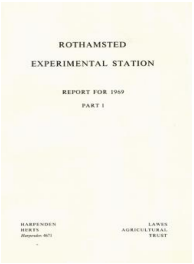
*This work is licensed under a Creative Commons Attribution 4.0 International License.*

Thank you for using eradoc, a platform to publish electronic copies of the Rothamsted Documents. Your requested document has been scanned from original documents. If you find this document is not readible, or you suspect there are some problems, please let us know and we will correct that.

ROTHAMSTED RESEARCH

# Report for 1969 - Part 1

*Full Table of Content*




## Abstracts of Rothamsted Papers

### Rothamsted Research

Rothamsted Research (1970) *Abstracts of Rothamsted Papers ;* Report For 1969 - Part 1, pp 361 - 428 **- DOI: https://doi.org/10.23637/ERADOC-1-124**

*This work is licensed under a Creative Commons Attribution 4.0 International License.*

# ABSTRACTS OF PAPERS


BEES 413

BIOCHEMISTRY 387

BOTANY 384

BROOM'S BARN 422

CHEMISTRY 368

ENTOMOLOGY 406

FIELD EXPERIMENTS 421

INSECTICIDES AND FUNGICIDES 399

NEMATOLOGY 394

PEDOLOGY 374

PHYSICS 362

PLANT PATHOLOGY 388

SOIL MICROBIOLOGY 379

SOIL SURVEY 427

STATISTICS 416


*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



## Physics Department

### General Papers

1.1 Brown, N. J. (1969) Cereal cultivations and the prospect of new techniques for the future. *Farming World*, 23 January 1969.

1.2 Penman, H. L. (1969) Weather, 1968. *Trans. Herts. nat. Hist. Soc. Fld Club* **26.** (In the press.)

### Research Papers

1.3 Currie, J. A. (1970) Heterogeneous distribution of nutrients, air and water within the soil. *Report of Welsh Soils Discussion Group* **11.** (In the press.)

In soil science we are concerned with the environment provided for the roots of our crops but to what extent do we assess our soils in terms of the needs of these roots? These needs are space to grow, water, nutrients and air. These are measured, for example, as bulk density, water content, available N, P or K, and porosity. All these measurements are referred to the whole soil and presuppose random distribution and uniform availability. In most soils, however, the pore system is far from random. Discrete blocks of fine-pored soil, the peds of nature, or clods and crumbs of man-made tilth, are separated by a more or less continuous system of larger pores. The larger pores, which are most likely to contain air and permit easy passage of the roots, hold neither water nor the associated nutrients. These are in the fine-pored matrix which is less accessible to roots and possibly anaerobic.

Measurements of gaseous diffusion through soils have been used to discuss the effect of this heterogeneity of pore structure on soil aeration.

1.4 Currie, J. A. (1970) Movement of gases in soil respiration. In: *S.C.I. Monogr.* **37.** (In the press.)

Gases may move through soil by mass flow or molecular diffusion. The magnitude and merit of each process in ventilating the soil pore system are considered. The exchange of gases under the influence of turbulent atmospheric pressure is attracting increased attention and is discussed here at greater length. The amount of gas that must be moved is important in assessing the efficiency of a transport mechanism. Some experimental results for seasonal and daily variations in soil respiration rates are presented for cropped and uncropped soils.

1.5 Lake, J. V. (1970) Glasshouse and leaf canopy enclosures as tools for studying the effects of environment on the growth and nature of the photosynthetic apparatus. In: *Productivity of photosynthetic systems*, Ed. I. Setlik. (Proc. I.B.P. Technical Meeting, Trebon.)

One object of studies of this kind is to provide a quantitative basis for dynamic models of the effects of weather on crop growth. The problem is simplified by considering only the effects of leaf temperature and the rate of carbon dioxide exchange, instead of the numerous interacting environmental factors on which they depend.

Leaf temperature can be controlled accurately in naturally illuminated plant enclosures, provided the air is stirred vigorously and the illumination is diffuse.

The rate of carbon dioxide exchange can be controlled manually for a few hours at a time and, in principle, automatic control could be maintained for days or weeks.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



Glasshouses and portable leaf canopy enclosures covered with glass or plastics can be used both to apply different environmental treatments of this kind and to measure the resulting effects on photosynthetic function.

