagrams almost identical with Fig. 1, so that change in positive ion has little influence on stability. This is consistent with the fact that the alkyl sulphates of lithium, sodium, potassium and ammonium all give approximately the same interfacial tension–concentration curve, and is in marked contrast with the changes which occur on variation of the halide ion in the alkyl pyridinium salts.

Immersion of single fleece samples

These measurements were made to determine the influence of wetting agent concentration, positive ion and chain length on the uptake of emulsion. One-g. samples of fleece were immersed in 50 ml. of emulsion for 30 minutes. Emulsion uptake is expressed as a percentage of the total oil-phase originally present in the emulsion, and the results are given in Table I.

Table I

Influence of chain length and positive ion of anionic wetting agent on emulsion uptake by root fleece

Concn. of wetting agent M	Uptake of oil phase (%)					
	Lithium dodecyl sulphate		Lithium tetradecyl sulphate	Lithium hexadecyl sulphate	Sodium tetradecyl sulphate	
0·002	8·5	10·0*	15·2	12·2	15·0	11·0†
0·005	9·0	9·6	18·0	19·0	17·7	11·6
0·008	10·0	11·0	20·2	21·8	18·5	10·8
0·01	10·5	12·2	21·5	—	21·0	10·8
0·015	14·4	14·6	—	—	—	—
0·02	21·0	19·0	—	—	—	—

* Results obtained using DDT in oil phase, and analysis of DDT on fleece
† Results obtained using tip fleece

Results in the preceding paper show that increase in the inactivation of wetting agent by fleece with increase in alkyl chain length is not considerable, and that over the concentrations used here, variation in alkali metal ion has little effect. These general observations apply to the results in Table I also, so that there is a close relationship between inactivation of the wetting agent and the uptake of emulsion by the fleece. Two important practical aspects emerge from a comparison of these results with those for cationic emulsions. Firstly, the emulsion uptake is much smaller, and is now acceptable from the dipping point of view. Secondly, in no case did the emulsions break, but there was a considerable tendency towards creaming, particularly with tip fleece samples, even with solutions made up in the complete stability concentration range (Fig. 1).

Variation in emulsion uptake with immersion time

The results in Fig. 2 illustrate the one serious defect which anionic wetting agents possess from the point of view of their use in dips. The emulsion uptake varies almost linearly with time over the first two minutes of fleece immersion, and continues to increase slowly thereafter. In an ideal dip it is essential that the deposition of oil phase, and thus insecticide, should be capable

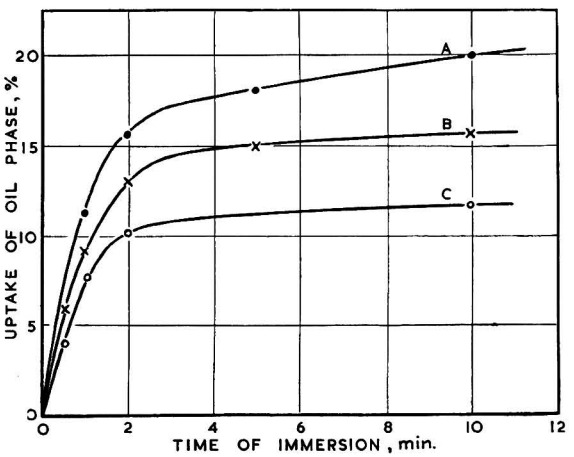

FIG. 2.—*Influence of immersion time on the uptake of oil phase from xylene–water emulsions by root fleece*

A 0·005M-lithium tetradecyl sulphate
B 0·0025M-sodium tetradecyl sulphate
C 0·002M-lithium hexadecyl sulphate

of close control. The control of immersion times alone is not enough ; a sheep carries a considerable volume of dip fluid from the bath, and the rate at which this drains away varies with the weight and physical nature of the fleece. Under these conditions it would appear to be impossible to control the insecticide deposit with any accuracy.

Successive addition of fleece samples

One-g. samples of fleece were immersed successively in 50 ml. of emulsion for one minute. The cumulative percentage of oil phase removed is given in Figs. 3 and 4, and in Table II.

Emulsion removal from cationic and anionic emulsions is compared in Fig. 3. With the cationic emulsions only 0·5-g. samples of fleece were used, so that for true comparison the values for anionic emulsions should be approximately halved. This emphasizes the considerable differences in behaviour of the two emulsions. The values given in Table II show that emulsion removal is regular, each sample removing the same quantity of emulsion from the bath. The fleece weight : emulsion volume ratios used are much larger than those in practice, which would be equivalent to the use of 0·1- to 0·2-g. fleece samples in 50 ml. of emulsion. The removal of

Table II

Wetting agent	Concentration M	Nature of wool sample	Cumulative percentage of oil phase removed by wool sample numbered 1	2	3	4	5	6
Potassium dodecyl sulphate	0·003	Root flank	5	11	17	24	33	—
	0·003	Tip flank	8	16	23	30	35	—
	0·015	Root flank	6	12	17	22	26	—
	0·015	Tip flank	6	11	16	21	27	—
Sodium tetradecyl sulphate	0·001	Root flank	6	12	18	24	30	37
	0·001	Tip flank	6	12	17	23	29	35
	0·005	Root flank	7	14	21	28	36	—
	0·005	Tip flank	4	9	15	21	28	—
Lithium hexadecyl sulphate	0·0005	Root flank	5	10	15	21	27	—
	0·0005	Tip flank	6	12	18	24	30	—
	0·002	Root flank	8	15	21	28	33	—
	0·002	Tip flank	7	14	22	29	35	—

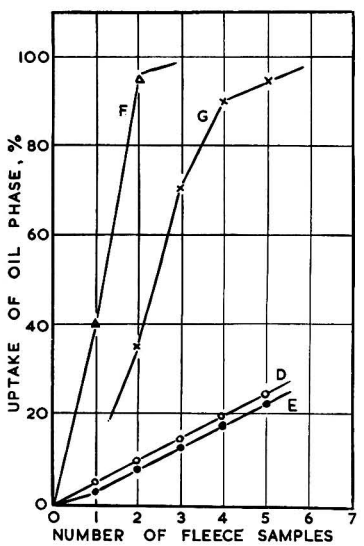

FIG. 3.—*Comparison of cumulative uptake of oil phase from anionic and cationic emulsions by successive fleece samples*

Curve	Wetting agent	Concn., M	Fleece sample
E	Lithium dodecyl sulphate	0·015	root flank
D	Lithium dodecyl sulphate	0·005	tip flank
F	Dodecylpyridinium iodide	0·005	root flank
G	Dodecylpyridinium iodide	0·005	tip flank

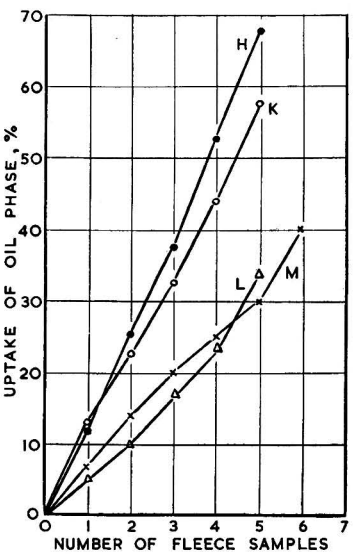

FIG. 4.—*Cumulative uptake of oil phase from lithium tetradecyl sulphate solutions by successive fleece samples*

Curve	Concn., M	Fleece sample	Immersion time, min.
H	0·005	tip flank	1·5
K	0·005	root flank	1·5
L	0·001	tip flank	1·0
M	0·001	root flank	1·0

emulsion is broadly independent of the positive ion, the chain length or the concentration of the wetting agent. This attractive picture is marred only by the variation in uptake with immersion time ; Fig. 4 (curves K and H) shows the considerable increase in successive uptake which results from an increase in immersion times from 1 to 1·5 minutes. Although these properties have been tested for the alkyl sulphates only, they are of a fundamental nature and are likely to apply, to a greater or lesser extent, to all anionic emulsions.

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Reference

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MINERALIZATION OF THE NITROGEN OF UREA–FORMALDEHYDE COMPOUNDS IN RELATION TO SOIL pH

By G. W. WINSOR and M. I. E. LONG

Mineralization of the nitrogen of two urea–formaldehyde compounds has been studied in twenty soils having initial pH values ranging from 3·9 to 7·8. The results show highly significant negative correlations between soil pH and the accumulation of inorganic nitrogen throughout the experiments. For comparison, the initial rates of decomposition of a sample of hoof were also studied in the same soils. In contrast to the urea–formaldehyde compounds, mineralization of the nitrogen of hoof was markedly retarded in three of the most acid soils, the results for the remaining soils showing no significant relationship to soil pH.

Introduction

As part of an investigation of the decomposition of nitrogenous fertilizers in the soil, experiments on the preparation and testing of urea–formaldehyde compounds have already been described.[1] Some of the urea–formaldehyde materials examined proved similar to finely ground hoof and horn both in rate and extent of decomposition in the soil. In general, however, it appeared difficult to prepare materials in which the properties of slow decomposition and high ultimate availability in the soil were combined. The soil used in these earlier experiments was a market garden soil having a pH value of approximately 7·3. Mineralization of the nitrogen of natural organic fertilizers proceeded readily in this soil, accompanied by relatively small changes in pH. Preliminary tests with other soils, however, subsequently showed more rapid decomposition of urea–formaldehyde compounds in acid soils than in the market garden soil. More extensive experiments were accordingly made, using a group of 20 soils differing widely in origin and having initial pH values ranging from 3·9 to 7·8. A brief description of these soils is given in Table I.

Two samples of urea–formaldehyde compound were tested in the 20 soils. Sample A was prepared in the laboratory by refluxing urea dissolved in formalin for one hour at pH 5·5, the molar ratio of urea to formaldehyde being 0·5. The reaction mixture was then neutralized and dried at 80°. The product contained 26·2% of nitrogen, 59·4% of the total nitrogen being water-soluble. Sample B consisted of plastic waste milled in the laboratory, containing 17·8% of nitrogen of which only 4·3% was water-soluble. In order to compare the initial rates of decomposition of urea–formaldehyde materials with a natural organic fertilizer in the various soils, tests were also made with a sample of hoof containing 15·7% of nitrogen.

Experimental

Experiments on the decomposition of the urea–formaldehyde samples in soil were made in glass jars containing 700 g. of moist soil, at a concentration of 300 p.p.m. of added nitrogen calculated on the basis of oven-dry soil. The moisture content was adjusted to the moisture equivalent of each soil. The soils were incubated at 23·5°, samples being taken from duplicate jars for the determination of ammonia and nitrate as previously described.[1]

For measurements of the solubility of urea–formaldehyde samples in solutions of known pH 0·2 g. samples were incubated in stoppered flasks with 100 ml. of 0·05M-phthalate or -phosphate buffer solution, with three drops of toluene added as preservative. For analysis the solutions were filtered and nitrogen determined in the filtrate by the Kjeldahl procedure.

Determinations of pH were made with a glass electrode in soil suspensions shaken for one hour at a water/soil ratio of 2·5. A centrifuge was used in the determination of moisture equivalents.

Results

Determinations of ammonia and nitrate were made for urea–formaldehyde samples A and B after 1, 2, 3, 4, 6, 8, 12, 16 and 26 weeks in the 20 soils. The complete data are too extensive to be recorded here in full. The form of the mineralization curves for samples A and B in five soils having widely different initial pH values is illustrated in Figs. 1 and 2 respectively. Data for three periods of incubation, together with the pH values of the treated soils at the final date of sampling, are given in Table I. The values for percentage mineralization of nitrogen have been calculated as the sums of ammonia and nitrate in the treated soils, less the corresponding values for the control soils, expressed as a percentage of the total nitrogen added.

Values for the percentage mineralization of the nitrogen of sample A after incubation for 2 weeks range from 8% in an alkaline soil to 69% in a highly acid soil, and for sample B from 3 to 45%. The rates of mineralization of nitrogen thus increased markedly with decreasing pH. The results for an incubation period of 26 weeks in general show a similar relationship to pH, though in certain acid soils the calculated values for percentage mineralization of nitrogen appeared to decrease in the later stages of the experiment.

Correlation coefficients relating the percentage mineralization of nitrogen and soil pH are given in Table II. Data for the mineralization of nitrogen after 1-, 2- and 4-week periods of incubation have been correlated with initial soil pH ; for longer periods of incubation the actual pH of the treated soils was used.

All the correlation coefficients in Table II relating mineralization of the nitrogen of the two urea–formaldehyde samples to soil pH are highly significant ($P = 0{\cdot}001$). It may, however, be noted that for sample A after incubation for 26 weeks the percentage mineralization of nitrogen is less closely correlated with soil pH than is the case for shorter periods of incubation. This result is associated with the tendency, already referred to, for the calculated values for percentage mineralization of nitrogen to decrease on prolonged incubation in certain acid soils.

With soils having pH values not less than 6·5 the amounts of ammonia–nitrogen resulting from treatment with the urea–formaldehyde compounds never exceeded 3 p.p.m. Appreciable amounts of ammonia were, however, present in more acid soils incubated with the urea–formaldehyde samples. Thus soils having initial pH values of 6·2 or less accumulated 11–185 p.p.m. of ammonia–nitrogen within the first week of incubation. Little or no nitrification occurred within the first three weeks in soils having initial pH values up to 5·4 when incubated with urea–formaldehyde sample A, or with pH values up to 4·4 for sample B. With the exception of soil 19 treated with sample A, however, some nitrate accumulated in all soils treated with urea–formaldehyde on incubation for 26 weeks.

Accumulation of ammonia and nitrate caused appreciable changes in the pH of many of the soils tested. In the more alkaline soils nitrogen accumulated mainly as nitrate, and the presence of carbonate prevented more than a small decrease in pH. Soils having initial pH values in the approximate range 5·5–6·5 were far less well buffered against acidity, and differences in pH of up to 1 unit between the treated and untreated soil samples were observed. For the last five soils in Table I, having initial pH values of 4·5 or less, the pH after incubation with urea–formaldehyde samples for 26 weeks exceeded that of the corresponding control soils owing to accumulation of

Table I

% Mineralization of the nitrogen of urea-formaldehyde samples A and B after incubation for 2, 8 and 26 weeks, together with the pH of the treated soils at the final date of sampling. (Results for hoof after incubation for 2 weeks are included for comparison)

Soil no.	Origin	Initial pH	Moisture equivalent	Nitrogen %	Sample A				Sample B				Hoof
					Incubation period, weeks			pH after 26 weeks	Incubation period, weeks			pH after 26 weeks	Incubation period, 2 weeks
					2	8	26		2	8	26		
1	Farm	7·8	12·0	0·11	8	29	42	7·7	3	5	10	7·8	38
2	Farm	7·8	18·5	0·28	9	27	39	7·6	3	9	16	7·5	30
3	Farm	7·7	13·2	0·22	13	35	56	7·3	4	8	19	7·4	47
4	Glasshouse	7·6	22·8	0·42	10	23	36	7·5	4	9	8	7·5	32
5	Woodland	7·5	25·0	0·39	21	48	60	6·6	4	8	17	7·0	22
6	Farm	7·3	16·0	0·25	16	49	60	6·6	3	9	18	7·0	48
7	Garden	7·0	23·9	0·41	16	45	65	6·5	3	7	21	6·9	50
8	Clay (excavated)	6·5	18·2	0·22	25	65	85	5·8	4	13	42	5·9	28
9	Forestry Commission	6·2	24·6	0·33	40	85	95	4·7	11	46	76	4·7	27
10	Forestry Commission	6·0	25·0	0·36	49	81	90	4·6	14	51	76	4·6	43
11	Forestry Commission	5·9	18·5	0·20	46	72	81	4·7	13	50	67	4·8	47
12	Orchard	5·7	24·9	0·34	47	82	88	5·0	13	45	76	4·9	31
13	Farm	5·6	12·8	0·14	43	77	84	4·6	10	50	76	4·8	39
14	Forestry Commission	5·4	22·0	0·32	49	74	71	4·3	22	59	64	4·2	25
15	Forestry Commission	5·0	15·8	0·22	34	70	84	4·5	12	44	59	4·4	40
16	Forestry Commission	4·5	19·8	0·28	47	67	72	4·4	29	56	75	4·3	30
17	Field	4·4	17·2	0·21	59	80	87	4·8	30	61	79	4·7	11
18	Woodland	4·2	23·5	0·37	67	78	62	4·3	41	69	74	4·3	10
19	Field	4·1	13·8	0·18	47	68	81	5·0	30	53	70	4·7	18
20	Woodland	3·9	25·2	0·36	69	78	52	4·4	45	62	69	4·6	9

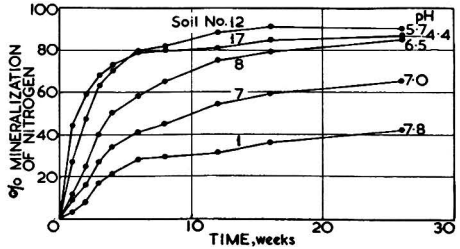

FIG. 1.—*Mineralization of the nitrogen of urea-formaldehyde sample A in 5 soils having initial pH values ranging from 4·4 to 7·8*

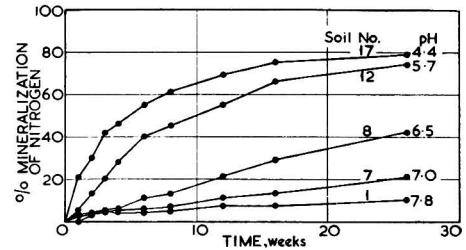

FIG. 2.—*Mineralization of the nitrogen of urea-formaldehyde sample B in 5 soils having initial pH values ranging from 4·4 to 7·8*

Table II

Correlation coefficients relating soil pH and % mineralization of added nitrogen

Period of incubation	Sample A	Sample B
1*	− 0·885	**
2*	− 0·920	− 0·910
4*	− 0·837	− 0·948
8	− 0·887	− 0·962
16	− 0·899	− 0·974
26	− 0·727	− 0·965

* Correlated with initial soil pH
** Non-linear relationship

ammonia. As the result of pH changes during incubation the final pH values showed far less variation than did the initial values. Thus the last 12 soils in Table I, having initial pH values of 3·9–6·2, showed final pH values of 4·3–5·0 and 4·2–4·9 after incubation for 26 weeks with urea–formaldehyde samples A and B respectively.

The close relationship between mineralization of nitrogen and changes in soil pH is illustrated in Fig. 3. The data shown are for the 12 soils in Table I having initial pH values up to 6·2, thus avoiding the buffering effect due to the presence of carbonate. Expressing the values for ammonia, nitrate and pH as differences between soils incubated for 16 weeks with and without urea–formaldehyde, the amounts of nitrate-nitrogen formed, minus the amounts of ammonia formed, have been plotted against the accompanying changes in soil pH. As may be expected, accumulation of equivalent amounts of ammonia and nitrate had little effect on soil pH.

In view of the relationship found between mineralization of the nitrogen of urea–formaldehyde samples and the pH of the soils it was considered of interest to examine the effect of pH upon the solubility of urea–formaldehyde materials. As shown in Table III, the amount of soluble nitrogen found after incubation for 2 and 7 days increased with acidity.

Discussion of results

The results given in Table I and Figs. 1 and 2 show that the rate of decomposition of urea–formaldehyde materials varies greatly from soil to soil. As shown in Table II the rates of conversion to inorganic forms of nitrogen are significantly correlated with the pH of the soils. The relationship between mineralization of nitrogen and soil pH is complicated by the changes in pH caused by accumulation of ammonia or nitrate; an even closer relationship with pH might be found if due allowance could be made for the changing pH values throughout the period of incubation. Whether such variations in pH account for certain deviations from the general relationship between pH and mineralization of nitrogen, or whether some other properties of the soil influence decomposition of urea–formaldehyde, is as yet unknown. The degree of correlation shown in Table II does, however, indicate that pH is of primary importance in the decomposition of urea–formaldehyde compounds in the soil.

Kralovec & Morgan[2] have published data for the nitrification of a urea–formaldehyde sample in 3 soils, nitrification being more rapid in a soil having an initial pH value of 6·1 than in soils of pH 5·0 and 7·3. The results for accumulation of nitrate in our experiments support those of Kralovec & Morgan, the highest rates of nitrification being found in soils having initial pH values within the approximate range 5·5–6·0. The existence of this optimum range of pH for the formation of nitrate from urea–formaldehyde samples may be attributed to two factors—(1) the rate of mineralization of nitrogen increases with increasing acidity, (2) in the more acid soils

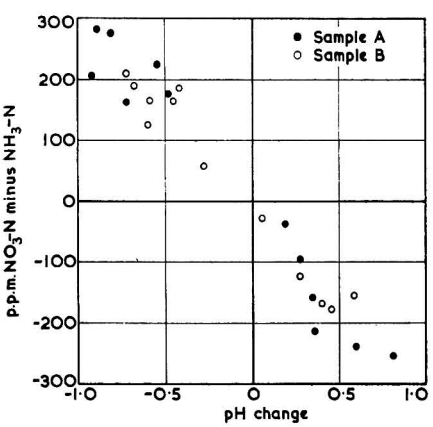

FIG. 3.—*The relationship between accumulation of inorganic nitrogen in the forms of ammonia and nitrate and changes in soil pH, all values being expressed as differences from the corresponding untreated soils after incubation for 16 weeks*

Table III

Effect of pH on the solubility of urea–formaldehyde sample B in buffered solutions

pH	% Soluble nitrogen*	
	After 2 days	After 7 days
4·0	37·9	50·5
4·5	34·0	45·0
5·0	26·6	39·9
5·5	18·7	26·1
6·0	15·3	18·3
6·5	8·7	13·1
7·0	8·1	10·4
8·0	7·0	9·1

* Expressed as a percentage of the total nitrogen content of the sample

nitrification is retarded and the inorganic nitrogen formed accumulates in the form of ammonia. Since both ammonia and nitrate can, in general, be utilized for plant growth, the rate at which the nitrogen of urea–formaldehyde samples becomes available in the soil will be governed by the processes leading to formation of ammonia rather than by its subsequent nitrification.

The results of laboratory experiments with sample B, and unpublished data for two other samples, suggest that urea–formaldehyde waste materials (' flash ') should be of value as nitrogenous fertilizers in soils having initial pH values not exceeding 6–6·5, but not in alkaline soils. Thus, in the 12 soils in Table I having initial pH values of 6·2 or less, 61–75% of the nitrogen of sample B was converted into inorganic form within 16 weeks.

