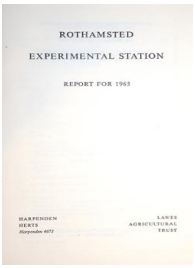
ROTHAMSTED RESEARCH

Rothamsted Experimental Station Report for 1965

Full Table of Content



Abstracts of Papers

Rothamsted Research

Rothamsted Research (1966) *Abstracts of Papers ;* Rothamsted Experimental Station Report For 1965, pp 317 - 367 **- DOI: https://doi.org/10.23637/ERADOC-1-60**

ABSTRACTS OF PAPERS

https://doi.org/10.23637/ERADOC-1-60

Physics Department

General Papers

1.1 Monteith, J. L. (1966) Analysis of the photosynthesis and respiration of field crops from vertical profiles of carbon dioxide. *Proc. UNESCO Symposium*, Copenhagen 1965. (In the press)

1.2 Monteith, J. L. (1965) Light and crop production. *Fld Crop Abstr.* **18**, 213–219.

1.3 Monteith, J. L. (1965) Radiation and crops. *Expl. Agric.* **1**, 241–251.

1.4 Penman, H. L. (1965) A physicist looks at his job. *The Listener* **74**, 277–278.

Research Papers

1.5 Cashen, G. H. (1966) Electric charges of clays. *J. Soil Sci.* **17** (In the press).

Conductimetric titrations, with sodium hydroxide, of solutions containing aluminium ion detect two hydroxy-ions of aluminium in the acid range, with hydroxyl to aluminium ratios of ions such as $Al(OH)^{2+}$ and $Al_6(OH)_{15}{}^{3+}$; in the alkaline range aluminate $Al(OH)_4{}^{-1}$ is formed. Similar titrations of an aluminium kaolin, prepared by acid washing, give results that can be adequately interpreted in terms of these three ions, i.e., by the reaction with alkali of Al^{3+} ions balancing the permanent isomorphous replacement charge. If there are reactions with alkali at the edge faces of the kaolin, e.g., the neutralisation of residual positive edge charge, these edge charges must be small in comparison with the permanent charge. Bonding by the complex ion $Al_6(OH)_{15}{}^{3+}$, formed on the surfaces of clay particles, explains why the viscosity of aluminium clays is greatest at the five-sixths stage of neutralisation, because the formation of the hydroxide $Al(OH)_3$ is theoretically equivalent to the measurement of the permanent charge.

1.6 Currie, J. A. (1966) The volume and porosity of soil crumbs. *J. Soil Sci.* **17**. (In the press.)

A simple and inexpensive apparatus (a test-tube, burette and pin) is described for measuring volumes by liquid displacement to an accuracy of greater than 0·5%. This has been adapted to measure soil crumb porosities, ε_C, by saturating 3–4-g samples of crumbs with kerosene, measuring the weight of kerosene retained internally, then measuring their volume by displacement. Three estimates of crumb porosity from these data are compared and their merits and errors discussed. Experimental values range from $\varepsilon_C = 0{\cdot}205$ for an arable headland to $\varepsilon_C = 0{\cdot}351$ for a permanent pasture. Crumb porosity is proposed as a measure of structural status for soils because it assesses the degree to which soil management has succeeded in holding the constituent primary particles apart from the positions of inherent closest packing that they would ultimately assume in an unstable soil. By comparison, the inter-crumb porosity, ε_V, can be used as a measure of cultivation status. In the form expressed, these two porosities are related to the more frequently encountered total porosity ε_T by the relation $\varepsilon_T = \varepsilon_C(1 - \varepsilon_V) + \varepsilon_V$.

https://doi.org/10.23637/ERADOC-1-60

1.7 MONTEITH, J. L. (1966) Analysis of micro-climate in cereals and grasses. *Proc. 12 Easter Sch. agric. Sci. Univ. Nott.* Sutton Bonington, 1965, pp. 123–137.

The distinctive feature of micro-climate in cereals and grasses is the penetration of radiation between the leaves. A layer of leaves with unit leaf-area index transmits about 60–80% of incident radiation without interception, compared with 40% in species with more horizontal leaves. The decrease of wind speed and transfer coefficients within the canopy is roughly an exponential function of height, but in some stands wind increases anomalously with decreasing height in the leafless region below the main canopy.

Generalising from limited experience, daytime temperature profiles with a maximum in the canopy are characteristic of well-watered crops in temperate climates, and for a given income of radiation, transpiration decreases as the maximum moves downwards. In the limit, the maximum is at the soil surface, a profile characteristic of crops short of water and/or growing in an arid environment. Differences of profile shape can be related to differences in stomatal resistance to the diffusion of water vapour. The resistance plays an important part in determining the micro-climate of the leaf surface. Assuming that the air in the inter-cellular spaces is saturated at a (uniform) leaf temperature, the relative humidity at the epidermis will often be 60–70% during the day, but the leaf temperature will seldom exceed air temperature by more than 2° or 3° C when the stomata are wide open.

1.8 MONTEITH, J. L. (1965) Carbon dioxide and crop production. *Agric. Prog.* **40**, 75–82.

When measurements of atmospheric carbon dioxide became accurate at the end of the nineteenth century the average concentration was about 290 ppm. In 1960 it was 314 ppm. This increase implies that about two-thirds of the CO_2 formed by burning fuel is still in the atmosphere and that the rest has dissolved in the oceans. If the trend of fuel consumption continues until 2000 concentrations may reach 400 ppm and the dry-matter production of crops may increase by about 20% in consequence.

Superimposed on the secular changes of concentration are annual and diurnal changes related to plant activity. Within crop canopies in the open, the concentration is seldom less than 270–280 ppm, even during rapid photosynthesis, because the air is effectively mixed by turbulence, but in glasshouses, where mixing is relatively slow, the concentration can fall below 200 ppm unless CO_2 is supplied artificially. Conversely, it is relatively easy to increase the supply of CO_2 to plants in glasshouses but almost impossible outdoors. Equations based on the concept of diffusive resistances predict rates of photosynthesis as a function of the CO_2 supplied by respiration from the soil or combustion in burners.

1.9 MONTEITH, J. L. (1966) Local differences in the attenuation of radiation over Britain. *Q. Jl R. met. Soc.* **92**, 254–262.

In relation to other British stations, radiation totals at Aberporth on the Welsh coast are anomalously high: the annual mean intensity of *direct* radiation is 31·5 mW cm^{-2} compared with 26 mW cm^{-2} elsewhere. Taking into account the ratio of actual to maximum possible sunshine, the effective transmission of the atmosphere was greatest at Aberporth and Lerwick, less at Eskdalemuir and least at Cambridge and Kew, consistent with differences in air pollution. The relatively clean air implied by the Aberporth record seems confined to a very narrow coastal strip.

https://doi.org/10.23637/ERADOC-1-60

At Kingsway the direct radiation per hour of sunshine increased from 21 mW cm^{-2} in 1957 to 26 mW cm^{-2} in 1963, consistent with the decrease of smoke in central London. Kingsway and Kew now have the same radiation régime, in which attenuation is roughly 1% for 10μg cm^{-3} smoke.

Applying the analysis to the radiation balance of Britain, previous estimates of potential evaporation in north Scotland were raised from 13 to 17 in./year, removing most of the difference in estimated evaporation over Britain.

1.10 MONTEITH, J. L. (1966) The transpiration and photosynthesis of crops. *Expl Agric.* **2**, 1–14.

When a leaf absorbs radiant energy only a small fraction is stored chemically in photosynthesis. In sunlight this fraction is at most one-fifth of the energy in the visible spectrum, decreasing with increasing light intensity because of the finite resistance to the diffusion of carbon dioxide through the leaf to the chloroplasts. Energy absorbed but not stored in photosynthesis is dissipated by transpiration and convection.

The potential or maximum photosynthesis of a crop canopy can be estimated from a set of six parameters describing the photosynthesis–light curve of single leaves, the arrangement of leaves in the canopy and radiation climate. Comparing estimates of potential photosynthesis with measurements of carbon dioxide exchange over a field of sugar beet, the estimated rate of respiration was 2 g carbohydrate per m^2 leaf area per day, equivalent to 44% of gross photosynthesis over the whole growing season. Over the season, the foliage lost 34% of incident radiation by transmission to the soil.

The potential rate of transpiration can be found from Penman's formula assuming values of external (aerodynamic) and internal (mainly stomatal) resistance for the canopy as a whole. In south-east England the energy for potential transpiration is almost equal to net heat H in summer, and is therefore about half the energy of incoming solar radiation. For a real crop of grass subject to moisture stress, transpiration was less than the potential rate at about 0·8 H on average and 0·3 H in very dry weather.

During the summer cumulative photosynthesis increases linearly with cumulative transpiration to give a production ratio (gross photosynthesis/transpiration) of $\frac{1}{100}$ in the Thames Valley and $\frac{1}{200}$ in the Sacramento Valley. The production ratio is expected to change with crop type as well as with climate.

1.11 MONTEITH, J. L., SZEICZ, G., & WAGGONER, P. E. (1965) The measurement and control of stomatal resistance in the field. *J. appl. Ecol.* **2** 345–355.

The rate of evaporation from a crop is expressed in terms of weather parameters and a quantity r_s derived from profiles of temperature, humidity and wind. In transfer equations r_s is formally similar to the diffusion resistance of the stomata in a single leaf, and measurements in a field of barley support the hypothesis that r_s is the diffusion resistance of the complete crop canopy. The resistance is relatively small when the leaf-area index is great, when soil is moist and when sunlight is bright. It increases as the plants mature, but is independent of wind speed, and is therefore unrelated to the rate of diffusion by turbulent mixing.

More directly, r_s was correlated with stomatal resistance r_p measured on individual leaves with a porometer. From 75 sets of porometer readings taken when the leaf-area index was between 6 and 10 the relation was

$$r_p = 1{\cdot}11 + 0{\cdot}87 r_s$$

Because r_p was measured on upper sunlit leaves, which were more porous than

https://doi.org/10.23637/ERADOC-1-60

lower, shaded leaves, the ratio of r_p to r_s was expected, and was found to be less than the leaf-area index.

Finally, stomata were closed and r_p was increased by spraying the top of the canopy with NSA (the methyl ester of nonenyl succinic acid). The increase of r_s calculated from the decrease of transpiration rate was consistent with the change of r_p.

1.12 PENMAN, H. L. (1966) Evaporation from forests: a comparison of theory and observation. *Proc. int. Symp. Forest Hydrology*, Pennsylvania, 1965. (In the press.)

Where water supply is non-limiting the important terms in the energy balance are net radiation (H), evaporation (E) and sensible heat transfer to the atmosphere (Q). Expressed in the same units, $H = E + Q$. The working equations based on this use relationships derived over grass or equivalent short crops, and because weather records over trees are lacking there is as yet no better form of theoretical calculation for forests. Expected differences are: a smaller reflection coefficient (r) will give a bigger value of H; a greater roughness will give a bigger ratio of E/H. For grass and the like Q is often small, so as a first approximation to be tested (using obvious suffixes for calculated and measured quantities)

$$E_M \simeq H \simeq H_C \quad (H_M \text{ is rare anywhere})$$

and as a second approximation (Q still small, or the same for forest and grass)

$$E_M \simeq E_C$$

When Q is not small, and differs for the two surfaces, then expectation is

$$E_M > E_C$$

Two tests are made. (1) East Africa, at Kericho (high montane forest) and Kimakia (bamboo) (1957–60); (2) the Netherlands, at Castricum, on small contiguous areas of conifers and deciduous trees (1955–64). In millimetres the mean annual values for comparison are

		E_M		E_C			H_C	
Site	Cover	$r =$	0·15	0·20	0·25	0·15	0·20	0·25
Kericho	Montane forest	1,550	1,380	1,280	—	1,660	1,520	—
Kimakia	Bamboo	1,140	1,290	1,200	—	1,660	1,510	—
Castricum	Conifer	655	578	—	501	542	—	443
	Deciduous	500						

An uncertain analysis of the Castricum data suggests that the summer (full leaf cover on both) components of E_M may be near 465 and 410 mm.

1.13 SZEICZ, G. (1966) Field measurements in the 0·4 to 0·7 micron range. *Proc. Symp. Br. ecol. Soc.* 1965. (In the press.)

Measurements with a redesigned solarimeter, using flat RG 8 filters and with tube solarimeters fitted with Wratten 88A filters, gave hourly and daily totals of radiation in the photosynthetically active 0·4–0·7-μ band.

Above the canopy the ratio of visible to total radiation was nearly constant at 0·42, indicating that climatological records of solar radiation can safely be used in studies of photosynthetic efficiency of field crops. Within the crop, however, the measurements show different degrees of absorption for barley and kale, mainly because of different leaf orientation.

https://doi.org/10.23637/ERADOC-1-60 pp 6

Chemistry Department

Thesis

2.1 Cornforth, I. S. (1965) The influence of soil structure on the uptake of nutrients by plants. Ph.D. Thesis, University of London.

General Papers

2.2 Cooke, G. W. (1965) Principles of manuring. *J. Inst. Corn agric. Merch.* **14** (No. 1), 19–24.

2.3 Cooke, G. W. (1966) Soil fertility problems in intensive agriculture. *Span*, **9**, 9–12.

2.4 Cooke, G. W. (1965) Soils and fertilisers. *Jl R. agric. Soc.* **126**, 154–174.

2.5 Cooke, G. W. (1965) Using nitrogen to regulate growth. *Dairy Fmr Ipswich* **12** (No. 2), 41–43.

2.6 Cooke, G. W. (1965) £120m. expenditure on fertilisers. *Financial Times* 13 December 1965.

2.7 Mattingly, G. E. G. (1965) Evaluation of phosphate fertilizers by solubility tests. *N.A.A.S. advis. Pap.* No. 3, 26 pp.

2.8 Mattingly, G. E. G. (1965) The influence of intensity and capacity factors on the availability of soil phosphorus. *Tech. Bull. Minist. Agric. Fish Fd* No. 13, Soil Phosphorus, London: H.M.S.O., pp. 1–9.

Research Papers

2.9 (Acquaye, D. K.) & Cunningham, R. K. (1965) Losses of nitrogen by ammonia volatilisation from surface-fertilised tropical forest soils. *Trop. Agric., Trin.* **42**, 281–292.

Losses of ammonia by volatilisation from nitrogen fertilisers applied to six tropical forest soils were measured by a micro-diffusion technique, and effects on losses were studied of changing soil pH, temperature, drying, water content, cation-exchange capacity, fertiliser placement and sterilisation. Volatilisation increased when soil pH, temperature and drying increased; it was greater from soils with smaller CEC. Nitrogen losses were decreased by burying the fertiliser in the soil, sterilising the soil and by adjusting soil moisture above and below 25% water-holding capacity. The losses of ammonia from various nitrogen fertilisers were compared, and ways of preventing or lessening these losses are discussed.

2.10 Blakemore, M. (1966) Seasonal changes in the amounts of phosphorus and potassium dissolved from soils by dilute calcium chloride solutions. *J. agric. Sci., Camb.* **66**, 139–146.

Variations during 12 months in the concentrations of soil P and K soluble in 0·01*M*-$CaCl_2$ solution were measured on several sites with contrasted histories at both Rothamsted and Woburn. Concentrations were always less in fresh than in air-dried soils.

P concentrations in the heavy soils at Rothamsted were remarkably constant, varying seasonally only where FYM or phosphate fertilizers were applied during

https://doi.org/10.23637/ERADOC-1-60

the year. At Woburn concentrations were constant in the poorer soils, but varied in rich soils.

On Barnfield at Rothamsted the plots receiving FYM each year contained more soluble P than those treated with super-phosphate. Where both FYM and superphosphate were applied, P concentrations were greater than the sum of values on plots receiving FYM and superphosphate separately because a given amount of P remained more soluble when FYM was regularly applied. P also remained more soluble on plots given ammonium sulphate.

Plots given FYM contained less soluble K than plots given K as inorganic fertilizer. The concentration of soluble K varied more than of P during the season (except on fallow plots not given potassium fertilizer); the variations were smaller where $NaNO_3$ or $(NH_4)_2SO_4$ was applied. K concentrations fell as crops grew in the spring, rose in the autumn but fell again in winter, and in April 1962 were as in April 1961.

None of the changes that occurred during a year altered the general classification into "low", "medium" and "high" of either the P or the K status of particular soils.

To obtain consistent results for advising farmers, time of sampling is important and must be standardised. Measurements of soluble P or K change little during the year in soils of the "low" category, which can be sampled at any time, but richer soils should be sampled during spring. Provided sampling is carefully timed in relation to cropping and manuring, consistent results from year to year can be expected, and measurements of P and K soluble in dilute calcium chloride solutions should indicate genuine changes in soluble nutrients caused by cropping and manuring.

2.11 CUNNINGHAM, R. K. & KARIM, A. (1965) Cation–anion relationships in crop nutrition. IV. Maximum contents of cations and anions in Italian ryegrass. *J. agric. Sci., Camb.* **64**, 229–233.

Italian ryegrass was grown in the greenhouse in clay loam soil in winter 1962 with several rates of a nutrient solution containing NO_3–N and P, K, Ca and Mg to see whether the grass had maximum values for sums of the cations and anions (Σ cations, Σ anions). Two other experiments were done in summer 1962 with a similar nutrient solution containing either NO_3–N alone or NO_3–N plus NH_4–N.

With the same amount of added nutrients summer yields of grass were about twice those in winter, and there was little difference when nutrient mixtures with NO_3–N + NH_4–N or with NO_3–N alone were used. The sum of the cations (m-equiv/100 g dry matter) in the grass was positively correlated with % N in dry matter, was greater in winter than in summer and greater in grass grown in the greenhouse than in the field. With increasing NO_3–N, Σ cations increased steadily, but with NH_4–N tended to a maximum value, which decreased as more NH_4–N was given. The sum of the anions in the grass increased with increasing N and did not tend to a maximum. Suggestions by others that ryegrass cannot have values for Σ cations and Σ anions in excess of 200 and 400 m-equiv/100 g respectively are not substantiated for cations; maximum value for cations in this work was 259 m-equiv/100 g, 25% more than previously estimated.

The ratio (R) Σ cations:Σ anions, was inversely proportional to % N in Italian ryegrass, confirming previous results. This relationship depended on the form of N, the season and whether the grass was grown in the greenhouse or in the field.

https://doi.org/10.23637/ERADOC-1-60

2.12 CUNNINGHAM, R. K. & NIELSEN, K. F. (1965) Cation–anion relationships in crop nutrition. V. The effects of soil temperature, light intensity and soil–water tension. *J. agric. Sci., Camb.* **64**, 379–386.

The effects of soil temperature, light intensity, soil-water tension and amount and form of N on cation–anion relationships in Italian ryegrass were tested by growing grass in a clay loam in three experiments under glass. The grass had six levels of NO_3–N or NH_4–N with a uniform dressing of P, S, K, Ca and Mg; NH_4–N was treated with "N-Serve" to prevent nitrification. In the first experiment the grass was grown at 11°, 19·5° and 28° C, in the second in 100, 68 and 44% glasshouse "daylight", and in the third at three soil-water tensions.