1.6 LAKE, J. V. & (BEGG, J. E.) (1970) Conductimetric measurements of carbon dioxide concentration using de-ionised water. In: *Plant photosynthetic production: manual of methods*, Ed. Z. Sestak and J. Catsky. Academic Press.

An earlier description is amplified with details of recent experience and modifications. A theoretical comparison shows that an instrument in which the air and water are in counter-flow is inherently faster in response and more sensitive than one with parallel flow.

1.7 PARKINSON, K. J. (1970) The effects of silicone coatings on leaves. *J. exp. Bot.* **21**. (In the press.)

Dimethyl silicones of viscosities 0·25, 10 and 125 St were applied to leaf surfaces and their effects on the rates of transpiration and photosynthesis were measured. The effect of the 10 and 125 St materials lasted more than 16 days, decreasing both photosynthesis and transpiration. The diffusion coefficients of water vapour and carbon dioxide through 10 St silicone were measured in a separate experiment and it is shown that the leaf results can be interpreted as an almost complete silicone cover over the stomates. Calculations show that for materials with $DH_2O/DCO_2$ greater than 1·6 (free air ratio), provided they have no physiological effects, the most effective mode of action would be complete blockage of a fraction of the stomates rather than partial blockage of all.

The amount of water saved by doubling the stomatal resistance of three crop types (short grass, farm crops, and trees) in two contrasting environments (S. England and California) is calculated, and it is inferred that anti-transpirants would be most effective when applied to well-watered tall crops in regions of high evaporative demand.

1.8 PARKINSON, K. J. & PENMAN, H. L. (1970) A possible source of error in the estimation of stomatal resistance. *J. exp. Bot.* **21**. (In the press.)

During transpiration, water vapour diffusing through the stomata moves through air that has no mean motion: the diffusive inward flux is balanced by an outward mass flow. The effect is to accelerate outward diffusive flow (water vapour : $CO_2$ in respiration) and retard inward diffusive flows (air : $CO_2$ in assimilation), and alter the apparent ratio of diffusion coefficients. The magnitude of the effect is calculated theoretically, and estimated practically for an experiment on sugar-beet leaves. For this particular case the error in estimating mesophyll resistance is near 2%, but for other conditions could be much larger. Estimated values of the apparent ratio of the diffusion coefficient of water vapour and carbon dioxide (true value = 1·59) ranged from −0·027 to 2·79, but could lie anywhere between − and + ∞.

1.9 PENMAN, H. L. (1970) Woburn Irrigation 1960–1968. IV. Design and interpretation. *J. agric. Sci.* **75**. (In the press.)

Results are given for a second period of 9 years, 6 on the pattern of 1951 to 1959, with the last 3 years used for *ad hoc* management experiments. The meteorological specification of a year of 'irrigation need' was satisfied in 4 years: there were good responses in 5 years. During the first 6 years, out of 24 sets of crop yields (from eight different crops), very good responses were obtained on nine,



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



good responses on eight, and zero or very slightly negative responses on the other seven.

A general theory of the inter-relationships of growth and water, and of growth and radiation, leads to an expression

$$k = 39\epsilon \text{ tonnes ha}^{-1} \text{ cm}^{-1}$$

as the maximum possible response to irrigation in terms of *total* dry matter produced, where $\epsilon$ is the fraction of solar radiation fixed by the crop ($\epsilon$ has a range 50 to $100 \times 10^{-4}$ for good to very good farming)—when irrigation is needed. The 'need' is defined through

$$Y = k(E + D_l - D_m)$$

where $Y$ is the yield, $E$ is the total potential evaporation, $D_l$ is a limiting deficit up to which there is no check to growth (and beyond, there is no growth), and $D_m$ is the maximum deficit experienced by the crop at the time of measuring $Y$. The agronomic object of the experiments is to determine $D_l$, i.e., what reserve of soil water can be used by the crop before irrigation is necessary.

1.10 PENMAN, H. L. (1970) Woburn Irrigation 1960–1968. V. Results for leys. *J. agric. Sci.* **75**. (In the press.)

Experiments on a sandy loam, using adequate fertiliser, gave:

(a) crop yield (as total dry matter) when soil water content was kept near field capacity;
(b) a measure of the departure from field capacity (limiting deficit, $D_l$) that produced no detectable change in yield;
(c) responses to irrigation:
  (i) conventional, as $\delta Y/\delta I$;
  (ii) a theoretical maximum, $k$, after allowing for $D_l$ in the water balance;
(d) other information, botanical and technical.