The initial rates of decomposition of urea–formaldehyde and of hoof in the 20 soils, as shown on incubation for 2 weeks, were found to be negatively correlated, values of the correlation coefficient r being — 0·580 and — 0·729 significant at P = 0·01 and 0·001, respectively, for urea–formaldehyde samples A and B. The relationship between soil pH and decomposition of the natural organic fertilizer thus differs from that found for urea–formaldehyde materials. When all 20 soils are included a positive relationship between the initial rates of decomposition of hoof and soil pH is apparent (r = 0·584, significant at P = 0·01) ; this relationship is greatly influenced by the slow breakdown of hoof in three of the most acid soils, however, the remaining 17 soils, showing no significant relationship with pH (r = + 0·251).

The different relationship between pH and the decomposition of hoof and of urea–formaldehyde samples in the soil suggests differences in the processes of decomposition of the two types of material. It may even be that the initial stages in the decomposition of urea–formaldehyde samples in soil are chemical rather than biological. Some support for this view may be found in experiments on the solubility of urea–formaldehyde samples in buffer solutions, the solubility increasing with acidity within the range pH 4–8 (Table III). The solubility of urea–formaldehyde samples in acid buffer solutions may prove a useful guide to their rates of decomposition in the soil, and further experiments on this subject are in hand.

Acknowledgments

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JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

AUGUST, 1956

The general arrangement of the abstracts is as follows: 1.—AGRICULTURE AND HORTICULTURE. 2.—FOOD; also appropriate Microbiological Processes; Essential Oils. 3.—SANITATION, including Water; Sewage; Atmospheric Pollution, etc. 4.—APPARATUS AND UNCLASSIFIED.

INDEX OF AUTHORS' NAMES

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JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

AUGUST, 1956

I.—AGRICULTURE AND HORTICULTURE

General : Soils and Fertilisers

Classification of soils. G. W. Leeper (*J. Soil Sci.*, 1956, **7**, 59—64).—Present methods of classification are discussed and criticised and a new method of classification is put forward. A. H. CORNFIELD.

Coloured photographs of soil profiles. E. A. Fitzpatrick (*J. Soil Sci.*, 1956, **7**, 65—67).—A technique for the production of illustrations of soil profiles in their natural colours is described. A. H. CORNFIELD.

Profile development in the sand dunes of Culbin Forest, Morayshire. II. Chemical properties. T. W. Wright (*J. Soil Sci.*, 1956, **7**, 33—42).—Chemical properties of the soil (including litter) in sand dunes under tree crops of different species and age class are presented. For up to 15—20 years, corresponding with complete closure of canopy, downward movement of nutrients was rapid but thereafter percolation of nutrients from the litter restored the balance. In plots with older trees enrichment of surface layers has increased further. Both total and available PO_4''' increased markedly with decreasing sand-grain size, although the general level of total PO_4''' was very low. There were considerable variations in the nutrient content of the litter with season. A. H. CORNFIELD.

Soil survey : Macon Co., N. Carolina. E. F. Goldston, W. Gettys and J. W. Moon (*U.S. Dep. Agric.*, 1956, Series 1944, No. 6, 124 pp.).—The types and phases of the soils in the area named are described and their use, management and productivity are discussed. H. S. R.

Soil survey : Mecklenburg Co., Va. E. F. Henney, A. W. Sinclair, H. H. Perry, C. S. Simmons, R. V. Leighty, H. R. Satterfield, N. B. Pfeiffer and W. E. Hearn (*U.S. Dep. Agric.*, 1956, Series 1942, No. 13, 116 pp.).—A general description is given, with maps, of the different types of soils found in the area named, and their character, phases, uses and management. H. S. R.

Soils of the Katherine-Darwin regions, Northern Territory. R. A. Stewart (*Commonw. sci. industr. Res. Org., Aust.*, 1955, *Soil Publ.* No. 6, 68 pp.).—A description and classification is given of the soils in the area named and their ecology and genesis are discussed. An attempt has been made to estimate the chemical fertility of the soils, and factors likely to influence agricultural development are indicated. H. S. R.

Gilgai phenomena in tropical black clays of Kenya. I. Stephen, E. Bellis and A. Muir (*J. Soil Sci.*, 1956, **7**, 1—9).—Mineralogical, chemical and physical characteristics of gilgai soils, derived from intermediate larvas of high Na content which have weathered straight into montmorillonite, are reported. The " puff " (island) soils contained less clay, were lower in exchangeable Na, and swelled to a smaller extent in water than did the " shelf " (surrounding) soil. Growth of crops on the puff was markedly superior to that on the shelf soil. A. H. CORNFIELD.

Alpine soils of the Rocky Mountains. J. L. Retzer (*J. Soil Sci.*, 1956, **7**, 22—32).—Morphological characteristics and geological relationships of Alpine turf, meadow and bog soils in the Rocky Mountains are presented. Chemical and physical characteristics of the Alpine turf soils are also recorded. A. H. CORNFIELD.

Some moving soils in Spitsbergen. J. Smith (*J. Soil Sci.*, 1956, **7**, 10—21).—Characteristics of the soils are described. A. H. CORNFIELD.

Houston Black Clay, the Type Grumusol. I. Field morphology and geography. E. H. Templin, I. C. Mowery and G. W. Kunze. **II. Mineralogical and chemical characterisation.** G. W. Kunze and E. H. Templin (*Proc. Soil Sci. Soc. Amer.*, 1956, **20**, 88—90, 91—96).—I. Distribution, morphology and relationship to similar series and catenary associations are described.

II. Mineralogical and chemical characteristics of five profiles are presented. A. H. CORNFIELD.

Silica particles in some British soils. F. Smithson (*J. Soil Sci.*, 1956, **7**, 122—129).—The occurrence of quartz, chalcedony (flint, chert) and opaline silica in British soils is described. The manner in which the different forms of silica have arisen is discussed. A. H. CORNFIELD.

Occurrence of an aluminium-sepiolite in a soil having unusual water relationships. L. E. R. Rogers, J. P. Quirk and K. Norrish (*J. Soil Sci.*, 1956, **7**, 177—184).—The chemical composition and physical properties of a mineral found in the clay fraction of a swamp soil are compared with those of other minerals. The mineral is isostructural with sepiolite but contains much more Al, less Mg and shows higher water retention than does the latter. A. H. CORNFIELD.

Cristobalite in clay fractions of volcanic ashes. R. R. Hardjosoesastro (*J. Soil Sci.*, 1956, **7**, 185—188).—*X*-Ray measurements showed that the $<0{\cdot}5\mu$. fraction of volcanic ashes contained varying amounts of α-cristobalite. The significance of this in relation to soil genesis is discussed. A. H. CORNFIELD.

System for the description of soil structure and consistence in the field. B. E. Butler (*J. Aust. Inst. agric. Sci.*, 1955, **21**, 239—249).—Description of structure follows traditional lines but there is a more definite integration of the concept of the *ped*. and the parameters of grade, shape and size are more clearly defined. Consistence is based on an assessment of the yield-point, and on the effect of a small, prescribed amount of work done on a piece of the soil material ; two concepts, coalescence and pulverescence being introduced. The consistence parameter of a no. of soil materials is also discussed in relation to moisture status and texture. (18 references.) E. G. BRICKELL.

Physical, chemical and mineralogical properties of brown podsolic soils in southern New England : Paxton and Merrimac series. T. Tamura (*Soil Sci.*, 1956, **81**, 287—299).—Detailed analyses are given. T. G. MORRIS.

Soil density determination by direct transmission of gamma rays. R. K. Bernhard and M. Chasek (*Amer. Soc. Test. Mat.*, 1955, *Prepr.* **86**, 18 pp.).—An investigation on soil *d* determination by means of γ-ray transmission was undertaken. Experiments in the laboratory and in the field are described. A radiation source of 60 m.curie (irradiated ^{60}Co) and a radiation detector, comprised of a scintillation head in combination with a binary counter, were available. Fourteen different soils, characteristic of New Jersey, were investigated under various compaction and moisture conditions. Equations could be derived relating soil *d* with transmitted radiation energy and distance between radiation source and detector. Further studies are recommended. J.A.C. ABSTR., BULD. SCI. ABSTR. (R. B. C.).

Acidic properties of quartz. J. Rex Goates and K. Anderson (*Soil Sci.*, 1956, **81**, 277—282).—Finely divided (100—300 mμ.) quartz was treated with sodium ethoxide in alcohol or aq. NaOH. After centrifuging the concn. of Na in the supernatant liquid was determined. Two types of acidic sites were demonstrated. The data obtained are considered mathematically. T. G. MORRIS.

Ion-exchange phenomena in some soils containing amorphous mineral constituents. K. S. Birrell and M. Gradwell (*J. Soil Sci.*, 1956, **7**, 130—147).—The cation exchange capacity of volcanic ash and lateritic soils containing allophane, palagonite and amorphous oxides varied with nature and concn. of displacing cation used as well as with vol. of alcohol and its water content. This indicated that an adsorption mechanism other than normal base exchange was occurring in these soils. Equilibrium tests with various cations indicated that physical adsorption of cations was largely responsible for the apparent high exchange capacity of these soils. The type of adsorption closely resembles that which was exhibited by a synthetic hydrated alumina. Acetate and Cl′ were adsorbed to a much lesser extent than were cations. A. H. CORNFIELD.

Rainfall test for structure of tropical soils. H. C. Pereira (*J. Soil Sci.*, 1956, **7**, 68—74).—Undisturbed soil cores are brought to a standard moisture tension, the drainage tension is maintained at a standard value and the rate of infiltration (rainfall acceptance) is measured under the action of artificial rainfall of controlled drop-size and intensity. Rainfall acceptance of a soil which had been in ley for two or three years was greater than where the soil had been in ley for only one year. A. H. CORNFIELD.

[A] Balance of water in soils. L. Turc. **[B] Eighteen years of lysimetric studies.** E. M. Batisse (*C.R. Acad. Agric. Fr.*, 1956, **42**, 140—141).—[A] The phenomenon of retention of water by soil and its relation to temp. are discussed, the relationship giving a series of curves corresponding to different rain measurements and at varying temp. Given the climatic conditions of rainfall and temp., the flow

of rivers, supply to the water table, and the quantity of water necessary to irrigate a dry region may be calculated.

[B] The collected data from lysimetric studies during the period 1932—1949 were presented in three publications comprising about 260 pp. covering the balance of water and the lixiviation of certain elements, Si, Al, Fe, N, S, of H_3PO_4, org. matter, chalk, Mg and K. E. M. J.

Soil and water conservation research in Puerto Rico, 1938—1947. R. M. Smith and F. Abruna (*Puerto Rico agric. Exp. Sta.*, 1955, *Bull.* 124, 51 pp.).—Soil and water losses were much higher from fallow than from cropped soils. Water losses were less but soil losses were greater from soils under cultivated crops than from soils under grass. In comparison with burning the leaves, mulching sugar cane with sugar cane leaves had little effect on run-off, but greatly reduced soil losses. There were considerable increases in soil and water losses from a clay soil growing coffee following removal of cover plants and litter. The most effective covers for reducing soil losses were sugar cane with a complete mulch and tropical kudzu, whilst run-off was most effectively reduced with grass sods and tropical kudzu. Erosion losses are compared with those in the U.S. A. H. CORNFIELD.

Decreasing soil moisture evaporation loss. E. R. Lemon (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 120—125).—Recent Russian and American work on methods of reducing soil moisture evaporation are described. Reducing evaporation losses through the turbulent transfer of water vapour above the ground is done by allowing stubble to stand, adding surface mulches, increasing soil surface roughness and using windbreaks. Windbreaks and surface mulches were not always effective in reducing evaporation. Reducing evaporation losses by decreasing the capillary conductivity in the surface soil has been achieved by stratifying the soil and also by adding soil conditioners to increase aggregate size. Reducing losses by decreasing capillary flow through the use of surfactants (Na oleate, cetyl alcohol) was effective in some cases. A. H. CORNFIELD.

Degrees of adoption of erosion control practices in Shelby County, Iowa. W. N. Sutherland and W. D. Shrader (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 117—119).—The extent to which the Soil Conservation Service recommendations for controlling erosion on land of varying degree of slope were being followed by farmers is reported. A. H. CORNFIELD.

Hydraulic conductivity in large channels as determined by an electric analogue. W. D. Kemper and J. F. Lutz (*Soil Sci.*, 1956, **81,** 283—286).—The analogue consists of a pair of Cu screen electrodes suspended in an agar gel. A conductivity bridge is connected across the electrodes and the conductivity is measured under these conditions and also when lengths of Cu wire are distributed and orientated at random in the gel. The percentage increase in conductivity appeared to be a linear function of the total length of wire immersed. An equation connecting the % increase in conductivity and total length of wire was derived and applied to the hydraulic conductivity of soil which contained worm and root holes. T. G. MORRIS.

Effect of organic matter on erosion and run-off. R. E. Taylor, O. E. Hays and C. E. Bay (*Wisconsin agric. Exp. Sta.*, 1955, *Bull.* 516, 16 pp.).—All treatments (green manure or farmyard manure applied to the surface or ploughed under) reduced soil losses from a cropped severely eroded silt loam on 16% slope. Green manure was more effective than farmyard manure whilst mixtures of the two materials were the most effective. The treatments were not as effective in reducing run-off. A. H. CORNFIELD.

Mechanism of the exchange of adsorbed hydrogen ions by aluminium ions in soils. V. A. Chernov and L. P. Kislibsyna (*Pochvovedenie*, 1955, No. 3, 7—16).—Krasnozem and sod-podsolised soils were treated alternately with 0·05N-HCl and N-KCl. The KCl extracts of acid-treated soils all contained $H^{\cdot}$ and $Al^{\cdot\cdot\cdot}$ but the ratio of these ions depended on the soil type, the horizon within a given profile and on the interval between the acid and the saline extractions, replacement of $H^{\cdot}$ by $Al^{\cdot\cdot\cdot}$ on the soil particles increasing with the interval. Repeated alternate treatments did not alter the exchange capacity of the two upper horizons of the podsols but increased the capacity of the krasnozem, probably by extracting basic forms of the sesquioxides. SOILS & FERT. (A. G. P.).

Effect of soil reaction on uptake of nickel from a serpentine soil. W. M. Crooke (*Soil Sci.*, 1956, **81,** 269—276).—Oats were grown in pots with a high exchangeable Ni content, the soil receiving NPK at two levels and at different pH levels, the changes in pH level being brought about by either $CaCO_3$ or Na_2CO_3. In all treatments the exchangeable Ni decreased with increasing pH, Na_2CO_3 being slightly more effective than $CaCO_3$. Yields of oats with the low rate of fertiliser increased with pH to a max. at a pH of 6·4 for $CaCO_3$ and at 5·7 for Na_2CO_3 but generally yields with $CaCO_3$ were higher. With fertiliser at the higher rate yields with $CaCO_3$ increased with pH to a max. at pH 7 but with Na_2CO_3 the max. was at pH 5. The Ni content of leaves decreased with increasing pH and symptoms of toxicity did not appear except on the controls. The amount of Ni recoverable from the soil by N-ammonium acetate was reduced by increasing pH. $ZnSO_4$ either aq. or in acetic acid extracted more Ni than did water, acetic acid or aq. K_2SO_4. Possibly Zn displaced Ni from org. complexes. Destruction of the org matter of the soil freed more Ni than did Zn displacement. T. G. MORRIS.

Effect of soil pH and calcium on uptake of zinc by plants. J. I. Wear (*Soil Sci.*, 1956, **81,** 311—315).—Sorghum was grown in the greenhouse in a Zn-deficient soil (pH 5·6) treated with four levels of $CaCO_3$, Na_2CO_3 or $CaSO_4$ together with fertiliser and three levels of Zn. At harvest (35 days) the plants were analysed for Ca and Zn. 2000 lb. of $CaCO_3$ per acre increased the soil pH and the Ca content of the plant but considerably reduced the Zn uptake. Larger applications of $CaCO_3$ further reduced the uptake of Zn. Na_2CO_3 increased soil pH without affecting the Ca uptake, but reduced the Zn uptake of the plant. $CaSO_4$ increased both soil pH and Zn uptake and also increased the Ca content of the plant and the exchangeable Ca in the soil. Zn uptake was significantly related to soil pH but not to the Ca level of the plant. T. G. MORRIS.

Fixation and extractability of fission products contaminating various soils and clays. I. ^{90}Sr, ^{91}Y, ^{106}Ru, ^{137}Cs and ^{144}Ce. H. Nishita, B. W. Kowalewsky, A. J. Steen and K. H. Larson (*Soil Sci.*, 1956, **81,** 317—326).—Five soils and two clay minerals were treated with the desired amount of radio-isotope in aq. suspension. After 2 hr. the soils were dried at 100°, to help fixation, and then suspended in the appropriate leaching solution, left overnight and filtered: The filtered samples were leached with water, followed by neutral N-ammonium acetate or with the acetate only, to give " water-sol.", " exchangeable " and " extractable " fractions of the isotopes, respectively. The fixed fraction was obtained by difference. The amounts of isotopes found in each fraction increased with increasing dose but comprised a constant percentage of the dose. No fixed order was found in which the three fractions of the five radio-isotopes were retained in the soils. In comparison with other isotopes ^{137}Cs and ^{106}Ru were fixed in relatively large amounts by kaolinite. Bentonite after acid treatment adsorbed less ^{137}Cs and ^{144}Ce than did the untreated. The release of ^{91}Y, ^{137}Cs and ^{144}Ce, was greater in leaching solutions up to pH 5·5 than at higher pH. T. G. MORRIS.

Distribution of phosphorus in profiles and particle-size fractions of some Scottish soils. E. G. Williams and W. M. H. Saunders (*J. Soil Sci.*, 1956, **7,** 90—108).—The distribution of various forms of P in the whole soil of profiles as well as in clay, silt and sand separates was determined for seven profiles covering four main soil associations and including three pairs of corresponding freely-drained and poorly-drained members. Total soil P and org. P, in particular, decreased down the profiles. The clay + silt fraction contained 85% or more of the soil org. P. In top soils 27—67% of the P present was in org. form. Poorly-drained soils had much lower org. P contents than did freely-drained soils. In general total P was highest in the clay and lowest in the coarse sand fractions, although in gleyed subsoils the fine sand contained more P than did the clay. The P in the sand fractions was largely inorg. and was Ca-bound. The effects of parent material are discussed and the importance of drainage conditions on P relationships of the soils is emphasised. A. H. CORNFIELD.

Electron-microscope observations of the reaction of phosphate with minerals, leading to a unified theory of phosphate fixation in soils. J. A. Kittrick and M. L. Jackson (*J. Soil Sci.*, 1956, **7,** 81—89).—Greenalite (iron silicate) and kaolinite reacted with sol. PO_4''' by the mechanism of chemical pptn. to form separate-phase PO_4''' crystals. The reaction products depended on temp. (e.g., kaolinite formed taranakite at room temp. and minyulite at 90°) and sometimes also on pH and nature of the cations present. The formation and growth of separate-phase PO_4''' ppt. of varying composition depending on the predominant cations, and of varying reactivity depending on sp. surface, formed by the mechanism of chemical pptn., provides a unified theory of PO_4''' fixation which explains the whole range of observed facts of PO_4''' reaction in Fe, Al and Ca systems. A. H. CORNFIELD.

Formation of dark-coloured clay-organic complexes in black soils. S. Singh (*J. Soil Sci.*, 1956, **7,** 43—58).—Mortmorillonitic clays separated from various soil types (including black soils) formed dark-coloured complexes with anaërobically-fermented grass extracts. Kaolinite and a red soil clay (rich in kaolinite) did not produce dark-coloured complexes in spite of the high adsorption of org. matter by the red soil clay. The C/N ratio of the org. matter adsorbed by the different clays varied only slightly. Na-clays adsorbed greater amounts of org. matter and gave darker products than did H-, Ca- or Mg-clays. The fact that org. complexes were

adsorbed to an appreciable extent only at pH below about 7 indicates that the colour of black cotton soils develops only when acidity is developed under periodic anaërobic conditions. The C/N ratio of the adsorbed org. matter was similar with varying conditions of pH during reaction and with different bases present.
A. H. CORNFIELD.

Organic-matter and nitrogen status of East African soils. H. F. Birch and M. T. Friend (*J. Soil Sci.*, 1956, **7**, 156—167).—Org. matter content (Walkley-Black-C × 2) of 570 surface samples of E. African soils is presented. Of the soils 47% contained more than 4% of org. matter. Org. matter content was significantly correlated with altitude and rainfall. Each 1000-ft. increase in altitude was associated with 0·8% increase whilst each 10 in. increase in rainfall was associated with 1·3% increase in org. matter content. Rainfall was the main factor governing org. matter content. The direct effect of temp. on org. matter and N contents was small compared with that of rainfall. The clay content was unimportant in determining org. matter content.
A. H. CORNFIELD.

Influence of some common soil fungi on growth of citrus seedlings. J. P. Martin, L. J. Klotz, T. A. DeWolfe and J. O. Ervin (*Soil Sci.*, 1956, **81**, 259—267).—Citrus and non-citrus soil was fumigated with propylene oxide, and after five days spread out to remove the fumigant. Citrus seedlings were then grown in the soil which was inoculated with spores of different soil fungi. Destruction of the fungus in citrus soil increased plant growth to a degree comparable with that obtained with non-citrus soil. Of the four fungi used, only *Fusarium oxysporum* caused (slight) reduction in growth; all the others singly, or in combination had no effect. *F. oxysporum* was ineffective when in combination with the others. Among fungi known to increase in citrus soils, only *Thielaviopsis basicola* markedly reduced growth alone; it was much less effective in combination with others. On another soil *T. basicola* in combination with *F. solani*, *Penicillium funiculosum*, *Trichoderma viride* or *P. chrysogenum* decreased growth almost as much as it did alone, although with *Stachybotrys atra* or *P. nigricans* its effect was much less. Leaves of plants on the untreated, old citrus soil were chlorotic; fumigation prevented this, but *T. basicola* caused it to reappear. Fumigation reduced leaf-Ca and increased the -Mn content but inoculation of the soil with fungi had little effect on leaf constituents.
T. G. MORRIS.