Yields were greatest at 19·5° C, 100% glasshouse "daylight" and most water, and least at 11° or 28° C, 44% light and driest soil; yields did not affect cation–anion relationships. Relationships between Σ cations, R and % total N were confirmed and found to depend on "weather" factors as well as form of N. Cation–anion relationships were better explained by relating R to % organic N rather than % total N, agreeing with a suggestion that the proportions of cations and anions taken up by grass from the soil are regulated by a plant mechanism linked to N metabolism; R% organic N relationships depended on soil temperature, light intensity and soil moisture. The effects of these "weather" factors explained some of the differences between the cation–anion relationships of grass grown in the glasshouse and those of grass from the field. Many more cations than anions were taken up when grass was given NH_4–N, but the reverse happened with NO_3–N.

2.13 GASSER, J. K. R. (1965) Effects of 2-chloro-6-(trichloromethyl)-pyridine on the nitrification of ammonium sulphate and its recovery by ryegrass. *J. agric. Sci. Camb.* **64**, 299–303.

Ammonium sulphate alone and treated with the nitrification inhibitor 2-chloro-6-(trichloromethyl)-pyridine, at rates equivalent to 1 and 2% of the weight of N applied, was applied to sandy- and clay-loam soils. Ammonium sulphate was given in November 1962, and soil samples, taken in spring 1963, down to 36 in. on the sandy-loam and 18 in. on the clay-loam, were analysed. When the ammonium sulphate was broadcast on the soil surface 2% of the inhibitor inhibited nitrification of the ammonium-N more than 1%, but not when placed in the soil.

Untreated ammonium sulphate was applied in spring to previously unfertilised plots, and ryegrass was sown on all plots. On the sandy soil yield and N uptake were increased most by the N applied in spring; of the autumn-applied dressings, treated fertiliser placed in the soil increased yield and uptake most and untreated fertiliser broadcast on the surface least. On the clay-loam soil spring-applied fertiliser and autumn-applied treated fertiliser placed in the soil increased yields of dry matter most, but ryegrass took up more N from the spring than from the autumn dressings. Untreated fertiliser broadcast on the surface in autumn on this soil anomalously increased yields and N uptake more than treated fertiliser similarly applied, and more than untreated fertiliser placed in the soil.

2.14 GASSER, J. K. R. (1965) Effects of urea on the germination and early growth of kale, barley and wheat. *Pl. Soil* **23**, 351–370.

Kale was grown in pots in the glasshouse and barley and wheat in bottomless boxes in the open with increasing amounts of urea applied to the soils maintained at various moisture contents. Two sandy soils and two clay soils (one of each

https://doi.org/10.23637/ERADOC-1-60

containing much and little organic matter) were used in both pots and boxes; in addition, four calcareous soils (two developed over Chalk, and two over hard limestone) were used in the boxes to compare the effects of the applied urea on the germination and early growth of crops on different soils.

The greatest amount of urea applied to the soils containing little organic matter decreased growth of kale in pots, particularly on drier soils, but not with soils rich in organic matter; in contrast, with barley and wheat grown in boxes, urea was more damaging in the soils rich in organic matter.

The various soils used could be grouped according to the amount of urea giving maximum yield. On a soil containing much free calcium carbonate derived from Chalk, urea either did not affect yield or depressed it below that of the unfertilised crop.

2.15 NOWAKOWSKI, T. Z. & CUNNINGHAM, R. K. (1966) Nitrogen fractions and soluble carbohydrates in Italian ryegrass. II. Effects of light intensity, form and level of nitrogen. *J. Sci. Fd Agric.* **17**, 145—

S.22 Italian ryegrass grown in a glasshouse during June on clay-loam soil at three light intensities (100, 68 and 44% of daylight) was given six amounts of N (0–500 ppm) as NH_4^+–N or NO_3^-–N. Grass grew best in 100% daylight, and with NH_4^+–N yields were most at 500 ppm and with NO_3^-–N at 200 ppm. Total N, total soluble N and nitrate-N were much more, and protein-N, amide-N (particularly asparagine-N) and α-amino-N much less in grass given NO_3^-–N than in grass given NH_4^+–N. These differences increased with increasing amounts of applied N. Shading or increasing the amount of N increased total N, total soluble-N, soluble organic-N and nitrate-N, and decreased protein-N and soluble carbohydrates. Light intensity had most effect on the amount of soluble carbohydrates in grass given 100 ppm of N, and the effect decreased with increasing amounts of N. "N-Serve" indirectly influenced the chemical composition of grass by maintaining N in the soil in the NH_4^+–N form.

2.16 TALIBUDEEN, O. & YAMADA, Y. (1966) Total potassium in soils by radioactivity measurements. *J. Soil Sci.* **17**, 107–120.

The β- and γ-analysis methods were fully tested on 19 British soils; "marker" γ photo-peaks of daughter-elements were used for estimating Th and U, and the 1·46-MeV–^{40}K photo-peak for K. The photo-peaks for Th and U that give values for the K contents of the soil closest to the chemically determined values are ^{208}Tl(ThC"), 2·615 MeV, and ^{214}Bi(RaC), 0·609 MeV, respectively. Reasonable values for the Th content of these soils are obtained by this method, but U contents seem to be considerably overestimated.

2.17 (TWYFORD, I. T.) & COULTER, J. K. (1964) Foliar diagnosis in banana fertilizer trials. In: *Plant analysis and fertilizer problems* IV. ed. C. BOULD *et al.* (*Amer. Soc. hort. Sci.*), pp. 357–370.

Experiments to develop a diagnostic leaf-sampling technique in Robusta bananas are described. Nutrient concentration differed considerably on opposite sides of sections of the lamina and along the lamina length. Differences were smallest near the middle of the leaf. Using middle sections, the effects of leaf age were studied. N rises to a maximum at about the third or fourth fully opened leaf, then declines with increasing leaf age. K declines sharply from the youngest to the oldest leaf; P declines less so, but in the same direction; Ca rises sharply from youngest to oldest leaf and Mg less so.

Stages of plant growth were divided into small (3–4 ft high), medium (4–8 ft high), large (well grown but not yet "shot") and "shot". Medium and large plants did not differ significantly in nutrient content; small plants contained

https://doi.org/10.23637/ERADOC-1-60

more N, P and K but similar amount of Ca and Mg, and most "shot" plants contained less N, P and K, more Ca and the same amount of Mg as before shooting.

A tentative sampling technique is suggested, using material from both sides of the middle portion of the lamina of the fourth leaf, counting from the youngest (at least partially unfurled) and bulking samples from several similar plants.

Ten 3 × 3 × 3 NPK factorial experiments were sampled and the results used to try to estimate adequacy levels for N, P and K. N and K fertiliser considerably increased their mean leaf concentration, but P fertiliser produced only small and irregular increases.

N fertiliser gave responses at all sites, K at 8 and phosphate at 4 of 10. There was evidence of luxury consumption, and to estimate adequacy only the leaf contents should be used from plants giving maximum growth with the least fertiliser. This set an adequacy limit for K at about 3·8% K_2O; for N the chief limit was about 2·9% N, but 2·6% on two very light soils, where there may be a different nutrient balance at maximum growth. For P, the limit ranged from 0·29 to 0·48% P_2O_5. Below 0·25% plants appear always deficient, and above 0·43% always adequate. Further work is thus required on leaf P, but fortunately P deficiency is easy to detect in the field.

Soil analyses indicated that 0·41% total N is inadequate for the N nutrition of bananas, that the adequacy level for exchangeable K is between 0·31 and 0·42 m-equiv%, provided there are no other important soil sources of supply, and that the critical level for Truog phosphate is between 7 and 32 ppm P_2O_5.

2.18 VAIDYANATHAN, L. V. & TALIBUDEEN, O. (1965) A laboratory method for the evaluation of nutrient residues in soils. *Pl. Soil* **23**, 371–376.

A laboratory method used ion-exchange resins to extract phosphate ions from soils and to measure the rate at, and the extent to which, non-labile phosphate reserves in soils change into the isotopically exchangeable phosphate when the soils are allowed "to recover". The method was tested on heavy and acid Indian soils, both unmanured and treated with NPK fertilisers.

2.19 WIDDOWSON, F. V. & PENNY, A. (1965) Experiments measuring the residual effects of nitrogen fertilisers. *J. agric. Sci. Camb.* **65**, 195–200.

An experiment on a clay-loam soil measured responses to three amounts of nitrogen on alternate crops of wheat and potatoes; these dressings were tested in all combinations with three rates of N applied 1 and 2 years previously. Nitrogen applied for potatoes consistently increased yields of following wheat. The residue from applying 1·5 cwt N/acre for potatoes was equivalent to top-dressing the wheat with 0·55 cwt N/acre; the value of the residue was decreased by applying N to the wheat. Potato yields were increased little by applying N to the preceding wheat crop, and the residues were of little significance when compared with the responses to new N. There was no gain from N applied 2 years previously for either crop.

An experiment on a clay-loam soil measured the effects of N and of undersowing with ryegrass (with and without ploughed-in straw) on barley yields. Nitrogen consistently and greatly increased yield. Ryegrass undersown in barley decreased grain yields, but the loss was least when N was applied. Neither ploughed-in ryegrass nor ryegrass plus straw affected the yield of the final crop, but residues from the N applied for the two preceding crops increased yields slightly. Little take-all was present; infection was decreased by ryegrass and by applying N.

https://doi.org/10.23637/ERADOC-1-60 *pp 11*

2.20 WIDDOWSON, F. V., PENNY, A. & WILLIAMS, R. J. B. (1965) An experiment measuring effects of N, P and K fertilisers on yield and N, P and K contents of grass. *J. agric. Sci., Camb.* **64**, 93–100.

The effects of "Nitro-Chalk", superphosphate and muriate of potash on yield and N, P and K content of grass were measured from 1958 to 1963.

Applying 0·3, 0·6 or 0·9 cwt N/acre/cut consistently and greatly increased yields; mean percentage increases from these rates of N were 150, 223, and 241% respectively. Applying 0·25 or 0·50 cwt K/acre/cut increased yields little from 1958 to 1962 at any rate of N; K greatly increased yields in 1963 on plots receiving 0·6 or 0·9 cwt N/acre/cut. Mean percentage increases from 0·25 or 0·5 cwt K/acre/cut were 5 and 8 respectively. Applying 0·52 cwt P/acre/year increased yields by only 3%.

Percentage K in the grass was not maintained by any treatment; it decreased from 1958 to 1963. The decrease was proportional to the rate of N applied, and was least where K also was given. Percentage P in the grass also decreased with time, whether or not P was given.

Initially the soil contained much acid-soluble P and K but little mineralisable N. The recovery of N was always large (71–84%), of P very small (8–12%) and of K intermediate; K uptake was increased by N from 35 to 71%. Maximum P uptake (0·331 cwt/acre/year) was less than the maximum P applied (0·52 cwt P/acre), but maximum K uptake (2·66 cwt K/acre/year) was much greater than the maximum rate of K applied (1·42 cwt K/acre), and so the amount of HCl-soluble K in the surface soil decreased. The initial level of HCl-soluble soil K was maintained only by using 0·5 cwt K with 0·3 cwt N/acre/cut; this corresponded to a fertiliser with an N:K ratio of 1:1·66.

2.21 WIDDOWSON, F. V., PENNY, A. & WILLIAMS, R. J. B. (1965) Experiments comparing concentrated and dilute NPK fertilisers and four nitrogen fertilisers on a range of crops. *J. agric. Sci., Camb.* **65**, 45–55.

In 1959 a concentrated granular fertiliser (15% N, 10% P_2O_5, 20% K_2O) was compared with an equivalent mixture of ammonium sulphate, superphosphate and muriate of potash (each supplying 0·75 or 1·50 cwt N/acre) for potatoes. At Rothamsted (on heavy soil) the two fertilisers gave similar yields, but at Woburn (on light soil) the larger dressing of the concentrated fertiliser gave about 1 ton/acre more potatoes. In similar barley experiments a concentrated granular fertiliser (20% N, 10% P_2O_5, 10% K_2O) was compared with a dilute granular fertiliser (12% N, 6% P_2O_5, 6% K_2O); each was combine-drilled to supply 0·3 or 0·6 cwt N/acre. At Rothamsted the two fertilisers gave identical yields, but at Woburn the concentrated fertiliser (at the double rate) gave significantly more grain.

A 3-year experiment done at Rothamsted in 1960–62 compared a concentrated granular fertiliser (20% N, 10% P_2O_5, 10% K_2O) with an equivalent mixture of ammonium sulphate, granular superphosphate and muriate of potash for a rotation of kale, Italian ryegrass and barley; each supplied 0·3 or 0·6 cwt N/acre for barley and 1·0 or 2·0 cwt N/acre for kale and Italian ryegrass. The concentrated fertiliser gave the larger yields in two-thirds of the available comparisons; its superiority was greater at the double rate of manuring.

The same experiment also compared ammonium sulphate, ammonium nitrate, calcium nitrate and urea on the same crops and at the same rates of N, but with basal P (as triple superphosphate) and K (as potassium bicarbonate). Ammonium nitrate gave the largest yields of barley and of the first cut of ryegrass, but calcium nitrate gave the largest kale yields. Ammonium sulphate and urea were

https://doi.org/10.23637/ERADOC-1-60

each inferior to the nitrate-N fertilisers; ammonium sulphate was better than urea for Italian ryegrass.

The percentage of the applied N that was recovered was similar for barley, ryegrass and kale. Barley and kale recovered more N from calcium nitrate or ammonium nitrate than from ammonium sulphate or urea; ryegrass also did when 1·0 cwt N/acre was used, but with 2·0 cwt N/acre it recovered most N from ammonium sulphate and least from urea.

The three-crop rotation (kale, Italian ryegrass and barley), manured with the double rate of fertiliser, altogether removed half as much P (54–62 lb/acre), but more than one and a half times more K (346–379 lb/acre) than was added in fertiliser (112 lb P plus 214 lb K/acre) from 1960 to 1962. The K from potassium bicarbonate was recovered slightly less completely than from potassium chloride, but the P from granular single and triple superphosphates was recovered equally.

Between March 1960 and autumn 1962 the surface soil pH was maintained only by calcium nitrate. Ammonium sulphate (at the double rate) decreased soil pH from 7·3 to 6·3 in 2½ years; the other fertilisers had intermediate effects. The amount of soil P soluble in 0·3*N*-HCl increased from 1960 to 1962, but the amount of acid-soluble soil K was no more than maintained by any fertiliser.

Barley grown with 0·6 cwt N/acre in 1963 measured residual effects. Grain yields were much smaller where the barley followed ryegrass in 1962 than where it came after kale or barley. N applied to the preceding barley or kale slightly increased, and N applied to ryegrass greatly increased barley grain yields.

Pedology Department

General Papers

3.1 Bloomfield, C. (1965) Organic matter and soil dynamics. In: *Experimental Pedology. Proc. 11 Easter Sch. agric. Sci., Univ. Nott.* 1964, 257–266.

3.2 Jenkinson, D. S. (1965) Organic matter in soil. *New Scient.* 746–748.

Research Papers

3.3 Brown, G. (1965) Contribution to discussion on the paper "Role of Crystal Structure in Solid State Reactions of Clays and Related Minerals", by G. W. Brindley in Vol. 1, p. 37. *Proc. int. Clay Congr.*, Stockholm, 1963, **2**, 97–99.

The role of solid state reactions in naturally occurring mineral alterations is discussed with reference to the alteration of olivine to "iddingsite".

3.4 Brown, G. (1965) Significance of recent structure determinations of layer silicates for clay studies. *Clay Miner.* **6**, 73–82.

Structure determinations of layer silicates by Fourier and least-squares methods are summarised; all show significant distortions from the ideal structures. Inconsistencies are shown to exist between the model structure for micas proposed, taking account of these distortions, and for some micas the structures of which have been fully determined. The implications of recent structure determinations of layer silicates and related minerals for studies of absorption by clay minerals are also considered.

https://doi.org/10.23637/ERADOC-1-60

3.5 BROWN, G. & WEIR, A. H. (with chemical analyses by G. Pruden) (1965) Addition to paper "The identity of rectorite and allevardite" in Vol. 1, p. 27. *Proc. int Clay Congr.*, Stockholm, 1963, **2**, 87–90.

Allevardites from Dagestan, Baluchistan and Allevard, and rectorite from Arkansas were re-analysed after purification; structural formulae calculated from the analyses confirm the similarity of the three allevardites to the rectorite and show that the minerals have alternating sodium mica-like interlayers and beidellite-like interlayers.

3.6 JENKINSON, D. S. (1965) Studies on the decomposition of plant material in soil. I. Losses of carbon from ^{14}C labelled ryegrass incubated with soil in the field. *J. Soil Sci.* **16**, 104–115.

A new method for determining ^{14}C in soil is described.

Ryegrass roots and tops uniformly labelled with ^{14}C were allowed to decompose for 4 years in soil under field conditions. About one-third of the labelled (ryegrass) C was left in the soil after 6 months, but thereafter decomposition was much slower, about one-fifth of the labelled C remaining after 4 years. Throughout the period labelled C was less resistant to decomposition than unlabelled C, i.e., the C present in the soil before the labelled ryegrass was added. Even in the fourth year after addition of the ryegrass the percentage of labelled C in the soil decomposing per year was four times that of unlabelled C. Initially ryegrass tops decomposed faster than roots, but after 1 year the differences disappeared and the same amount of residual C remained from each. For periods of 1 year and longer the percentage of labelled C retained in a soil with 2·4% organic C was the same as in a soil containing 1% organic C. The percentage C retained was the same when either 0·3 or 0·6% ryegrass tops were added to the soil. Similar amounts of labelled plant C were retained in soils incubated for 1 year in two contrasting seasons (1959 and 1962).

3.7 KING, H. G. C. & BLOOMFIELD, C. (1966) The reaction between water-soluble tree leaf constituents and ferric oxide in relation to podzolisation. *J. Sci. Fd Agric.* **17**, 39–43.

Sterile aqueous extracts of tree leaves dissolve ferric oxide, and the reaction products are sorbed on residual ferric oxide. Extracts of autumn-fallen leaves of oak, beech and larch, and picked Scots pine needles, were allowed to react with ferric oxide under conditions in which both the solution and sorption processes may be assumed to go to completion, and the effect on the composition of the extracts was determined. Under these conditions the net excess of solution of iron over sorption was quite small, and polyphenols, sugars, α-amino acids and carboxylic acids were retained in the ferric oxide.

3.8 RAYNER, J. H. (1966) Classification of soils by numerical methods. *J. Soil Sci.* **17**, 79–92.

Twenty-three profile descriptions of soils in Glamorganshire and the laboratory measurements on soil samples of the 91 horizons into which they were divided by the surveyor were examined by the methods of numerical taxonomy. The similarities between the horizons calculated by these methods were reduced to a table of similarities between profiles by averaging the similarities of those horizons that matched best, judged by their similarity and order in the profile. The soil-similarity matrix was sorted to give a dendrogramme. Calculations of the latent roots and vectors of the matrix gave a two-dimensional representation of the relationships between the soils. The Great Soil Groups to which the surveyor assigned his profiles can be picked out in this diagram.

https://doi.org/10.23637/ERADOC-1-60

3.9 RAYNER, J. H. (1965) Multivariate analysis of montmorillonite. *Clay Miner.* **6**, 59–70.

Varty & White's application of multivariate analysis to Grim & Kulbicki's measurements on montmorillonites has been re-examined and extended. Inconsistencies between their table of scored data and derived similarity table, and some unexplained errors in the similarity table, have only a small effect on their results. Similarities calculated from Grim & Kulbicki's data, using a different similarity co-efficient, lead to a two-dimensional representation which separates the groups of montmorillonites more clearly. The groups can be clearly separated, even in a one-dimensional representation, by changing the relationship between distance and similarity. The choice of relationship is discussed, and the features of the montmorillonites associated with this one-dimensional representation are found.