*Grass* (S22 Italian ryegrass)
Two-year crop, cut 14 times, October 1959 to October 1961.

(a) Best yields: 1960, 15 t ha$^{-1}$ ($\epsilon \simeq 100 \times 10^{-4}$);
  1961, 12 t ha$^{-1}$ ($\epsilon \simeq 70 \times 10^{-4}$).
(b) $D_l \simeq 5$ cm.
(c) (i) $\delta Y/\delta I$: 1960, 0·36; 1961, 0·43 t ha$^{-1}$ cm$^{-1}$
  (ii) $k$: 1960, 0·40; 1961, 0·27 t ha$^{-1}$ cm$^{-1}$.
(d) In 1960 irrigation was needed in spring only: the benefit was maintained on plots with large N and K dressings, but almost disappeared on those with small dressings ($Y = 11$ t ha$^{-1}$). In 1961 the unirrigated crop could not exploit all the limited summer rain: hence $\delta Y/\delta I > k$.

One-year crop, cut five times, March to October 1965.

(a) Yield, 12 t ha$^{-1}$ ($\epsilon \simeq 90 \times 10^{-4}$, from emergence).
(b) and (c) (i) The meteorological need was slight, $D_l$ (above) was not exceeded, and there was no response.
(c) (ii) $k = 0{\cdot}46$ t ha$^{-1}$ cm$^{-1}$.

*Lucerne* (Du Puits)
Three-year crop, cut 11 times, April 1962 to November 1964.

(a) Best yields: 1962, 7; 1963, 8; 1964, 10 t ha$^{-1}$.
(b) $D_l = 11$ cm for established crop.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



(c) (i) No response other than in first dry spring of establishment. At first cut $\delta Y/\delta I = 0{\cdot}18$ t ha$^{-1}$ cm$^{-1}$.
(ii) $k = 0{\cdot}26$ t ha$^{-1}$ cm$^{-1}$.
(d) Extra K seemed to be helpful in sustaining the early benefit throughout the 3 years.

*Clover* (Crimson)
One-year crop, drilled April and cut (once only) July 1963.

(a) Best yield: 3 t ha$^{-1}$.
(b) $D_l$, not detectably different from zero. (Evidence inadequate.)
(c) (i) $\delta Y/\delta I = 0{\cdot}16$ t ha$^{-1}$ cm$^{-1}$.
(ii) $k \simeq \delta Y/\delta I$ (?).
(d) First cut completely defoliated irrigated crop, there was no recovery, and the experiment was abandoned.

*Clover* (Dorset Marl)
One-year crops undersown in previous barley crops, 1963 for 1964 (3 cuts), 1964 for 1965 (3 cuts).

(a) Best yields: 1964, 9 t ha$^{-1}$ ($\epsilon \simeq 60 \times 10^{-4}$); 1965, 8 t ha$^{-1}$ ($\epsilon \simeq 60 \times 10^{-4}$).
(b) $D_l \simeq 2{\cdot}5$ cm.
(c) (i) $\delta Y/\delta I$: 1964, 0·24 t ha$^{-1}$ cm$^{-1}$. 1965, no response.
(ii) $k$: 0·22 to 0·34, depending on method of derivation.
(d) The response to irrigation was slightly greater on plots not previously irrigated in the barley year. In (c) the uncertainties arise out of excessive rain after the first irrigation in 1965; there was estimated drainage from the irrigated plots but not from the control plots. In 1964, the control plots failed to exploit all the summer rain.

*General.* There seems to be a need to know two limiting deficits, one the $D_l$ of these papers, that is a measure of what can be tolerated without any check to growth, and a second that is a kind of maintenance deficit, necessary to keep the crop non-senescent so that it can use all the rain it gets.

Irrigation greatly helped the establishment of all three leys, and both grass and clover responded well to later irrigation. Lucerne did not. In English units, the limiting deficits, $D_l$, for well fertilised established crops were—approximately—4 in. for lucerne, 2 in. for grass, and 1 in. for clover.

1.11 PENMAN, H. L. (1970) Woburn Irrigation 1960–1968. VI. Results for rotation crops. *J. Agric. Sci.* **75**. (In the press.)