Oxidation of hydrocarbons by soil bacteria. I. Morphological and biochemical properties of a soil diphtheroid utilising hydrocarbons. J. N. Ladd (*Aust. J. biol. Sci.*, 1956, **9**, 92—104).—The morphology is described of a soil bacterium, *Corynebacterium* sp., capable of oxidising aliphatic hydrocarbons; hexadecane, tetradecane and decane are completely oxidised. The organism also oxidises straight-chain fatty acids (C_1—C_{10}), fatty alcohols (C_2—C_{11}), several aliphatic aldehydes, and the higher Me ketones; it is unable to oxidise lower ketones and cyclic compounds. Decane oxidation is unaffected by malonate at concn. inhibiting succinate oxidation, but is inhibited to varying extents by fluoroacetate, CN′, azide, Hg^{II} and iodoacetate; cysteine completely reactivates cells inhibited by iodoacetate. Lactic and glutaric acids were identified chromatographically in the oxidation products of decane.
S. C. JOLLY.

Measurement of the hemicellulolytic activity of soils. I. Methods. J. Augier (*Ann. Inst. Pasteur*, 1956, **90**, 161—170).—The technique described consists of the inoculation, with diluted soil suspensions, of hemicellulolytic elective media and daily examination for nitrite content and reduction of hemicelluloses, the results being plotted as curves with respect to time and dilutions. The rate of attack of the hemiculluloses by the soil bacteria is indicated by a differential curve based on the two primary curves. The nitrite curve is hyperbolic.
J. S. C.

Tools for soil testing. Anon. (*J. agric. Food Chem.*, 1956, **4**, 122—123).—Equipment used for soil testing in the field, in county soil-testing laboratories and in research laboratories is illustrated.
N. M. WALLER.

Chemical basis for soil testing. J. F. Reed (*J. agric. Food Chem.*, 1956, **4**, 116—121).—A review of the chemical methods of soil testing used in America today. Analyses commonly conducted include soil acidity; mineral element determination, P, K, Ca and Hg; trace element determination; N content, and org. matter determination. (17 references.)
N. M. WALLER.

Molybdenum determination in soils and rocks with dithiol. L. J. Clark and J. H. Axley (*Analyt. Chem.*, 1955, **27**, 2000—2003).—From 0·02 to 10 μg. of Mo can be determined accurately by measuring the transmittance of the green Mo–dithiol complex (formed in 4N-HCl and extracted with *iso*amyl acetate) at 680 mμ. in a spectrophotometer fitted with 12 × 75 mm. cells. The colour is stable for at least 14 days; the Mo content is calculated from the calibration curve for standard Mo solutions. The precision is 0·02 μg. per g. of Mo, and the method is applicable to soils, rocks, sewage sludges, inorg. fertilisers, etc. Procedures for controlling interference from $Fe^{\cdots}$, W, Cu, Pt and SiO_2 are described.
W. J. BAKER.

Rapid determination of nitrogen, phosphorus and potassium in fertilisers. J. Solari (*Industr. agric. aliment.*, 1956, **73**, 25—27).—The determination of free NH_3 by distillation, fixed N by the Kjeldahl method, the Bertrand method of estimating K and P, the phosphomolybdate colorimetric method of determining P, and methods of determining K by pptn. as K tetraphenylboron, are reviewed in relation to their application to natural and artificial fertilisers, from the standpoint of rapidity and simplicity, coupled with sufficient accuracy for the purpose.
J. S. C.

Solubility relationships and nitrification characteristics of "urea-form." K. G. Clark, J. Y. Yee, V. L. Gaddy and F. O. Lundstrom (*J. agric. Food Chem.*, 1956, **4**, 135—140).—Thirty-five urea–formaldehyde reaction products, ranging from 0·75 to 1·4 in mol. ratio of urea to formaldehyde, are studied in relation to their use as fertilisers. Determinations of N and formaldehyde contents, neutral permanganate activities, solubility patterns, activity indexes and nitrification characteristics in soil media are recorded. The solubility pattern procedure and the recently adopted activity index are shown to be more reliable than the neutral permanganate activity in characterising the products for use as fertilisers. (17 references.)
N. M. WALLER.

Relative effectiveness of granule coating agents. R. Kumagai and J. O. Hardesty (*J. agric. Food Chem.*, 1956, **4**, 132—135).—The results are reported of laboratory caking tests on 12 : 12 : 12—N : P_2O_5 : K_2O, granular mixed fertiliser with and without the addition of varying amounts of 17 coating agents. Effectiveness is closely related to relative bulk density of the agent, those of low bulk density being most efficient. Additions of 2% of hydrated silica, synthetic Ca and Mg silicates and diatomaceous earth, with bulk densities in the range 7—15 lb./cu. ft., reduce crushing strength of fertiliser cake in the range 54—71%.
N. M. WALLER.

Effect of ammonia incorporated in superphosphate on the nodulation of clover on acid soils. J. F. Loneragan, D. Meyer, R. G. Fawcett and A. J. Anderson (*J. Aust. Inst. agric. Sci.*, 1955, **21**, 265—267).—In a pot experiment nodulation was greatly enhanced and the use of ammoniated superphosphate is recommended where seed and fertiliser are drilled on a prepared seed bed and it is desired to bring an acid soil into high production quickly.
E. G. BRICKELL.

Lime-pelleted clover seeds for nodulation on acid soils. J. F. Loneragan, D. Meyer, R. G. Fawcett and A. J. Anderson (*J. Aust. Inst. agric. Sci.*, 1955, **21**, 264—265).—An experiment is described in which subterranean clover, var. Bacchus Marsh, was pelleted with finely ground $CaCO_3$ (5 lb. of lime to 10 lb. of seed) after inoculation with *Rhizobium*. Marked benefit was obtained in overcoming the harmful effects of soil acidity on nodulation.
E. G. BRICKELL.

Diagnostic techniques for the saline and alkali soils of the Indian Gangetic alluvium in Uttar Pradesh. R. R. Agarwal and J. S. P. Yadav (*J. Soil. Sci.*, 1956, **7**, 109—121).—The value of the diagnostic techniques described in *U.S. Soil Salinity Lab. Hdbk.* No. 60, U.S. Dep. Agric., for assessing the status of saline and alkali soils in India was studied. There was a high correlation between electrical conductivity and salt concn. of saturation extracts and a fair correlation between pH and % of exchangeable Na. For non-calcareous soils the cation exchange capacity as determined by Bower's NaOAc method (*Soil Sci.*, 1952, **73**, 251) agreed fairly well with the sum of the exchangeable bases. Hissink's NaCl method gave satisfactory value for exchangeable Ca and Mg in calcareous soils. There was a relatively poor correlation between Na adsorption ratio $\left(Na^{\cdot} \div \sqrt{\frac{(Ca^{\cdot\cdot} + Mg^{\cdot\cdot})}{2}}\right)$ and exchangeable Na ratio (exchangeable Na ÷ [cation exchange capacity − exchangeable Na]).
A. H. CORNFIELD.

Influence of nitrogen and potassium on availability of fertiliser phosphorus. L. O. Fine (*S. Dakota agric. Exp. Sta.*, 1955, *Bull.* 453, 22 pp.).—Application of K fertiliser and varying levels of exchangeable soil K had little effect on utilisation of fertiliser P by oats, maize and lucerne. Application of N greatly increased the utilisation of fertiliser P. All N carriers, with the exception of $NaNO_3$, were equally effective in this respect. The % of P in the plant was increased in some cases and decreased in others where N was applied in addition to P. The N applications were less effective in increasing utilisation of fertiliser P where nitrophosphates and $CaHPO_4$ than where superphosphate was used. In some cases 65—70% of the P in the crop was derived from the fertiliser early in the season.
A. H. CORNFIELD.

Casing layer in the cultivation of the mushroom (*Psalliota hortensis*). P. B. Flegg (*J. Soil Sci.*, 1956, **7**, 168—176).—A review dealing with

the effects of nutrient status, pH, water relationships, structure and permeability of the casing layer on growth of mushrooms.
A. H. CORNFIELD.

Nitrophosphate fertiliser production. Tah-Ho Huang (*Agric. Chemicals*, 1955, **10**, No. 11, 45—46, 109, 111, 113).—A brief review of the commercial methods used for producing nitrophosphates.
A. H. CORNFIELD.

Effect of biuret on crop yields. R. W. Starostka and K. G. Clark (*Agric. Chemicals*, 1955, **10**, No. 10, 49—50, 103).—Application of not more than 16 lb. of N as biuret per acre had no effect on, whilst application of 30—40 lb. of biuret-N tended to reduce, the yields of perennial ryegrass in pot tests. Yields of maize, cotton, tomatoes and oats were similar whether 100 lb. of urea-N or urea containing up to 10% of its N as biuret was applied per acre. Biuret nitrified somewhat more slowly in soil than did $(NH_4)_2SO_4$ or urea.
A. H. CORNFIELD.

Plant Physiology, Nutrition and Biochemistry

Variations in the uptake by plants of soil phosphate as influenced by sodium nitrate and calcium nitrate. J. J. Lehr and J. Ch. van Wesemael (*J. Soil Sci.*, 1956, **7**, 148—155).—Tests with a variety of soils using a Neubauer-type seedling test indicated that uptake of P by wheat was greater where N was applied as $NaNO_3$ than as $Ca(NO_3)_2$. This difference was apparent with soils of low and medium, but not with soils of high, P availability.
A. H. CORNFIELD.

Calcium-boron relationships in Siberian millet. W. J. McIlrath and J. A. DeBruyn (*Soil Sci.*, 1956, **81**, 301—310).—Siberian millet was grown in sand culture with nutrient solutions containing Ca at four different levels and B at four levels for each Ca level. Regardless of Ca treatment, applications of B of 0 to 0·5 p.p.m. had no effect on dry wt. yields. At Ca levels of 160—320 p.p.m., B (5·0 p.p.m.) caused significant decreases in the yield and at 50 p.p.m. greatly reduced yields. At higher levels the percentage dry wt. of the plants increased with both Ca and B levels. After two weeks, Ca deficiency symptoms appeared in the plants receiving Ca in concn. 40 p.p.m. No Ca toxicity symptoms were evident. B deficiency was never apparent but toxicity symptoms were present with [B] $\leqslant$5 p.p.m. The ash contents of the plants increased with the B supply at all Ca levels, but with Ca the reverse was true. Sol. and total B in the tops was unaffected by B treatment up to 0·5 p.p.m. but concn. of 50 p.p.m. increased both forms. B levels did not affect the Ca levels in the plant, but generally, Ca levels in the nutrient were reflected by those in the plant. The Ca/B ratio increased with Ca supply and decreased with increasing B supply. T. G. MORRIS.

Enzymic activities of subcellular particles from leaves. I. Occurrence of mitochondria in green leaves of the pea plant. R. M. Smillie (*Aust. J. biol. Sci.*, 1956, **9**, 81—91).—Cytoplasmic particles corresponding to the mitochondria of animal and etiolated plant tissues and containing the complete tricarboxylic acid cycle complex of enzymes were obtained from green pea leaves. Enzymes capable of oxidising fumarate, lactate, several amino-acids and reduced cytochrome *c* are located in these particles; di- and tri-phosphopyridine nucleotides and succinate-linked cytochrome reductases are also present. The effects of various co-factors and inhibitors on the oxidative capacities of the particles are reported. Values of 2—3 were obtained for the ratio P esterified to O_2 consumed for all tricarboxylic acid substrates except succinate, for which a value of 1·58 was found. S. C. JOLLY.

Flame-spectrophotometric determination of potassium, calcium, magnesium and sodium in plant ashes. Determination of total nitrogen by semi-microdistillation. E. Bovay (*Mitt. Lebensm. Hyg., Bern*, 1955, **46**, 540—568).—The construction and operation of the Beckman flame-spectrophotometer are described. Determinations of K or Na are not affected by the other normal constituents of plant ash, and can be carried out with reference to standard graphs established with pure aq. KCl or NaCl. Values obtained for Ca and Mg are thus affected (positively or negatively), especially by phosphates, SO_4'', SiO_2 or Fe. In order to compensate for these effects, suitable buffer solutions containing the relevant interfering elements have been devised for admixture with the reference solutions of Ca^{++} and Mg^{++}, respectively. These solutions are also added to the ash-solutions in amounts sufficient to ensure max. interference, beyond which further additions have no effect. The results agree well with those obtained by standard methods. The distillation apparatus used for the semi-micro-Kjeldahl determination of N is a modified form of that devised by Maume *et al.* The determination of P is carried out by the Zinzadzé method. P. S. ARUP.

Amino-acid derivatives of 4-chlorophenoxyacetic acid and their plant-regulating effects in preliminary screening tests. C. F. Krewson, T. F. Drake, C. H. H. Neufeld, T. D. Fontaine, J. W. Mitchel, and W. H. Preston (*J. agric. Food Chem.*, 1956, **4**, 140—143).—The synthesis of a series of D-, L- and DL-amino-acid derivatives of 4-chlorophenoxyacetic acid is described and their plant-growth regulating activity, on mono- and di-cotyledonous plants examined. The 18 compounds tested are the derivatives of alanine, aspartic acid, leucine, methionine, phenylaniline and threonine. In general the D-amino-acid derivatives are least active and most selective, but the D-alanine derivative is an exception being as active as its L-isomer. (29 references.) N. M. WALLER.

Foliar diagnosis for sugar cane. B. G. Capo, G. Samuels, P. Landrau, jun., S. A. Alers and A. Riera (*Puerto Rico agric. Exp. Sta.*, 1955, *Bull.* 123, 47 pp.).—Procedures used for sampling and analysing sugar cane leaves for diagnosis of their mineral status are described. Fertiliser recommendations based on these values are presented.
A. H. CORNFIELD.

Mineral nutrients in South Carolina plants and effects of fertiliser on the mineral content of the plants. J. H. Mitchell (*S. Carolina agric. Exp. Sta.*, 1955, *Circ.* 96, 15 pp.).—Application of trace elements to the soil resulted in increased content of Zn, Cu, Mn and Fe in the leaves of peach trees. The increases were generally greater where Versenates than where inorg. salts were used. Uptake of Cu and Zn, but not of Mn and Fe, was increased by applying trace elements to the soil. The N, P, Ca and Mg contents of fertilised (N–P–K) and unfertilised grasses grown at a no. of locations are presented. A. H. CORNFIELD.

Ascorbic acid content of some Vermont-grown fruits and vegetables. R. Hopp and M. P. Lamden (*Vermont agric. Exp. Sta.*, 1955, *Bull.* 579, 26 pp.).—The ascorbic acid content of a no. of species of fruits and vegetables over four years is reported. There were variations in ascorbic acid content due to variety, season, and date of sampling. The effects of sunshine and temp. are also noted.
A. H. CORNFIELD.

Peroxide genesis in plant tissues and its relation to indolylacetic acid destruction. S. M. Siegel and A. W. Galston (*Arch. Biochem. Biophys.*, 1955, **54**, 102—113).—In the indolylacetic acid oxydase system, visible radiation, Mn^{++}, and certain substituted phenols (e.g., 2 : 4-dichlorophenol) hasten the reaction by enhancing the generation of peroxides. Indolylacetic acid is, itself, peroxigenic. Probably the auxin mol. can be attacked by dehydrogenation and also by peroxidation. HORT. ABSTR. (A. G. P.).

Photolysis of indol-3-ylacetic acid: paper chromatographic investigations. H. H. Mayr (*Planta*, 1956, **46**, 512—515).—The growth substance was rapidly destroyed on exposure to radiation from a Hg vapour lamp. The rate of decomposition was much greater in 96% alcohol than in 2% aq. alcohol; it was greatly retarded in presence of alcoholic (96%) extracts of plant tissue. A. G. POLLARD.

Action of β-indolylacetic acid on the metabolism of *Avena* coleoptiles. M. Busse and O. Kandler (*Planta*, 1956, **46**, 619—642).—The influence of time in relationships between the effects of β-indolylacetic acid (**I**) on respiration, cell elongation and on carbohydrate changes in the plant is examined. The primary action of **I** may be that of increasing the plasticity of the cell wall which then stretches under osmotic forces. A. G. POLLARD.

Differences in the qualitative composition of proteins and peptides in pressed leaf juices of healthy and potato plants infected with leaf-roll virus. F. Reindel and W. Bienenfeld (*Hoppe-Seyl. Z.*, 1956, **303**, 262—271).—It is established by paper electrophoretic separation, that from the pressed juice obtained from the leaves of healthy potato plants seven components can be isolated which give a stain with benzidine, whereas the juice from the leaves of plants infected with the leaf-roll virus contains eight such components. This additional component appears to be a P-containing oligopeptide, the others being amino-acids, which were identified by paper chromatography. The terminal amino-acid of the peptide chain is glycine. G. R. WHALLEY.

Crops and Cropping

Sprinkler irrigation of field maize. C. M. Lund, W. P. Law and O. W. Beale (*S. Carolina agric. Exp. Sta.*, 1955, *Bull.* 421, 34 pp.).—Over eight years sprinkler irrigation increased the average annual yields of maize by 41 bushels per acre. Yields of green matter for silage were increased by 11 tons per acre. Greater returns per acre-inch of water applied were obtained by withhholding irrigation until the boot of the tassel appeared. Irrigation had no effect on incidence of lodging. There were no significant differences between varieties in response to irrigation. Heavier fertiliser rates and denser plant populations could be used where irrigation was practised.
A. H. CORNFIELD.

Maize production practices in South Carolina. D. E. Crawford (*S. Carolina agric. Exp. Sta.*, 1955, *Bull.* 420, 32 pp.).—A general account. A. H. CORNFIELD.

Sweet clover in Texas. R. C. Potts (*Texas agric. Exp. Sta.*, 1955, *Bull.* 791, 16 pp.).—The important species and varieties of sweet-clover which are adapted to Texas are described. Effects of planting date, row spacing, location and fertiliser treatment on yields are presented. The value of sweet clover as hay and silage and the place of the plant in rotations is discussed. Diseases and insect pests are described. A. H. CORNFIELD.

Moisture utilisation by forage crops. N. A. Willits and A. E. Erickson (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 126—128).—Moisture used by two species of grass and by two species of legume over three years during the period May 23 to September 16 is reported. Water consumption increased during May and June, reached a max. about July 1 and then decreased with advancing season. Over the period May 27 to June 24 (when water on the first date was at field capacity and rainfall over the period was low) 66—75% of the water used came from the surface 9 in. except in the case of lucerne which used only 57% from the surface 9 in. and more from the lower depths. Fescue used less water than did the other species. Grass which was cut frequently used less total water and more from the upper soil layer than did grass which was not cut. There was high correlation between the amount of water used from a horizon during a drying-out period and the amount present in the horizon at the beginning of the period. The correlation coeff. decrease with depth. A. H. CORNFIELD.

Effect of planting dates on yields, total solids, and frying and chipping qualities of potato varieties. R. V. Akeley, F. J. Stevenson and D. Merriam (*Amer. Potato J.*, 1955, **32,** 441—447).—The effect of four planting dates (from May 5 to June 4) on yields, total solids and quality of chips and French fries of eight varieties of potatoes was studied over three years. Yields and % of total solids in all varieties decreased with delay in planting. There were considerable varietal differences in yield response to variations in planting date. Some varieties produced acceptable chips and French fries regardless of planting date, whilst others gave acceptable products only from the earlier planting dates. For any given planting date the colour of the products varied from year to year. A. H. CORNFIELD.

Forest management practices as related to and influenced by forest soil differences in Western Washington. W. J. Lloyd, F. E. Schlots and C. E. Deardorff (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 105—107).—A general account and discussion. A. H. CORNFIELD.

Tentative technique for determining the influence of soil on the growth of forest plantations. A. L. Leaf and T. Keller (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 110—112).—Methods used for assessing the ecological homogeneity of plantations, rate of tree growth, soil properties, including the properties of ground water in hydromorphic soils and chemical composition of foliage are described briefly. The application of the technique to red pine and white spruce plantations is described. A. H. CORNFIELD.

Uprooting of trees: A forest process. E. P. Stephens (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 113—116).—Methods used for studying the phenomenon of natural uprooting of forest trees are described. The factors causing uprooting and the influence of uprooting on the process of forest formation and on soil properties are discussed. A. H. CORNFIELD.

Height growth response of Douglas fir to nitrogen fertilisation. S. P. Gessel and R. B. Walker (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 97—100).—Nitrogen was applied annually to the soil at the rate of 100 lb. per acre for four years to 15—20-year-old Douglas fir stands on " poor " sites. There was a marked response in height growth to the treatment on both shallow residual and deep glacial outwash soils. In general the larger trees responded better to the treatment than did the smaller, and the former suppressed the growth of the latter. The treatment resulted in change of foliage colour from yellow to dark green. This change occurred before any growth response occurred. The treatment increased the N content of the foliage from $<1\%$ (dry matter basis) to 1·2—1·8%. A. H. CORNFIELD.

Effect of biocides on the development of ectotrophic mycorrhizæ in Monterey pine seedlings. S. A. Wilde and D. J. Persidsky (*Proc. Soil Sci. Soc. Amer.*, 1956, **20,** 107—110).—The effects of chlordane, $C_6H_4Cl_6$, Thiosan, $HgCl_2$, HCHO, $Al_2(SO_4)_3$, allyl alcohol, and Stoddard solvent applied to the soil at rates common in current nursery practice, as well as at double these rates, on the development of ectotrophic mycorrhizæ on the roots of Monterey pine seedlings were studied. The effect of treatment varied with material and rate of application. The normal rates usually resulted in slight changes in the development of the mycorrhizæ. The high application rates reduced the no. of mycorrhizæ or completely arrested their development. A. H. CORNFIELD.

Pest Control

Insect physiology in relation to insecticides. V. B. Wigglesworth (*J. roy. Soc. Arts*, 1956, **104,** 426—438).—The importance of insect physiology to the study of insecticides is discussed. The use of pyrethrum in conjunction with DDT in an aërosol cloud in mosquito control, the mode of action of fly sprays generally, histology and physiology of toxic action in insects are considered. E. M. J.

Modern pest control agents. F. R. Preuss (*Dtsch. ApothZtg*, 1956, **96,** 84—86).—A general review of recent pest control agents with special reference to the 3-substituted 4-hydroxycoumarins (including Tomorin, dicoumarol and warfarin). G. R. WHALLEY.