3.10 RAYNER, J. H. & BROWN, G. (1965) Structure of pyrophyllite. *Clays and Clay Minerals* (Pergamon Press), **13**, 73–84.

Pyrophyllite gives a diffraction pattern consisting of sharp and diffuse reflections. The unit cell for all the reflections is monoclinic with $a = 5{\cdot}17$ Å, $b = 8{\cdot}92$ Å, $c = 18{\cdot}66$ Å, $\beta = 99{\cdot}8°$. From the absences the space group is either $C\,2/c$ or $C\,c$, but there are additional absences of hkl reflections with $k = 3n$ and l even. The additional systematic absences show that the structure is partially disordered, the disordered state being based on a small sub-cell defined by the sharp reflections. This sub-cell is monoclinic with $a' = a = 5{\cdot}17$ Å, $b' = b/3 = 2{\cdot}97$ Å, $c' = c/2 = 9{\cdot}33$ Å, $\beta' = \beta = 99{\cdot}8°$ and belongs either to the space group $C\,m$ or $C\,2/m$. Co-ordinates have been found in the space group $C2/m$ by Fourier and least-squares methods which give $R = 0{\cdot}180$ for $h0l$ reflections and $R = 0{\cdot}148$ for hkl reflections with $h = 0, 1, 2$. The Si–O tetrahedra are twisted 10° to 10½° from the "ideal" arrangement leading to a ditrigonal array of oxygens on the surfaces of the layers. The average Si–O bond length is 1·610 Å and the average octahedral site–O distance is 2·025 Å. The surfaces of the layers can come together in three ways; the O–O contacts for any pair of layers are either approximately parallel to (010) with contacts 2·890 Å and 3·028 Å alternately, or approximately parallel to planes making angles of ± 120° with (010) with contacts 3·009 Å, 3·066 Å, 3·009 Å, 3·343 Å, 3·009 Å, . . . sequentially.

3.11 WEIR, A. H. (1965) Potassium retention in montmorillonites. *Clay Miner.* **6**, 17–22.

The amounts of potassium retained after exchange with normal ammonium acetate solution at pH 7 were measured with six montmorillonite–beidellite minerals whose interlayer charge ranged from 0·72 to 1·00 M^+/Si_8O_{22} and where tetrahedral substitution of Al for Si ranged from 0·14 to 0·93 M^+/Si_8O_{22}. The amount of potassium retained increased with increasing interlayer charge, but there was no correlation between the amount of potassium retained and the tetrahedral charge.

3.12 WEIR, A. H. & CATT, J. A. (1965) The mineralogy of some Upper Chalk samples from the Arundel Area, Sussex. *Clay Miner.* **6**, 97–110.

Seven samples, representative of all zones of the Upper Chalk in the Arundel area of Sussex, were treated with acetic acid and the residues analysed to determine their mechanical and mineralogical compositions. The sand and silt fractions of the residues consist mainly of flint and opaline silica, collophane, limo-

https://doi.org/10.23637/ERADOC-1-60

nite and quartz, and the clay fractions consist of montmorillonite, mica, quartz and apatite. Authigenic apatite and quartz occur in the clay and silt and authigenic alkali felspar in the silt. The montmorillonite may also be authigenic.

Soil Microbiology Department

Book

4.1 Jackson, R. M. & Raw, F. (1966) *Life in the soil.* London: Edward Arnold. 64 pp.

General Papers

4.2 Bascomb, S. (1965) *The Rothamsted Collection of Rhizobium: Catalogue of strains.* 11 pp.

All strains in the Rothamsted Collection of *Rhizobium* species (214 strains) have been lyophilised. The catalogue gives the principal symbiotic characters of each strain (whether virulent or avirulent, effective or ineffective in nitrogen fixation). In addition to *Rhizobium*, the collection also contains strains of bacteriophage of *Rhizobium*, *Azotobacter*, *Beijerinckia*, *Nitrosomonas* and *Nitrosococcus*.

4.3 Brown, M. E. & Jackson, R. M. (1965) Bacterial inoculation of non-leguminous crops. *N.A.A.S. q. Rev.* **70**, 69–73.

4.4 Brown, M. E., Jackson, R. M. & Burlingham, S. K. (1965) Growth and effects of bacteria introduced into soil. In: *Ecology of soil bacteria* (Symposium: Hartley Botanical Laboratory, Liverpool). (In the press.)

4.5 Nutman, P. S. (1966) Genetical and physiological factors in clover nodulation and nitrogen fixation. *Proc. 9th int. Congr. Microbiology*, Moscow. (In the press.)

4.6 Skinner, F. A. (1965) The anaerobic bacteria of soil. In: *Ecology of soil bacteria* (Symposium, Hartley Botanical Laboratory, Liverpool). (In the press.)

Research Papers

4.7 Festenstein, G. N., Lacey, J., Skinner, F. A., (Jenkins, P. A. & Pepys, J.) (1965) Self-heating of hay and grain in Dewar flasks and the development of farmer's lung antigens. *J. gen. Microbiol.* **41**, 389–407. (For summary, see No. 6·16).

4.8 Jackson, R. M. (1965) Studies of fungi in pasture soils. II. Fungi associated with plant debris and fungal hyphae in soil. *N.Z. Jl. agric. Res.* **8**, 865–877.

The fungi colonising plant debris in New Zealand pasture soils were studied by a washing and isolating technique. Differences between fungi occurring at different seasons in one soil were small. Three fungi, *Paecilomyces carneus*, *Gliocladium roseum* and *Cladosporium* sp., occurred on debris in all the soils examined, but others occurred only in some.

The length of hyphae per g of soil differed greatly at different seasons and in different soils. Many of the hyphae are probably of vesicular–arbuscular mycorrhizal fungi.

A method for isolating fungi from hyphae in soil is described. Few of the extracted hyphae germinated, probably because some were dead and others were

https://doi.org/10.23637/ERADOC-1-60

of vesicular–arbuscular mycorrhizal fungi unable to grow in culture media. Flotation methods extracted large *Endogone*-like spores and micro-sclerotia from the three pasture soils examined.

4.9 JACKSON, R. M. (1965) Studies of fungi in pasture soils. III. Physiological studies on some fungal isolates from the root surface and from organic debris. *N.Z. Jl. agric. Res.* **8**, 878–888.

Fungi isolated from the surfaces of live roots or root debris were compared for their ability to use a range of compounds as carbon and energy sources. Most of the fungi had similar abilities, but one isolate of *Mortierella alpina* was exceptional in not growing on xylose, sucrose or pectin, and growing poorly on glucose. An isolate of *Cladosporium* sp. grew better on glucose than any of the others, and was the only one that grew poorly on starch.

Paecilomyces carneus, a dominant isolate from debris, and several strains of *Mortierella* decomposed chitin readily; *Gliocladium roseum* did so less readily, and *Trichoderma sporulosum* and *Humicola* sp. only weakly.

The four isolates of *Fusarium oxysporum* tested all attacked cellulose, but not equally readily. They differed more in their ability to produce cellulase than in their ability to grow on cellulose or disintegrate cellulose fibres.

The four isolates of *Fusarium oxysporum* and one of *Cylindrocarpon radicicola* tolerated 4·6% of myrobalan tannin better than did other fungi. Several fungi used tannins as a carbon source.

4.10 JACKSON, R. M., BROWN, M. E. & BURLINGHAM, S. K. (1964) Similar effects on tomato plants of *Azotobacter* inoculation and application of gibberellins. *Nature, Lond.* **203**, 851–852.

Azotobacter may alter plant growth by producing growth-regulating substances. Inoculating tomato seeds or seedlings with cultures of *Azotobacter chroococcum* produced effects similar to those following treatment with gibberellic acid. Development of stem, leaves and flowers was accelerated. Preliminary assays of Azotobacter cultures for growth regulators showed they contained GA_3 and unidentified gibberellin-like substances.

4.11 KLECZKOWSKI, J. (1965) Mutations in symbiotic effectiveness in *Rhizobium trifolii* caused by transforming DNA and other agents. *J. gen. Microbiol.* **40**, 377–383.

A strain of *Rhizobium trifolii* able to fix nitrogen in root nodules of clover plants lost its effectiveness when treated with deoxyribonucleic acid (DNA) from an ineffective strain. Attempts to transform two ineffective strains to effectiveness failed, even when the donor of DNA and the recipient strains were genetically related and apparently differed only in symbiotic property. The efficiency of transformation by DNA to ineffectiveness was compared with mutagenic and selective treatments. The results support the idea that symbiotic effectiveness involves compatability between several plant and bacterial factors, changes in any one of which makes the bacterium ineffective.

4.12 MEIKLEJOHN, J. (1965) Azotobacter numbers on Broadbalk field, Rothamsted. *Pl. Soil.* (In the press.)

Azotobacter chroococcum, an aerobic nitrogen-fixer, was counted during 1955–58 and in 1962, in soil samples taken from nine plots from Broadbalk field at Rothamsted. In the fallow sections of the plots, and in sections carrying the fourth successive wheat crop, *Azotobacter* were few, especially in the plots given ammonium sulphate every year. *Azotobacter* numbers increased after fallowing. In cropped sections *Azotobacter* were fewest in the plot with nitrogen only. With nitrogen

https://doi.org/10.23637/ERADOC-1-60

and phosphate but no potash they were fewer than in the plots without nitrogen. The most *Azotobacter* were in the plots with nitrogen, phosphate and potash. These trends are correlated with yield, but *Azotobacter* were too few (ranging from < 100 to a maximum of 9,400/g soil) to fix enough nitrogen to affect crop growth.

4.13 WALKER, N. & (LIPPERT, K. D.) (1965) Formation of gentisic acid from 2-Naphthol by a *Pseudomonas*. *Biochem. J.* **95**, 5C–6C.

2,5-Dihydroxybenzoic acid (gentisic acid) was isolated in appreciable yield from cultures of a *Pseudomonas* strain growing on 2-naphthol as its sole source of carbon. Measurements of oxygen uptake by washed 2-naphthol-grown *Pseudomonas* organisms in presence of gentisic acid showed no lag period. Gentisic acid is an intermediate metabolite of 2-naphthol in the *Pseudomonas* used.

Botany Department

THESIS

5.1 DYSON, P. W. (1965) Analysis of growth and yield of the potato crop with particular reference to nutrient supply. Ph.D. Thesis, University of London.

GENERAL PAPERS

5.2 (NIELSEN, K. F.) & HUMPHRIES, E. C. (1966) Effects of root temperature on plant growth. *Soils Fertil.* **29**, 1–7.

5.3 THORNE, G. N. (1966) Physiological aspects of grain yield in cereals. In: *The growth of cereals and grasses*, ed. F. L. Milthorpe & J. D. Ivins. London: Butterworths, pp. 88–105.

RESEARCH PAPERS

5.4 DYSON, P. W. (1965) Effects of gibberellic acid and (2-chloroethyl)-trimethylammonium chloride on potato growth and development. *J. Sci. Fd Agric.* **16**, 542–549.

The effects of gibberellic acid (GA) and (2-chloroethyl) trimethylammonium chloride (or Chlorocholine chloride, CCC) on growth of potatoes in pots were measured by growth analysis. GA was applied to the "seed pieces" and CCC to the soil at emergence.

GA accelerated emergence and stem growth but delayed leaf and tuber growth. CCC decreased growth of stems, leaves and stolons and caused tubers to form earlier. CCC did not modify the effects of GA. The initial effects of both regulators were reversed in the later stages of growth, so that yield and leaf area duration were unchanged.

5.5 GOODMAN, P. J., WATSON, M. A. & HILL, A. R. C. (1965) Sugar and fructosan accumulation in virus-infected plants: rapid testing by circular-paper chromatography. *Ann. appl. Biol.* **56**, 65–72.

The effects of infection with beet yellows, yellow-net, yellow-net mild yellows, carrot motley dwarf and cereal yellow dwarf viruses were studied by circular-paper chromatography. Soluble carbohydrates increased with each infection, except with yellow-net virus of sugar beet. Virulent strains apparently decreased photosynthesis more than avirulent strains, resulting in less carbohydrate accumulation.

https://doi.org/10.23637/ERADOC-1-60

5.6 HUMPHRIES, E. C., WELBANK, P. J. & WITTS, K. J. (1965) Effect of CCC on growth and yield of spring wheat in the field. *Ann. appl. Biol.* **56**, 351–361.

Spring wheat, var. *Phoebus*, drilled at 1½ times usual rate and grown with 3 rates of nitrogen was treated with 2·5 or 5 lb CCC/acre at the sixth-leaf stage. At maturity the height of treated plants was only 60% of that of untreated plants. The percentage shortening was less as nitrogen increased. Although untreated plants did not lodge, CCC increased mean grain yield by 5%, by increasing the number of ears and number of grains per ear. Grain weight per ear and thousand-grain weight were decreased by CCC. The explanation of the increase in shoot number by CCC is not known, but possibly less light was intercepted by the shorter plants, so that later-formed shoots survived to produce ears.

CCC decreased assimilatory area by shortening stems, and hence leaf-sheath area; lamina area was little affected. It delayed ear emergence by up to 8 days. Leaf area index was decreased by CCC, and as it increased, net assimilation rate decreased. CCC did not affect nitrogen uptake per unit area of land, but it increased nitrogen as percentage of dry matter because it decreased dry-matter yields.

5.7 NÖSBERGER, J. & HUMPHRIES, E. C. (1965) The influence of removing tubers on dry matter production and net assimilation rate of potato plants. *Ann. Bot.* N.S. **29**, 579–588.

To study the effect of removing tubers on growth and net assimilation rate (E) of potato, plants were grown in pots partly filled with soil, and the shoot grew through a black polythene cover. Tubers developed in the dark space between the cover and the soil surface.

Removing tubers immediately they began to form had little effect on E at the beginning of the experiment, but later greatly slowed it. Shading slowed E more at the beginning of the experiment than later. Removing tubers decreased total dry weight, but much of the material that would have moved to tubers accumulated in leaves and stems. In intact plants the loss of weight by shading was mainly from the tubers; in plants without tubers it was mainly from stems and leaves. Removing tubers increased leaves on lateral stems. Increasing the amount of nitrogen supplied diminished the effect on E of removing tubers, presumably because the extra N allowed other sinks for carbohydrate to develop. The growth of some buds of the potato plant is so strongly inhibited that they cannot grow and act as sinks for excess carbohydrate when tubers are removed. Such internal inhibition of growth may sometimes suffice to influence the magnitude of E of normal plants. Removing tubers usually increased sugar and starch content and protein N content of stems and leaves.

5.8 NÖSBERGER, J. & THORNE, G. N. (1965) The effect of removing florets or shading the ear of barley on production and distribution of dry matter. *Ann. Bot.* N.S. **29**, 635–644.

Halving the number of florets per ear of barley shortly after the ears emerged increased the dry weight of the rest of the plant. The effect was greatest 17 days after the ears emerged, and until then the increase in weight of the shoot of the plant nearly equalled the decrease in ear weight. Later, when the shoots lost weight, the difference between shoots with 24 or 12 florets per ear disappeared, presumably because all the extra labile carbohydrate was lost by respiration. Unshaded plants or plants with shaded ears or shoots were affected similarly. Removing florets did not affect net assimilation rate, although it slightly decreased the rate of photosynthesis of the flag-leaf lamina between 10 and 17 days after the ear emerged.

https://doi.org/10.23637/ERADOC-1-60

The weight of the rest of the plant was decreased by shading the ear, but less than it was increased by removing florets. Shading decreased ear weight at all samplings. The effect was small, especially when florets were removed.

Thus, the size of the sink provided by the ear for carbohydrate affected the movement of carbohydrate from the shoot. This invalidates some of the methods used to estimate photosynthesis by the ear.

5.9 THORNE, G. N. (1965) Photosynthesis of ears and flag leaves of wheat and barley. *Ann. Bot.* N.S. **29**, 317–329.

Immediately after anthesis, ears of spring wheat absorbed less than 0·5 mg CO_2/h in daylight and later evolved CO_2 in the light and in the dark. The rate of apparent photosynthesis of the combined flag-leaf lamina and sheath and peduncle (collectively called flag leaf) of two spring wheat varieties, Atle and Jufy I, was 3–4 mg/h; the rates of the flag leaf and the ear of two spring barleys, Plumage Archer and Proctor, were each about 1 mg/h.

The gas exchange of ears and flag leaves between ear emergence and maturity accounted for most of the final grain dry weight. The CO_2 fixed by the wheat ear was equivalent to between 17 and 30% of the grain weight, but more than this was lost by respiration, so assimilation in the flag leaf was equivalent to 110–120% of the final grain weight. In barley, photosynthesis in the flag leaf and the net CO_2 uptake by the ear each provided about half of the carbohydrate in the grain.

Barley ears photosynthesised more than wheat ears because of their greater surface, and flag leaves of wheat photosynthesised more than those of barley because they had more surface and a slightly greater rate of photosynthesis per dm^2.

5.10 THURSTON, J. M. (1966) Survival of seeds of wild oats (*Avena fatua* L. and *Avena ludoviciana* Dur.) and charlock (*Sinapis arvensis* L.) in soil under leys. *Weed Res.* **6**, 67–80.

The survival of seeds of wild oats (chiefly *A. fatua*) under leys on clay soils was studied in two field experiments. During the first year under ley the number of seeds in the soil decreased by 41% and 86% respectively. Subsequent decreases were smaller, and after 5 years under ley enough seeds remained to re-infest a cereal crop. These results suggest that a long ley is not an efficient method of eliminating wild-oat seeds from soil and that a 1-year ley can be almost as effective as one lasting for 5 years.

The number of wild-oat seeds germinating when a ley is ploughed up decreases as the duration of the ley, and hence the age of the seeds in the soil, increases, and is almost unaffected by weather. In contrast, germination of Charlock (*Sinapis arvensis* L.) does not decrease regularly with increasing age of seeds up to 5 years, but is most in years when April and May are wet.

5.11 WELBANK, P. J., FRENCH, S. A. W. & WITTS, K. J. (1966) Dependence of yields of wheat varieties on their leaf area durations. *Ann. Bot.* N.S. **30**, 291–300.

In a field experiment three wheat varieties: autumn-sown Cappelle Desprez, Prestige, both autumn- and spring-sown, and spring-sown Jufy I, each supplied with 0·5 or 1·0 cwt nitrogen/acre had grain yields nearly proportional to their leaf area durations (D) during grain development. Squarehead's Master had a smaller grain yield relative to its total D, but with 0·5 cwt N/acre the ratio of its grain yield to D of parts above the flag-leaf node (D_F) was similar to the other varieties. The difference in this ratio between varieties was less when D_F was calculated from anthesis than from ear emergence to ripening. Squarehead's Master with 1·0 cwt N/acre had a smaller ratio of grain yield to D_F than other

https://doi.org/10.23637/ERADOC-1-60

treatments, implying less grain per ear relative to D_F per shoot, perhaps because of lodging, or because factors limiting size of ears restricted their ability to accept all the assimilate the shoots could produce with this amount of N.

5.12 WHEELER, A. W. (1965) Betaine content and growth of leaves of *Phaseolus vulgaris* L. *Phyton, B. Aires* **22**, 147–151.

The betaine content of dwarf bean leaves increased greatly during their expansion, in proportion to increase in cell number. The concentration of betaine expressed as weight per g fresh or dry weight of leaf decreased with leaf expansion. Glycine betaine, at the same concentration as in young expanding dwarf bean leaves, retarded growth in light of disks cut from young dwarf bean primary leaves. Trigonelline, choline and tryptophane also occurred in the aqueous extracts of dwarf bean leaves, and when separated on paper chromatograms became red-brown with iodine vapour, as did glycine betaine. However, they did not affect growth of leaf disks in light.