Experiments on a sandy loam, using adequate fertiliser gave:

(a) crop yield when soil water content was kept near field capacity;
(b) a measure of the departure from field capacity (limiting deficit, $D_l$) that produced no detectable change in yield;
(c) responses to irrigation:
(i) conventional, as $\delta Y/\delta I$;
(ii) a theoretical maximum, $k$, after allowing for $D_l$ in the water balance;
(d) other information, botanical and technical.

*Sugar beet*

(a) Best yields of sugar: 1963, 9; 1964, 10; 1965, 8 t ha$^{-1}$.
(b) Limiting deficit can increase to *c.* 10 cm by end of September.
(c) (i) Best $\delta Y/\delta I$. 1963, 0·18 t ha$^{-1}$ cm$^{-1}$ (some need); 1964, 0·62 t ha$^{-1}$ cm$^{-1}$ (great need); 1965, slightly negative (no need).



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



(ii) Inferred $k = 0{\cdot}4$ t ha$^{-1}$ cm$^{-1}$ for sugar, and *c.* 1·0 t ha$^{-1}$ cm$^{-1}$ for total dry matter. For the period sowing to harvest the values of $\epsilon$ are 0·7 and $1{\cdot}8 \times 10^{-2}$ respectively.

(d) Excess water (as in 1965) seems to depress the sugar yield slightly.

*Potatoes, main crop* (part of an experiment on control of nematodes, under continuous cropping).

(a) Best fresh weight yields of tubers: 1966, 46, without irrigation; 1967, 38 with irrigation; 1968, 33, with irrigation, t ha$^{-1}$.

(b) Evidence inadequate.

(c) Responses were small, or negative;
(i) best response, in 1967, 0·7 t ha$^{-1}$ cm$^{-1}$.
(ii) evidence inadequate.

(d) Decreased yield in 1966 may be caused by early summer leaching: the effect was about equal to removing half of the nitrogen fertiliser applied.

*Potatoes, early* (Arran Pilot)

(a) Best fresh weight yields of tubers: 1960, 32; 1961, 37; 1962, 16 t ha$^{-1}$, all at larger of two nitrogen dressings, and after normal cultivation.

(b) $D_l \simeq 2{\cdot}5$ cm.

(c) (i) Best $\delta Y/\delta I$. 1960, 1·7; 1961, 2·0; 1962, 1·1 t ha$^{-1}$ cm$^{-1}$.
(ii) $k = 1{\cdot}8$ t ha$^{-1}$ cm$^{-1}$ for nitrogen at 0·6 cwt acre$^{-1}$
$k = 2{\cdot}1$ t ha$^{-1}$ cm$^{-1}$ for nitrogen at 1·2 cwt acre$^{-1}$.
Inferred values of $\epsilon$ are 1·15 and $1{\cdot}45 \times 10^{-2}$.

(d) Weed control by chemical means failed: all yields and responses were decreased by about one-third.

*Barley, spring* (Proctor, Maris Badger)

After early potatoes, some plots had a crop of trefoil, ploughed in (crops of 1961, 1962, 1963). In 1968, barley was test crop in an experiment on fumigants. Cropping in 1960 and 1964 was normal.

(a) Best yields of grain, 3·4 to 4·8 t ha$^{-1}$ (without trefoil); 4·1 to 5·4 t ha$^{-1}$ (after trefoil).

(b) $D_l \simeq 4$ cm before ear emergence, and unimportant thereafter.

(c) (i) Best $\delta Y/\delta I$, in 1962, *c.* 0·20 (no trefoil) and 0·30 (after trefoil) t ha$^{-1}$ cm$^{-1}$, both at upper of two nitrogen dressings.
(ii) $k$ (for variety Proctor only, and no trefoil) $\simeq$ 0·20 t ha$^{-1}$ cm$^{-1}$ and may be independent of nitrogen treatment.

(d) Previous management of early potatoes did not affect barley yields. For 1961 to 1963—average yield of all treatments = 3·53 t ha$^{-1}$—the average responses were: to trefoil, 0·46 t ha$^{-1}$; to nitrogen, 0·76 t ha$^{-1}$; to water 0·95 t ha$^{-1}$. Trefoil halved the response to nitrogen, and may have increased the response to water.

Within limits, water and nitrogen seem to be interchangeable as management factors.

*Wheat, spring* (1965, Opal, in a normal experiment. 1966, 1967, Kloka in an experiment with a dwarfing compound, CCC. Four levels of N fertiliser.)

(a) Best yields of grain, 1965, 4·5; 1966, 5·8; 1967, 5·9 t ha$^{-1}$.