Major trends in the pesticide industry. W. Moyer (*Agric. Chemicals*, 1955, **10,** No. 10, 45—46, 98—99).—An address. A. H. CORNFIELD.

Rôle of the formulator in making a pesticidal composition. J. H. Cochran (*Agric. Chemicals*, 1955, **10,** No. 10, 49, 108—109).—An address dealing with the problems facing the formulator of pesticides. A. H. CORNFIELD.

Malathion formulations. II. J. F. Yost, J. B. Frederick and V. Migrdichian (*Agric. Chemicals*, 1955, **10,** No. 10, 42—44, 105).—The stability of 4—5% malathion dusts and the compatability and stability of malathion with various insecticides, fungicides and fertilizer salts are reported. A. H. CORNFIELD.

Interactions between plant roots and pathogenic soil fungi. A. Kerr (*Aust. J. biol. Sci.*, 1956, **9,** 45—52).—Both *Pellicularia filamentosa* and *Sclerotinia homeocarpa* affect a wide range of plants; *P. filamentosa* causes typical damping-off of seedlings whereas *S. homeocarpa* caused severe stunting without penetrating the plant tissue. Using a " Cellophane-bag " technique, it was shown that these fungi excrete substances toxic to plants. The roots of lettuce and radish seedlings stimulate the growth of *P. filamentosa*, but those of tomatoes do not. Preliminary investigations on the relation of root excretions to infection and susceptibility of seedling are described. (16 references.) S. C. JOLLY.

Residual properties of the systemic insecticide OO-dimethyl 1-carbomethoxyprop-1-en-2-yl phosphate. J. E. Casèda, P. E. Gatterdam, L. W. Getzin, jun. and R. K. Chapman (*J. agric. Food Chem.*, 1956, **4,** 236—243).—*OO*-Dimethyl 1-carbomethoxyprop-1-en-2-yl phosphate (compound 2046) consists of about $\frac{2}{3}$ *cis* and $\frac{1}{3}$ *trans* isomers; the *cis* is ~100 times more toxic than is the *trans* isomer to insects and mammals; the residual persistence of the *trans* isomer in the plant is greater, but the residual toxic hazard is negligible in comparison with those properties of the less stable, more toxic *cis* compound. In the plant enzymes attack both isomers at the carboxylic ester group followed by hydrolysis of the vinyl phosphate bond. Based on anticholine-esterase determinations there was a 90% residual loss in <2 days and over 99% loss in four days after foliar application to field crops. The toxic 2046 residues in crop plants treated at dosage levels used for insect control were essentially dissipated within two days following insecticide application. (39 references.) E. M. J.

Plant disease control by a new class of chemicals, 2-pyridinethiol-1-oxide. P. Allison and G. L. Barnes (*Phytopathology*, 1956, **46,** 6).—Promising results were obtained with this substance and its Cu and Zn derivatives as foliage sprays against *Monilinia fructicola*. As soil fungicides the compounds were as effective or superior to pentachloronitrobenzene in controlling *Pellicularia filamentosa* or to Captan in controlling *Pythium ultimum*. A. G. POLLARD.

New materials as eradicant fungicides. E. E. Wilson and J. M. Ogawa (*Phytopathology*, 1956, **46,** 31).—When used as dormant sprays on almond trees dinitro-*o*-*sec*.-amylphenol (**I**) alone or mixed (1 : 4) with 2-*sec*.-butyl-4 : 6-dinitrophenol (**II**) compared favourably with Na pentachlorophenate (**III**) in preventing the carry-over of conidial inocula of *Sclerotinia laxa* and in reducing the extent of blossom infection. The triethanolamine derivative of **II** was less effective. In controlling fruit infection by *Coryneum beijerinckii* or by *Cladosporium carpophilum*, *N*-phenylmercuriethylenediamine was more efficient than was **III** or **I**. A. G. POLLARD.

Differential action of chelators on growth and spore germination of *Monilinia fructicola*. S. Rich (*Phytopathology*, 1956, **46,** 24).—Among chelators examined, those toxic to spores were, in general, also toxic to mycelium. A few (dimethylglyoxime, α-furildioxime) were non-toxic to spores but highly toxic to mycelium of *M. fructicola*; others (2-amino-2-methylpropan-1-ol, chrysoidine-γ) were not toxic to either stage but increased sporulation. The toxic mechanism is discussed. A. G. POLLARD.

Correlation of antimicrobial activity and chemical structure. S. I. Cohen and M. S. Frant (*Phytopathology*, 1956, **46,** 9).—The toxicity

of derivatives of acetophenone to *Aspergillus niger, Aerobacter aerogenes* and to spores of *Sclerotinia fructicola* and *Stemphylium sarcinæforme* was determined. Introduction of -OH into acetophenone in the *p*-position increased toxicity but further hydroxylation in the nucleus or the introduction of $-NH_2$ in the *p*-position had the opposite effect. α- and β-unsaturated ketones formed by replacement of the CH_3-group by -C=C- greatly increased toxicity. Addition of cyclic units (benzal, furfural) to the terminal $-CH_3$-group of these ketones reduced their activity. An increased activity followed the addition of -COOH to the terminal $-CH_3$ to form β-benzoylacrylates; further increased toxicity resulted from conversion into lower alkyl esters, the Me ester being the most effective. Introduction of -Cl in the *p*-position of Me benzoylacrylate increased its toxicity and that of $-CH_3$, -Br, or -OH had the reverse effect.
A. G. POLLARD.

Relative biological activities of the four monochloro-o-cresoxyacetic acids. J. M. F. Leaper, J. R. Bishop and W. P. Anderson (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 9—14).—The effects of 2-methyl-3-, -4-, -5- and -6-chlorophenoxyacetic acids and amides on various crop plants are compared. The 4-chloro-isomer was particularly active in inhibiting root growth of lupin seedlings and was the only one of the series which, when applied in lanolin paste to stems of snap beans, inhibited terminal growth. The 4- and 5- isomers markedly restricted cell proliferation. The 6-isomer was outstanding in producing formative effects and the 5-isomer in inhibiting root initiation. The highest herbicidal activity was shown by the 4-isomer; the 5-isomer (especially the amide) had considerable effects on broad-leaved plants.
A. G. POLLARD.

Nematocidal efficacy of some intermediate-numbered carbon fatty acids. A. C. Tarjan and P. C. Cheo (*Phytopathology*, 1956, **46**, 28).—Straight-chain, unsubstituted fatty acids containing 7—11C showed high nematocidal action towards *Panagrellus redivivus*. Of acids tested on cysts of *Heterodera tabacum*, only nonanoic acid completely prevented the emergence of larvæ.
A. G. POLLARD.

Allyl alcohol as a soil fungicide. A. J. Overman and D. S. Burgis (*Phytopathology*, 1956, **46**, 22).—When applied as a drench (25 lb. in 5500 gal, of water per acre) allyl alcohol effectively controlled *Pellicularia* spp., *Pythium* spp. and *Fusarium* spp. in vegetable seed beds, the seed being sown at least seven days after the treatment. In treated soils *Trichoderma* spp. increased significantly within seven days after treatment, the increase persisting throughout the seedling period thus contributing to the efficiency of the treatment.
A. G. POLLARD.

Bio-assay of the translocated fungicide, 2-pyridinethiol-1-oxide in cucumber seedlings. E. Sander and P. Allison (*Phytopathology*, 1956, **46**, 25).—The fungicide penetrated the primary leaves of cucumber and was rapidly translocated through the plant system. After 12 hr. the concn. in roots exceeded that in other organs. The substance was inactivated by extracts of young shoots or of cotyledons. The method of assay is based on the inhibition of *Monilinia fructicola* by tissue homogenates of treated plants compared with that by corresponding homogenates from control plants.
A. G. POLLARD.

Fungus spores in reducing sulphur to hydrogen sulphide produce an equivalent of carbon dioxide. S. E. A. McCallan and L. P. Miller (*Phytopathology*, 1956, **46**, 20).—Conidia of *Neurospora sitophila, Monilinia fructicola* and *A. niger* and also cells of *Saccharomyces cerevisiæ* reduced elementary S to H_2S and simultaneously produced an additional equi-mol. proportion of CO_2.
A. G. POLLARD.

Differential action of medium and fungus in the toxicity of copper 8-quinolinolate. G. A. Zentmyer and J. G. Horsfall (*Phytopathology*, 1956, **46**, 32—33).—Amino-acids in media may sequestrate Cu from Cu 8-quinolinolate forming Cu complexes of different levels of toxicity and having different relative toxicities to individual fungal species.
A. G. POLLARD.

Antagonistic action of cysteine and certain other compounds on the fungitoxicity of sodium dimethyldithiocarbamate. B. S. Smale, C. E. Cox and H. D. Sisler (*Phytopathology*, 1956, **46**, 27).—The toxicity of Na dimethyldithiocarbamate to *Penicillium* spp. was counteracted by cysteine or glutathione. *Glomerella cingulata* was also protected by cysteine, to small extents by dihydroxyphenylalamine, phenylalanine or homocystine but not by pyruvic, α-ketoglutaric or oxaloacetic acid.
A. G. POLLARD.

Effect of ketones on sporulation of *Monilinia fructicola*. J. G. Horsfall (*Phytopathology*, 1956, **46**, 15).—In general, ketones and carboxylic acids suppressed the sporulation of *M. fructicola* but α- and β-unsaturated ketones and acids (examples given) had the reverse effect. These compounds probably counteract the operation of natural inhibitors by forming addition products, e.g., with NH_2- or SH- groups. Fumaric acid failed to stimulate sporulation owing to steric hindrance.
A. G. POLLARD.

Effects of fungicides on levels of adenosine polyphosphates, inorganic phosphate and phosphate esters contained in fungus spores. R. G. Owens (*Phytopathology*, 1956, **46**, 23).—The P distribution in asexual spores of *Neurospora sitophila* and other fungi showed that adenosine di- and tri-phosphates occurred in approx. equal proportions in conidia and remained at a steady level during incubation in presence or absence of fungicides. The initial proportion of inorg. PO_4''' exceeded that of adenosine phosphates but diminished during incubation when inorg. P was incorporated in an org. mol. Incubation of spores in presence of toxic concn. of S, dithiocarbamates, quinones, imidazoline or captan inhibited the assimilation of inorg. PO_4''' and, in some cases, increased the amount of inorg. PO_4''' present. Possible mechanisms of the inhibitory process are discussed.
A. G. POLLARD.

Effects of feeding Systox-treated lucerne hay to dairy cows. P. A. Dahm and N. L. Jacobson (*J. agric. Food Chem.*, 1956, **4**, 150—155).—Technical demeton fed in capsules for three consecutive days at the rate of 0·1, 0·5 and 2·5 mg./kg. body wt. causes severe symptoms of org. P poisoning, reduced milk production and increased fat %. Systox-treated hay containing excessively high residue of demeton toxins (51 p.p.m.), fed in increasing amounts for seven weeks causes mildly adverse effects on wt. gain and red blood cell choline-esterase activity. Hay containing normal demeton residues, fed for eight weeks at a uniform rate, causes no adverse effects on wt. change and milk production, but red blood cell choline-esterase activity decreases gradually during the last six weeks of the feeding period.
N. M. WALLER.

Shell egg quality as affected by Arasan (tetramethylthiuram disulphide) in the diet of laying hens. M. H. Swanson, P. E. Waibel, N. V. Helbacka and E. L. Johnson (*Poultry Sci.*, 1956, **35**, 92—95).—Addition of Arasan 10 p.p.m. (tetramethylthiuram disulphide 7·5 p.p.m.) to the diet of laying hens for 16 days resulted in the production of a small % of shell-less eggs. With 50 p.p.m. Arasan in the diet shell-less and misshapen eggs and eggs with reduced shell thickness and albumin firmness were produced. With more than 100 p.p.m. Arasan nearly all the eggs produced were soft-shelled.
A. H. CORNFIELD.

Feeding chemically-treated seed grains to hens. G. F. Heuser (*Poultry Sci.*, 1956, **35**, 160—162).—Feeding laying hens with maize seed which had been treated with Arasan resulted in a severe drop in egg production. Production returned rapidly to normal when the treated maize was replaced by Arasan-free maize. Seed treated with Ceresan M and Semesan jun. had no effect on egg production. Wheat which had been treated with Improved Ceresan also caused a decline in egg production when incorporated in the dams's diet.
A. H. CORNFIELD.

Effect of some organic dyes on microflora and viability of cereal grains. W. F. Milowskaya, G. D. Dombrowski and L. G. Atanass (*Mitt. VersSta. Gärungsgew.*, 1956, **10**, 11—13).—Brilliant green is a more efficient antiseptic than is methylene-blue or auramine; used in 0·25% solution (with a steeping-time of 1 hr.) it destroys surface-infecting micro-organisms on the grains (wheat, millet or maize) without reducing germinating capacity. The treatment increased the germinating capacity of maize, probably due to the destruction of a mould infection. Surface sterilisation reduces the total respiration of the grain by eliminating the respiration of the micro-organisms, a factor which amounts to 25—33% of the total respiration of the untreated grain at R.H. 12—13, and 50% at R.H. 17—20%.
P. S. ARUP.

Organic chemicals containing chlorine as seed treatments for wheat smut control. L. H. Purdy (*Phytopathology*, 1956, **46**, 23—In comparative tests of non-Hg fungicides for controlling smut in wheat the efficiency, as seed disinfectants, of C_6Cl_6, C_6HCl_5 and $C_6H_2Cl_4$ diminished in the order named. Substitution of one Cl by NO_2 also lowered the efficiency in each case. C_2Cl_6 was ineffective for this purpose although inhibiting spore germination on agar media.
A. G. POLLARD.

Mode of action of the wet anaërobic storage treatment for the control of loose smut in barley. T. T. Hebert (*Phytopathology*, 1956, **46**, 14).—The disease was controlled by soaking the seed in water for 0·25—4·0 hr. followed by storage in sealed containers for 36 hr. at 32°, 48 hr. at 28° or 60 hr. at 24°. The spores failed to survive after the removal of O_2 from the containers by normal respiration of the seed.
A. G. POLLARD.

Responses of the rice plant to different formulations and methods of application of 2 : 4-D, MCP and 2 : 4 : 5-T. P. B. Kaufman and A. S. Crafts (*Hilgardia*, 1956, **24**, 411—453).—In the trials of herbicides described injury to rice was favoured by applications made in the early stages of growth, particularly if the herbicide was added to the water in which the rice was growing, and by sowing the seed on the soil surface instead of drilling below the surface. 2 : 4-D was the most harmful of the substances used. Application in

pellet form gave better results than that made in solution, weed control being more effective and some stimulation of growth occurring. MCP controlled weeds and was less injurious than 2 : 4-D to rice. 2 : 4 : 5-T was not an effective herbicide under these conditions. A. G. POLLARD.

Analysis of steep-water in the water-soak seed treatment for control of small-grain diseases. C. Leben, R. W. Scott and D. C. Arny (*Phytopathology*, 1956, **46**, 18).—Water in which seeds had been soaked for 56 hr. at 26° contained formic, acetic, butyric and succinic acids. A synthetic solution containing these acids in approx. the same proportions as in the steep liquor, restricted or prevented germination of spores of *Ustilago nuda*. Soaking seed probably sets up anaërobic conditions in which germination of *U. nuda* is adversely affected. A. G. POLLARD.

Fumigation of encysted golden nematode larvæ under controlled environmental conditions. M. B. Harrison and W. F. Mai (*Phytopathology*, 1956, **46**, 14).—Larvæ were fumigated with D–D mixture, chloropicrin, ethylene dibromide or Vapam (Na *N*-methyldithiocarbamate). The degree of control obtained with each substance was not greatly affected by temp. (10—30°) but was directly related to R.H. A. G. POLLARD.

Soya-beans as a green manure crop for the prevention of potato scab. J. W. Oswald and O. A. Lorenz (*Phytopathology*, 1956, **46**, 22).—Green manuring with soya-bean almost eliminated scab from the following potato crop during seven successive seasons. Green manuring with autumn peas had little effect and that with autumn barley increased the incidence of the disease. A. G. POLLARD.

Effect of virus infection on yield, flowering and chemical composition of Ladino clover. K. W. Kreitlow, O. J. Hunt and H. L. Wilkins (*Phytopathology*, 1956, **46**, 17).—Virus infection lowered the yields of the clover by 48—54% and the no. of flowers by 32%. Virus-free plants contained higher % of ash, crude fibre and Et_2O-extract but smaller % of crude protein and N-free extract than did infected plants. A. G. POLLARD.

Biology and control of the timothy mite, *Paratetranychus pratensis*, Banks. D. R. Malcolm (*Wash. agric. Exp. Sta.*, 1955, *Tech. Bull.* 17, 35 pp.).—Characteristics of the pest and the nature of injury to timothy are described. A wide range of host plants is listed. Tests with a variety of pesticides indicate that one of the following should give satisfactory control: Systox 6—8 oz., parathion 1 lb. as spray or 0·5 lb. as 2% dust, and S 25 lb. per acre. The applications should be made preferably in late summer. A. H. CORNFIELD.

Apple powdery mildew in eastern Washington. R. Sprague (*Wash. agric. Exp. Sta.*, 1955, *Bull.* 560, 22 pp.).—A field survey over three years showed that apple powdery mildew was widespread not only on highly susceptible varieties, but on all varieties. Even with resistant varieties injury was appreciable at some locations. During years of severe winter killing of twigs and buds the carry-over of mildew was slight. In other years it was heavy. Sprinkler irrigation increased moderately the incidence of mildew. Of many materials tested for control only the S materials (lime–S, polysulphides) and Karathane (Arathane) were effective. A. H. CORNFIELD.

Effect of fungicides on apple pollination and fruit-set. A. E. Rich and J. D. Bilbruck (*Phytopathology*, 1956, **46**, 24).—Although pollen showed poor germination after immersion in captan, gliodin, ferbam or Dichlone even at concn. below normal spraying levels, it germinated satisfactorily on the tree following normal spraying with these fungicides. A. G. POLLARD.

Tolerance of deciduous fruits to moist heat and fumigants. L. L. Claypool and H. M. Vines (*Hilgardia*, 1956, **24**, 297—355).—A no. of fumigants was tested for elimination of Oriental fruit fly and other flies on numerous species and varieties of fruits to meet quarantine requirements. Ethylene dibromide and the chlorobromide were particularly effective and afforded a wider margin of safety between concn. lethal to flies and those harmful to fruit than did methyl bromide. Residual Br in treated fruit was not a likely health hazard. A. G. POLLARD.

Bait sprays for fruit fly control. L. F. Steiner (*Agric. Chemicals*, 1955, **10**, No. 11, 32—34, 113, 115).—Bi-weekly applications of 4 lb. of 25% malathion wettable powder and 1 lb. of protein hydrolyzate (insect attractant) per acre in 5—150 gal. of water gave good control of fruit flies. Better control at less cost was obtained with these sprays than with the more conventional types. Most of the currently used fungicides reduced the effectiveness of the bait sprays when mixed with them. For controlling isolated infections 3% Pyrolan in methyleugenol impregnated in cane fibre board was effective in attracting and killing male flies from 0·5 mile or more. A. H. CORNFIELD.

Control of fruit pests other than red spider. E. L. Williams (*J. Sci. Food Agric.*, 1956, **7**, Suppl. Issue, s103—s109).—Recent work is reviewed generally, covering: winter washing or spring spraying, comparison of insecticides for pre-blossom spraying, low- and medium-vol. spraying. Details are given of control of 10 pests, notably aphis and codling moth. E. M. J.

Control of red spider on fruit. J. E. Cranham (*J. Sci. Food Agric.*, 1956, **7**, Suppl. Issue, s93—s102).—Recent developments in the chemical control of red spider mites are reviewed, with special reference to the use of chlorbenside (*p*-chlorobenzyl *p*-chlorophenyl sulphide) and of *p*-chlorophenyl *p*-chlorobenzenesulphonate and to the timing of sprays. (18 references.) E. M. J.

Biology and control of the peach twig borer (*Anarsia lineatella*, Zeller) in Utah. C. J. Sorenson and F. H. Gunnell (*Utah agric. Exp. Sta.*, 1955, *Bull.* 379, 19 pp.).—Characteristics of the pest are described. On the basis of tests carried out over four years the following spray programme is recommended: lime–S (12 gal. per 88 gal. water) applied from buds up to early pink-bud stage and basic Pb arsenate (3—4 lb. per 100 gal.) applied just before the second brood of borers emerge (when peach fruit is 0·75—1·00 in. in diam.). Relatively poor control was obtained with dormant-type oil spray and with two applications of DDT. A. H. CORNFIELD.

The purple mite and its control. W. L. Thompson, R. B. Johnson and J. W. Sites (*Citrus Mag.*, 1955, **17**, No. 5, 8—11).—Infestations of the mite (*Metatranychus citri*) were lowered by spraying trees with S previously: parathion had little effect. A mixed oil emulsion–parathion spray gave good control of scale insects and of the purple mite. HORT. ABSTR. (A. G. P.).

Method of testing fungicides in the laboratory for controlling *Botrytis* fruit rot in strawberries. N. Horn (*Phytopathology*, 1956, **46**, 15).—Berries in the " white " stage were dipped in a suspension containing the fungicide and conidia of *Botrytis cinerea* and immediately placed in a high-R.H. chamber at 75°F. The no. of berries rotting subsequently is noted. Data for a no. of fungicides and antibiotics are recorded. Org. Hg compounds, e.g., *N*-phenylmercuriethylenediamine, phenylmercury dimethyldithiocarbamate were notably effective. Endomycin was the most successful antibiotic examined. A. G. POLLARD.

Influence of irrigation on the incidence and control of tomato anthracnose. P. J. Lloyd and D. F. Crossan (*Phytopathology*, 1956, **46**, 18).—In trials with maneb and zineb, irrigation increased the incidence of the disease in the fruit. Maneb gave the better control after irrigation but without irrigation the two fungicides were equally effective. A. G POLLARD.

Survival of root-knot nematodes in grape and tomato roots recovered from soils fumigated with Nemagon. B. Lear and D. J. Raski (*Phytopathology*, 1956, **46**, 18).—Experimental data indicates that Nemagon (1 : 2-dibromo-3-chloropropane) does not readily penetrate un-rotted roots of tomato or grape in concn. sufficient to kill the nematode unless heavy dosages, e.g., 20 gal. per acre, are applied. A. G. POLLARD.