5.13 WHEELER, A. W. (1965) Effect of seed treatment on growth and growth-substance content of dwarf French beans (*Phaseolus vulgaris*). *J. exp. Bot.* **16**, 714–720.

The longer the seeds of dwarf French bean were soaked in water before sowing, the smaller were the seedlings they produced. Soaking for 24 hours removed only little dry matter, but detectable amounts of a gibberellin and a betaine. The amounts of these removed increased with increased time of soaking. Long soaking of seeds decreased the amounts of gibberellin and auxin in the cotyledons, and of gibberellin, auxin and betaine in the primary leaves of seedlings. Aerating, cooling or increasing the volume of water in which the seeds were soaked also retarded the growth of the seedlings, but did not affect the amount of growth substances removed from the seeds or contained in the cotyledons. The deleterious effect of soaking seeds was not alleviated by treating the seeds or seedlings with gibberellic acid or glycine betaine. Although larger seedlings were produced by heavy than by light seeds, their cotyledons and primary leaves contained similar concentrations of growth substances.

Biochemistry Department

GENERAL PAPERS

6.1 CLARKE, A. J. (1965) Artificial hatching agents for cyst-forming nematodes. *Chemy Ind.* 363–366.

6.2 PIRIE, N. W. (1964) Gluttony. *New Scient.* 838–841.

6.3 PIRIE, N. W. (1965) The alleviation of world protein shortage. In: *Urea feeding*. ed. M. H. Briggs. Oxford: Pergamon Press. (In the press.)

6.4 PIRIE, N. W. (1965) Biological organisation of viruses. In: *Principles of biomolecular organisation.* CIBA Foundation. 136–152.

6.5 PIRIE, N. W. (1965) Food from leaves. *Sci. Reporter* **2**, 188–9.

6.6 PIRIE, N. W. (1965) Listnyat belt'k. *Nauka Tckh., Mladeshta* (Bulgaria), 25–27.

6.7 PIRIE, N. W. (1965) The maldistribution of research effort. In: *The science of science*. ed. M. Goldsmith & A. Mackay. London: Souvenir Press, p. 157.

https://doi.org/10.23637/ERADOC-1-60 *pp 21*

6.8 PIRIE, N. W. (1965) The nature and origins of life. *Sci. Reporter* **2**, 484–487.

6.9 PIRIE, N. W. (1965) The scale of work on leaf protein. *Fertil. Feed. Stuffs J.* **62**, 812.

6.10 PIRIE, N. W. (1965) Techniques of tele-analysis. In: *COSPAR II (Space Research IV)*. Washington U.S.A.: Spartan Books Inc. (In the press.)

6.11 PIRIE, N. W. (1966) A rational approach to world feeding. *The Rationalist Annual*, 31–42.

RESEARCH PAPERS

6.12 BACON, M. F. (1965) A sample applicator for preparative layer chromatography. *Chemy Ind.*, 1692–1693.

The sample is applied as a uniform streak. The rate of application can be varied, and any length of plate can be accommodated.

6.13 CLARKE, A. J. & SHEPHERD, A. M. (1965) Zinc and other metallic ions as hatching agents for the beet cyst nematode, *Heterodera schachtii* Schm. *Nature, Lond.* **208**, 502.
(For summary see No. 8.7)

6.14 CLARKE, A. J. & SHEPHERD, A. M. (1966) The action of nabam, metham-sodium and other sulphur compounds on *Heterodera schachtii* cysts. *Ann. appl. Biol.* **57** (In the press.)
(For summary see No. 8.8)

6.15 CLARKE, A. J. & WIDDOWSON, E. (1966) The hatching factor of the potato-root eelworm. *Biochem. J.* (In the press.)

Purified hatching factor for the potato-root eelworm was obtained from potato-root diffusate. The yield was 18 μg/l potato-root diffusate; 20% of the activity of the original diffusate was recovered. The purified material was a colourless gum. On paper chromatograms it gave a single weakly fluorescing spot, which reacted with 2,4-dinitro-phenylhydrazine and aniline–xylose reagents. It was confirmed that the hatching factor is an acid, and inactivated at >pH 9. Other properties were ready oxidation by permanganate, and reaction with certain carbonyl reagents. It showed no light absorption maxima at wavelengths above 210 mμ; infra-red absorption bands are given.

6.16 FESTENSTEIN, G. N., LACEY, J. & SKINNER, F. A. (JENKINS, P. A. & PEPYS, J.) (1965) Self-heating of hay and grain in Dewar flasks and the development of farmer's lung antigens. *J. gen. Microbiol.* **41**, 389–407.

In moist hay allowed to self-heat aerobically in Dewar flasks the pattern of temperature change with time was affected considerably by the type of hay and duration of storage, but there was a relationship between water content and maximum temperature reached. Below 29% water content there was little heating or antigen production; in the critical range of 29–34% water content, different lots of hay self-heated to different temperatures between 33° and 55° C and varied widely in their content of farmer's lung hay antigen complex (FLH), the wetter hays usually producing the more antigen; all samples with 40% water heated to *c.* 65° C and produced FLH antigen, associated with the presence of *Thermo-polyspora polyspora*. Progressively less antigen, especially in the lower regions of the flasks, was produced as water content increased from 47 to 68%. Moist

https://doi.org/10.23637/ERADOC-1-60

barley and oat grain also self-heated and produced FLH antigen, usually only in the middle of the grain mass, where *T. polyspora* was most abundant; the drier upper layers and the lower regions where excess water accumulated were free from the antigen.

6.17 HILL, J. M. & MANN, P. J. G. (1966) The oxidation of Schiff's bases of pyridoxal and pyridoxal phosphate with amino acids by Mn^{2+}ions and peroxidase. *Biochem. J.* (In the press.)

Oxygen was taken up rapidly when pyridoxal or pyridoxal phosphate was added to mixtures of pea-seedling extracts and Mn^{2+}ions. It is suggested that the reactions were oxidations of the Schiff's bases formed between pyridoxal or pyridoxal phosphate and the amino acids present, mediated by a manganese oxidation–reduction cycle catalysed by peroxidase (donor: hydrogen peroxide oxidoreductase EC 1.11.1.7) or by light, and resulting in the oxidative decarboxylation and deamination of the amino acids. The pyridoxal and pyridoxal phosphate had little or no catalytic activity in the system, but were themselves changed, possibly oxidised.

6.18 HOLDEN, M. (1965) Chlorophyll bleaching by legume seeds. *J. Sci. Fd Agric.* **16**, 132.

Legume seeds and extracts made from them bleached chlorophyll in the presence of long-chain fatty acids. The most effective acids were substrates for lipoxidase, but oleic acid and even palmitic and stearic acid were also active. The bleaching was inhibited by commercial antioxidants.

Chlorophyll was bleached by extracts with lipoxidase activity, but not by purified lipoxidase preparations. Adding lipoxidase to seed extracts stimulated bleaching two- to three-fold with linoleic acid, but only slightly with oleic acid.

The optimum pH for bleaching was about 6, and for linoleate hydroperoxide formation was near 8. Evidence is given that at pH 6 hydroperoxide was being destroyed.

Chlorophyll seems to be bleached by co-oxidation during a chain reaction involving peroxidation of fatty acid and the breakdown of hydroperoxide by a heat-labile factor.

6.19 PIERPOINT, W. S. (1966) The enzymic oxidation of chlorogenic acid and some reactions of the quinone produced. *Biochem. J.* **98**, 567–580.

Extracts of tobacco leaves oxidise chlorogenic acid to brown products with an oxygen uptake of about 1·6 atoms/molecule oxidised. The first step in the oxidation is the formation of a quinone with an uptake of 1 atom of 0; this quinone is quantitatively trapped by benzene sulphinic acid to give a sulphone, which has been isolated. The quinone reacts with a range of N-containing compounds much as simpler quinones do. Reagents commonly used to inhibit the oxidation of polyphenols, including ascorbate, diethyldithiocarbamate, potassium ethyl xanthate and cysteine, both inhibit the leaf enzyme and combine with the quinone.

6.20 PIERPOINT, W. S. & (LATIES, G. G.) (1966) Effect of chloral hydrate and acetaldehyde on mitochondrial preparations from sweet potato. *Pl. Physiol.* **41**, 105.

The inhibitory effects of chloral hydrate and acetaldehyde were studied on oxidations performed by mitochondrial preparations of sweet potatoes. With many substrates, chloral acts very like amytal, but only $\frac{1}{5}-\frac{1}{10}$ as effectively; it affects those reactions expected to depend on the oxidation of intramitochondrial DPNH more than the oxidation of succinate or of added DPNH. It also acts like amytal when oxygen is replaced by other electron-accepting agents. It is

https://doi.org/10.23637/ERADOC-1-60

more effective, for example, against the malate reduction of cytochrome c than against the malate reduction of 2,6 dichlorophenol indophenol.

Inhibitions produced by acetaldehyde are more complex. Some DPN-dependent oxidations, especially those of pyruvate and α-oxoglutarate, are strongly inhibited, whereas that of citrate is not.

It is suggested that chloral affects the electron-transport sequence of sweet-potato mitochondria at a similar locus to amytal. Although the present work fails to provide unambiguous evidence that acetaldehyde acts in the same manner, experiments described in the literature have been interpreted in this way.

Plant Pathology Department

Theses

7.1 Okusanya, B. A. M. (1966) Studies on some African isolates of groundnut rosette virus. M.Sc. Thesis, University of London.

7.2 Serjeant, E. P. (1965) Some properties of cocksfoot mottle virus. Ph.D. Thesis, University of London.

General Papers

7.3 Bawden, F. C. (1965) Sir John Russell, O.B.E., F.R.S. *Nature, Lond.* **207**, 1031–1032.

7.4 Glynne, M. D. (1965) Crop sequence in relation to soil-borne pathogens. In: *Ecology of soil-borne plant pathogens—Prelude to biological control.* Ed. K. F. Baker & W. C. Snyder. London: John Murray, pp. 423–433.

7.5 Gregory, P. H. (1965) Problems of sampling for atmospheric microbes. In: *Proceedings of the atmospheric biology conference.* Ed. H. M. Tsuchiya & A. H. Brown. Minneapolis: University of Minnesota, pp. 165–169.

7.6 Hirst, J. M. (1965) The dispersal of soil microorganisms. In: *Ecology of soil-borne plant pathogens—Prelude to biological control.* Ed. K. F. Baker & W. C. Snyder. London: John Murray, pp. 69–81.

7.7 Hirst, J. M. & (Schein, R. D.) (1965) Terminology of infection processes. *Phytopathology* **55**, 1157.

7.8 Kassanis, B. (1965) Therapy of virus-infected plants. *Jl R. agric. Soc.* **126**, 105–114.

7.9 Salt, G. A. (1964) Pathology experiments on Sitka spruce seedlings. *Rep. Forest Res., Lond.* for 1963, 83–87.

Research Papers

7.10 Buxton, E. W., Khalifa, O. & Ward, V. (1965) Effect of soil amendment with chitin on pea wilt caused by *Fusarium oxysporum* f. *pisi*. *Ann. appl. Biol.* **55**, 83–88.

Chitin applied to soil naturally infested with *F. oxysporum* f. *pisi* greatly lessened the severity of wilt in Onward peas, sown at the time the chitin was applied to the field. In the glasshouse different pea varieties sown in the field soil 8 months after the chitin was applied were protected equally against infection by any of

https://doi.org/10.23637/ERADOC-1-60

the three races of the fungus. The severity of wilt decreased with increasing amounts of chitin added to the soil.

Applying chitin to artificially inoculated soil a month before pea seedlings were planted in pots also greatly diminished the severity of wilt.

Adding chitin to soil decreased the population of *Fusarium* and increased the number of actinomycetes. Many of the actinomycetes were antagonistic towards *Fusarium*.

7.11 (CROWLEY, N. C.), HARRISON, B. D. & (FRANCKI, R. I. B.) (1965) Partial purification of lettuce necrotic yellows virus. *Virology* **26**, 290–296.

Lettuce necrotic yellows virus was partially purified by clarifying leaf extracts with the fluorocarbon Freon-113, followed by differential centrifugation and rate zonal centrifugation in sucrose density gradients. Adding either chelating or reducing substances to the extraction medium of 0·1*M*-phosphate buffer (pH 7·4) did not increase infectivity; clarifying extracts with acid, butanol or chloroform greatly decreased or abolished it. Emulsifying extracts with Freon gave clearer, more infective, preparations than treating them with hydrated calcium phosphate gel. Infectivity decreased with increasing number of Freon treatments, more infectivity was lost when the Freon phase solidified than when it did not, and losses increased with increasing time or vigour of emulsification. Infective material sedimented in 10 minutes at 40,000 g or 40 minutes at 10,000 g. After density-gradient centrifugation of preparations from lettuce, infectivity was associated with one light-scattering band specific to preparations from diseased plants; with preparations of one virus isolate from *Nicotiana glutinosa*, infectivity was associated with two light-scattering bands. The final virus preparations scattered light strongly; those from lettuce were almost colourless, and those from *N. glutinosa* pale green. They infected *N. glutinosa* when diluted to 10^{-5} but not at 10^{-6}.

7.12 FESTENSTEIN, G. N., LACEY, J. & SKINNER, F. A. (JENKINS, P. A. & PEPYS, J.) (1965) Self-heating of hay and grain in Dewar flasks and the development of farmer's lung antigens. *J. gen. Microbiol.* **41**, 389–407.
(For summary see No. 6.16.)

7.13 GOODMAN, P. J., WATSON, M. A. & (HILL, A. R. C.) (1965) Sugar and fructosan accumulation in virus-infected plants: rapid testing by circular-paper chromatography. *Ann. appl. Biol.* **56**, 65–72.
(For summary see No. 5.5.)

7.14 HARRISON, B. D. & (CROWLEY, N. C.) (1965) Properties and structure of lettuce necrotic yellows virus. *Virology* **26**, 297–310.

Lettuce necrotic yellows virus (LNYV) loses infectivity less rapidly in partially purified preparations than in leaf sap. Infectivity is greatly decreased or abolished by treatment with chloroform, diethyl ether or water-saturated phenol. Isolates of LNYV from widely separated parts of Australia are antigenically similar. Partially purified preparations from lettuce contain one major component with a sedimentation coefficient of 943 $\pm$ 16 S, a buoyant density in sucrose solution of about 1·20 g/ml and bacilliform or bullet-shaped particles 66 mμ wide and most commonly about 227 mμ long. When treated with uranyl acetate or uranyl formate the particles appear to have an outer coat loosely enclosing a tubular inner body showing cross-banding at intervals of 4·5 mμ. In sucrose density-gradients infectivity is associated with the zone containing these particles. Two other types of particle are also seen only in preparations from LNYV-infected lettuce or *Nicotiana glutinosa* L., one probably the empty outer coat and the other

https://doi.org/10.23637/ERADOC-1-60

almost spherical, probably a distorted form of the bacilliform particle. Preparations of a virulent isolate of LNYV cultured in *N. glutinosa* contain, in addition to the 943 S component, a second, which sediments about 1·4 times faster but has the same buoyant density, is infective, and is antigenically similar to the 943 S component. Electron microscopy suggests that it consists of particles aggregated in pairs or threes.

7.15 HARRISON, B. D., NIXON, H. L. & WOODS, R. D. (1965) Lengths and structure of particles of barley stripe mosaic virus. *Virology* **26**, 284–289.

Preparations of barley stripe mosaic virus contain a major component with a sedimentation coefficient of 189 S and three minor components with sedimentation coefficients of 180, 199 and 250 S, respectively. Mounts in phosphotungstate show particles ranging in length from 20 to 280 mμ, but the commonest length is 128 mμ, and frequency distribution diagrams show two other peaks at 111 and 148 mμ. These three particle lengths probably correspond with the three components sedimenting at 180, 189 and 199 S, and the 250 S component may indicate aggregation of these particles in pairs. Particles shorter than 111 mμ were not infective; whether infectivity is restricted to particles with one of the three commonest lengths or is common to all could not be determined, because the three could not be separated from one another. When mounted in phosphotungstate a few particles show a loose helical structure.

7.16 HIRST, J. M., STEDMAN, O. J., LACEY, J. & HIDE, G. A. (1965) The epidemiology of *Phytophthora infestans*. IV. Spraying trials, 1959 to 1963, and the infection of tubers. *Ann. appl. Biol.* **55**, 373–395.

The methods needed to decrease losses from potato blight differ between the varieties Majestic and King Edward. Few Majestic tubers become infected, and control depends chiefly on prolonging the life of the haulm to ensure the maximum yield of tubers. With King Edward, infected tubers often cause more loss than premature defoliation. Tuber infection often occurs very early in the attacks, when profuse sporulation coincides with enough rain to penetrate through soil to the tubers.

Spraying with fungicide delayed initial tuber infection of King Edward, but did not necessarily decrease the proportion of tubers infected at harvest. The largest yield of sound tubers from fungicide-sprayed plots in the 1960 epidemic was obtained by killing the haulm when only 5% has been destroyed by blight. Allowing the foliage to survive beyond this did not increase the yield of sound tubers, even in years when blight attacks were late and slow. Protection with fungicide, and haulm destruction are complementary treatments, both of which require careful timing to obtain the best result with tuber-susceptible varieties.

7.17 KASSANIS, B. & KLECZKOWSKI, A. (1965) Mutual precipitation of two viruses. *Nature, Lond.* **205**, 310.

Tobacco mosaic virus (TMV) and bromegrass mosaic virus (BMV) are isoelectric at pH values of about 4 and 8 respectively. When equal amounts of TMV and BMV are mixed in salt-free solutions they precipitate each other quantitatively at pH values between their isoelectric points (pH 4·0–6·5). The precipitates dissolve in 0·4% NaCl.

7.18 KASSANIS, B. & MACFARLANE, I. (1965) Interaction of virus strain, fungus isolate, and host species in the transmission of tobacco necrosis virus. *Virology* **26**, 603–612.

Transmission of strains A and D of tobacco necrosis virus (TNV) by three different isolates of *Olpidium brassicae* (called 1, 3, 4) was tested on different

https://doi.org/10.23637/ERADOC-1-60 pp 26

host plants. The host plants were seedlings of lettuce, cress and Mung bean, and tissues of tobacco and *Parthenocissus tricuspidata* growing in agar and liquid medium, respectively. *Olpidium* 4 did not transmit either strain to any host, and *Olpidium* 3 transmitted both more readily than did *Olpidium* 1. Strain D was usually transmitted more readily than strain A, but *Olpidium* 1 transmitted A more readily than D to tobacco callus. Apparent differences in transmission of the two strains are not correlated with the host's ability to support virus multiplication when inoculated mechanically. Nor can specific transmission by *Olpidium* isolates be explained in terms of different susceptibilities of the hosts to individual olpidia. For example, *Olpidium* 4 multiplies profusely in cress, to which it does not transmit TNV, whereas *Olpidium* 3 transmits TNV to cress, in which it does not multiply or form zoosporangia. Although *Olpidium* 1 transmits strain A to tobacco tissues, it does not to lettuce and cress, even in conditions when it makes more penetrations than does *Olpidium* 3, which transmits the virus.