(b) $D_l \simeq 4$ cm before ear emergence, and *c.* $E_T/4$ thereafter. The evidence is flimsy.

(c) (i) Best $\delta Y/\delta I$. 1965, 0·11; 1966, 0·16; 1967, 0·12 t ha$^{-1}$ cm$^{-1}$.
(ii) Evidence is inadequate to derive values of $k$, but it seems to be very small with $N_1$ (0·4 cwt acre$^{-1}$ N), and *perhaps* of order 0·2 ha$^{-1}$ cm$^{-1}$ at all the bigger dressings (2, 3, and 4 × $N_1$).



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



(d) On average, CCC had no effect on grain yields, but it decreased straw yields. In 1967 many sub-plots gave very large yields: the average of nine was 12 t $ha^{-1}$ as total dry matter; three were not irrigated, and had no CCC; three had CCC and were irrigated. None was at the smallest N treatment.

Spring wheat responds to water like any other crop when given enough N (*c.* 0·8 cwt/$acre^{-1}$ N, or a little more). The need continues after ear emergence.

*Beans, winter* 1960, *spring* 1961, 1962, 1968.

(a) Best yields of grain, 1960, 3·7; 1961, 3·1; 1962, 3·6; 1968, 3·0 t $ha^{-1}$.

(b) $D_l \simeq 4$ cm.

(c) (i) Best $\delta Y/\delta I$. 1960, 0·18 (late watering); 1961, 0·15 (early watering); 1962, 0·22 (late watering); 1968, 0·02 (early watering and then rain in excess).

(ii) $k = 0{\cdot}17$ t $ha^{-1}$ $cm^{-1}$.

(d) There is no evidence to show that irrigation is more important either before or after flowering (early and late, in (c)).

*General.* Except for the main crop potatoes, all crops responded to irrigation as expected, with gains of 50 to 100% in the driest summers. In English units, the values of the limiting deficits were—approximately—up to 4 in. by the end of September for sugar beet, 1 in. for early potatoes, 1½ in. for barley before ear emergence, 1½ in. for wheat before ear emergence and up to about 3 in. 5 weeks later, and 1½ in. for beans.

1.12 PENMAN, H. L. (1970) Water as a factor in productivity. In: *Proc. Symp. on Potential Crop Production in Britain.* (Aberystwyth, July 1969.)

Production is defined as total botanical yield, and efficiency, $\epsilon$, as the ratio of the yield, as energy equivalent, to the solar radiation income. For average British farming $\epsilon \simeq 35 \times 10^{-4}$. For some crops it is known that when water is not limiting, the yield $Y$, is proportional to the potential transpiration, $E_T$, which is closely related to the solar radiation. With assumptions, a growth equation is derived (water not limiting) as $Y/E_T = 39\epsilon$ tonnes $ha^{-1}$ $cm^{-1}$, and (water limiting) a response equation, $\delta Y/\delta I = 39\epsilon$ t $ha^{-1}$ $cm^{-1}$, where $I$ is necessary irrigation. Irrigation is defined as necessary only after the soil moisture deficit has passed a limiting value $D_l$, and only until it reaches a potential maximum value for the season, $D_m$. Then the growth equation becomes $Y = k(E_T + D_l - D_m)$ with $k = \delta Y/\delta I$. Experimental results are given for two well fertilised crops (grass and potatoes) to justify the assumptions and test the inferences. For grass, $\epsilon \simeq 90 \times 10^{-4}$, and irrigation responses are as predicted for $D_l \simeq 5$ cm. For early potatoes, $\epsilon \simeq 140 \times 10^{-4}$, and irrigation responses correspond to $D_l \simeq 2{\cdot}5$ cm. Judicious irrigation will give most help to the best management.

1.13 PREBBLE, R. E. (1970) Root penetration of smeared soil surfaces. *Exp. Agric.* **6.** (In the press.)

Winter wheat seeds were grown on compressed soil, (a) with and without smearing; (b) with surface horizontal or at 45°; (c) with and without a sand cover. Germination was not affected. At a soil suction of 0·1 bar, root penetration of the horizontal surface was decreased by smearing and by absence of an overburden; on a surface at 45° smearing had very little effect.

As a general summary of the limited information, root penetration is decreased by 50% for a ten-fold increase in suction above 0·1 bar; the effect of smearing is equivalent to a five-fold increase; the effect of slope is equivalent to a four-fold decrease.