Control of [A] late blight on tomato with streptomycin. W. J. Zaumeyer and S. P. Doolittle. **[B] downy mildew on Lima beans with streptomycin.** W. J. Zaumeyer and R. E. Wester (*Phytopathology*, 1956, **46**, 32).—[A]. A streptomycin (**I**) prep. (100 p.p.m.) sprayed on to 8-in. plants protected them against infection by *Phytophthora infestans*. Pure **I** was less effective than the commercial prep. of the same concn. of **I**. Addition of glycerol (1%) to the crude **I** spray lowered its efficiency.

[B]. Crude **I** prep. were more active than pure **I** sulphate in protecting the beans against *Phytophthora phaseoli*. A prep. containing **I** (25 p.p.m.) and a neutral Cu compound (Cu 25 p.p.m.) was more efficient than either the Cu fungicide or **I** used alone at concn. 50 p.p.m. When applied 48 hr. after inoculation **I** was ineffective. A. G. POLLARD.

***Aphanomyces* root rot of peas—effect of a potassium fertiliser on the severity of the disease in a potassium-deficient soil.** G. C. Wade (*J. Aust. Inst. agric. Sci.*, 1955, **21**, 260—263).—In a greenhouse experiment KCl at 4 cwt. per acre reduced mortality in plants subjected to moisture saturation for one week and reduced infection in plants held at normal moisture content. Growth was improved in all cases. E. G. BRICKELL.

Testing canning pea seed for adequacy of seed treatment. D. J. Hagedorn (*Phytopathology*, 1956, **46**, 13).—Pea seed treated with dichlone (as Phygon) or captan (as Orthocide) germinated better than that treated with chloranil (Spergon). Of samples tested only 10% showed >81% whilst 75% showed <60% germination. A. G. POLLARD.

Split-dosage application of soil fumigants to control stem and bulb nematode in garlic in California. B. Lear (*Phytopathology*, 1956,

46, 18).—Better results were obtained by two applications of half the normal dosage of D–D mixture or of Nemagon (1 : 2-dibromo-3-chloropropane) at 10-day intervals than by the ordinary single-dosage method. A. G. POLLARD.

Crop tolerance period following application of Amizol on Ewingsville soil. A. J. Tafuro, R. H. Beatty and R. T. Guest (*Proc. 9th annu. Mtg Northeast Weed Control Conf.*, 1955, 31—39).—Amizol (3-amino-1 : 2 : 4-triazole) was applied to soil at rates of 4—40 lb. per acre and crops were sown at varying intervals afterwards. Results of preliminary trials with a no. of vegetable crops are recorded. A. G. POLLARD.

Control of root-knot on carrot, celery and onion in muck soil by ethylene dibromide or D–D mixture. J. D. Wilson (*Phytopathology*, 1956, **46,** 31).—Autumn application of ethylene dibromide (9 or 12 gal. per acre) was more effective than D–D mixture at 30 or 45 gal. per acre. A. G. POLLARD.

Comparative control of radish yellows by various soil fumigants and fungicides. J. D. Wilson (*Phytopathology*, 1956, **46,** 31).—Of fungicides tested Crag 974 (95% tetrahydro-3 : 5-dimethyl-2*H*-1 : 3 : 5-thiadiazine-2-thione) gave better results than did Na methyldithiocarbamate or formaldehyde. Among fumigants, chloropicrin and ethylene dibromide, used at rates comparable with those required for nematode control in soil, were the most effective. A. G. POLLARD.

Application aspects of aphis control in sugar beet, brassicas and related crops. J. C. Gifford (*J. Sci. Food Agric.*, 1956, **7,** Suppl. Issue, s51—s53).—The use of low-vol. sprays and of systemic insecticides is discussed. E. M. J.

Control of fungi under glass. R. E. Taylor (*J. Sci. Food Agric.*, 1956, **7,** Suppl. Issue, s82—s88).—Problems arising in the greenhouse culture of tomatoes are considered. Cultural methods, greenhouse hygiene and the use of fungicides and soil sterilants are discussed, mainly for the control of *Didymella*, *Botrytis* and *Phytophthora* spp. E. M. J.

Control of insects under glass. W. H. Read (*J. Sci. Food Agric.*, 1956, **7,** Suppl. Issue, s89—s92).—Fumigants, smokes, " aërosols " and dusts are discussed and conditions of application and costs involved are considered. The control of the red spider is dealt with. E. M. J.

Effect of fungicides in miticide–fungicide dust formulations on the winter carry-over of the fungus causing black-spot of roses. W. D. McClellan, E. A. Taylor and F. F. Smith (*Phytopathology*, 1956, **46,** 20).—The incidence of black-spot in one season reflected the relative efficiencies of fungicides used in the previous season. Of fungicides examined basic Cu sulphate (Cu 3·4%)–S(25%), zineb (6·5%) and ferbam (7·6%)–S (25%) gave the best results. A. G. POLLARD.

Eradicant treatments for narcissus bulbs and gladiolus corms harbouring soya-bean nematode cysts. N. N. Winstead and C. B. Skotland (*Phytopathology*, 1956, **46,** 31).—Steeping corms and bulbs after harvest, in aq. Na 2 : 4 : 5-trichlorophenate (3 : 100) destroyed unhatched larvæ in the nematode cysts and, simultaneously, *Fusarium* bulb and corm rots. A. G. POLLARD.

Control of *Stromatinia* disease of gladiolus by soil treatments and cultural methods. R. O. Magie (*Phytopathology*, 1956, **46,** 19).—Root rot caused by *S. gladioli* was considerably reduced by treating the soil with Terraclor (75% pentachloronitrobenzene), Vapam (Na methylchlorocarbamate) or Crag Fungicide 974 (95% tetrahydro-3 : 5-dimethyl-2*H*-1 : 3 : 5-thiadiazine-2-thione) at rates of 100—200 lb. per acre in each case. The disease was more prevalent in better-drained soils. A. G. POLLARD.

Diffusion of soil fumigants in tobacco row treatments. T. W. Graham (*Phytopathology*, 1956, **46,** 13).—Ethylene dibromide or D–D mixture was applied in the bottom of a 6-in. furrow and immediately covered with soil and ridged to 10 in. total depth. Fumigation was effective (as assessed by nematode counts) over areas of 8—12 in. distance horizontally, from the line of application and in an 8-in. arc above it. A. G. POLLARD.

Chemical control of *Sclerotium rolfsii* in groundnuts. W. E. Cooper (*Phytopathology*, 1956, **46,** 9—10).—Best results were obtained by spraying with pentachloronitrobenzene, captan or thiram at the rate of 12 lb. (in 900 gal.) per acre. A. G. POLLARD.

Control of the pine leaf aphid, *Pineus pinofoliæ*, Fitch. W. R. Adams (*Vermont agric. Exp. Sta.*, 1955, *Bull.* 582, 8 pp.).—Characteristics of the pest and nature of the injury to white pine are described. Spraying with miscible oil (1 qt. per 8 gal.) during the 3—4 weeks period after eggs had been laid gave satisfactory control. A. H. CORNFIELD.

Modifications in soils of southern pine nurseries produced by fungicidal and nematocidal chemicals. A. A. Foster, E. F. Cairns and B. Hopper (*Phytopathology*, 1956, **46,** 12).—In soils on which losses of pine seedlings by root rot were normally heavy, the no. of healthy survivors was markedly increased by fumigation with MeBr. Ethylene dibromide and D–D mixture were somewhat less effective. A. G. POLLARD.

New class of herbicidal chemicals. L. H. Hannah (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 15—19).—α-Chloro-*NN*-diallyl- and -diethyl-acetamide effectively eliminated grasses when used as pre-emergence herbicides at the rate of 3—6 lb. per acre. Damage to crops was minimal. Both substances were absorbed rapidly by the surface layer of soil and were not leached downwards into the root zone of the crop. The water content of the soil immediately before or soon after the application did not affect the herbicidal efficiency. The use of these chemicals is unlikely to involve a toxic hazard (LD_{50} for rats, diallyl- 700, diethyl-derivative 500 mg. per kg. body-wt.). A. G. POLLARD.

Absorption and translocation of Dalapon [herbicide]. P. W. Santelmann and C. J. Willard (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 21—29).—Dalapon (Na 2 : 2-dichloropropionate) in concn. exceeding 1000 p.p.m. rapidly killed the foliage of quack grass but did not kill the rhizomes. Entry into the leaves was rapid and within the plant Dalapon is translocated partly with the products of photosynthesis and partly by other means. A. G. POLLARD.

Killing woody plants in West Virginia. K. L. Carvell and H. P. Berthy (*W. Virginia agric. Exp. Sta.*, 1955, *Circ.* 98, 7 pp.).—Chemical methods, using 2 : 4-D, 2 : 4 : 5-T and Ammate, for killing trees and other types of plants are described. A. H. CORNFIELD.

Bindweed control in the Panhandle of Texas. A. F. Wiese and H. E. Rea (*Texas agric. Exp. Sta.*, 1955, *Bull.* 802, 8 pp.).—Good control of bindweed was obtained by application of $NaClO_3$ (5 lb.), Concentrated Borascu (an insol. borate), 16, Atlacide (ClO_3' type), 7, Polybor chlorate ($NaClO_3$–Na pentaborate) 12, or Karmex W (3-*p*-chlorophenyl- 1 : 1-dimethylurea), 0·375 lb. per sq. rod. A re-treatment was usually necessary. Large infestations were controlled by intensive cultivation with sweep-type ploughs at 3-week intervals where soil moisture was low and a 2-week intervals where soil moisture was normal. Two annual applications of 2 : 4-D ester or amine (1 lb. per acre) controlled the weed in areas where cultivation was not feasible. On cropped land the most effective control was through competitive cropping and use of 2 : 4-D. Wheat was the best of the competitive crops. A. H. CORNFIELD.

Animal Husbandry

Grass silage. W. A. King (*S. Carolina agric. Exp. Sta.*, 1955, *Circ.* 97, 1 p.).—Advantages and disadvantages of using grass for making silage rather than hay are discussed. Preservatives and types of silo are described. A. H. CORNFIELD.

Silo construction costs and silage production practices. A. C. Magee (*Texas agric. Exp. Sta.*, 1955, *Bull.* 798, 12 pp.).—The comparative costs of construction and the cost of storing silage in different types of silo are presented. Silage production practices are described and the performance of a no. of silage field cutters is reported. A. H. CORNFIELD.

Forage crushing to aid drying. H. D. Bruhn (*Wisconsin agric. Exp. Sta.*, 1955, *Bull.* 514, 6 pp.).—Methods of crushing forage so as to accelerate air-drying prior to storage are described. A. H. CORNFIELD.

Texas range plants poisonous to livestock. O. E. Sperry, J. W. Dollahite, J. Morrow and G. O. Hoffman (*Texas agric. Exp. Sta.*, 1955, *Bull.* 796, 47 pp.).—A description of 69 species and varieties of plants known to be toxic to animals is given. The distribution, animals poisoned, toxic principle, symptoms, and management and control for each of the species are described. A. H. CORNFIELD.

Nutrients in rice bran and rice polish and improvement of protein quality with amino-acids. M. C. Kik (*J. agric. Food Chem.*, 1956, **4,** 170—172).—A study is reported on the content of vitamins of the B group, amino-acids, Ca, P and Fe in commercial rice bran and rice polish. Also the growth and protein efficiency of the addition of lysine, threonine and vitamin B_{12} to rations containing rice bran and polish as the only protein source are investigated. The results show that the proteins are improved by these dietary additions fed to rats. (15 references.) N. M. WALLER.

Effect of feeding different grades of hay and cod-liver oil concentrate to dairy cattle. IV. From birth through one to three lactations. H. B. Ellenberger, J. A. Newlander and C. H. Jones (*Vermont*

agric. Exp. Sta., 1955, *Bull.* 580, 32 pp.).—The animals' performance was somewhat better where good-quality (early cut) than where poor-quality (late cut) hay was supplied. Cod-liver oil concentrate was necessary for optimum performance only where poor-quality hay was supplied. A. H. CORNFIELD.

Methods for determining consumption and digestibility of pasture forages by sheep. B. H. Schneider, B. K. Soni and W. E. Harn (*Wash. agric. Exp. Sta.*, 1955, *Tech. Bull.* 16, 42 pp.).—The literature is critically reviewed and original data on the use of indicator method, with particular reference to the chromogen technique (*J. Dairy Sci.*, 1950, **33,** 60), is presented. Digestibility of orchardgrass as determined by the chromogen method was 64·4, 57·6 and 56·1 for the bloom, seed and second-cutting stages respectively. Digestibility was similar for the three age groups of sheep used. Dry matter consumption per day was 0·8, 1·7 and 2·2 lb. per 100 lb. body wt. for the adult ram, yearling and lamb respectively. The chromogen method gave results similar to those obtained by the " N content of fæces method " (*N.Z. J. Sci. Tech.*, 1949, **31,** 31). Use of the % digestible energy (*J. Anim. Sci.*, 1951, **10,** 344) gave lower values for total digestible nutrients than did the chromogen method. A. H. CORNFIELD.

Utilisation of smooth bromegrass (*Bromus inermis*) under rotational and strip grazing systems of pasture management. I. Animal and pasture production. A. L. Brundage, W. J. Sweetman, H. J. Hodgson and R. J. Bula. **II. Digestibility–intake studies.** A. L. Brundage, W. J. Sweetman and R. J. Bula. **III. Animal behaviour.** A. L. Brundage and W. J. Sweetman (*J. Dairy Sci.*, 1956, **39,** 280—286, 287—296, 297—302).—I. Under Alaskan conditions, the total utilisation of a single-species grass pasture (*Bromus inermis*) at a moderate level of milk production was only slightly more efficient with strip grazing than with conventional rotational grazing. A practical system of using electric fencing for strip grazing is described.

II. Fæcal production and milk production, resulting from previous ingestion of herbage, occur simultaneously. Under strip grazing, a positive correlation occurs between milk production and apparent dry-matter digestibility which is independent of time. Estimates of pasture utilisation based on (i) digestibility–intake studies, (ii) calculated total digestible nutrient requirements, and (iii) clippings made prior to grazing, have been compared ; all three methods have valid applications.

III. The grazing behaviour of cows under the two systems are compared. S. C. JOLLY.

Feedstuffs values and chemical changes in spontaneously heated lucerne pellets. W. S. Ruliffson, M. Milner and H. L. Mitchell (*J. agric. Food Chem.*, 1956, **4,** 167—170).—An analytical study is described showing progressive deterioration of sound feed pellets. Spontaneous heating is initiated and sustained by sugar–protein interactions of the Maillard type, and is accompanied by rapid sugar utilisation, slower fat destruction and increased ash, total N and crude fibre content. Before flaming combustion occurs decomposition is advanced in terms of colour, chemical deterioration and nutritive losses. N. M. WALLER.

Supplemental value of lucerne hay when fed to cows on pasture. D. M. Seath, C. A. Lassiter, C. L. Davis, J. W. Rust and M. Cole (*J. Dairy Sci.*, 1956, **39,** 274—279).—Feeding lucerne hay *ad lib.* for 2 hr. twice daily during summer failed to increase significantly the milk production of cows grazing a bluegrass–white clover pasture supplemented with a 14%-protein grain mixture although the dry-matter intake was increased by 11%. Hay supplementation tended to increase the production of fat-corrected milk for a short period, but otherwise average milk production was reduced ; it also resulted in an average increase of 50 lb. in the body wt. of the cows. S. C. JOLLY.

Nutritive value of various grasses and grass–legume mixtures. W. E. Watkins and J. V. Kearns, jun. (*J. Anim. Sci.*, 1956, **15,** 153—162).—Metabolism trials using western wheat-grass, crested wheat-grass, Bermuda grass alone or mixed with lucerne and with Alta fescue alone or mixed with ladino clover are recorded. The mixtures generally showed high feeding values. The lignin contents of the grasses were closely correlated with their crude fibre contents and thus could serve as an indication of the quality of the roughage. A. G. POLLARD.

Effect of Fab and lecithin on the digestibility of an all-hay ration. W. A. Hardison, W. N. Linkous, R. W. Engel, W. E. C. Moore and G. C. Graf (*J. Dairy Sci.*, 1956, **39,** 339).—The feeding of detergent (Fab) (10 or 20 g. daily) or purified lecithin (0·1—0·3 lb. daily) to heifers had no detrimental effect on reticulo–rumen micro-organisms or dry-matter digestibility of a ration of lucerne–oat hay mixture. S. C. JOLLY.

Determination of total digestible nutrients in grazed forage. G. P. Lofgreen and J. H. Meyer (*J. Dairy Sci.*, 1956, **39,** 268—273).—A method is described for determining the total digestible nutrients of grazed forage based on the digestibility and ether extract of the org. matter of a clipped sample. Selective grazing may be more pronounced with mature than with immature forage. S. C. JOLLY.

Antibiotics in dairy cattle nutrition. VI. Effects of aureomycin feeding on the apparent digestibility of certain calf rations. E. E. Bartley, D. B. Parrish and K. L. Wheatcroft (*J. Dairy Sci.*, 1956, **39,** 319—325).—Administration of aureomycin (25 mg. per 100 lb. of body wt.) to calves fed only milk had little effect on digestibility of the nutrients. When the ration was supplemented with oats or hay, the only marked and consistent effect was a reduction in the digestibility of crude fibre by 13-week-old calves fed milk and oats and by 9- but not 13-week-old calves fed milk and lucerne hay. Hay counteracts the depressing effect of the antibiotic on nutrient digestion. The beneficial effects of aureomycin on growth and feed efficiency are not due to improved digestibility of feeds. S. C. JOLLY.

Influence of aureomycin on *in-vitro* cellulose digestion by bovine rumen micro-organisms. J. R. Lodge, J. T. Miles, N. L. Jacobson and L. Y. Quinn (*J. Dairy Sci.*, 1956, **39,** 303—311).—Rumen inocula from aureomycin (**I**)-fed cows (80 mg. daily) digested less cellulose (73%) in the artificial rumen than did that from control cows (85%). Rumen liquid from cows contained 0·22 μg. at 4 hr. and 0·08 μg. of **I** per ml. at 16 hr. after feeding 240 mg. of **I.** Addition of 0·4—2·4 μg. of **I** per ml. of fermentation mixture in the artificial rumen strongly inhibited cellulose digestion by micro-organisms from control cows, but not by those from **I**-fed animals ; the inhibitory effect is mostly lost after a period of adjustment. **I**-resistant strains of *Pseudomonas* and *Monilia* emerge. This may explain the lack of effect of **I**-feeding on wt. gains, milk production and efficiency of feed utilisation. S. C. JOLLY.

Anabolic effect of stilbœstrol on cattle as indicated by carcass composition. M. T. Clegg and F. D. Carroll (*J. Anim. Sci.*, 1956, **15,** 37—47).—Implantation of stilbœstrol (12 or 60 mg.) in steers on a fattening ration diminished the deposition of fat and increased protein anabolism. The % of bone was unaffected but the % of water in carcasses was increased in heifers although unchanged in steers. The rate of gain in wt. increased but carcass grading was lowered in some cases. Detailed analyses of blood and carcass examination are recorded. A. G. POLLARD.

Œstrogenic activity of lucerne and other feeding-stuffs. P. J. S. Pietease and F. N. Andrews (*J. Anim. Sci.*, 1956, **15,** 25—36).—The activity of first-year lucerne varied considerably with the stage of growth, peak values occurring in the early bud stage and again during flowering. In the second year high values were reached only at the " dough " stage and in the third and fourth years the activity remained consistently low. Activity was established in ladino and red clover, birdsfoot trefoil, soya-bean oil meal, mouldy maize, wheat, rye and oats but not in sweet clover, soya-bean plants, brome grass, fescue or orchardgrass, or in fish solubles, fish meal or dried distillers' solubles. A. G. POLLARD.

Influence of oral administration of diethylstilbœstrol on œstrogenic residues in the tissues of beef cattle. R. Preston, E. Cheng, C. D. Story, P. Homeyer, J. Pauls and W. Burroughs (*J. Anim. Sci.*, 1956, **15,** 3—12).—Administration of diethylstilbœstrol (2—12 mg. per head daily) to steers over a period of 112 days (up to the time of sending to market) caused no detectable residual of œstrogen (<2 μg. per kg.) in lean or fat tissue or organs at slaughter. A. G. POLLARD.

Biological assay of beef steer carcasses for œstrogenic activity following the feeding of diethylstilbœstrol at a level of 10 mg. per day in the ration. C. W. Turner (*J. Anim. Sci.*, 1956, **15,** 13—24).—In steers receiving 10 mg. of stilbœstrol (**I**) daily until within 44 hr. of slaughter detectable amounts of the œstrogen were found only in kidneys (4) and lungs (12 pt. per billion). Fæces contained substantially the same amount of **I** as did the ration. A. G. POLLARD.

Effects of low-level implantation of stilbœstrol in steers on pasture. C. C. O'Mary and A. E. Cullison (*J. Anim. Sci.*, 1956, **15,** 48—51).—The average daily gain in wt. of two lots of steers on pasture was increased by 0·69 and 0·58 lb. respectively after implantation (24 mg. per head). A. G. POLLARD.

Effects of low-level implantation of stilbœstrol in steers fattened on dry-lot rations. C. C. O'Mary, E. P. Warren, T. J. Davis and H. H. Pierce, jun. (*J. Anim. Sci.*, 1956, **15,** 52—58).—Implantation of stilbœstrol (36 mg. per head) in the steers significantly increased the rate of gain in wt. A further implantation 42 days later had no additional effect. Carcass grade and dressing % were unaffected by the treatment. When the dosage of œstrogen was divided (12 mg. initially + 24 mg. after 42 days) no significant effects were observed. A. G. POLLARD.

Use of antipyrine in nutritional and meat studies with cattle. G. H. Wellington, J. T. Reid, L. J. Bratzler and J. I. Miller (*J. Anim. Sci.*, 1956, **15**, 76—85).—The % of body water in cattle, as determined by the antipyrine method (R. Soberman *et al.*, *J. biol. Chem.*, 1949, **179**, 31) was closely correlated with that found by slaughter and analysis. The % of body fat calculated from that of body water was correlated with the level of intake of total digestible nutrients (TDN). The dressing % was directly related to the TDN intake but not to the age of the animal. A. G. POLLARD.