Virus infection in cress roots inoculated with *Olpidium* 3 and virus can be inhibited by inoculating the roots later with *Olpidium* 4. The inhibition can be destroyed by heating the doubly inoculated roots at 50° C for 10 seconds, which inactivates the fungus but not the virus. Other olpidia that do not transmit strain D to cress, but do so to other hosts, also inhibited transmission by *Olpidium* 3.

The results suggest that vector specificity may be determined, at least in part, by responses of the host cells, and that whereas some olpidia produce changes in the cells that favour virus infection, others produce changes that prevent it.

7.19 KHALIFA, O. (1965) Biological control of *Fusarium* wilt of peas by organic soil amendments. *Ann. appl. Biol.* **56**, 129–137.

Pure chitin added to soil significantly lessened the severity of pea wilt caused by *Fusarium oxysporum* f. *pisi* (Linf.) Snyder & Hansen. Pectin, glucose, cellulose and laminarin had less effect. In the glasshouse the wilt index was diminished by 12% when chitin was added to inoculated soil the same day pea seedlings were planted in the soil, and by 25 and 45% when it was added 3 and 8 weeks before transplanting. In the field, applying chitin to naturally infested soil when peas were sown decreased wilt index by 82 and by 75% when applied 4 weeks earlier.

Chitin did not affect the growth of healthy pea seedlings, suggesting that it affects wilt indirectly by changing the soil microflora. Both in the glasshouse and the field chitin greatly increased the numbers of actinomycetes, fungi and bacteria in the rhizosphere, whereas it decreased the population of *F. oxysporum* f. *pisi*. Similar microbial changes occurred in "wilt-sick" soil without plants, indicating that root exudates and debris intensified rather than determined these changes.

Micro-organisms isolated from the rhizosphere soil treated with chitin were more antagonistic towards *F. oxysporum* f. *pisi* race 1, and the sterile rhizosphere extracts were also more inhibitory to its spore germination *in vitro* than were those from the rhizosphere in soil without chitin. Chitin therefore seems to diminish wilt by stimulating micro-organisms that antagonise and/or lyse the pathogen.

7.20 KISIMOTO, R. & WATSON, M. A. (1965) Abnormal development of embryos induced by inbreeding in *Delphacodes pellucida* Fabricius and *Delphacodes dubia* Kirschbaum (Araeopidae, Homoptera), vectors of European wheat striate mosaic virus. *J. invert. Path.* **7**, 297–305.

The embryos of *Delphacodes pellucida* Fabricius show various types of abnormalities, and the proportion of abnormal eggs depend on the degree of relation-

https://doi.org/10.23637/ERADOC-1-60

ship between the parents. Abnormalities were rare in eggs of females mated to males of another family, but they increased with sibling matings. Many eggs from the first generation of inbreeding were abnormal and failed to hatch, and in the second generation some that hatched produced sterile females. Embryos became abnormal at various stages of growth.

D. pellucida is a vector of European wheat striate mosaic virus, and the eggs produced by several groups of infective and non-infective females of laboratory colonies were compared, but no consistent effects of virus on embryonic development were noted.

Delphacodes dubia Kirschbaum, a newly discovered vector of European wheat striate mosaic virus, showed abnormalities of embryonic development similar to *D. pellucida*. Inbreeding, whether or not the individuals were infective, caused abnormalities.

7.21 KLECZKOWSKI, A. (1965) A study of the effects of salt and of pH on precipitation of antigen–antibody compounds. *Immunology* **8**, 170–181.

Tobacco mosaic virus (TMV) combines with its homologous antibody to much the same extent, irrespective of whether or not salt is present, but without salt the complex not only fails to precipitate but the virus particles do not aggregate. TMV-antibody precipitate formed in the presence of salt, like that formed between human serum albumin (HSA) and its homologous antibody, dissolves when suspended in distilled water to form stable and transparent solutions, although the precipitate may not disaggregate completely.

To dissolve HSA–antibody complex in distilled water, the pH of the water must be raised to about 7·0. At pH near 6·0 HSA–antibody complex precipitates even in the absence of salt, but the precipitate dissolves immediately the pH is raised to 7·0.

All these facts are incompatible with the theory of precipitation based on the "lattice hypothesis" and argue strongly in favour of the theory that antigen–antibody complexes are hydrophobic and, as such, flocculate when sufficiently discharged either by salt or by suitably adjusting the pH of the medium.

7.22 KLECZKOWSKI, A. (1965) Reply to a note by R. B. Setlow and Jane K. Setlow concerning the proper use of short-wavelength reversal of ultraviolet light inactivation of nucleic acids. *Photochem. Photobiol.* **4**, 941.

7.23 LACEY, J. (1965) The infectivity of soils containing *Phytophthora infestans*. *Ann. appl. Biol.* **56**, 363–380.

Infectivity of soil was measured by incubating samples on potato tuber slices during and after outbreaks of potato blight in 3 years. Surface soil was always more infective than deeper soil, the most infective surface soil containing the equivalent of 2,100 sporangia of *P. infestans* per ml. Infectivity usually diminished rapidly with increasing depth, and only occasionally did infectivity below 2 in. exceed the equivalent of 100 sporangia/ml. Exceptionally large infectivity was once found at all depths sampled after heavy rain, but rain did not consistently affect infectivity. The surface soil remained infective for at least 32 days after the haulm was killed with acid, but the concentration of viable spores declined to a small value during the first week after treatment. In the laboratory infectivity persisted for 11 weeks after sporangia were mixed with unsterilised soil originally with a moisture content of 20%. *P. infestans* mycelium grew only in sterilised soils, perhaps because some soil micro-organisms inhibit its growth, and others parasitise it (e.g. *Trichoderma viride*) or lyse it (e.g. *Rhizoctonia solani*). The three soils tested all contained substances that inhibit the germination of sporangia.

https://doi.org/10.23637/ERADOC-1-60

7.24 LACEY, J. (1965) Interim report on the microflora of airborne dust from moist-stored barley grain. In: The use of concrete staved silos for storing high-moisture barley. *A.R.C. exp. Farm Buildings Rep. No.* 4, 21–24.

The spore contents of air in concrete-staved silos used for storing moist barley, and of the grain removed from them were estimated during the 1964–65 storage season using the Andersen sampler and Cascade impactor. A similar range of organisms, including several potentially pathogenic fungi and actinomycetes, was isolated from each of the six silos examined, but numbers of particular species varied between sampling occasions and between silos. These variations may be related to the initial moisture content of the grain, the method of capping the silo and the rate the grain is removed. The optimum moisture content for this method of storage seemed to be about 30%, but at least 3 in. grain should be removed daily to prevent self-heating and the rapid multiplication of potential pathogens. On present evidence, silage seems the best capping material during the storage period. Efficient dust respirators should be worn by workers entering the silos.

7.25 LAPWOOD, D. H. (1965) Laboratory assessments of the susceptibility of potato-tuber tissue to blight (*Phytophthora infestans*). *Eur. Potato J.* **8**, 215–229.

Fifty-five potato varieties were compared with Majestic for the resistance of their tuber tissues to infection by *Phytophthora infestans* (Mont.) de Bary in three kinds of test using: (1) halved tubers; (2) tubers slices; and (3) whole tubers.

Tissue resistance was better indicated by the extent surface mycelium developed after the fungus had grown through a slice of standard thickness (Test 2) than by the density of surface mycelium on the inoculated surface (Test 1) or by the area of necrotic tissue (Test 1 and 3).

Most varieties that suffer few tuber infections when grown as field crops were rated as resistant by these tests. Tissue resistance as assessed by these simple laboratory tests, which require only few replicates, could be used to select tuber-resistant varieties.

7.26 LAPWOOD, D. H. & DYSON, P. W. (1966) An effect of nitrogen on the formation of potato tubers and the incidence of common scab (*Streptomyces scabies*). *Pl. Path.* **15**, 9–14.

The incidence of common scab (*Streptomyces scabies*) on King Edward tubers from a fertiliser experiment in 1964 increased with increasing amount of nitrogen fertiliser. Nitrogen may have affected tuber susceptibility, but the increase more likely resulted from nitrogen delaying the time when tubers were initiated and developed. Plants given little or no nitrogen formed tubers during early June when the soil was wet (conditions unfavourable for infection), whereas plants given abundant nitrogen initiated their tubers during the dry weather of late June (conditions favourable for infection). Had the weather pattern been reversed, scab would probably have been more prevalent on tubers from plots without nitrogen than from plots with nitrogen.

7.27 SLOPE, D. B. & BARDNER, R. (1965) Cephalosporium stripe of wheat and root damage by insects. *Pl. Path.* **14**, 184–187.

Adding wireworms to soil inoculated with *Cephalosporium gramineum* increased the percentage of wheat plants that became infected with the fungus from 1 to 29. It is suggested that wireworms facilitate infection by injuring roots or other underground parts of the plants.

https://doi.org/10.23637/ERADOC-1-60

Nematology Department

Book

8.1 Goodey, J. B., Franklin, M. T. & Hooper, D. J. (1965) *T. Goodey's The nematode parasites of plants catalogued under their hosts*. 3rd ed., revised. Farnham Royal; Comm. agric. Bur., iv + 214 pp.

Theses

8.2 Lima, M. B. (1965) Studies on species of the genus *Xiphinema* and other nematodes. Ph.D. Thesis, University of London.

8.3 Whitehead, A. G. (1965) Taxonomy, distribution and host parasite relationships of the genus *Meloidogyne* Goeldi (Nematoda: Heteroderidae). Ph.D. Thesis, University of London.

8.4 Yuen, P. H. (1965) Studies on the nematode fauna of Broadbalk Wilderness. Ph.D. Thesis, University of London.

General Papers

8.5 Whitehead, A. G. (1965) Nematodes associated with "Docking disorders" of sugar beet. *Br. Sugar Beet Rev.* **34**, 77–78, 83–84, 92.

8.6 Whitehead, A. G., Greet, D. N. & Fraser, J. E. (1966) Plant-parasitic nematodes and their control in relation to stunting of sugar beet in England. *Proc. Br. Insect. & Fung. Conf.*, Brighton 1965.

Research Papers

8.7 Clarke, A. J. & Shepherd, A. M. (1965) Zinc and other metallic ions as hatching agents for the beet cyst nematode, *Heterodera schachtii* Schm. *Nature, Lond.* **208**, 502.

Zn^{2+} and Cd^{2+} were as active as sugar-beet root diffusate in stimulating *Heterodera schachtii* eggs to hatch *in vitro*. MoO_4^-, Pb^{2+}, Al^{3+}, Mn^{2+}, Co^{2+}, Fe^{2+}, Ba^{2+} and Ca^{2+} were also moderately or slightly active, whereas Na^+, K^+, Mg^{2+}, NH_4^+ and Hg^{2+} were inactive or inhibitory. Optimum concentrations were from 0·6 to 8 mM. Zinc chloride also hatched eggs of *H. carotae*, *H. cruciferae*, *H. glycines*, *H. rostochiensis*, *H. tabacum* and *H. trifolii*.

8.8 Clarke, A. J. & Shepherd, A. M. (1966) The action of nabam, metham-sodium and other sulphur compounds on *Heterodera schachtii* cysts. *Ann. appl. Biol.* **57**. (In the press.)

When used in tests against eggs of *Heterodera schachtii*, sodium ethylenebis-dithiocarbamate (nabam) solutions break down to give several compounds, some hatch-inhibiting, others hatch-stimulating. The compound mainly responsible for the hatch-stimulating activity of nabam solutions is ethylenethiuram monosulphide. Stored solutions of sodium ethylenebisdithiocarbamate lose activity because the ethylenethiuram monosulphide disappears.

Zinc and manganese ethylenebisdithiocarbamates were more active hatching agents than equi-molar mixtures of zinc or manganese sulphates with nabam. Hatch stimulation was least with a zinc sulphate/nabam mixture of mole ratio 1·5:1, in which the dithiocarbamate ion became largely replaced by the sparingly soluble zinc dithiocarbamate. Increasing the zinc concentration in the mixture increased hatching because of the hatching activity of the zinc ion.

https://doi.org/10.23637/ERADOC-1-60

Nabam solutions containing manganese sulphate were inactivated because the manganese ion catalysed decomposition to the hatch-inhibiting carbon disulphide.

Sodium *N*-methyldithiocarbamate (metham-sodium; "Vapam"), which readily decomposed in aqueous solution, was toxic to, and prevented the hatching of, *H. schachtii*. Methylisothiocyanate, the major decomposition product, was toxic to *H. schachtii* at concentrations greater than 0·1 mM.

8.9 (Coomans, A.) & Lima, M. B. (1965) Description of *Anatonchus amiciae* n.sp. (Nematoda: Mononchidae) with observations on its juvenile stages and anatomy. *Nematologica* **11**, 413–431.

Anatonchus amiciae n.sp., found in orchard soil at Brescia (Italy), is described and figured; it differs from all previous species of *Anatonchus* in that the posterior gonad of the female is degenerate. In the position of the teeth it comes nearest to *A. tridentatus* and *A. ginglymodontus*. The different position and attachment of the teeth in these two species probably reflect a different functional condition of the head and seem to have no diagnostic value.

Number, orientation and position of the teeth in the buccal cavity are the most important features separating the different juvenile stages. Only the third and fourth juvenile stages have three active teeth.

The cephalic region has two sets of specialised muscles, the labial and stomatal muscles. The musculature of the posterior region of the male is very complicated and consists of copulatory muscles, accessory copulatory muscles, gubernacular muscles, spicular muscles and caudal copulatory muscles. The male has rectal glands.

8.10 Green, C. D. & Webster, J. M. (1966) The effect of ultraviolet radiation on the stem and bulb nematode *Ditylenchus dipsaci* (Kühn). *Nematologica* **11**, 638–642.

Suspensions of fourth-stage larvae of *Ditylenchus dipsaci* were exposed to ultraviolet radiation, about 2,537 Å, at doses from 16 μW-min/cm² to 84,000 μW-min/cm². The nematodes did not reproduce after doses of 100 μW-min/cm², were immobilised after 10,000 μW-min/cm² and ruptured after 80,000 μW-min/cm².

8.11 Hooper, D. J. (1965) *Longidorus profundorum* n.sp. (Nematoda: Dorylaimidae). *Nematologica* **11**, 489–495.

Longidorus profundorum n.sp. is described and figured from England. It was found in soil around apple and quince root stocks and about the roots of rough grass and bushes. It has a truncate lip region, which is continuous with the body contour, and the female has a roundly conoid tail about an anal-body-width long. The amphids have evenly bilobed pouches. *L. profundorum* is closest to *L. goodeyi* Hooper, 1961, and *L. caespiticola* Hooper, 1961, but differs in the shape of the head and amphids. Males are common, and most of the tail supplements are in a single ventro-median row.

8.12 Hooper, D. J. (& Merny, G.) (1966) Two rice nematodes new to Africa. *Pl. Prot. Bull. F.A.O.* (In the press.)

Aphelenchoides besseyi and *Tylenchorhynchus martini* are reported in Africa for the first time. Both were found on rice from Sierra Leone; *A. besseyi* was also found in rice seed from Senegal.

https://doi.org/10.23637/ERADOC-1-60

8.13 JAIRAJPURI, M. S. & GOODEY, J. B. (1966) *Metadorylaimus pachylaimus* n.gen., n.sp. (Dorylaimoidea). *Nematologica* **12**. (In the press.)

This nematode, from Malawi, is characterised by its flatly conical lip region, conspicuous thick-walled spear and the presence of a "mucro" in the subventral wall of the anterior part of the oesophagus. In other respects it resembles *Eudorylaimus*. Only the female is known.

8.14 JONES, F. G. W. & PARROTT, D. M. (1965) The genetic relationships of pathotypes of *Heterodera rostochiensis* Woll. which reproduce on hybrid potatoes with genes for resistance. *Ann. appl. Biol.* **56**, 27–36.

The hypothesis is advanced that the major genes for resistance to *Heterodera rostochiensis* in potatoes bred from *Solanum tuberosum* ssp. *andigena* (*Ab*) from *S. multidissectum* (*aB*) and from both (*AB*) are matched by recessive genes in the nematodes able to overcome resistance. The hypothesis postulates the existence of a pathotype that multiplies only on *ab* plants (susceptible commercial potatoes) and of one that multiplies on plants with both genes (*AB*). Evidence for the first is of a negative kind, but there is positive evidence for the second. When the results of pot tests were combined with tests previously made, and the 40 populations were divided into four groups, the proportions of pathotypes in two groups fitted expectation. Proportions also fitted expectation for the other two groups and for the means of all 40 populations when an adjustment was made to allow for the excessive number of cysts formed on plants ex *andigena* (*Ab*). The three groups of populations with appreciable numbers of the pathotype able to reproduce on *AB* plants discriminated between *AB* plants with and without an additional factor for resistance derived from *S. multidissectum*. This indicates the existence of yet another pathotype. *AB* plants with the additional resistance were about equally as resistant as *S. vernei* to all forty populations.

Assuming that males of all genetic constitutions (*AA*, *Aa*, *aa*) can mature in the roots of resistant plants but only recessive females (*aa*) can mature, the proportion of *aa* progeny should rise to 50% at the end of the second generation. Pot experiments fit expectation, but, in field plots, persistence of the old population delays increase in the proportions of recessive individuals. The growing of plants with one dominant gene for resistance increases the proportions of the pathotype that can reproduce upon them and also the pathotype able to reproduce on plants with both genes.

The hypothesis parallels the gene-for-gene theory advanced to explain inheritance of the ability of certain rust fungi to overcome the resistance of their hosts, but, when applied to *Heterodera rostochiensis*, has to take into account the faculty of larvae to become either male or female according to circumstances.

8.15 POINAR, G. O., Jr. (1965) The bionomics and parasitic development of *Tripius sciarae* (Bovien) (Sphaerularidae, Aphelenchoidea), a nematode parasite of sciarid flies (Sciaridae, Diptera). *Parasitology* **55**, 559–569.

Tripius sciarae (Bovien) was found for the first time in England parasitising unidentified sciarid larvae. This nematode successfully parasitised *Bradysia paupera* Tuom., a common sciarid fly at Rothamsted and, using it as host, the biology and parasitic development of *T. sciarae* was studied. Greenhouse experiments suggest that *T. sciarae* is a possible agent for biological control of sciarid flies.

https://doi.org/10.23637/ERADOC-1-60

8.16 POINAR, G. O., Jr. (1965) The life history of *Pelodera strongyloides* (Schneider) in the orbits of murid rodents in Great Britain. *Proc. helminth. Soc. Wash.* **32**, 148–151.

Pelodera strongyloides (Schneider) has an infective, ensheathed larva which can develop in the lachrymal fluid of murid rodents. After 2–3 weeks the larvae leave the orbit and moult to the adult stage in the soil. While in the lachrymal fluid the larvae develop enlarged phasmids possibly associated with the excretion of salt, thus regulating their osmotic balance.

8.17 WEBSTER, J. M. (1965) Controlled mating to produce hybrids between pathotypes of *Heterodera rostochiensis* Woll. *Nematologica* **11**, 299–300.

8.18 WEBSTER, J. M. & LOWE, D. (1966) The effect of the synthetic plant growth substance, 2,4-dichlorophenoxyacetic acid, on the host–parasite relationships of some plant parasitic nematodes in monoxenic callus culture. *Parisitology* **56**, 313–322.