*https://doi.org/10.23637/ERADOC-1-124* *pp 8*

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



1.14 PREBBLE, R. E. & CURRIE, J. A. (1970) Soil water measurement by a low resolution nuclear magnetic resonance technique. *J. Soil Sci.* **21.** (In the press.)

A low resolution nuclear magnetic resonance analyser was used to measure soil water. The physical principles of the method are outlined to enable the non-linearity of the response to water to be discussed. Two sands, five soils and vermiculite were tested in the laboratory. The instrument readings were all depressed below the values that might have been expected for absolute water contents. In sands the depression increases with water content, that is, as pores of progressively larger size fill with water. In clay soils an initial depression is attributable to the rigidity with which the first small amounts of water are adsorbed on to the clay lattice: with more water, the depression, as in sand, reflects the size distribution of the macro pores. 'Relaxation,' a condition needed to ensure accuracy, can be induced by adding iron compounds and salts, but there is evidence that where these substances are present naturally in the soil they may cause different degrees of relaxation. When many soils of known type, structural state and chemical status have to be analysed, a good calibration curve can be obtained and used to give water content to a fraction of a per cent. A moisture characteristic was measured on a sand to assess the ability of the instrument to scan moisture profiles in long columns.

## Chemistry Department

### THESIS

2.1 COULTER, J. K. (1969) The productivity and physical properties of some soil mapping units of the Soil Survey of England and Wales. Ph.D. Thesis, University of London.

### GENERAL PAPERS

2.2 ADDISCOTT, T. M. & TALIBUDEEN, O. (1969) The buffering capacity of potassium reserves in soils. *Potash Rev.* Subject 4, Soil Sci., 45th Suite, pp. 1–24.

2.3 BENZIAN, B., BOLTON, J. & FREEMAN, S. C. R. (1969) Nutrition experiments in forest nurseries. Sulphur. *Rep. Forest Res., Lond.*, 1969, 139–141.

2.4 COOKE, G. W. (1969) Fertilisers in 2000 A.D. *Phosphorus in Agriculture* (*Bull. Docum. Ass. int. Fabr. Superphos.*) No. 53, pp. 1–13. (Reprinted in part in *Fertiliser Feed & Pesticide Journal*, December 1969, pp. 4–6.)

2.5 COOKE, G. W. (1969) Prediction of nitrogen requirements of arable crops in mainly arable cropping systems. In: *Nitrogen and soil organic matter. Tech. Bull. Minist. Agric. Fish. Fd*, No. 15 (Proceedings of a conference organised by the Soil Scientists of the National Agricultural Advisory Service, 22–23 October 1964), pp. 40–60.

2.6 GASSER, J. K. R. (1969) Some processes affecting nitrogen in the soil. In: *Nitrogen and soil organic matter. Tech. Bull. Minist. Agric. Fish. Fd*, No. 15 (Proceedings of a conference organised by the Soil Scientists of the National Agricultural Advisory Service, 22–23 October 1964), pp. 15–29.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



2.7 GASSER, J. K. R. (1969) Determination of the nitrogen requirements of crops by analysis. I. Laboratory methods of measuring soil nitrogen status and methods of correlating measurements with crop performance. In: *Nitrogen and soil organic matter. Tech. Bull. Minist. Agric. Fish. Fd*, No. 15 (Proceedings of a conference organised by the Soil Scientists of the National Agricultural Advisory Service, 22–23 October 1964), pp. 71–77.

2.8 MATTINGLY, G. E. G. (1969) Glasshouse studies needed to supplement field experiments. In: *Experimental techniques for coordinated field fertility experiments using isotopically-labelled fertilisers. Technical Report International Atomic Energy Agency, Vienna*, No. 113, pp. 171–186.

PAPERS IN ROTHAMSTED REPORT, PART 2

2.9 JOHNSTON, A. E. (1970) The value of residues from long-period manuring at Rothamsted and Woburn. I. Introduction. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 5–6.

2.10 JOHNSTON, A. E. (1970) The value of residues from long-period manuring at Rothamsted and Woburn. II. A summary of the results of experiments started by Lawes and Gilbert. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 7–21.

This paper summarises the results of the many tests made by Lawes and Gilbert of the value of residues of fertilisers and manures. Later, further tests were made, some of which still continue and the results of these experiments are included.