Metabolism of bull semen. II. Fructolysis relations with sperm concentration and fertility. R. E. Erb, F. H. Flerchinger, M. H. Ehlers and F. X. Gassner (*J. Dairy Sci.*, 1956, **39**, 326—338).—For the accurate estimation of fructolytic activity on a 10^9-sperm basis, an incubation period at 37° of 1 hr. is too long; fructose utilisation is ∝ no. of sperm in the incubate and correlations with fertility are improved if utilisation at 10 min. (calc. from 1st-order reaction formula) is used. For highly conc. highly motile semen, 20-min. incubation is suggested. There was no relation between non-returns to service and any fructose measurement for semen samples within bulls. Providing allowance is made for interfering variables, fructose utilisation by 10^9 sperm per unit time is a satisfactory laboratory method for estimating bull fertility.
S. C. JOLLY.

Lowering the volatility of lindane cattle sprays by addition of film-forming material. I. Hornstein, W. S. McGregor and W. N. Sullivan (*J. agric. Food Chem.*, 1956, **4**, 148—149).—Lindane dosages of 10 × normal (20 g. per animal) were applied to cattle, without harmful effects, by using a lindane-chlorinated terphenyl mixture in a pressurised spray. Fly control remained good for four weeks after one application. The treatment is not recommended for use on dairy or beef cattle since there is a high initial concn. of lindane (8·4 p.p.m.) in the milk. N. M. WALLER.

Energy requirements of chickens. III. Effect of dietary energy level on the rate and gross efficiency of egg production. F. W. Hill, D. L. Anderson and L. M. Dansky. **IV. Evidence for a linear relationship between dietary productive energy level and the efficiency of egg production.** F. W. Hill (*Poultry Sci.*, 1956, **35**, 54—59, 59—63).—III. Increasing the productive energy of the ration (from 740 to 930 kg.-cal. per lb. in one and from 945 to 1025 kg.-cal. per lb. in another test) resulted in increased egg production only in the winter months. Feed efficiency with respect to egg production increased with the productive energy of the ration. Body wt. of dams was maintained at a somewhat higher level by the high- than by the low-energy rations.

IV. Over the productive energy range 740 to 945 kg.-cal. per lb. there was a linear relationship between energy level and efficiency of egg production. Providing a value of 2900 kg.-cal. per lb. was used for the productive energy of tallow then the linear relationship continued for diets (containing tallow) having productive energy of up to 1025 kg.-cal. per lb. A. H. CORNFIELD.

Method for estimating the rate of oxygen consumption of young chicks. G. H. Strite and H. Yacowitz (*Poultry Sci.*, 1956, **35**, 142—144).—A simple apparatus, which is suitable for studying the relative rates of O_2 consumption of chicks fed different rations, is described. The O_2 consumption per kg. of body wt. of male chicks three weeks old was increased by adding thyroprotein (0·15 g. per lb.) but not by adding fresh calf thymus (24 g. per lb. of feed) to the diet. A. H. CORNFIELD.

Effect of diet on the pH and microflora in various regions of the intestinal tract of chickens. R. W. Wiseman, O A. Bushnell and M. M. Rosenberg (*Poultry Sci.*, 1956, **35**, 126—132).—The pH at different sites of intestines of birds fed a diet containing B-grade molasses as the main source of carbohydrate did not differ markedly from that of the same sites of birds receiving maize as the main carbohydrate source. There was a lower count of "aërobes" and lactobacilli in nearly all sites with the molasses than with the maize ration. The population of bacteria was lowest in the more acid region of the alimentary tract and increased as pH approached 7 and then decreased with higher pH (large intestine and fresh droppings). A. H. CORNFIELD.

Effect of diet on the ether-extract content of chicken muscles. R. W. Lewis, P. E. Sanford, A. T. Ericson and R. E. Clegg (*Poultry Sci.*, 1956, **35**, 132—137).—With all diets the dark meat of birds contained a greater ether-extract (%) than did the light meat. Max. ether-extract occurred in dark meat where a diet containing 62% of cerelose was supplied and min. ether-extract where cerelose was replaced by ground maize. In the light meat ether-extract was at a max. with a cerelose or cerelose–barley diet and at a min. with a cerelose–maize diet. In general, ether-extract decreased with increasing fat content of the diet, and birds fed diets which resulted in the least ether-extract being deposited in the meat had the largest amount of external fat. A. H. CORNFIELD.

Study of New Hampshire X Barred Columbian chicks from two days of age to ten weeks of age. I. Growth, organ weights, liver fat and protein, femur and tibia fat and ash of chicks fed a ration free from antibiotics and coccidiostats. C. E. Schoettle, E. F. Reber, J. O. Alberts and H. M. Scott (*Poultry Sci.*, 1956, **35**, 95—98).—The chemical analyses indicated are recorded. A. H. CORNFIELD.

Trichloroethylene-extracted and expeller-type meat scraps and tallow in the diets of young chickens. S. L. Balloun, G. A. Donovan and R. E. Phillips (*Poultry Sci.*, 1956, **35**, 163—167).—Trichloroethylene-extracted and expeller-type meat scraps usually improved chick growth when added at 5—10% to maize-soya-bean oil-meal diets. Feed conversion was improved and mortality rate and growth of chicks to 12 weeks of age were not adversely affected by 20% trichloroethylene-extracted meat scraps in the diet. Addition of 2—4% of tallow to the diets improved chick growth, the improvement being less marked when the diet contained expeller-type meat scraps. A. H. CORNFIELD.

Cannibalism, pick-outs and methionine. W. M. Neal (*Poultry Sci.*, 1956, **35**, 10—13).—Supplementation of the feed with 0·1% of methionine completely prevented cannibalism and pick-outs. Addition of methionine to the feeds resulted in their being consumed much more avidly by the birds. A. H. CORNFIELD.

Absorption of vitamin A in aqueous and oil solutions by depleted New Hampshire chicks. R. L. Squibb, J. E. Braham and N. S. Scrimshaw (*Poultry Sci.*, 1956, **35**, 73—76).—When 7500 i.u. of vitamin A was administered in various ways to vitamin A-depleted chicks there was a rapid increase in serum-vitamin-A level where aq. solutions were injected intramuscularly or supplied orally or when an oil solution was supplied orally, but a much slower increase in vitamin A level when oil solutions were injected intramuscularly or subcutaneously. Blood serum-vitamin-A level ranged from 24 to 37 μg. per 100 ml. 11 days after administration, the highest level being obtained with the intramuscular injection of aq. vitamin A. Where 1800 i.u. of vitamin A in oil was injected subcutaneously serum vitamin A level reached a max. of 5 μg. per 100 ml.
A. H. CORNFIELD.

Rôle of vitamin E (α-tocopherol) in poultry nutrition and disease; a review. S. R. Ames (*Poultry Sci.*, 1956, **35**, 145—159).—A review of recent literature. The total tocopherols and α-tocopherol contents of a large variety of feeding-stuffs are also presented.
A. H. CORNFIELD.

Response of growth and dressing-out percentage in imported breeds of cockerels to stilbœstrol implantation in Egypt. H. F. Issawi, S. S. Khishin and S. Hafez (*Poultry Sci.*, 1956, **35**, 85—91).—Cockerels of four imported breeds as well as of indigenous breeds were implanted with 0·015 g. of stilbœstrol at 20—25 weeks of age and examined 13 weeks after implantation. Implantation had no effect on growth rate of Light Sussex, White Leghorn and indigenous breeds but accelerated the growth of Blue Holland and Rhode Island Reds. Growth acceleration was greater when implantation was done at 20 than at 25 weeks of age. The treatment increased the dressing-out % of all but the indigenous breeds and reduced testis wt. to varying extents depending on breed.
A. H. CORNFIELD.

Feeding high levels of antibiotics to chickens. G. F. Heuser (*Poultry Sci.*, 1956, **35**, 81—84).—Under conditions involving an outbreak of respiratory disease a low level of antibiotic (10 g. chlortetracycline per ton of feed) had no effect on feed efficiency and increased market wt. and decreased mortality only slightly. High levels of antibiotics (50—100 g. chlortetracycline or 100 g. oxytetracycline per ton of feed) increased wt., improved feed efficiency, decreased mortality and reduced the time required to bring the birds to marketable size. A. H. CORNFIELD.

Response of bobwhite quail to antibiotics. F. R. Mraz, R. V. Boucher and E. W. Callenbach (*Poultry Sci.*, 1956, **35**, 76—80).—Addition of aureomycin, bacitracin, penicillin and Terramycin (10 g. free base per ton of feed) to the diet of bobwhite quail from 0 to 16 weeks of age increased growth rate to three weeks of age, but wt. at 16 weeks of age was similar for treated birds and controls. Streptomycin had no effect on growth at any age. In another test bacitracin and penicillin (5—20 g. free base per ton of feed) stimulated growth to six weeks of age to a greater extent than did terramycin. The treatments had no significant effect on mortality.
A. H. CORNFIELD.

Relationship of coliforms to the growth response of chicks to antibiotics. M. M. Hauser, G. W. Anderson, W. F. Pepper and S. J. Slinger (*Poultry Sci.*, 1956, **35**, 27—36).—In a relatively clean environment chicks receiving chloromycetin (10—200 p.p.m.) in the feed gave a growth response only towards the end of the 17-day test; this response was accompanied by an increase in intestinal coliforms. Feed efficiency improved and intestinal lactobacillus counts decreased with increasing level of chloromycetin. Chicks

in a contaminated environment were given penicillin, aureomycin, Terramycin, chloromycetin or sulphisoxazole (25 p.p.m.) or 3-nitro-4-hydroxyphenylarsonic acid (50 p.p.m.) in the feed. The greatest increases in growth rate due to treatment occurred early in the test and were usually accompanied by increases in coliforms and reduction in enterococci. A. H. CORNFIELD.

Removal of chicken tapeworms by di-*n*-butyltin dilaurate. S. A. Edgar (*Poultry Sci.*, 1956, **35**, 64—73).—When administered at 0·5 g. per kg. of feed for 2—6 days or by capsule at 0·075—0·125 g. per bird, di-*n*-butyl-Sn dilaurate was effective in eliminating *Raillietina cesticillus* and three other species of tapeworm from laboratory-infested birds. When administered to field-infested hens at 0·5 g. per kg. of feed or at 0·125 g. as a capsule or in combination with nicotine or phenothiazine, the treatments were highly effective in eliminating six common species of tapeworm. A single dose of 0·125 g. per bird had no effect on whilst 0·3 g. reduced egg production temporarily. Limited tests with 2 : 2′-dihydroxy-5 : 5′-dichlorodiphenylmethane, piperazine hexahydrate, and di-*n*-butyltin oxide are also reported. A. H. CORNFIELD.

Response of susceptible chickens to graded doses of the virus of visceral lymphomatosis. B. R. Burmester and R. F. Gentry (*Poultry Sci.*, 1956, **35**, 17—26).—Deaths from visceral lymphomatosis occurred 22 days after inoculation among birds receiving the heaviest dose. The incidence of the disease ranged from 55·5% in the low to 90·1% in the high dosage lot, with average age at death ranging from 56 days for the high to 128 days for the low dosage lot. The % of intravascular lymphomatosis increased whilst that of extravascular lymphomatosis decreased with dose of inoculum. Osteopetrosis occurred in all inoculated lots but its extent was in general not related to dose. Females were slightly more susceptible than were males to lymphomatosis, whilst the reverse was true for osteopetrosis. A. H. CORNFIELD.

Effect of a naturally occurring outbreak of Newcastle disease on egg quality and production. J. P. Quinn, A. W. Brant and C. H. Thompson, jun. (*Poultry Sci.*, 1956, **35**, 3—10).—The % of thick white of eggs from birds which had recovered from Newcastle disease (ND) was greater than that of eggs from birds which had not had the disease. When stored 14 days at 37·8° the % of thick white increased to a much greater extent in the eggs from the ND-recovered birds than in the eggs in control birds. Candled score and albumin score of day-old eggs from the recovered group were higher than those of eggs from the control group. Both groups of eggs deteriorated at the same rate on holding. Eggs from recovered pullets weighed less than eggs from control pullets, but had better shell quality. A. H. CORNFIELD.

Incidence of lymphomatosis in poultry at the University of Nottingham School of Agriculture. E. W. Nightall (*Poultry Sci.*, 1956, **35**, 109—125).—The level of lymphomatosis was lower in the battery than in either the semi-intensive or fold unit systems. The incidence of the disease was much lower in the cross between Rhode Island Reds and Light Sussex than in either of the parent stocks, and in Leghorn and Rhode Island Red crosses it was lower than in the parent stock until 1951, when the incidence of lymphomatosis rose very sharply, probably due to the use of a different strain of Leghorn male. Deaths from visceral lymphomatosis occurred mainly during the actual laying period and increased up to the fourth laying season. Neural lymphomatosis occurred chiefly at the age of maturity, and its incidence decreased and disappeared with increasing age. Suggestions for lowering the incidence of the disease through breeding are presented. A. H. CORNFIELD.

Vaccination methods for controlling Newcastle disease and infectious bronchitis in poultry. D. J. Richey (*S. Carolina agric. Exp. Sta.*, 1955, *Circ.*, 99, 11 pp.).—Symptoms of the two diseases and methods of treatment with various types of vaccine are described. A. H. CORNFIELD.

Control of coccidiosis in chickens. J. O. Heishman, C. J. Cunningham and T. B. Clark (*W. Virginia agric. Exp. Sta.*, 1955, *Bull.* 376, 11 pp.).—The low incidence of coccidiosis even in control birds failed to show whether 0·0062—0·0125% sulphaquinoxaline or 0·0125% nitrophenide (Megasul) in the feed was effective in controlling the disease. However, the nitrophenide and the high level of sulphaquinoxaline had a definite beneficial effect on livability, body wt., and feed utilisation. There were no indications of any toxic effects from the drugs. A. H. CORNFIELD.

Anti-parasitic activity of Nicarbazin. A. C. Cuckler, C. M. Malanga and W. H. Orr (*Poultry Sci.*, 1956, **35**, 98—109).—Nicarbazin [chemical complex formed by 4 : 4′-dinitrocarbanilide (**I**) and 2-hydroxy-4 : 6-dimethylpyrimidine (**II**)] was well tolerated by chickens in brooder and floor pen trials when fed at 0·005—0·060% in the feed for 11—12 weeks. Addition of 0·1% Nicarbazin to the diet of turkeys from one day to 27 weeks of age reduced growth rate only slightly. The treatments had no effect on **hæmoglobin concn.**, whole blood clotting times or histopathological changes of spleen, liver and kidney. The **I** component of Nicarbazin was eliminated from the blood and muscle tissues within 24—48 hr. after termination of medication. The **II** component was not detectable in the plasma and muscles but was present in the liver, from which it was eliminated within 24 hr. after withdrawal of medication. Nicarbazin effectively prevented mortality from inoculations of *Eimeria tenella* and *E. necatrix* in chickens and *E. gallapavonis* and *E. meleagrimitis* in turkeys. A. H. CORNFIELD.

Treatment of soil. Food Machinery & Chemical Corp. (B.P. 737,548, 22.12.53. U.S., 5.2.53).—Soil is simultaneously fertilised and fumigated by injection thereinto of fluid containing NO_2, N_2O_3, and optionally air and non-oxidising gas, e.g., CO_2. F. R. BASFORD.

Preparation for prolonging the life of cut flowers. Drug Houses of Australia, Ltd. (Inventors: Trustram F. West and Alan L. C. Wallace) (B.P. 737,157, 21.11.53).—Cut flowers are immersed in an aq. solution of bis-(2-hydroxy-3 : 5 : 6-trichlorophenyl)methane (hexachlorophene) or a salt thereof 5—12 p.p.m. There may also be present a respiratory substrate, essential mineral, trace element, tissue preservative, or plant hormone (e.g., *p*-chlorophenoxyacetic acid). F. R. BASFORD.

Preparation of urea–formaldehyde condensate fertiliser compositions. E. I. du Pont de Nemours & Co. (B.P. 737,468, 15.8.52. U.S., 12.9.51).—A urea–formaldehyde condensate, useful as a fertiliser, is prepared by heating a solution of formaldehyde 1, urea 1·5—4·5, and water 20—80 mol. at 20—65°, pH 1—6 while being subjected to mild agitation to increase the particle size of the initially pptd resin from 2—6μ. to 20—200μ. The mixture is then adjusted to pH $\leq$6 (with $CaCO_3$), and the condensate is filtered off. F. R. BASFORD.

Preparation of novel polymerisation products. Röhm & Haas G.m.b.H. (B.P. 736,468, 18.8.53. Ger., 25.8.52).—Novel and useful products are made by polymerising at temp. <200 (100—140)° the reaction products of urea with $\alpha\beta$-unsaturated acids of formula CH_2:CR·COOH, where R is H or an alkyl or aryl group [methacrylic acid (**I**)]. E.g., a mixture of 1 mol. of **I** with 0·5—3 mol. of urea is heated to 100—130° for ½ hr., then 0·05—1% of benzoyl peroxide is added and the reaction mixture is polymerised at 100—140° to yield a hard infusible product which contains free COOH groups. It is only partially soluble in water but easily dissolves in the form of its NH_4, alkali metal, or mixed NH_4 and alkali metal salts. If the polymerised product, in suitable state of division, is treated with gaseous NH_3 a crumbly water-sol. product is obtained. The products (especially the NH_4 salts) are useful for improving agricultural soils and for the granulation of fertilisers. H. L. WHITEHEAD.

Quaternary ammonium compounds and herbicides containing them. Monsanto Chemical Co. (B.P. 736,597, 25.8.52. U.S., 25.8.51).—A herbicidal composition comprises $C_6H_4R{\cdot}CH_2{\cdot}NR'R''R'''Cl$ (R is alkyl of 5—7 C, R′—R‴ are alkyl of 1—5 (or R‴ is Ph) and an inert carrier. A mixture of $NPhMe_2$ (29·2), *p*-*sec.*-pentylbenzyl chloride (40), and EtOH (~120) is boiled during 18 hr., then the filtered solution is evaporated, and the residual syrup is washed with ether, to give *phenyl*-(p-sec.-*pentylbenzyl*)*dimethylammonium chloride* (40 g.), as a green, viscous product, Cl 12·47%. This, in aq. suspension, at a concn. of 100 p.p.m., limits the root growth of wheat seeds germinated therein to 4% of that obtained in H_2O alone. The following other compounds are also described: **p-sec.-pentylbenzyl**-*tripentylammonium chloride*, a yellow syrup, and *-trimethylammonium chloride*, a yellow gel. F. R. BASFORD.

2.—FOODS

Application of the spouted bed technique to wheat drying. K. B. Mathur and P. E. Gishler (*J. appl. Chem., Lond.*, 1955, **5**, 624—636).—The spouted bed technique for agitating solids that are of too coarse and uniform a particle size to be fluidised satisfactorily is outlined. Its application to the drying of wheat is described; air temp. much higher than conventionally used are permitted, without overheating the wheat kernels. The effects of feed moisture content, feed rate, bed depth and inlet air temp. on the rate of moisture removal were studied on a small pilot-plant scale. The temp. and humidity profiles within a wheat bed agitated by this technique are described. J.A.C. ABSTR.

Effect of air humidity on through drying of wheat-grain. E. McEwen and J. R. Callaghan (*Trans. Instn chem. Engrs*, 1955, **33**, 135—138).—Data are presented for drying rates of wheat-grain in thin layers, with a wide range (10—80%) of R.H. in the drying

air stream. A suitable R.H. correction is introduced for use with the drying-rate formula of McEwen, Simmonds & Ward (*ibid.*, 1953, **31**, 279). J.A.C. ABSTR.

Chemistry of wheat lipins. E. D. Slifer (*Dissert. Abstr.*, 1956, **16**, 444).—A benzene extract of wheat flour was fractionated into four distinct components by a Craig distribution between *n*-heptane and 95% methanol. The composition of the extract was as follows: 40%, a triglyceride fraction of saponification no. 250 and I val. 70; 3%, a sterol believed to be stigmasteryl palmitate; 3 to 4% unesterified sterol; 14% lipoprotein, the peptide moiety containing at least six amino-acids including serine, tyrosine and glutamic acid; 23% carbohydrate, consisting of α-D-galactopyranosyl-1 : 6-β-D-galactopyranosyl-1 glycerol and β-D-galactopyranosyl-1 glycerol. O. M. WHITTON.

Chemical distinction between proteins of wheat and rye. II. Amino-acid composition of proteins from aleurone cells, endosperm, and embryo of wheat and rye. M. Rohrlich and R. Rasmus (*Z. LebensmittUntersuch.*, 1956, **103**, 89—96; cf. J.S.F.A. Abstr., 1955, ii, 282).—The amino-acid compositions of the protein hydrolysates obtained from the water- and EtOH-sol. fractions of the mechanically separated grain constituents are compared by radial chromatography. No qual. differences in aleurone- or embryo-protein compositions are found as between wheat and rye, but the wheat proteins contain comparatively little lysine and arginine, and more glutamic acid. Similar results are found for the endosperm proteins, the rye proteins showing notably higher arginine contents. The embryo- and aleurone-fractions show small differences in cystine and lysine contents. The water- and 70% EtOH-sol. wheat-endosperm fractions have practically the same amino-acid composition. The possible significance of the observed differences is considered. P. S. ARUP.

Cereal proteins. II. A. Bourdet (*Rev. Ferment. Industr. aliment.*, 1956, **11**, 19—33; cf. J.S.F.A. Abstr., 1956, i, 269).—The physico-chemical properties (mol. wt., structure, isoelectric point) of cereal proteins, and the amino-acid compositions of proteins from wheat, barley, oats, rye, rice and maize are tabulated. The baking qualities of flours are discussed. A bibliography of ~200 references is appended. J. S. C.

Objective evaluation of the maturity factor in processed sweet maize. B. A. Twigg, A. Kramer, H. N. Falen and F. L. Southerland (*Food Technol.*, 1956, **10**, 171—174).—On the basis of examination of many samples, the trimetric test, consisting of determination of % of alcohol-insol. solids, % of pericarp and kernel size, may be used with considerable reliability to evaluate the tenderness-maturity of canned or frozen whole kernel maize. E. M. J.