Some callus tissue induced by 2,4-D and derived from plants resistant to plant parasitic nematodes lost their resistance to the nematodes. Red-clover callus supported a large population of *Aphelenchoides ritzemabosi*, whereas red-clover seedlings did not. Six races of *Ditylenchus dipsaci* were cultured on lucerne and red-clover callus tissues and reproduced rapidly, although races usually multiplied more on callus from susceptible than from resistant plants. *A. ritzemabosi*, normally only a foliage parasite, reproduced equally well in stem and root callus. *Heterodera rostochiensis* did not reproduce in callus culture.

Nematodes multiplied most in callus that grew fastest; both nematode reproduction and callus growth were greatest with 0·125 mg/l of 2,4-D. Reproduction was inhibited by 5·0 mg/100 ml of 2,4-D. 2,4-D influenced nematode reproduction indirectly by making callus, which provides a better environment for nematode feeding and reproduction.

Nematode extracts added to an agar medium caused callus formation on red-clover seedlings, and nematodes feeding on these tissues reproduced faster than on normal seedlings. Hence, the substances secreted by a nematode into a plant act on the tissues in a manner similar to 2,4-D. The host–parasite relationship is probably partially controlled by the host's plant growth substances and the effect on them of the nematode's secretions.

8.19 YUEN, P. H. (1966) Further observations on *Helicotylenchus vulgaris* Yuen. *Nematologica* **11**, 623–637.

The oval-shaped nuclei surrounding the oesophagus and glands and in the ventral hypodermal chord of *H. vulgaris* seem to be nuclei of the hypodermal cells and not nerve nuclei. The oesophageal glands do not envelop the intestine, except perhaps at the oesophago-intestinal junction.

Three larval stages of *H. vulgaris* were found and are best characterised by the structures of the genital primordium, which consists of 4 cells in L_2, 12 in L_3 and 84 in L_4. The structure of the genital primordium remained unchanged between moults, and the length of the genital primordium did not overlap between stages. Specimens ensheathed in moulted cuticles possess the genital primordium of the next stage.

https://doi.org/10.23637/ERADOC-1-60

Insecticides and Fungicides Department

General Papers

9.1 Graham-Bryce, I. J. & Lord, K. A. (1964) Control of pests—insecticides. *Rep. Prog. appl. Chem.* **XLIX**, 364–376.

9.2 Needham, P. H. (1965) Studies on bee poisoning in Great Britain. *Proc. XII Int. Congr. Ent., London*, 1964, 571–572.

9.3 Potter C. (1965) Research on insecticides and their safety in use. *Sci. Progr.* **53**, 393–411.

9.4 Potter, C., Strickland, A. H. & Bardner, R. (1965) The use of pesticides and fungicides for plant protection in British Agriculture. *Chemicals and the Land in relation to the welfare of man. Proceedings of a Symposium held at the Yorkshire (WR) Institute of Agriculture, April 1965*, pp. 31–43.

Research Papers

9.5 Arnold, A. J. (1965) A high speed automatic micrometer syringe. *J. scient. Instrum.* **42**, 350–351.

A simple, fully automatic, low-voltage micrometer syringe is described. It has a delivery rate of 80 doses per minute from an "Agla" all-glass syringe. Doses of 0·1 to 1·0 μl, in 10 equal steps, can be selected rapidly, and an integral syringe holder and motorised unit allow the instrument to be used in any position. Low voltage and small power consumption enable it to be operated from mains or battery, in a wide range of conditions, giving both safety and versatility.

9.6 Arnold, A. J. (1965) An electro-pneumatic microelectrode puller. *J. scient. Instrum.* **42**, 723–724.

An instrument for making glass micro-electrodes is described. The glass is drawn in two stages, the first pull by gravity, the second by an air cylinder. Use of an air cylinder allows the instrument to be more compact and simple than the previous ones, while equally versatile.

9.7 El Basheir, S. & Lord, K. A. (1965) DDT tolerance in diazinon-selected and DDT-selected strains of houseflies. *Chemy Ind.* 1598–1599.

The causes of resistance to DDT of two strains of houseflies differed. One strain was selected for resistance to diazinon (SKA) and the other for resistance to DDT (F58W).

First, DDT penetrated through the cuticle of the SKA strain more slowly than with either the F58W or the susceptible strain. Secondly, as the dose was increased, the proportion of DDT penetrating in a given time decreased more in both the F58W and the susceptible flies than in the SKA strain. Thirdly, the DDT absorbed by the flies was rapidly metabolised in the two resistant strains, but in the susceptible flies much DDT remained unchanged.

The only metabolite detected was DDE; it was abundant in F58W flies, but only traces were found in the SKA flies, thus suggesting a difference in the degradation mechanism(s) between the two strains.

https://doi.org/10.23637/ERADOC-1-60

9.8 BURT, P. E., BARDNER, R. & ETHERIDGE, P. (1965) The influence of volatility and water solubility of systemic insecticides on their movement through soil and absorption by plant roots. *Ann. appl. Biol.* **56**, 411–418.

When applied in the soil at the time potato tubers were planted, phorate and disulfoton were more effective than dimethoate and menazon in controlling aphids on the foliage of the crop in dry years, but all four were equally effective in wet years. The reason was sought by comparing the ability of the roots of wheat seedlings to absorb these systemic insecticides from air and from water. When absorbed from solution in water, all four insecticides were almost equally effective in killing *Rhopalosiphum padi* fed on the leaves, but when the roots were in contact only with the vapours of the insecticides phorate and disulfoton were much more effective than dimethoate or menazon. This is thought to be the first demonstration that sufficient of the vapours of systemic insecticides can be absorbed by the roots of a plant to render the leaves toxic to insects feeding on them.

These results, and the physical properties of the insecticides, suggest that only insecticides as volatile as phorate and disulfoton can move through dry soil to the roots of plants, and that even in moist soil phorate and disulfoton probably move mainly through the air rather than through the soil water. The more soluble and less volatile dimethoate and menazon are probably absorbed in amounts able to make the foliage toxic to aphids only when they can move to the roots through water.

9.9 ELLIOTT, M. (1965) The pyrethrins and related compounds. VI. The structures of the "Enols" of pyrethrolone. *J. chem. Soc.* 3097–3101.

2-Alkenyl-3-methylcyclopent-2-en-4-olones such as cinerolone and allethrolone, which have no conjugated double bonds in the side chain, are converted by sodium methoxide in methanol into enolic forms of the corresponding cyclopentane-1,4-diones. Their side chains are unaltered. Under the same conditions, pyrethrolone, with a conjugated *cis*-pentadienyl side chain, gives mainly a cyclopentene-1,4-dione with oxidation of the hydroxyl group and reduction of one of the side-chain double bonds.

9.10 (CORRAL, C.) & ELLIOTT, M. (1965) The pyrethrins and related compounds. VII. New pyrethrin-like compounds with ester and ketonic groups in the alcoholic side chain. *J. Sci. Fd Agric.* **16**, 514–518.

Pyrethrin-like esters of a new type were obtained by reaction of the 4-bromo derivatives of esters (Et, Pr, Ph) of 3-methylcyclopent-2-enone-2-acetic acid with silver chrysanthemates. The structure of the intermediate bromo compounds, and hence of the esters, was deduced from the ease with which hydrogen bromide was eliminated by tertiary amines to give cyclopentadienones. 2-Acetonyl-3-methylcyclopent-2-enone was prepared, and by similar reactions gave a chrysanthemyl derivative.

9.11 ELLIOTT, M., JANES, N. F., JEFFS, K. A., NEEDHAM, P. H. & SAWICKI, R. M. (1965) New pyrethrin-like esters with high insecticidal activity. *Nature, Lond.* **207**, 938–940.

New esters of chrysanthemic acid were prepared with highly specific insecticidal action. Two of the new compounds were more toxic to some insect species than the natural pyrethrins or allethrin, and were more stable than the natural pyrethrins.

To adult female *Musca domestica* L. (houseflies), 4-allylbenzyl (±)-*trans*-chrysanthemate was approximately four times, and the (±)-*cis-trans*-chrysan-

https://doi.org/10.23637/ERADOC-1-60

themate twice, as toxic as the mixture of esters of the natural pyrethrins. By this method the mixed pyrethrins, allethrin and pure pyrethrin I were equitoxic and 4-allyl-benzyl (±)-*cis-trans*-chrysanthemate (ABC) was seven times more toxic than dimethrin. But to adult *Phaedon cochleariae* Fab. (mustard beetles) allethrin was twice as toxic as dimethrin and six times more toxic than ABC. Methyl groups on the benzene ring of ABC increased toxicity to mustard beetles considerably. Thus, 4-allyl-2,6-dimethylbenzyl (±)-*cis-trans*-chrysanthemate (DMABC) was twice as toxic as allethrin and half as toxic as the natural pyrethrins mixture to mustard beetles and just significantly more toxic than ABC to houseflies. 4-Allyl-2,6-dimethylbenzyl and 4-allylbenzyl (±)-*trans*-chrysanthemates were more toxic to houseflies than was any other pyrethrin-like ester, natural or synthetic; also with other insect species (for example, *Tribolium castaneum* (Herbst.), *Periplaneta americana* (L.), *Aphis fabae*, Scop., and the red spider mite *Tetranychus telarius* (L.), the 2,6-dimethyl compound (DMABC) was as toxic or more so than allethrin.

2,4,6-Trimethylbenzyl (±)-*cis–trans*-chrysanthemate was approximately one-third as toxic as DMABC to houseflies and about twice as toxic as dimethrin to houseflies and mustard beetles.

Those benzyl alcohols with structures most closely related to pyrethrolone, cinerolone, etc., gave the most toxic chrysanthemates.

9.12 FARNHAM, A. W., LORD, K. A. & SAWICKI, R. M. (1965) Study of some of the mechanisms connected with resistance to diazinon and diazoxon in a diazinon-resistant strain of houseflies. *J. Insect Physiol.* **11**, 1475–1488.

The toxicities of diazinon and diazoxon to two strains of housefly (normal and resistant) were measured by injection and topical application. Both compounds were more toxic by injection. The difference in susceptibility by the two ways of poisoning was greater with the resistant than the susceptible flies, because insecticide penetrates less readily into the resistant flies, as indicated by measurement of loss from the surface using radioactive diazinon.

Resistance of both strains increased with age; C^{14} diazinon penetrated the cuticle of younger flies faster than of older flies. Even when injected, more diazinon or diazoxon was needed to kill resistant than susceptible flies, indicating that slow penetration was not the only reason for resistance. C^{14} diazinon was decomposed more efficiently by resistant than by susceptible flies.

9.13 GRAHAM-BRYCE, I. J. (1965) Diffusion of cations in soils. In: *Plant nutrient supply and movement* (*Technical Report 48, International Atomic Energy Agency, Vienna*), pp. 42–56.

The rate at which a nutrient diffuses through soil may limit its availability to plants. In this paper some previously published self-diffusion coefficients (D) for cations in soil are reconsidered, together with some unpublished data. The self-diffusion coefficients were measured by determining the quantities of radiotracers diffusing from labelled to initially unlabelled soil sections through suitably prepared ion-exchange membrane barriers. Diffusion coefficients in soil were approximately 10^{-2} of the values in aqueous solution; this is attributed to geometrical and electrical factors. In homoionic soils monovalent ions diffuse faster than divalent ions, and in soils containing both monovalent and divalent ions diffusion coefficients for monovalent ions are reduced. Effects of soil solution concentration, compaction and temperature on D_{Rb} suggest that cations diffuse in the exchange phase, although more slowly than in free pore solution, and that diffusion in the exchange phase is affected by the extent to which the electrical fields from the fixed charges overlap. Moisture content has a large

https://doi.org/10.23637/ERADOC-1-60

effect on D_{Rb}, and would probably be the most important factor affecting diffusion in the field. It is suggested that there are several phases in the relationship between diffusion coefficient and moisture content, corresponding to diffusion in different pore systems. The effect of soil type was investigated by measuring D_{Rb} in eight widely different soils under standard conditions. No simple relationship with any of the soil properties measured was found. Estimation of the quantities of K and Mg supplied to a cylindrical root under idealised conditions are calculated by means of a flux equation. On the basis of the dynamic picture of nutrient supply, methods of assessing nutrient availability are discussed.

9.14 McINTOSH, A. H. & EVELING, D. W. (1965) Bioassay and other laboratory methods for testing formulations of potato blight fungicides. *Ann. appl. Biol.* **55**, 397–407.

Three laboratory methods are described for comparing formulations of potato-blight fungicides; all use the upper surfaces of leaflets detached from glasshouse-grown King Edward plants, and artificial rain in some form.

Rain-fastness (tenacity) was quickly estimated by measuring advancing acute *contact angles* of distilled water (representing rain) on dry spray deposits. *Tenacity* itself was measured by "rain-washing" deposits with 0·65 in. of tap water in 30 minutes (light "rain") or up to 2·5 in. in 40 minutes (heavy "rain"). Contact angles and tenacities of copper oxychloride deposits were usually positively correlated. In *bioassay* tests deposits were washed with 2·5 in. of heavy "rain", inoculated with sporangia of *Phytophthora infestans* (Mont.) de Bary, and later classed as infected or not infected; results were analysed by the probit method. With copper oxychloride and triphenyl tin (fentin) acetate, differences in effectiveness of 2·5 times or more were usually significant when 50–60 leaflets were used per formulation.

9.15 McINTOSH, A. H. & EVELING, D. W. (1965) Tests of aphicides for possible systemic control of potato blight. *Eur. Potato J.* **8**, 98–103.

The sytemic aphicide disulfoton, applied as "Disyston" granules to the soil, can decrease the amount of potato blight in the field. However, neither disulfoton nor two other systemic aphicides, menazon and dimethoate, were systemically fungicidal, in glasshouse-grown King Edward plants, to zoospores of *P. infestans*. Disulfoton probably affects blight in the field indirectly, untreated plants becoming more susceptible when attacked by aphids, rather than treated plants becoming more resistant.

Entomology Department

BOOKS

10.1 JACKSON, R. M. & RAW, F. (1966) *Life in the soil.* London: Edward Arnold. 64 pp.

10.2 JOHNSON, C. G. & (SMITH, L. P.) Edit. (1965) *The biological significance of climatic changes in Britain.* (Institute of Biology Symposia No. 14.) London: Academic Press, x, 222 pp.

THESES

10.3 BUAHIN, G. K. A. (1965) The problems of soil recolonisation by micro-arthropods. Ph.D. Thesis, University of London.

10.4 EL HARIRI, G. (1965) The accumulation and use of reserve substances in Coccinellidae. Ph.D. Thesis, University of London.

https://doi.org/10.23637/ERADOC-1-60

10.5 NEWELL, P. F. (1965) The behaviour and distribution of slugs. Ph.D. Thesis, University of London.

GENERAL PAPERS

10.6 EDWARDS, C. A. (1965) Changes in soil faunal populations caused by aldrin and DDT. *Proc. 8th int. Congr. Soil Sci. Bucharest.* (In the press.)

10.7 EDWARDS, C. A. (1965) Insecticide residues in soils. *Residue Reviews.* (In the press.)

10.8 JOHNSON, C. G. (1965) A focal point for insect ecology in agriculture. *PANS* A.11, 359–365.

10.9 JOHNSON, C. G. (1966) A functional system of adaptive dispersal by flight. *A. Rev. Ent.*, **11**, 233–260.

10.10 JUDENKO, E. (1965) The assessment of economic effectiveness of pest control in field experiments (with supplementary notes). *PANS* A.11, 359–368.

10.11 NEWELL, P. F. (1966). Mollusca. A chapter in: *Soil Biology*; edit. BURGESS, A. N. & RAW, F. London: Academic Press. (In the press.)

10.12 POTTER, C., (STRICKLAND, A. H.) & BARDNER, R. (1965) The use of pesticides and fungicides for plant protection in British Agriculture. *Chemicals and the Land in relation to the welfare of man. Proceedings of a Symposium held at the Yorkshire (WR) Institute of Agriculture, April 1965*, pp. 31–43.

10.13 TAYLOR, L. R. (1965) Flight behaviour and aphid migration. *Proc. N. Cent. Brch Ent. Soc. Amer.*, **20**, 9–19.

RESEARCH PAPERS

10.14 BURT, P. E., BARDNER, R. & ETHERIDGE, P. (1966) The influence of the volatility and water-solubility of systemic insecticides on their movement through soil and absorption by plant roots. *Ann. appl. Biol.* **56**, 411–418. (For summary see No. 9.8.)

10.15 EDWARDS, C. A. & JEFFS, K. A. (1965) The persistence of some insecticides in soil and their effects on soil animals. *Proc. XII int. Congr. Ent., London*, 1964, pp. 259–60.

Small replicated plots were treated with DDT at 6, 15 and 60 lb a.i. or aldrin at 4 lb a.i./acre and kept fallow. Insecticides were extracted with acetone and hexane, and aliquots were analysed by gas–liquid chromatography on a column composed of 2·5% silicone elastomer E 301 and 0·25% epikote 1001 on celite (3), with detection by electron capture. After 39 months most aldrin had disappeared; 40% remained, but was nearly all dieldrin. About half the aldrin applied had disappeared after 4 months. After 39 months 77% of the DDT remained in plots treated with 60 lb a.i. and 73% in those with 6 lb a.i./acre.

Aldrin did not affect predatory mites, nematodes, earthworms or enchytraeid worms. DDT killed predatory mites, but not Collembola, which increased. Generally DDT was less toxic to soil animals than aldrin, but killed dipterous larvae.

https://doi.org/10.23637/ERADOC-1-60

10.16 EL HARIRI, G. (1966) Changes in metabolic reserves of three species of aphidophagous Coccinellidae (Coleoptera) during metamorphosis. *Entomologia exp. appl.* (In the press.)

Newly moulted fourth-instar larvae of *C. 7-punctata*, *A. 2-punctata* and *P. 14-punctata* contained only small amounts of reserve fat and glycogen but much water. The larvae fed voraciously and accumulated reserves of fat and glycogen faster than water. During the pupal stage these reserves were rapidly consumed, so that the young adult contained relatively more water than the pupa. During metamorphosis 53–75% of the fat and 71–87% of the glycogen was consumed, but only small quantities of water were lost. Newly emerged adult *C. 7-punctata* and *A. 2-punctata* reared as larvae on *A. pisum* were not only heavier but also contained more actual water, fat and glycogen than those reared on *A. fabae*. In contrast, adult *P. 14-punctata* reared on *A. pisum* were lighter and contained less water than those fed on *A. fabae*, but their fat and glycogen contents were nearly the same when fed on either aphid species. Newly emerged adult *A. 2-punctata* that had fed as larvae on *M. evansii* on nettles in the field were heavier and contained more reserves than those that had fed on *A. fabae* on bean plants in the field. Adult *A. 2-punctata* that had fed as larvae on *A. fabae* in the field were also heavier and contained more reserves than those reared from larvae fed on laboratory-reared *A. fabae*.

10.17 EL HARIRI, G. (1966) Laboratory studies on the reproduction of *Adalia bipunctata* (L.) (Coleoptera, Coccinellidae). *Entomologia exp. appl.* (In the press.)

The pre-oviposition period, but not the longevity, of adult *A. bipunctata* was significantly shorter when reared to the adult stage on *Microlophium evansii*, and then fed on *Acyrthosiphon pisum*, than when fed in the adult stage on *Aphis fabae*. When adult beetles, reared as larvae on *M. evansii*, were fed on *A. pisum* they laid twice as many eggs as similarly reared adults fed on *A. fabae*. The species of aphid fed to the insects during their adult life (but not their larval life) affected fecundity, and *A. pisum* is perhaps a more nutritious food than *A. fabae* for *A. bipunctata*. Virgin females laid infertile eggs, but only half as many as the total fertile eggs laid by mated females.