Spectrophotometry of yellow sweet maize. H. C. Lukens and K. J. Palmer (*Food Technol.*, 1956, **10**, 190—193).—The relation between the reflectance properties of individual ears of yellow sweet maize and their moisture content over a wide maturity range is considered in detail and methods of utilising these data as the basis for a technique to measure maturity are discussed. A photoelectric photometer was developed, adapted to measure the ratio of reflected radiant energy received by two photomultiplier tubes, through filters, from a sample of yellow sweet maize. E. M. J.

Phase contrast microscopy in the examination of starch granules. H. B. Wigman, W. W. Leathen and M. J. Brackenbeyer (*Food Technol.*, 1956, **10**, 179—184).—The instrument used in this work has the advantage of exact reproducibility of field contrast at any time, giving photomicrographs, suitable for reference material, at spaced intervals. Granule changes of starches, modified starches and flours during processing were studied and photomicrographs were produced of the normal appearance of a wide variety of thickening agents. A method for preparing slurries and slides is described. E. M. J.

Gas production and yeast roll quality after freezer storage of fermented and unfermented doughs. B. Meyer, R. Moore and R. Buckley (*Food Technol.*, 1956, **10**, 165—168).—Manipulation of fermented and unfermented yeast doughs after freezing for 2, 4, 8 or 12 weeks, as shaped rolls, or bulk dough was the most important factor affecting the quality of the rolls. Bulk doughs held in frozen storage for 12 weeks yield acceptable quality rolls, but inferior quality rolls were obtained from each test period from doughs shaped before freezing. Gas production determined by pressure meter was decreased significantly in both fermented and unfermented doughs after four weeks in frozen storage. E. M. J.

Determination of ergosterol in yeasts. O. Hummel (*Z. Lebensmitt-Untersuch.*, 1956, **103**, 190—198).—Spectrophotometric measurement of the absorption at 293·5 mμ. is the uost specific of the methods available for this determination. At this λ interference by other sterols is at a min. The result is corrected by subtraction of a blank value measured at 310 mμ., at which λ irrelevant adsorption only, is measured. Destruction of the cells of *Torula* spp. and liberation of ergosterol is best accomplished with the use of methanolic 5% KOH, but in the case of *Saccharomyces* spp., max. yields of ergosterol are obtained with the use of aq. 40% KOH. After hydrolysis of the fatty matter, the sterols are quant. extracted by means of Et_2O. The measurements are carried out on an ethanolic solution of the residue obtained by the evaporation of an aliquot portion of the Et_2O solution. Results of greater accuracy can be obtained by carrying out the measurement on the pptd. and separated digitonides in EtOH solution. The absorption values of the digitonides are identical with those of the sterols. The sterols are more easily extracted from the dried than from the undried yeasts. (33 references.) P. S. ARUP.

Effect of ethylene oxide treatment on the nutritive value of certain foods. B. L. Oser and L. A. Hall (*Food Technol.*, 1956, **10**, 175—178).—Six samples of yeast treated with ethylene oxide under conditions approximating commercial usage had slight insignificant losses in thiamine, riboflavin, niacin, choline and pantothenic acid contents, but losses of pyridoxine and folic acid may have been significant. The inclusion of 10% of treated yeast in a test diet resulted in no adverse effects on young rats during a 5-week period, but there was lower growth response and efficiency of food utilisation during the first week. E. M. J.

New uses for sugar. H. B. Hass (*Rev. Ferment. Industr. aliment.*, 1956, **11**, 17—18).—Recent work on the ammoniation of sugar-beet pulp and of molasses, in order to produce satisfactory cattle foods, is reviewed (cf. J.S.F.A. Abstr., 1955, ii, 108; 1956, i, 220). J. S. C.

Quality of apples and pears as determined by variety. J. Tavernier and P. Jacquin (*Ann. Nutr., Paris*, 1955, **9**, A143—A171).—Conclusions arising from a detailed review of data for the composition of the fruits include the following: certain varieties of table apples are particularly rich in vitamin C. Taste is largely affected by the sucrose content in proportion to glucose and fructose. Apples suitable for making sweet cider are relatively rich in sugars and poor in compounds of N; apples of the reverse type are suitable only for making dry cider or brandy. Difficulties experienced in defecating juice from immature apples are explained in terms of chemical composition. Malic acid is the principal acid constituent of table pears, and citric acid that of perry pears. Certain varieties of apples and pears, particularly rich in malic acid and sorbitol, respectively, are suggested as sources for these chemicals. Consideration of the chemical composition of the fruits deserves a place beside economic and agricultural considerations. (86 references.) P. S. ARUP.

Dehydration and quick-freezing of apples and peas. Rept. 615 and 658 of I.B.V.T. J. C. M. Meijer and H. R. F. M. Pilzecker (*Conserva*, 1956, **4**, 268).—Satisfactory results have been obtained from experimental treatements on lines developed in U.S.A., viz. drying to approx. half the original wt. by means of a current of hot air, followed by quick-freezing. P. S. ARUP.

Quality of peaches and plums as determined by variety. E. Peynaud and H. Caillavet (*Ann. Nutr., Paris*, 1955, **9**, A173—A190).—Long-term observations on a wide basis have led to the recommendation for general cultivation of 19 varieties of peaches and 17 varieties of plums. Varietal characteristics have been defined in publications for the information of buyers and various horticultural institutions. Analytical data are given for the fruits of a no. of varieties. (21 references.) P. S. ARUP.

Rôle of pH in the canning of mangoes: effect of adding acid or other fruits to the canned products. G. S. Siddappa and B. S. Bhatia (*Food Res.*, 1956, **21**, 163—169).—In canning fruits the pH of the fruit (preferably below 4·5) is the critical factor that determines the efficacy of the heat processing. *Raspuri* mango pulp (pH ~3·5) requires no addition of citric acid; mixed with half its wt. of syrup, the pH decreases from 3·6 to 2·95 when 1% of acid is added. The pH of *Badami* mangoes varies from 3·8 to 4·5 and 0·3—0·5% of acid is added to the syrup. *Badami* may be canned with more acid fruits, e.g., pineapple. Bangalora mangoes (pH ~3·2) can be used to lower the pH of fruits like jack fruit, banana and orange (pH 4·8—5·2). E. M. J.

[A] **Preservation of quality of fresh fruits and vegetables by refrigeration.** R. Ulrich. [B] **Preservation of quality of fresh fruits and vegetables by processes other than refrigeration.** R. Ulrich and P. Marcellin (*Ann. Nutr., Paris*, 1955, **9**, A249—A264, A265—A293).—[A] A review covering changes liable to occur during cold storage, and their estimation, criteria for the quality of cold-stored products, and optimum conditions for cold storage. (30 references.)

[B] A review covering the use of gaseous and other antiseptics for surface sterilisation and treatment of packing material, and protection from deterioration of various descriptions by storage in atm. of

modified composition, and the use of special wrappings. (103 references.) P. S. ARUP.

Quality of tomatoes as determined by variety. G. Sanfourche (*Ann. Nutr., Paris*, 1955, **9**, A205—A215).—A review covering characteristics of a no. of varieties, with special reference to productivity, rate of ripening, resistance to fungi, and the shape, size and appearance of the fruit. P. S. ARUP.

Technological aspects of tomato production. A. Barret (*Ann. Nutr., Paris*, 1955, **9**, A217—A220).—A review covering commercial aspects, composition of the fruit, and suggestions for the better preservation of the lycopene and vitamins during processing. P. S. ARUP.

Quality of potatoes as determined by variety. R. Diehl (*Ann. Nutr., Paris*, 1955, **9**, A191—A203).—A review covering nutrient value, composition and quality factors relevant to human and animal consumption, and industrial use, respectively. P. S. ARUP.

Residual DDT on stored potatoes. Possibility of toxic hazards. S. N. Mitra and S. C. Roy (*J. Instn Chem. India*, 1955, **27**, 233—240).—Stored potatoes sold in Calcutta markets are treated with DDT to protect them against damage by insects. The DDT content of samples bought in the market was determined by the org. chlorine method of the Ass. off. agric. Chemists. In only one case was the residual DDT content greater than the max. limit of 7 p.p.m. permitted for stored foodstuffs. DDT was found not to penetrate the skins of the potatoes. J. M. JACOBS.

Effects of the different methods of blanching on the quality of home frozen spinach. G. L. Tinklin and G. A. Filinger (*Food Technol.*, 1956, **10**, 198—201).—Of three methods of blanching tried, no one method was superior when palatability and nutritive value of the frozen spinach were considered. To preserve greater ascorbic acid retention blanching in boiling water for 2 min. is recommended. E. M. J.

Formation and composition of green pigment in crushed garlic tissue. M. A. Joslin and Tatsuo Sano (*Food Res.*, 1956, **21**, 170—183).—The formation of a green pigment in macerated tissue of garlic cloves free of preformed chlorophyll was studied. Complete maceration was necessary, and the naturally occurring phenolases and peroxidases were not involved, but optimum conditions for the formation of the green pigment were pH 4 at 70° when the puree was heated for 3 min. At room temp. (22°) and pH 6·0 max. greening occurred in 24 hr., slowly changing to brown, yellow and light cream. Both the green and the brown pigments were soluble in 70—80% acetone. The green pigment in acetone solution gave a high absorption in the region of 400—450 mμ. and the brown pigment gave a max. at 440 mμ. (14 references.) E. M. J.

Nutritive value of various leaf-vegetables and its varietal and ecological fluctuations. W. Schuphan (*Ann. Nutr., Paris*, 1955, **9**, A67—A93).—A review with 23 references. P. S. ARUP.

Potentiometric determination of formol value. O. Wyler (*Mitt. Lebensm. Hyg., Bern*, 1955, **46**, 515—524).—Results of the ordinary titration are affected by the presence of buffering agents, colouring matter and other substances (e.g., SO_2, CO_2, phosphates, or org. acids). Greater consistency is achieved by means of the potentiometric titration of the defecated juices, with the adoption of a standard end-point of pH 9. Results obtained by the two methods for the juices of 24 varieties of fruits are compared. Provided that the juices have not been treated with ion-exchangers (in which case the formol value is reduced to nil) the degree of concn. of fruit juices can be approx. determined by means of potentiometric titration. Values obtained for plum-juice increase with approaching ripening, and decrease during the actual ripening stage. P. S. ARUP.

Ripening of grapes as affected by climate and stock. J. Ribéreau-Gayon (*Ann. Nutr., Paris*, 1955, **9**, A95—A112).—A review of the work of Peynaud *et al.* on the influence of climatic and varietal factors on the production of malic and tartaric acid in grapes. P. S. ARUP.

Characteristics of grapes for production of wine and fruit juice, and for table use. M. Flanzy (*Ann. Nutr., Paris*, 1955, **9**, A113—A141).—A review. Observations of structural characteristics, and determinations of physical and mechanical properties afford the most reliable means for distinction between the three types of grapes. The necessity for a standard sampling technique is urged. (36 references.) P. S. ARUP.

Stabilisation of wines by cation-exchangers. J. Ribéreau-Gayon, E. Peynaud, E. Portal, J. Bonastre and P. Sudraud (*Industr. agric. aliment.*, 1956, **73**, 85—91).—The use of cation-exchange resins to replace K, Ca, Fe, Cu and Pb in wines by Na, in order to eliminate pptn. of Fe and Cu and of K tartrates, and to reduce Pb below the legally permitted min., is reviewed and detailed analyses of wines treated in this way are tabulated and discussed. J. S. C.

Determination of sulphur in alcohol by combustion. R. J. Peltonen, P. Neuenschwander and H. Suomalainen (*Z. LebensmittUntersuch.*, 1955, **102**, 245—253).—A modification of the method used by the American Soc. for Testing Materials for the determination of S content in petroleum products is described; three double determinations can be carried out simultaneously in the apparatus illustrated. A weighed quantity of alcohol, ~20 g., is burnt in a special burner with a cotton wick, tests being made on samples containing S in the range 0·015—6·0 mg. per 100 ml. of alcohol. The gases are passed through a glass filter into an ammoniacal solution containing H_2O_2, any S being converted into NH_4 sulphate. Benzidine sulphate, pptd. by the addition of benzidine hydrochloride, is washed, dissolved in hot HCl and measured spectrophotometrically at 250 mμ. The method is suitable for the determination of S content in methanol and other alcohols. J.A.C. ABSTR. (E. M. J.).

Polarimetric determination of malic acid in musts and wines. E. Matthey and A. Ramuz (*Mitt. Lebensm. Hyg., Bern*, 1955, **46**, 503—508).—The method described depends on the separation of the malic acid from other optically active compounds, and its polarimetric determination as the (highly active) NH_4 dimolybdomalate. Tartaric acid is removed by a standard method, and tannins, pectins, sugars, etc. by defecation [using $ZnSO_4$ + $Ba(OH)_2$]. The Ba salts of malic, lactic, succinic and citric acids are pptd. by the addition of EtOH to their aq. solution, after which the Ba lactate and citrate are dissolved out by water, leaving the insol. Ba malate and succinate. After conversion of the latter insol. salts into sol. Na salts, the above-mentioned Mo compound is formed by the addition of aq. NH_4 molybdate + AcOH. A (linear) graph is given, showing the relationship between α and the concn. (0·2—8 g. per l.) of malic acid. The method is accurate within ±0·1 g. of malic acid per. l. P. S. ARUP.

Polarographic determination of malic acid in grape must and wine. II. H. Grohmann and E. Gilbert (*Z. LebensmittUntersuch.*, 1956, **103**, 32—41, cf. *ibid.*, 1954, **98**, 185).—A method is described, based on the quant. pptn. of the Ag salt and polarographic determination of malic acid in alcoholic solution, for separating quantitatively malic acid from lactic acid and to determine malic acid polarographically in dry and sweet wines, white wines containing a high content of lactic acid, dessert wines and must. In red wines and those of poorer quality derived from pressed grape skins, the interfering tannin present is first removed by treatment with ion-exchangers before obtaining the Ag ppt. E. M. J.

Aluminium contents of grape-must and wine from the Bavarian Palatinate. H. Thaler and F. H. Mühlberger (*Z. Lebensmitt-Untersuch.*, 1956, **103**, 97—108).—The following data apply to musts and wines prepared without the use of Al vessels or utensils, and with reasonable precautions against contamination. Unclarified musts contain ⩾32 mg. per l. of Al, 91—97% of which is removed with the trub on clarification. The average Al contents of red musts are ~67% < those of white musts (averaging 0·73 mg. per l.), but in red wines they are 0·75 as against 0·63 mg. per l. in white wines. These differences are accounted for by differences between the methods of prep. used for the two classes of wines. In both cases reductions in Al contents occur during fermentation. Wines from subsequent pressings have approx. the same Al contents as normal wines. P. S. ARUP.

Determination of glycerol in grape-must, wine and dessert wine by conversion into quinoline. H. Grohmann and F. H. Mühlberger (*Z. LebensmittUntersuch.*, 1956, **103**, 177—189).—The accuracy of the Reichard and Gspahn method (cf. *Anal. Abstr.*, 1954, **1**, 1678) is improved by a modification in the Skraup synthetic procedure for converting the glycerol into quinoline, and the standardisation of the steam-distillation procedure for isolating the quinoline. Sucrose, if present in amounts >20 mg. per l., must be removed by treatment with $Ba(OH)_2$ as described. Constant factors are established for converting the wt. of the HgI_2-quinoline complex formed from 15—200 mg. of glycerol into g. per l. of glycerol. For the determination of smaller amounts of glycerol, it is recommended to add 12 mg. (exactly) to the reaction mixture, and to calculate the original glycerol content by difference. The results obtained are generally accurate within ±0·1, showing max. deviations of ±0·3 mg. per l. of glycerol. P. S. ARUP.

Transformations of carbohydrates during malting, brewing and alcoholic fermentation. R. H. Hopkins (*Brass. et Malt. Belge*, 1956, **6**, 57—60).—The breakdown of starch, and the products resulting, during malting, brewing and fermentation are reviewed in general terms. J. S. C.

Evaluation and selection of brewery yeasts. E. Helm and R. S. W. Thorne (*Brass. et Malt. Belge*, 1956, **6**, 49—56).—The chief strains of cultured and wild yeasts are distinguished and the criteria of choice

defined as: (1) rate of fermentation, (2) flocculation, (3) capacity for reproduction and (4) production of taste. These are discussed in detail and methods of evaluation described. The possibility of developing new and better strains by selection, hybridisation or adaptation is briefly discussed. (16 references.) J. S. C.

Microbial source of diacetyl and acetoin in beer. A. Kocková-Kratochvílová, A. Vavruchová and D. Vopátková-Nováková (*Brauwissenschaft*, 1956, **9**, 73—82).—The reactions involved in the spoilage of beer, the development of the honey-like smell, the conversion of acetaldehyde under anaërobic fermentation into acetylmethylcarbinol (acetoin) followed by the formation of diacetyl under aërobic fermentation are discussed. The review also covers the use of various strains of *Pediococci*, the preparation of pure cultures and nutrients involved and collected data on primary and secondary fermentations of various substances during the brewing process by *Pediococci* and yeasts separately and together. The relationship between the requirements of *Pediococci* and amino-acids (glutamic and asparaginic) and the resulting quantities of diacetyl produced, are discussed. (65 references.) E. M. J.

Refrigeration problems of breweries. H. Engerth (*Kältetechnik*, 1956, **8**, 46—49).—Breweries have in the past, because of their conservative outlook, been critical of modern advances in refrigeration technique. The economic and qualitative advantages of modern methods are described in general terms, with illustrated examples of the various types of apparatus used in different processes. Application of these advanced techniques with determination and persistence yields considerable economic advantages. C. A. Finch.

Microbiological investigation for [detection of] preservatives in vinegar products. L. Paix (*Mitt. Lebensm. Hyg., Bern*, 1955, **46**, 525—526).—Preliminary investigations indicate the possibility of the detection of preservatives in vinegar by the inhibition of fermentation by yeast of the diluted and neutralised sample containing added glucose and yeast-extract. Previous use of the vinegar for preserving gherkins does not interfere with the test, but onions yield an inhibiting substance. P. S. Arup.

Biochemical observations on the vinegar eelworm [*Anguillula aceti*]. C. Gerpe (*Rev. esp. Fisiol.*, 1955, **11**, 182—186).—A description is given of the vinegar eelworm, a cylindrical nematode with a non-striated transparent cuticle, and its habitat, and a study was made of the conditions in which it develops free from bacteria and other micro-organisms; its metabolism, culture media, resistance to disinfectants and heavy metals; its resistance to acid and neutral liquids, but not to alkalis, and its dependence on yeasts and bacteria which develop in the vinegar. The % composition is given: total protein, lipins, glucides, ash, 30·02, 40·70, 22·05, 7·26% respectively. Fe and Mn were found in the ash. E. M. J.

Niacin in coffee and its nutritional importance. M. G. Daum (*Arch. venezol. Nutr.*, 1955, **6**, 61—70).—Coffee, roasted, milled and hydrolysed with HCl in an autoclave at 28 lb. pressure for 30 min., was assayed for niacin microbiologically using *Lactobacillus arabinosus*, and was found to contain 33·9 mg. per 100 g. Coffee prepared as a 10 g. per 100 c.c. infusion by household methods gave 3·4 mg. per 100 c.c. The niacin content of green coffee is low but rises on roasting. L. G. L. Unstead-Joss.

Organic acids in brewed coffee. A. F. Mabrouk and F. E. Deatherage (*Food Technol.*, 1956, **10**, 194—197).—The org. acids of five coffee extracts were determined by partition chromatographic method. The following acids were found: acetic, pyruvic, caffeic, chlorogenic, oxalic, malic, citric and tartaric. The predominant acid is chlorogenic, acetic acid is present in low concentration and in one coffee extract traces of formic acid were present. (16 references.) E. M. J.

Carbohydrates of the coffee bean. R. A. Plunkett (*Dissert. Abstr.*, 1956, **16**, 455).—Ground green Santos coffee beans were successively extracted with 80/20 ethanol water 2/1 benzene ethanol, water, 0·5% aq. ammonium oxalate (pectin removal), acidified aq. sodium chlorite (holocellulose preparation), and 10%. aq. KOH (hemicellulose removal). The following compounds were identified: sucrose (**I**), caffeine (**II**), chlorogenic acid (**III**), *iso*chlorogenic acid (**IV**), caffeic acid (**V**), trigonelline (**VI**), glycine, α-alanine, γ-aminobutyric acid, proline, valine, leucine (or *iso*leucine), tyrosine, aspartic acid, glutamic acid, serine and asparagine. Roast coffee extractions produced **I**, glucose, fructose, **III**, **IV**, **V**, **II**, **VI**, galactose, arabinose, rhamnosé, mannose and xylose. **II** was identified by drying the paper- or electro-chromatogram and dipping it in an acidified ether solution of pyrene (0·01% wt./vol.). Under u.v. light, caffeine appears as a spot of quenched fluorescence and bright yellow-white backbround. To detect **II** on clay, the column is streaked with slightly acidified bromothymol blue indicator; **II** appears as a blue-section on the yellow streak. O. M. Whitton.

Protein stability and wettability of milk powder as affected by changes in milk composition. D. Chakravarti (*Dissert. Abstr.*, 1956, **16**, 421).—The effects of changes of protein, carbohydrate, and fat concentrations, mineral balance, and heat treatment of the milk and of addition of the antioxidant nordihydroguaiaretic acid, and addition of the emulsifying and (solubilising) agents polyoxyethylene stearate and carboxymethylcellulose to the milk, on the protein stability and wettability of the resultant milk powder were investigated. The results are discussed. Addition of lactose or sucrose raised the protein stability and wettability of the milk powders. Preheat treatments of the milk from 200—205°F. for 5 min. raised, and 160°F. for 5 min. lowered the protein stability as compared with normal preheating at 170°F. for 20 min. The correlation between (*a*) protein stability and Ca content of the milk powders and (*b*) between wettability at 45°F. and wettability at 85°F. storage for six months was significant in each case. O. M. Whitton.

Studies on the inorganic equilibria in milk by an ion-exchange resin contact-time method. J. M. Baker (*Dissert. Abstr.*, 1956, **16**, 441—442).—The availability of Ca in milk was studied by a resin contact-time method. A desirable evaporated milk is dependent on the rate of availability of Ca, and the ionic Ca in the raw milk. The rate at which inorganic equilibria shifts occur largely determines protein stability. O. M. Whitton.