10.18 EL HARIRI, G. (1966) Studies of the physiology of hibernating Coccinellidae (Coleoptera). I. Changes in the metabolic reserves. *Proc. R. ent. Soc. Lond.* (In the press.)

Adult *Coccinella 7-punctata*, *Adalia 2-punctata* and *Propylea 14-punctata* in southern England entered hibernation during August and September containing 54% water; fat and glycogen were respectively 43% and 0·8% of the dry weight. Testes were mature, but ovaries immature; the fat bodies were large, but the guts were empty. Mortality of all species (greatest in *A. 2-punctata*) was greatest at the start of hibernation; it decreased during the winter and increased again in the spring. During the hibernation period of about 8 months all insects lost water, but *A. 2-punctata* lost a smaller proportion of water and consumed more fat and glycogen than the other species and had a greater metabolic rate. During hibernation 67% of the initial fat and 80% of the glycogen was consumed. Most reserves were used during the autumn when the weather was warm, least during winter and more again in the spring. After emergence from hibernation and after feeding on aphids the fat contents decreased during egg-laying. In late summer *P. 14-punctata* stopped mating and laying eggs, resorbed their ovaries, re-accumulated fat and glycogen and hibernated again; *A. 2-punctata* died when egg-laying finished.

https://doi.org/10.23637/ERADOC-1-60

10.19 El Hariri, G. (1966) Studies of the physiology of hibernating Coccinellidae (Coleoptera). II. Changes in the gonads. *Proc. R. ent. Soc. Lond.* (In the press.)

The coccinellid adults hibernated with immature ovaries, mature testes, large fat bodies and empty guts. The ovaries remained dormant during hibernation. At the end of hibernation and before feeding (late April) oogenesis began in *A. 2-punctata*, but the insects had to feed before the ovaries matured. In *C. 7-punctata* and *P. 14-punctata* oogenesis occurred after emergence from hibernation and after feeding. Mating was observed only after emergence from hibernation and after feeding on warm days. Four stages of development of ovarioles were recognised. Resorption of ovaries was recorded for *P. 14-punctata*.

10.20 French, R. A. (1966) Migration Records 1964. *Entomologist* **99**. (In the press.)

10.21 Heath, G. W., Arnold, M. K. & Edwards, C. A. (1966) Studies in leaf breakdown. I. Breakdown of leaves of different species. *Pedobiologia*. (In the press.)

Disks were cut from leaves of 11 different plant species, chosen to range from soft and attractive to tough and unattractive to soil animals as food. For each species four replicates of 50 disks, 2·5 cm in diameter, were placed in nylon bags 10 × 7 cm (mesh sizes 0·003, 0·5 and 7·0 mm) and buried 2·5 cm deep in woodland or fallow soil. In one experiment leaf disks of all 11 species were used, and disks of only five of the original species in a second to compare their rates of breakdown in the same two sites. Kale, beet, lettuce and bean disks disappeared within 2 months, probably because microbes can decompose their soft tissues rapidly. Oak only completely disappeared in 14 months, when 10% of the beech disks still remained. Elm, ash, birch, lime and maize disks disappeared at intermediate rates, slightly accelerated by allowing earthworms to feed on them.

10.22 Jones, M. G. (1965) The effects of some insecticides on populations of frit fly (*Oscinella frit*) and its enemies. *J. appl. Ecol.* **2**, 391–401.

Nearly twice as many eggs were laid by frit flies on oat plants in plots (1 sq. yd) protected from ground predators by DDT-treated barriers as on plants in untreated plots, and more than twice as many on protected plots that were also sprayed twice in May with parathion. More adult flies were caught in emergence cages from tillers in protected plots during July than from unprotected ones. Protected plots also produced the greatest number of flying-insects.

Only about half as many frit flies emerged from the panicles of plants from sprayed plots as from unsprayed ones.

Frit flies emerging from grass stems in May were preyed upon by empidids and by spiders, which were also abundant when the tiller and panicle generations emerged. An anthocorid bug was present among the glumes.

Late-sown oats sprayed twice with parathion yielded one-third more grain than untreated plants.

10.23 (Knutson, L. V.,) Stephenson, J. W. & (Berg, C. O.) (1965) Biology of a slug-killing fly, *Tetanocera elata* (Diptera: Sciomyzidae). *Proc. malac. Soc. Lond.* **36**, 213–220.

Tetanocera elata (Fab.) is widely distributed in Northern and Central Europe. Females mated readily in the laboratory, and the first instar larvae attacked *Agriolimax reticulatus* (Müll) and *A. laevis* (Müll), finding their way into the mantle cavity. The late second instar larvae became predatory, attacking and killing six different species of slug. The pupal period was passed in the soil.

https://doi.org/10.23637/ERADOC-1-60

10.24 LEWIS, T. (1965) The effects of an artificial windbreak on the aerial distribution of flying insects. *Ann. appl. Biol.* **55**, 503–512.

Suction traps were used to measure the aerial density of insects near a low, slatted wooden fence on an otherwise exposed plot. When winds blew approximately at right angles to the fence insects gathered in the air near to it, especially to leeward, where they were from 2 to 27 times as concentrated as elsewhere. The increases in concentration extended farther to leeward for day-flying insects than for night-flyers. These accumulations were caused mainly by wind, and turbulence in the incident air stream had a greater influence than wind velocity. The relative density profiles for winged insects, spiders and inert particles measured near the fence had much the same pattern, except that, close to the fence, the insects and spiders were more concentrated than the particles; strong day-flying insects gathered to leeward in greater numbers than weak day-flyers or night-flyers.

10.25 LEWIS, T. (1965) The effect of an artificial windbreak on the distribution of aphids in a lettuce crop. *Ann. appl. Biol.* **66**, 513–518.

On an exposed plot the distribution of lettuce damaged by lettuce-root aphid (*Pemphigus bursarius* L.) in summer was correlated quantitatively with the distribution of shelter, produced by an artificial windbreak, when the aphids were migrating in spring.

10.26 NEWELL, P. F. (1966) The analysis of the nocturnal behaviour of slugs on the surface of soil. *Med. biol. Illust.* **16.** (In the press.)

The tracks of *Agriolimax reticulatus* were recorded with a time-lapse ciné camera and showed that many animals emerge and then return to the same part of the arena (homing) and those that do not home spend a long period of time crawling on the soil surface after daybreak. It is concluded that most slugs emerge from the soil, crawl on the surface, feed, copulate (if they find a co-copulant), crawl, feed again and finally before daybreak return to the hole from which they emerged.

10.27 NEWELL, P. F. (1966) Recent methods of marking invertebrate animals for behaviour studies. *Anim. Behav.* **13**, 579.

Group marking methods have been considerably influenced by the recent development of new fluorescent paints and the widespread use of radio-isotopes. Some of these were tried on slugs, which were marked with P^{32} by feeding them on radioactive lettuce plants and with Ta^{182} pellets injected into the haemocoel.

10.28 NEWELL, P. F. (1966) Time-lapse ciné recording the soil surface activity of slugs. *Anim. Behav.* **13**, 583.

The nocturnal activity of slugs was recorded using a time-lapse switching mechanism on a ciné camera which exposed one frame every 15 seconds. The experimental arena was illuminated by a synchronised high-speed flash with a duration of $\frac{1}{3000}$ second. Half the slugs showed a "homing" reaction, that is they emerged and returned to the same part of the arena.

10.29 RAW, F. (1965) Current work on side-effects of soil applied organophosphorus insecticides. *Ann. appl. Biol.* **55**, 342–343.

Menazon applied to soil in amounts used to control aphids in field crops did not significantly affect soil fauna: larger amounts might have small, transient effects on Collembola in sandy soils. In a field test with five organophosphorus compounds applied as alternatives to chlorinated hydrocarbons for controlling wireworms in spring wheat, preliminary results show some effect of aldrin,

https://doi.org/10.23637/ERADOC-1-60

dieldrin and Bayer 38156 on wireworms, but little effect of any compound on other arthropods.

10.30 RYGG, T. D. (1966) Flight of *Oscinella frit* L. (Dipt., Chlorop.) females in relation to age and ovary development. *Entomologia exp. appl.* **9**, 74–84.

Frit-fly females were flown on pins at a temperature of 25–28° C in a headwind of 5 mph (2·2 m/sec). Females flown once only, flew for the longest periods when they were about 4 days old. Individuals that flew every second day failed to fly after they were 2–3 weeks old. Tethered flight in early adult life shortened the preoviposition period. Egg production and lifetime were not affected by a single flight.

Females caught in suction traps in the field were dissected and classified according to ovary development. Very young females occurred in equal numbers at all heights, but those with fully developed eggs were abundant at higher altitudes.

10.31 SLOPE, D. B. & BARDNER, R. (1965) Cephalosporium stripe of wheat and root damage by insects. *Pl. Path.* **14**, 184–187.
(For summary see No. 7.27.)

10.32 STEPHENSON, J. W. (1965) The effect of irrigation on damage to potato tubers by slugs. *Eur. Potato. J.* **8**, 145–149.

The potato varieties Redskin and Majestic both suffered most damage from slugs when irrigated after tuber formation. Redskin were more severely damaged than Majestic. Though irrigation increased yields of undamaged tubers of both varieties and Majestic derived the greater benefit, slug damage also increased.

10.33 YOUDEOWEI, A. (1965) Laboratory studies on the aggregation of feeding *Dysdercus intermedius* Dist. (Heteroptera: Pyrrhocoridae). *Proc. R. ent. Soc. Lond.* (A) **41** (In the press.)

Dysdercus intermedius Dist. aggregated while feeding on cotton seeds. Laboratory studies showed that at least two responses are involved. Seeds that had been pierced were detected by olfactory sense organs on the distal antennal segment: and the insects often aggregate on one seed out of several after it has been pierced. When several pierced seeds were offered to blind insects, however, the olfactory stimulus does not lead to aggregations, but insects not blinded aggregate. Therefore sight is the prime cause of aggregation unless only one pierced seed is offered, when olfaction also contributes.

Bee Department

GENERAL PAPER

11.1 FREE, J. B. (1965) The allocation of duties among worker honeybees. *Symp. zool. Soc. Lond.* No. 14, 39–59.

RESEARCH PAPERS

11.2 BAILEY, L. (1965) The effect of erythromycin on *Streptococcus pluton* (White). *J. apicult. Res.* **4**, 101–103.

Nine strains of *Streptococcus pluton* (White) were isolated at Rothamsted from larvae with European foulbrood from different parts of the world; all were very sensitive to erythromycin. Bacteria isolated elsewhere from bees with European foulbrood, and reported to resist erythromycin, are very atypical or, more probably, not *S. pluton* but secondary invaders.

https://doi.org/10.23637/ERADOC-1-60

11.3 BAILEY, L. (1965) The effect of *Acarapis woodi* on honeybees from North America. *J. apicult. Res.* **4**, 105–107.

Of 19 colonies infested with *Acarapis woodi* in spring, 1963 nine were requeened with queens from N. America; two of these become severely infested in 1963 and one in 1964. Of the 10 colonies left with English queens, one became severely infested in 1964. Infestation declined or remained slight in all the remaining colonies. *A. woodi* spread quickest in late summer in American bees, as it does in English ones. Severely infested colonies of both American and English bees appeared normal until their death in late winter.

11.4 BAILEY, L. (1965) The occurrence of chronic and acute bee paralysis virus in bees outside Britain. *J. invert. Path.* **7**, 167–169.

Honeybees from Austria and Switzerland, suffering from *Waldtrachtkrankheit*, and from Italy and Norway suffering from *Mal Noir*, contained as much chronic bee paralysis virus as bees suffering from "paralysis" in Britain and Malta. These diseases seem to be etiologically the same, therefore, and the variable and unreliable signs sometimes exhibited are perhaps caused by factors secondary to infection by the virus. Bees from Canada and Italy that appeared healthy were found to be infected with the virus of acute paralysis, as they are in Britain.

11.5 BAILEY, L. (1965) Paralysis of the honey bee, *Apis mellifera* Linnaeus. *J. Insect Path.* **7**, 132–140.

Chronic bee paralysis virus (CBPV) was differentiated from acute bee paralysis (ABPV) by the symptoms it caused when injected into normal bees and by histological and serological means. It was isolated from naturally paralysed bees from various parts of Britain and from Hong Kong and from one stock of apparently normal bees. Overt disease disappeared when the queens of naturally diseased colonies were replaced with others from normal colonies. Normal bees in colonies or cages were resistant to chronic paralysis when sprayed or fed with CBPV. Bees injected with CBPV transmitted it in the food they passed to normal bees.

11.6 BAILEY, L. (1965) Susceptibility of the honey bee, *Apis mellifera* Linnaeus, infested with *Acarapis woodi* (Rennie) to infection by air-borne pathogens. *J. invert. Path.* **7**, 141–143.

Honeybees infested with the mite *Acarapis woodi* (Rennie) were no more susceptible than normal bees to infection by the bacterium *Pseudomonas apiseptica* (Burnside), or by the viruses causing acute and chronic paralysis, when they were sprayed with suspensions of these pathogens.

11.7 BUTLER, C. G. (1965) Sex attraction in *Andrena flavipes* Panzer (Hymenoptera: Apidae), with some observations on nest-site restriction. *Proc. R. ent. Soc. Lond.* (A) **40**, 77–80.

Females of the solitary bee *Andrena flavipes* tend to mate and to nest only within the nest-sites where they are reared. Males seek nubile females in such nest-sites, largely ignoring those elsewhere. They are attracted by the odour of the nest-site, not of the females, and by the colour of the females' bodies, especially by their orange-coloured hind legs. These factors acting together are probably responsible for restricting a nest-site to a small part of a suitable terrain and for its persistence there.

https://doi.org/10.23637/ERADOC-1-60

11.8 BUTLER, C. G. (1966) The effects of extracts of various social insects on queen rearing and the development of workers' ovaries in the honeybee (*Apis mellifera*). *Z. Bienenforsch.* **8**, 143–147.

The queens of three species of honeybees, *A. mellifera*, *A. cerama* var. *indica* and *A. florea*, of a termite, *Odontotermes* sp., and of an ant, *Formica fusca*, contain substances able to inhibit queen rearing by workers of *A. mellifera* and the development of the ovaries of workers of this species. The queens of another species of ant, *Myrmica rubra*, as well as of another species of termite, *Zootermopsis angusticollis*, and of two species of bumblebees, *Bombus terrestris* and *B. pratorum*, and a social wasp, *Vespula germanica*, seem not to produce the same inhibitory substances.

11.9 BUTLER, C. G. & SIMPSON, J. (1965) Pheromones of the honeybee (*Apis mellifera* L.). An olfactory pheromone from the Koschewnikow gland of the queen. *Sci. Stud., Univ. Libcice*, **4**, 33–36.

Most of the odour of a queen honeybee that attracts workers comes from her mandibular glands, but some is produced in her Koschewnikow glands.

11.10 FREE, J. B. (1965) Attempts to increase pollination by spraying crops with sugar syrup. *J. apicult. Res.* **4**, 61–64.

More honeybees visited plots of apple and field beans after these were sprayed with sucrose syrup, but nearly all the bees collected syrup only. Fewer bees visited the flowers in sprayed than in unsprayed plots, and fewer flowers were set. The effect of spraying was very local and did not increase the number of bees visiting the flowers in other parts of the crop.

11.11 FREE, J. B. (1965) The behaviour of honeybee foragers when their colonies are fed sugar syrup. *J. apicult. Res.* **4**, 85–98.

Colonies fed sugar syrup collect more pollen mainly because the behaviour of individual foragers is changed. When sugar syrup is given in the hive most of the bees that take it have not foraged before and are at the stage in their lives when they would normally relieve returning foragers of the nectar loads; their absence from the hive entrance area probably discourages the foragers from collecting nectar.

11.12 FREE, J. B. (1965) The effect on pollen collection of feeding honeybee colonies with sugar syrup. *J. agric. Sci.* **64**, 167–168.

The total amount of pollen collected by colonies taken to crops of sweet cherry, field beans and red clover was greatly increased by feeding the colonies with syrup, thus increasing their pollinating value.

11.13 FREE, J. B. & SIMPSON, J. (1964) The pollination requirements of sunflowers (*Helianthus annuus* L.). *Emp. J. exp. Agric.* **32**, 340–342.

Sunflower heads isolated from insects set little or no seed, indicating that the florets are usually self-sterile. Cross-pollination by insects between heads of different plants set more seed than pollination between different florets on the same head.

https://doi.org/10.23637/ERADOC-1-60

Statistics Department

General Paper

12.1 Yates, F. (1965) George Udny Yule: 1871–1951. Notice for the *Dictionary of National Biography, Supplement*, 1951–1960.

Research Papers

12.2 Anderson, A. J. B. (1966) A note on the construction of a general survey programme in Extended Mercury Autocode. *Comput. J.* (In the press.)

A general programme for the analysis of surveys was written in Extended Mercury Autocode for the Rothamsted Orion; it is similar to that written earlier for the Elliott 401, but the derived variate instructions are written separately for each survey in E.M.A. by the user. The steering section is also written in E.M.A., and complicated cycling can therefore be introduced without difficulty. The programme provides for the use of magnetic tape for dumps and storage of tables.

12.3 (Ashton, E. H.), Healy, M. J. R., (Oxnard, C. E. & Spence, T. F.) (1965) The combination of locomotor features of the primate shoulder girdle by canonical analysis. *Proc. zool. Soc. Lond.* **147**, 406–429.

A set of nine measurements on primate scapulae had been shown earlier to be largely independent of overall size and individually to vary in a graded manner between brachiators, semi-brachiators and quadrupeds. A discriminant analysis showed that most of the difference between genera was conveyed by three compound measurements. The first of these ranges the Anthropoidea in a spectrum from the extreme brachiator *Hylobates* to such wholly quadrupedal forms as *Papio* and *Erythrocebus*. The second canonical variate distinguishes mainly between terrestial forms, such as *Gorilla* and *Papio*, on the one hand, and arboreal forms, such as *Pongo*, *Rhinopithecus* and *Cacajao*, on the other. The third variate exhibits little difference between the sub-human primates, but clearly distinguishes *Homo* from the rest. Some Prosimian genera were included in the analysis, which confirmed but added little to the distinction between quadrupeds and hangers established by the study of single measurements.

12.4 (Barnes, H.) & Healy, M. J. R. (1965) Biometrical studies on some common cirripedes. I. *Balanus balanoides*: measurements of the scuta and terga of animals from a wide geographical range. *J. mar. biol. Ass. U.K.* **45**, 779–789.

Eighteen measurements were made on the scutal and tergal valves of samples of barnacle from different locations. Size differences were allowed for by a regression technique, and remaining differences between the locations were studied by way of a discriminant analysis applied to each valve separately. The differences were small and were adequately described by a single compound measurement on each valve. The analysis gave evidence of a change in shape associated with water temperature, but locations on east and west Atlantic coasts were scarcely distinguished.

12.5 (Barron, S. L.) & Vessey, M. P. (1966) Immigration—A new social factor in obstetrics. *Br. med. J.* (In the press.)

A retrospective survey was made of all births occurring at Lambeth Hospital during the period 1958–60. Nationality differences in the various social factors that may influence the course of pregnancy and childbirth are described and discussed.

https://doi.org/10.23637/ERADOC-1-60 *pp 45*

12.6 BOYD, D. A., CHURCH, B. M., HILLS, M. G. & (HEAFIELD, T. G.) (1966) Types of fertilisers used on farm crops in England and Wales. *N.A.A.S. q. Rev.* (In the press.)