Fat–protein complex in powdered milk. I. I. Litman (*Dissert. Abstr.*, 1956, **16**, 517—518).—The formation of fat–protein complex in milk powder was investigated by isolating and analysing the insoluble fraction in milk powder manufactured and stored under different fractions. The results are given and discussed. There was a rapid decrease in the free-fat content of milk powder during storage at 85° and 100°F. but no change during storage at 45°F. The decrease resulted from the formation of a free-fat and protein complex. Scum formation only occurred in the reconstituted and centrifuged milk powder containing fat. Scum isolated from powder held at room temp. and above represented the insol. fat–protein complex. O. M. Whitton.

Automatic temperature regulation of flowing liquids. I and II. L. G. W. van der Loo (*Conserva*, 1956, **4**, 264—268, 300—304).—I. The following parts of a temp. regulator and recorder on the (German) market are described: (*a*) an installation for providing dry filtered air at constant pressure (~1 atm.), (*b*) a (steel) thermometer-bulb containing an alcohol of appropriate b.p., connected with a closed flexible metal spiral (constituting the actuating element) and (*c*) the mechanism of the devices for indicating and recording temp., and for giving warning signals.

II. In continuation of the previous description, a description is given of the mechanism by which the spiral spring actuates a device for diverting the air-current either to depress or release a membrane which, in its turn, actuates a device for returning insufficiently heated milk to the heating circuit. An installation for regulating and recording the pasteurisation temp. of milk is described, and directions are given for its installation. P. S. Arup.

Combined refrigerating and heat-pump plants. F. Leiding (*Kältetechnik*, 1955, **7**, 366—370).—A detailed description is given of refrigerating plants which also heat water by heat-exchange between the water and the hot gases passing from the compressor. The use of auxiliary electric heating of the water for meeting hot-water demands exceeding the heating capacity of the hot gases is also described. The design and operating efficiency of the plants are discussed, in the light of the varying demands for hot water and refrigeration due to seasonal changes etc. Typical applications, e.g., in the milk-canning industry where the hot water is used for intermittent scouring of the cans, are described. These combined plants can effect considerable economies. In comparison with normal refrigerators, larger compressors and higher evaporator temp. are necessary. J.A.C. Abstr.

Washed and non-washed butter. I. Flavour quality and curd content. A. H. White, D. M. Beattie and R. R. Riel (*J. Dairy Sci.*, 1956, **39**, 261—267).—The flavour, both initially and after storage, of butter manufactured and stored under Canadian conditions was not significantly affected by washing the butter granules. Initial cream acidity has a marked effect on flavour after six months at −5°F., but not after 10 months at −5°F. followed by two weeks at 50°F. Omission of washing increased butter yield due to a resulting higher curd concn. (average 0·53%) in the product. S. C. Jolly.

Neutral carbonyl compounds in blue-mould type cheese. M. E. Morgan and E. O. Anderson (*J. Dairy Sci.*, 1956, **39**, 253—260).—A simple method is described for the identification of Me ketones in blue-mould type cheese involving fractional distillation of relatively small samples followed by paper-chromatographic separation of the mixed 2 : 4-dinitrophenylhydrazones formed in the distillate. In 10 samples, including French Roquefort, Danish and Domestic Blue,

and Gorgonzola, acetone, acetaldehyde, butan-, pentan-, heptan- (**I**), nonan- (**II**) and undecan-2-one (**III**) occurred. **I** and **II** were absent from one sample having little or no desirable aroma. Only traces of **III** were present in two samples. S. C. JOLLY.

Italian cheese ripening. VI. Effects of different types of lipolytic enzyme preparations on the accumulation of various free fatty and free amino-acids and the development of flavour in Provolone and Romano cheese. J. E. Long and W. J. Harper (*J. Dairy Sci.*, 1956, **39**, 245—252).—The formation and concn. of free butyric acid (**I**) in Provolone and Romano cheese was related to type of enzyme product [rennet extract (Hansen) (*A*), *A* plus calf glandular prep. (Italase) (*B*), *A* plus kid glandular prep. (Capalase) (*C*), and crude kid rennet paste (*D*)] used, highest concn. resulting with *D* and *C*, followed by *B*; **I** production was very slow with *A*. The amounts of free amino-acids were not related to the enzyme product used. The flavour was related to **I** and glutamic acid (**II**) in Provolone and to **I** in Romano cheese. The leucines increased to a consistently higher level than did **II** in ripe Provolone cheese. S. C. JOLLY.

Various free amino- and fatty acids in domestic Swiss cheese. P. C. Hintz, W. L. Slatter and W. J. Harper (*J. Dairy Sci.*, 1956, **39**, 235—244).—Only cysteic acid (**I**), threonine–serine (**II**), glutamic acid (**III**) and tyrosine–phenylalanine (**IV**) were present in all samples of commercial Swiss cheese of varying ages (2—11 months). Concn. of all amino-acids varied considerably, proline (**V**) showing the widest variation (0—5·8 mg. per g.). The average amounts of **I**, **V**, taurine, lysine and histidine tended to increase with age, but the amount of glycine, when present, was relatively constant; the amounts of **II**, **III**, **IV**, aspartic acid, asparagine–glutamine and tryptophan were unrelated to age. Butyric, propionic (**VI**) and higher fatty acids were present in all samples, and valeric acid in all but one; there was no relation between amounts present and age of cheese. In cheeses having a satisfactory flavour, $<2{\cdot}0$ mg. of **V** and $<5{\cdot}0$ mg. of **VI** per g. of cheese were both present. S. C. JOLLY.

New test for thermostabilised eggs. S. A. Kaloyereas (*Food Technol.*, 1956, **10**, 162—163).—Two simple tests for thermostabilised eggs (heated in a constant temp. bath at 54° for 8 min.) are discussed: (*a*) is based on the no. of ml. of alcohol needed to flocculate a solution of egg white at 25° (prepared by diluting 1 : 3, 10 ml. of homogenised white, filtering, and using a 5-ml. portion of the filtrate); (*b*) consists of determining the stability of the thermostabilised sample in a water bath at a constant temp., 60°. The untreated sample of egg white remains limpid for a longer time than the thermostabilised sample. E. M. J.

Joint FAO/WHO Expert Committee on Meat Hygiene. First Report. (*FAO agric. Studies*, 1955, No. 30; *World Health Org., Tech. Rep. Series*, 1955, No. 99, 32 pp.).—The general principles of meat hygiene practice are defined. The major meat-borne diseases are listed and procedures for investigation of food poisoning recommended. The design, construction and management of abattoirs, meat inspection and laboratory examination of meat and measures to ensure proper cleanliness in the handling and transport of meat are also reviewed. The annexes include a bibliography of 21 selected texts, tabulation of basic data concerning the main types of bacterial food-poisoning, suggested designs of abattoirs, details of German (1940) meat inspection technique, a brief note on the Ascoli pptn. test for anthrax, procedures for temp. control and salt treatment of meat containing trichinæ or cysticerci, and the Danish rules and instructions for laboratory examination of carcasses. J. S. C.

Heat processing of beef. VI. Thermal diffusivity and "slopes" of heating and cooling curves for the high-temperature process. VII. Residual heating effects in beef processed at high retort temperatures. H. Hurwicz and R. G. Tischer (*Food Res.*, 1956, **21**, 147—155, 156—162; cf. J.S.F.A. Abstr., 1956, i, 115).—VI. Experimental and statistical evidence indicates that thermal diffusivity does not depend on the location in the container; it may be a function of processing temp. and reaches a max. for 261—279°F. ($k_{aver.}=0{\cdot}2623$ sq. cm. per min.). The "slopes" of the heating and cooling curves are significantly different and cannot be used interchangeably. Processing temp. between 261—279°F. may be in a critical region for the processing of beef where most of the physical characteristics assume their extremes. This temp. range may prove to be optimal for canning of safe and palatable beef.

VII. Neither the theoretical solution of the heat conduction equation nor a monotonic function approximate the experimental results for the intermediate cooling phase. The residual heating at the beginning of the cooling phase increases the effective processing time. This increase is most pronounced for short-time high-temp. processes. The contribution of residual heating to the sterilising effect indicates the same trend and possibly reaches max. at 297°F. retort temp. E. M. J.

3.—SANITATION

Pyrethrum and allethrin in insecticides and aërosols. K. F. Goodwin-Bailey (*Pyrethrum Post*, 1956, **4**, 3—10).—The history of the development of pyrethrum especially and of allethrin is briefly reviewed including improvement in assay techniques, uses and synergists. Typical formulations containing pyrethrins and piperonyl butoxide mixtures used in flysprays, aërosols, and for the control of cockroaches and stored products insects are given and residual efficiency is discussed. In the formulation of powders the type of carrier is of importance so that there is no degradation of the pyrethrins. Insects and resistance to insecticides are discussed, e.g., *Calandria granaria*, resistant to pyrethrins, was not resistant to pyrethrins + piperonyl butoxide. Modified and improved methods of application are mentioned, e.g., spray guns operated by compressed air, "Micro-sol" machines ("Swing-fog"), etc. The development and use of aërosols in U.S.A. and in Great Britain are described. E. M. J.

Pyrethrum analysis and methods. H. E. Coomber (*Pyrethrum Post*, 1956, **4**, 20—24).—Methods of analysis of pyrethrum in the United Kingdom since 1948 are surveyed. Two main lines of approach, the critical survey of existing chemical methods, and study of new methods confirm the view that substances present in the extracts of pyrethrum flowers seriously interfere with the accuracy of current methods. It is suggested that a relatively simple method of separating the interfering substances might be devised and that work carried out in the U.K. on chromatographic separation should be substantiated. E. M. J.

Analysis of pyrethrins. II. "Sulphur colour" test. III. Correlation of various analytical methods with bioassays. N. C. Brown, D. T. Hollinshead, R. F. Phipers and M. C. Wood (*Pyrethrum Post*, 1956, **4**, 24—29, 30—32).—II. Two aliquots (1 ml. each) of pyrethrum solution standardised to contain 1 mg. of pyrethrins per l. were pipetted into two centrifuge tubes; 3 ml. of 0·5N-LiOH solution were added to each; 3 ml. of S solution (2 g. per 1000 ml. of CCl_4) were measured from a burette into one tube, 3 ml. of CCl_4 were added to the other. The unknown pyrethrum extract was diluted to contain ~1 mg. of pyrethrins per l. and treated as the standard solution (above). Two "blank" solutions (*a*) without pyrethrum and S, (*b*) without pyrethrum were prepared. All the stoppered tubes were maintained at 40° in a water bath for 1 hr., cooled, centrifuged for 1 min., solutions transferred to 1-cm. glass cells and the absorption measured at 540 mμ. From data obtained the amount of pyrethrins in the solution of unknown strength can be calculated. The application of the "Sulphur colour" test is discussed.

III. The "false" materials formed during the degradation of pyrethrum extracts by exposure to artificial light (cf. Brown and Phipers, J.S.F.A. Abstr., 1955, i, 388) were removed either by pptn. from petroleum solutions, or by the use of an alumina chromatogram and the degraded extracts were examined by the Hg-reduction method and the "sulphur colour" test. Analytical data are presented and discussed. "True" pyrethrins figures obtained by the "S-colour" test are in closest approximation to the results from bioassays. When a pyrethrum extract is degraded to a point when the survival of the pyrethrins is $<30\%$, there could be a large accumulation of cinerins in such material. E. M. J.

Synergised pyrethrins in crop protection. G. D. G. J. (*Pyrethrum Post*, 1956, **4**, 34).—BHC and parathion useful in the control of "flea" beetles (*Phyllotreta* sp.) and pollen beetles (*Meligethes* sp.), the seed pod weevil (*Ceutorrhynchus assimilis*) and the pod midge (*Dasyneura brassicae*) in the production of Brassica seed crops, were superseded in 1952, owing to losses of pollinating insects especially honey bees, by the use of a dust impregnated with pyrethrins 0·05% and piperonyl butoxide 0·8% resulting in 80% control of weevils without damage to honey bees, etc. Atkins and Anderson (cf. J.S.F.A. Abstr., 1955, ii, 8) confirmed the low toxicity to honey bees of a 0·26% pyrethrins dust. E. M. J.

Reproductive potential, life span, and weight of house flies, *Musca domestica* L. Surviving initial exposure to an insecticide. Saad El Din Afifi (*Dissert. Abstr.*, 1956, **16**, 521).—The effect of a single insecticidal treatment of dieldrin, in acetone solution, upon the reproductive potential, life span and wt. of parent house flies and first three filial generations was investigated. The results are given and discussed. Treated parent females surviving a dosage of 2 μg. per g. of flies produced adult offspring at an increase of 16·7% as compared with untreated controls; F_1 generation produced an increase of 69·2% F_2 an increase of 9·3%; F_3 a decrease of 13·4%. Linear correlation was found between the wt. of the treated parent females and the no. of their progeny. O. M. WHITTON.

Efficiency of the quaternary ammonium germicides in the presence of hard water. F. R. Peabody (*Dissert. Abstr.*, 1956, **16**, 431).—Retardation of the germicidal action of a quaternary ammonium compound by hard water was unaffected by adding normal softeners but markedly reduced by adding Versene. O. M. Whitton.

Qualitative analysis of surface-active agents. V. W. Reid, T. Alston and B. W. Young (*Analyst*, 1955, **80**, 682—689).—A simple qual. scheme for the identification of surface-active agents is described, the necessity for a large no. of chemical tests being reduced by spectrophotometric examination. The active agent is separated from fillers etc. by extraction of the dried sample with ethanol and removal of insol. inorg. matter by filtration. The dried active ingredient is dissolved in water (~5 g. per l.), any turbidity being removed by addition of ethanol. The spectrogram (210—350 mμ.) of the suitably diluted solution is compared with those of reference compounds. Tests for ionic character and for presence of N assign the compounds to four main groups; each is subdivided according to the characteristics of the spectrogram. An unknown active agent is thus assigned to its class, and further chemical tests can then be made. Examples of the absorption curves are given. J.A.C. Abstr.

Membrane filters for water quality control. R. Eliassen (*Wat. & Sewage Wks*, 1955, **102**, 523—524).—The advantages of the membrane filter technique for the control of potable water supplies and for other purposes, e.g., stream sanitation studies, are reviewed in relation to its disadvantages. Its major advantage is the much greater precision in coliform analysis which it offers. It is agreed that it should now be accepted as an official standard procedure. J.A.C. Abstr. (J. S. C.).

Restoration of pressure equilibrium in membrane filtration. W. J. Tarrant (*J. Amer. Wat. Wks Ass.*, 1955, **47**, 1207—1209).—In using the membrane filter for coliform measurements, etc., it is desirable to be able to restore atm. pressure quickly and conveniently to the filter flask, and the use of spring tubing clamps on both the vac. line and the vent line is recommended. An aircraft pitot valve suitable for this purpose, is also described. J.A.C. Abstr. (J. S. C.).

Membrane filter: advantages and disadvantages. A. M. Rawn and F. R. Bowerman (*Wat. & Sewage Wks*, 1956, **103**, 36—37).—The results of four years of experience of the membrane filter technique for bacterial counts in the Los Angeles County Sanitation Districts are reviewed and discussed. Anomalies were found between this method and the standard lactose fermentation test and it is open to doubt whether the *same* organisms are counted in the two tests. The membrane filter appears to be selective for *E. coli* in sewage–sea water mixtures. J. S. C.

Corrosion and materials in the waterworks field. R. W. Henke (*Wat. & Sewage Wks*, 1955, **102**, 508—510).—The problems of mitigating various types of corrosion, including galvanic corrosion, which is considered in detail, in waterworks practice are reviewed. The selection and correct use of alloys and the conditioning of water to eliminate highly corrosive constituents are discussed. J.A.C. Abstr. (J. S. C.).

Legal aspects of river pollution with special reference to water quality. S. G. Barrett (*Proc. Soc. Water Treatment and Examination*, 1955, **4**, ii, 122—136).—The history of river pollution, e.g., the Tyne at Newcastle, is reviewed from 1693 and the prevention of pollution is discussed generally from 1865. The Public Health Acts 1875 and 1936 include provisions directed to ensuring the purity of surface waters. The Rivers (Prevention of Pollution) Act 1951 which repeals the Rivers Pollution Prevention Act 1876, the Act now in force for maintaining and restoring the wholesomeness of the rivers of England and Wales, is discussed at some length. The law on the subject does not commence with the date of the first of the Acts of Parliament mentioned; common law has from time immemorial governed the ownership of land and the 1951 Act provides that "Nothing contained in this Act shall affect the law relating to nuisance." The effect of this provision is explained and the effect of common law generally is summarised. Sewage and trade effluents are discussed. E. M. J.

Bursting bubbles and air pollution. A. H. Woodcock (*Sewage industr. Wastes*, 1955, **27**, 1189—1192).—Photographic studies of small bubbles bursting at water surfaces show that aërosols are produced through the break-up of minute water-jets formed by the collapse of the bubble cavities. The significance of this effect from the point of view of air pollution and contamination, and the spread of air-borne organisms is discussed. (17 references.) J.A.C. Abstr. (J. S. C.).

Agent for combating fungi, yeasts, bacteria, protozoa, etc. C. J. Faulkner (B.P. 734,119, 6.6.52. Neth. 9.6.51).—Various materials, e.g., leather, textiles, paints, lacquers, stored seeds, and especially timber, are preserved against attack by micro-organisms, by treatment with (a 0·02—0·3% solution of) a compound SnRR′R″X [R—R″ are (substituted) alkyl or phenyl, X is inorg. or org. group of >1 atom], e.g., $SnPr^i_3$·OH. J.A.C. Abstr.

Production of insect-repellent amides. G. E. Utzinger (B.P. 737,951, 1.7.53. Switz., 1.7.52).—Mildly fragrant insect-repellents of improved storage properties and adhesion to the skin, comprise amides R·[CH_2]$_2$·CO·NR′R″ made by heating R·CH_2·CH(COR‴)-CO·NR′R″ with a solution of caustic alkali in alcohol (R is phenyl substituted by halogen, alkyl, or alkoxy of ⩾9 C, R′—R‴ are alkyl of ⩾4 C). Thus, *o*-chlorobenzylacetoacetic diethylamide (30) is boiled with 15% MeOH–KOH 10 c.c. during 5 hr. then the solvent is distilled off. The residue is extracted with *iso*propyl ether, and the washed extract is distilled, to give 2-*o*-*chlorophenylethane*-1-*carbon*-NN-*diethylamide* (*o-chlorocinnamic acid diethylamide*), b.p. 188—190°/14 mm. F. R. Basford.

Hygienic compositions. M. Darcissac (B.P. 736,390, 6.10.53. Fr., 7.10.52 and 11.7.53).—The composition, for veterinary use, disinfecting public buildings, etc., comprises trichloroacetic acid (**I**), salicylic acid (**II**), alkali metal salicylate, or sulphosalicylic acid (0·08—0·16), glycerol or propylene glycol (⩽2 pt. per pt. of **I**), aq. or oily carrier and optionally Na alkylsulphonate of 8—18 C (wetting agent). Thus, **I** 30 is compounded with **II** 2·5, dimethyl phthalate (parasiticide) 5, ether 200, and vegetable oil to 1000 g., to provide a composition suitable for use in the treatment of animals (sheep) suffering from or liable to contract aphthous fever. F. R. Basford.

[Preparation of] [A] *O*-(2 : 4 : 5-trichlorophenyl)-methanephosphonic chloride and [B] -methanephosphonate. Dow Chemical Co. (Inventor: H. Tolkmith) (B.P. 736,337—8, 11 and 23.11.53).—[A] 2 : 4 : 5-Trichlorophenol is treated with ⩽1 mol. of $MePOCl_2$ at 20—80° in an inert solvent in presence of a HCl-acceptor (pyridine), to give O-(2 : 4 : 5-*trichlorophenyl*)*methylphosphonic chloride*, d_4^{20} 1·582, useful as a parasiticide. [B] This is converted by esterification with ethanol in presence of an HCl-acceptor (pyridine) into the *methanephosphonate*, d_4^{25} 1·253, also useful as a parasiticide. F. R. Basford.

4.—APPARATUS AND UNCLASSIFIED

Permeability of membranes and dialysis. E. Canals, R. Marignan and L. Bardet (*Rev. Ferment. Industr. aliment.*, 1956, **11**, 7—10).—The dialysis of a solution through a semi-permeable membrane is considered mathematically and the coeff. of diffusion and of dialysis are defined. Experimentally, the variation of these parameters with ion concn. and with membranes of differing porosities, in the case of the HPO_4'' ion, was followed using ^{32}P as tracer and the effects of the nature of the cation and its degree of hydration are shown. The variations are attributed to variable swelling of the membrane induced by the introduction of water molecules into the cellulose chain molecules of the membrane. J. S. C.

Spectrophotometric study of chlorophylls *a* and *b* under the influence of various physical and chemical agents. I. C. Lamort (*Rev. Ferment. Industr. aliment.*, 1956, **11**, 34—45).—Existing knowledge of the nature and structure of chlorophylls is reviewed historically and methods of preparing pure solutions and of determination by fluorometry and spectrophotometry are described. The decomposition of chlorophyll in acid medium to form pheophytin is studied kinetically by spectrophotometry and the effects of pH value, temp., light, air, O_2, oxidising and reducing agents, metals, anions and org. cations are examined. J. S. C.

Isolation of aromatic substances using modified charcoals. A. Asatoor and C. E. Dalgliesh (*Biochem. J.*, 1956, **62**, Proc. xxix).—Charcoal deactivated with 4% by wt. of stearic acid can be used for isolation or recovery, of benzene deriv. (including phenols), indoles, purines, and pyrimidines. Pyrroles and pyridines are less well recovered, whilst iminazoles behave like aliphatic compounds. Conjugates with glycine, glucuronic acid and H_2SO_4 are usually recovered as satisfactorily as the unconjugated substances. Polycyclic substances, such as riboflavin, and substances with many H bonding groups on an aromatic ring are only poorly recovered; the same happens with basic substances. High recoveries are obtained by use of an acid eluent such as phenol–acetic acid. Basic substances are readily displaced by a neutral eluent (aq. phenol) if the charcoal has been deactivated with octadecylamine, which may be a more suitable deactivating agent than stearic acid. Surface-active agents also usefully modify the adsorptive properties of charcoal. J. N. Ashley.