Information on types and amounts of fertiliser used on farm crops in 1962 was obtained from surveys of 30 districts chosen to represent the main farming types of England and Wales. In this paper compound fertilisers are assigned to nine groups according to their nutrient ratios, and their relative use is examined for individual crops and farming types. New compounds have helped farmers to bring manuring closer to individual crop needs, but use of such compounds does not always conform with current recommendations.

12.7 BOYD, D. A. & (DERMOTT, W.) (1966) Fertiliser requirements of potatoes in relation to kind of soil and soil analysis. *J. Sci. Fd Agric.* (In the press.)

Results are given of 125 fertiliser experiments on maincrop potatoes done by Soil Chemists of the National Agricultural Advisory Service in the years 1955–62. The experimental sites were in 13 soil groups, most of which correspond to particular soil series or complexes. The paper investigates how crop responses to fertilisers varied between the soil groups and discusses the influence of other soil factors, such as texture, chemical analysis and depth of freely drained soil. Discrepancies are noted between growers' current manurial practice and the optimal dressings indicated by experiment.

12.8 BOYD, D. A. & (TRIST, P. J. O.) (1966) The Saxmundham Rotation Experiments: Rotation II, 1899–1952. *J. agric. Sci.* (In the press.)

The Rotation II experiment at Saxmundham, which ran from 1899 to 1952, was designed to show how limited quantities of FYM, N and P could best be allocated to the crops of a four-course rotation; there were also tests of additional quantities of N and P. Both FYM and P fertiliser gave large increases in the yield of all crops, but the profitability of the rotation as a whole proved to be little affected by which crops received FYM or P fertiliser. The rates of N tested were too small to provide any information relevant to current farm practices. The optimal dressing of P fertiliser at 1965 prices was 0·5–0·6 cwt P_2O_5/acre.

12.9 (DELANY, M. J.) & HEALY, M. J. R. (1966) Variation in the white-toothed shrews (*Crocidura* spp.) in the British Isles. *Proc. R. Soc. B.* (In the press.)

Ten skull characters were measured on each of 300 specimens of *Crocidura suaveolens* (Pallas) and 99 specimens of *C. russula* Hermann from five of the Scilly Isles, four of the Channel Isles and one locality on the mainland of France. No place contained both species. The characters were skull length, skull width, lengths of upper and lower tooth rows, distance between the third upper molars, distance between the upper premolars, length from the palate to the foramen magnum, the combined length in ventral aspect of the third upper incisor and canine and the mandibular height.

The means of each measurement at each locality were calculated. Analyses of variance were also calculated, and from these variance components within locality groups were obtained. An analysis into canonical variates was made with a view to accounting for the largest possible part of the variation between groups using a few linear combinations of the original measurements. Most of the variance (82%) was contained in the first canonical variate and from the dispersion of the means of the samples the populations of *Crocidura* separated into two main groups. One contained animals from Alderney, Guernsey and

https://doi.org/10.23637/ERADOC-1-60 pp 46

Cap Gris Nez (*C. russula*) and the other the remainder (*C. suaveolens*). The latter group subdivided, particularly with reference to the second canonical variate, into animals from Sark and Jersey and those from the Isles of Scilly. Differences between populations from the Scilly Isles are very small, suggesting origin from a common stock. The shrews from Sark and Jersey differ more from each other than do any pair of Scilly Island populations. The three populations of *C. russula* do not form as close a cluster as the Scilly Island ones. The analyses of variance agree with those findings, although for certain characters highly significant differences often occur between localities in a particular group.

12.10 GOWER, J. C., MARTIN, A. H. & SIMPSON, H. R. (1966) An outline of a programming language for the analysis of surveys, experiments and multivariate data. *Proc. int. Symp. for Methods of Field Experimentation*, Halle, 1965. (In the press.)

The development of a programme for the analysis of surveys, experiments and multivariate data is described. This programme accepts a series of statements written in an autocode form. An outline of the autocode language is given, an important part of which implements a table algebra defining arithmetic operations on multiway tables, possibly of different sizes.

A flexible system of input and output instructions is provided. Input may be variate by variate (typical of experiments) or unit by unit (typical of surveys). Complex survey designs can be analysed. Output is organised so that, with a little trouble, the user may provide a complete system of headings for tables; without this information adequate standard headings are given. The user may also define his own output formats.

12.11 PREECE, D. A. (1966) Some row and column designs for two sets of treatments. *Biometrics*. (In the press.)

This paper provides some new, simple designs for the simultaneous estimation of the effects of two non-interacting sets of treatments, with two-way elimination of heterogeneity. The designs are suitable for use when a new set of treatments is to be applied to experimental material that may still be affected by an earlier set of treatments. One type of design, obtained by omitting a row or rows from a Graeco-Latin square of order t, has each set arranged in a $t \times k$ Youden square design, $t > k$; this type is O:OT:OTT, in the notation of Pearce (1963), and includes series of designs for which t is a prime of the form $(4n + 3)$ and $k = \frac{1}{2}(t \pm 1)$. Closely related $t \times \frac{1}{2}(t \pm 1)$ O:OP:OPP designs, for which t is a prime of the form $(4n + 1)$, are also described and discussed. A further type of design, first discussed by Clarke (1963), is for one set of t treatments arranged in a $t \times k$ Youden square design, and one set of k treatments; 7×3 and 11×5 designs of this O:OT:TOO type are given for the first time.

12.12 PREECE, D. A. (1966) Classifying Youden rectangles. *J. R. statist. Soc. B.* (In the press.)

Youden rectangles (Youden square designs) of various sizes are classified. The classification procedure is similar to that used by Norton (1939) for 7×7 Latin squares. For example, 7×4 Youden rectangles are grouped into six "species", resembling the 147 species of 7×7 Latin squares, and the six species into three "families". The classification led to the discovery of a method for generating balanced 7×3 and 11×5 row-and-column designs for two non-interacting sets of treatments, one set containing 7 or 11 treatments, the other set containing 3 or 5. The derivation of these designs is given. The existence of such designs had been postulated by Clarke (1963).

https://doi.org/10.23637/ERADOC-1-60

12.13 (SMITH, C.) & ROSS, G. J. S. (1965) Genetic parameters of British Landrace bacon pigs. *Anim. Prod.* **7**, 291–301.

The heritabilities of 26 traits and the phenotypic and genetic correlations among the traits have been estimated from data on Landrace pigs tested at the five British pig-progeny testing stations, and the results are compared with estimates from previous analyses. The importance of sire–sex and litter–sex interactions was also studied for the 26 traits. A summary of the inter-relationships among the traits was attempted using a principal component analysis.

12.14 (TRIST, P. J. O.) & BOYD, D. A. (1966) The Saxmundham Rotation Experiments: Rotation I. *J. agric. Sci.* (In the press.)

Saxmundham Rotation I is a long-term manurial experiment begun in 1899 and still continuing. The treatments are a $2 \times 2 \times 2$ factorial NPK system with additional farmyard manure and bonemeal plots applied to a four-course rotation of wheat, roots (mainly mangolds), and beans, peas or clover. The results are summarised. N and P gave large responses, but there was little response to K.

12.15 YATES, F. (1966) A fresh look at the basic principles of the design and analysis of experiments. *Proc. Fifth Berkeley Symp. on Mathematical Statistics and Probability*. (In the press.)

Various logical points arising in the design and analysis of replicated experiments are discussed. Reasons are given for believing that the distinction between fixed and random-effects models is based on a misconception, and serves no useful purpose. Response-surface designs are briefly considered, and it is concluded that ordinary factorial designs are more appropriate in agricultural research. The need for better computer programmes for the analysis of replicated experiments is stressed.

Field Experiments Section

RESEARCH PAPER

13.1 DYKE, G. V. (1965) Green manuring for sugar beet. *Br. Sug. Beet Rev.* **34**, 94–98.

Four experiments at Woburn tested green manures undersown in the preceding barley crop. Trefoil (*Medicago lupulina*) gave a mean increase of 5·6 cwt total sugar/acre, ryegrass gave 2·5 cwt, ryegrass with 0·6 cwt N applied after barley harvest 5·1 cwt. In three of the experiments the green manures increased the maximum yield obtainable by the use of nitrogen fertiliser.

Broom's Barn Experimental Station

THESIS

16.1 DRAYCOTT, A. P. (1965) Investigations into the agronomic value of fertilisers applied in solid and liquid state, with particular reference to placement. Ph.D. Thesis, University of Leeds.

GENERAL PAPERS

16.2 BYFORD, W. J. (1966) Experiments on the control of sugar-beet downy mildew with fungicides. *Proc. Br. Insect. Fung. Conf. Brighton*, 1965, 169–176.

https://doi.org/10.23637/ERADOC-1-60

16.3 BYFORD, W. J. (1965) Fungal diseases of beet. *Fmg Wld*—Agricultural supplement, April.

16.4 DUNNING, R. A. (1965) Insecticides for control of beet pests. Review of the current position. *Brit. Sug. Beet Rev.* **33**, 129–130, 135–136.

16.5 DUNNING, R. A. & WINDER, G. H. (1966). Sugar beet seedling populations and protection from wireworm injury. (With an addendum on the retention of insecticide dressings on beet seed.) *Proc. Br. Insect. Fung. Conf. Brighton*, 1965, 85–99.

16.6 HEATHCOTE, G. D. (1965) Links with the past at Broom's Barn Experimental Station. *East Anglian Magazine* **25**, 15–17.

16.7 HULL, R. (1965) Control of sugar-beet yellows. Symposium on some approaches towards integrated control of British insect pests. *Ann. appl. Biol.* **56**, 345–347.

16.8 HULL, R. (1965) Virus yellows of sugar beet. *Advis. Leafl. Minist. Agric. Fish.* No. 323 (revised edition).

16.9 HULL, R. (1966) Protection of sugar beet against pests and diseases. *Proc. Br. Insect. Fung. Conf. Brighton*, 1965, 67–72.

16.10 HULL, R. & DUNNING, R. A. (1965) Pests and diseases of sugar beet, fodder beet and mangolds. In: *Insecticide and fungicide handbook*. 2nd edition. Ed. H. Martin, Oxford: Blackwell Scientific Publications, Chapter 7, pp. 114–125.

16.11 TINKER, P. B. H. (1965) Minor element deficiencies in sugar beet. *Fmg Wld*—Agricultural supplement, April.

RESEARCH PAPERS

16.12 HEATHCOTE, G. D. (1965) Nematode-transmitted viruses of sugar beet in East Anglia, 1963 and 1964. *Pl. Path.* **14**, 154–157.

Tobacco rattle virus was found in 16, and tomato black ring virus in 14 of 135 samples of stunted beet sent to Broom's Barn Experimental Station during 1963 and 1964. All infected samples came from East Anglia. In July the fresh weight of beet plants infected with TRV was only 61% of that of their virus-free neighbours within an area of stunted plants, but only a small proportion of the crop was systemically infected with TRV. About 500 acres of sugar beet in eastern England and the Midlands were severely affected by Docking disorder in 1963 and about 1,200 in 1964. Only a few of the stunted beets associated with Docking disorder are infected with soil-borne viruses.

16.13 HEATHCOTE, G. D. (1966) The time of flight and the relative importance of *Myzus persicae* (Sulz.) and *Aphis fabae* Scop. in relation to the incidence of beet yellows as shown by trap catches at Rothamsted and Broom's Barn. *Bull. ent. Res.* (In the press.)

The numbers of *Myzus persicae*, *Aphis fabae* and of all aphids caught per week on sticky traps operated over sugar-beet crops at Rothamsted, Broom's Barn and elsewhere for 5 years are given. *M. persicae* flew early in 1960 and 1961 when beet viruses spread extensively, whereas in 1962, 1963 and 1964, when as many or more *M. persicae* were trapped later in the year, yellows spread much less. Many *A. fabae* flew in 1963, but beet viruses spread little.

https://doi.org/10.23637/ERADOC-1-60

16.14 (HOLMES, J. C.) & ADAMS, S. N. (1966) The effect of sowing date, harvest date and fertiliser on sugar beet. *Expl. Husb.* (In the press.)

Six experiments near Edinburgh and four near Lincoln measured the effect of sowing and harvest date on the response of sugar beet to fertiliser. Response was not significantly affected by changes in the length of growing season, although there was a suggestion that it was less with a combination of late sowing and early harvest. The optimum fertiliser rate for British sugar beet is therefore unlikely to vary for differences in length of growing season.

Sugar yield was enhanced by early sowing and increased on average by 6·7 cwt/acre in October and by 1·1 cwt/acre in November. There was some evidence at Lincoln that early sown beet grew more than late sown during autumn.

16.15 SCOTT, R. K. & (BREMMER, P. M.) (1966) The effect on growth, yield and development of sugar beet of extension of the growing season by transplantation. *J. agric. Sci., Camb.* (In the press.)

In experiments at Sutton Bonington in 1962, 1963 and 1964, extension of the growth period of sugar beet, by transplanting into the field seedlings raised under glass in March and early April, increased crop yields. A given leaf-area duration was more effective in June and July than in August and September. Lengthening the period of complete ground cover with foliage by transplanting increased yield more than did changing densities of plant stand or nitrogen dosage, which affected leaf area mainly at the time of peak leaf production. Crop growth rate did not increase with increase in leaf-area index beyond values of 4 to 5. A greater proportion of the total production of dry matter entered the roots of transplants than of sown beets.

On average for the 3 years, transplants from March sowings in the glasshouse outyielded field sowings between 23 April and 1 May by 7·6 tons/acre of roots, and in 1962 outyielded a field sowing on 20 March by 4 tons/acre.

16.16 TINKER, P. B. H. (1965) The effects of nitrogen, potassium and sodium fertilisers on sugar beet. *J. agric. Sci., Camb.* **65**, 207–212.

A series of 42 factorial field trials in 1959–62 tested the effects of 0·6 and 1·2 cwt/acre of N; O, 1·2 and 2·4 cwt/acre of K_2O; and O, 2 and 4 cwt/acre of salt on sugar beet. Extra plots received 0 and 1·8 cwt/acre of N.

On average, 0·6 cwt/acre of N was more profitable than 1·2 cwt/acre. There was a positive interaction between N and Na, and a lesser one between N and K; in presence of the heavy salt dressing, or the light salt dressing and potassium, the optimum nitrogen dressing was 1·0 cwt/acre. The heavy dressing of nitrogen depressed sugar percentage by 0·4%. The heavy dressings of salt and potash gave mean responses of 4·2 and 2·2 cwt/acre of sugar, respectively. There was a strong negative interaction between these fertilisers; in absence of salt the heavy dressing of potassium was profitable, but neither dressing was justified with the Na_2 dressing. The best combination was Na_2K_0. Salt gave an increase of about 2·5 cwt/acre of sugar over the yield with the optimum potassium dressing alone (over 2·4 cwt/acre K_2O). There was a close relationship between the responses to the two fertilisers in the individual trials.

Sodium decreased yield in only two trials, and was nearly always profitable. Potassium was justified in 28 trials in absence of salt, but in only 13 with salt; potassium then caused loss of yield as often as an increase.

The nitrogen response curves for individual trials showed that 1·0 cwt/acre N would be suitable for most; this average recommendation lost only 1 cwt/acre of sugar on average, compared to the optimum dressing for each field. The optimum dressings for 30 of the trials were between 0·6 and 1·4 cwt/acre N. There was no way of distinguishing the three trials where the recommended

https://doi.org/10.23637/ERADOC-1-60

dressing gave a serious loss of yield. Beet grown after crops other than cereals may need slightly less than the recommended dressing of nitrogen, but the optimum dressing was not affected by the number of years in which cereals had been grown previously. Virus yellows incidence had no consistent effect on nitrogen response.

The mean annual responses to nitrogen and potassium varied considerably, but for sodium much less so.

No relationship could be found between percentages of Na and K in the beet juice and the responses to fertilisers.

Soil Survey of England and Wales

Books

17.1 FINDLAY, D. C. (1965) The soils of the Mendip district of Somerset. Harpenden: Rothamsted Experimental Station, vii, 204 pp.

17.2 HODGE, C. A. H. & SEALE, R. S. (1966) The soils of the district around Cambridge. Harpenden: Rothamsted Experimental Station, viii, 175 pp.

General Papers

17.3 Soil map on 3rd Edition Sheet 125 (Derby) (1965) Southampton: Ordnance Survey.

17.4 (HOOPER, L. J.) & CRAMPTON, C. B. (1964) The use of potential horticultural soils in Glamorgan. Rep. Welsh Soils Discussion Group No. 5 pp. 83–98.

Research Papers

17.5 CRAMPTON, C. B. (1965) An indurated horizon in soils of South Wales. *J. Soil Sci.* **16**, 230–241.

An indurated horizon occurs in some soils of South Wales. The range of soils and the depth of induration preclude a specific pedological process as an explanation of its formation. Clay has been illuviated in one profile where there are also suggestions of some differential downward movement of sesquioxides. The restricted pore space of the indurated horizon is mostly filled with illuviated clay. Downward movement of water through an indurated horizon is usually very slow, and in this profile it has probably been deflected, so that the resulting lateral flow has produced a pedological discontinuity. Without podzolisation or illuviation, the discontinuity is replaced by a narrow transition zone.

17.6 CRAMPTON, C. B. (1965) Vegetation, aspect and time as factors of gleying in podzols of South Wales. *J. Soil Sci.* **16**, 210–219.

The study concerns the extensive loamy podzols with imperfect drainage in the eluvial horizon. Preferential preservation of *Polypodium* spores, the incomplete floristic sequence recorded by pollen grains in podzols on warm W. or S. slopes and the greater prominence of *Ericaceae* and birch in podzols on cold N. or E. slopes, suggest the soils on the colder slopes were both wetter and more acid in the past. Gleying and the formation of structures in the eluvial horizon probably began under *Ericaceae* in medieval times. In spoil tips, undisturbed for 100 years, these structures and gleying have developed only in cold damp areas of *Ericaceae* on N. slopes. A similar relationship holds in

https://doi.org/10.23637/ERADOC-1-60

land of high relief. The essential elements of the structure can be seen at open-cast sites 15 years after restoration under impoverished, neglected pastures.

17.7 GREEN, R. D. & (ASKEW, G. P.) (1965) Observations on the biological development of macropores in Romney Marsh. *J. Soil Sci.* **16**, 342–349.

Many of the soils formed in Recent alluvium have abundant interconnecting holes in their sub-surface horizons, formed by the activity of roots, ants and earthworms. Ants are considered the main agents in forming complex underground systems of galleries and chambers. These features are apparently continuous over large areas and occur on soils with a wide range of pH, salinity, texture and fluctuations of water-table. Drainage and other properties cannot be deduced from the soil structure or texture only. Characteristics of the macropores, revealed by infiltrating plaster of Paris into the soil, are described, and their origin, distribution and significance relative to land use are discussed.

17.8 (PERRIN, R. M. S.) & HODGE, C. A. H. (1965) Soils. In: *The Cambridge Region 1965*. British Association for the Advancement of Science, 68–84.

The parent materials and types of soil formation in the Cambridge district are described. Details are given of the clay mineralogy of soil parent materials and analytical data of some important soils. The soils are arranged in seven major groups and 17 sub-groups, their distribution being shown on a coloured map at the scale of $\frac{1}{4}$ in. to 1 mile. The extent of the probable wastage of Fenland peat is illustrated.

https://doi.org/10.23637/ERADOC-1-60