2.11 JOHNSTON, A. E. & WARREN, R. G. (1970) The value of residues from long-period manuring at Rothamsted and Woburn. III. The experiments made from 1957 to 1962, the soils and histories of the sites on which they were made. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 22–38.

This paper describes how the microplot experiments made from 1957 to 1962 were accommodated on the three sites used, and gives the histories of the sites. All experimental details including the basal and test fertilisers are given. Barley, potatoes and sugar beet were grown on all three sites, and spring wheat, kale and swedes on one site.

2.12 JOHNSTON, A. E., WARREN, R. G. & PENNY, A. (1970) The value of residues from long-period manuring at Rothamsted and Woburn. IV. The value to arable crops of residues accumulated from superphosphate. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 39–68.

This paper gives the results of the experiments made to test P residues and new P given to starved and enriched soils. Yields, %P in the dry matter of the crops and P uptakes are given.

2.13 JOHNSTON, A. E., WARREN, R. G. & PENNY, A. (1970) The value of residues from long-period manuring at Rothamsted and Woburn. V. The value to arable crops of residues accumulated from potassium fertilisers. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 69–90.

This paper gives the results of the experiments made to test K residues and new K given to starved and enriched soils. Yields, %K in the dry matter of the crops and K uptakes are given.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



2.14 MATTINGLY, G. E. G., JOHNSTON, A. E. & CHATER, M. (1970) The residual value of farmyard manure and superphosphate in the Saxmundham Rotation II experiment, 1899–1968. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 91–112.

This paper describes the analysis of the soils at the end of the original (1899–1964) manuring, the changes in soil analysis between 1964 and 1968, when more superphosphate and farmyard manure were given, and the crop yields and nutrients removed between 1965 and 1968.

2.15 WIDDOWSON, F. V. & PENNY, A. (1970) The effects of partially sterilising agricultural soils with formalin, and of applying nitrogen fertiliser, on the yields and N contents of spring and winter wheat, of barley and of grass. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 113–129.

The experiments measured the direct, residual and cumulative effects of formalin on crops grown without N and with a range of N dressings at Woburn, Rothamsted and Saxmundham.

## RESEARCH PAPERS

2.16 ADDISCOTT, T. M. (1969) A method for measuring the phosphate potential of a Tanzanian soil. *E. Afr. agric. For. J.* **35**, 21–27.

Measurement of the phosphate potential $\frac{1}{2}$pCa + $pH_2PO_4$ is affected by time and method of agitation of the soil suspension, soil : solution ratio, and incubating the moist soil before measurement. The nature of these effects was shown for a hillsand from Ukiriguru. The P concentration and pH of the soli suspension changed greatly after 4 hours' agitation. This was attributed to the onset of microbial respiration. A method suitable for measuring phosphate potentials in local soils (N.W. Tanzania) is described. This involves agitation by air for 1 hour, or possibly overnight, a 1 : 5 soil : solution ratio, and incubating the moist soil at constant temperature for 10 days before measuring the phosphate potential.

2.17 ADDISCOTT, T. M. (1969) Relationships of yields of maize and cotton, and their response to phosphate fertiliser, with soil phosphate potentials in Tanzania. *J. agric. Sci., Camb.* **72**, 401–403.

Yields of maize and cotton given N, and sometimes K but not P, were related to equilibrium values of the monocalcium phosphate potential $(\frac{1}{2}\text{pCa} + pH_2PO_4)_{eq}$, at which P is neither lost nor gained by the soil. The responses to phosphate fertiliser were not clearly related to phosphate potentials, though small responses at large values of $(\frac{1}{2}\text{pCa} + pH_2PO_4)_{eq}$ were sometimes explained by very small values of $\Delta I/\Delta Q$ (the rate of change of $\frac{1}{2}$pCa + $pH_2PO_4$ with change in the amount of P on the soil) or by soil reaction. In only one set of maize experiments, response to P was related to $\Delta I/\Delta Q$. $(\frac{1}{2}\text{pCa} + pH_2PO_4)_0$ and $(pH_2PO_4)_0$, determined without adding P to the solution were equally useful and both were just as well related to yields without P as $(\frac{1}{2}\text{pCa} + pH_2PO_4)_{eq}$. $(pH_2PO_4)_0$ appeared more useful than the logarithm of the total P concentration measured without added P. It was not necessary to find the equilibrium phosphate potential, or to measure Ca concentration, but correcting the phosphate concentration for pH (so that only $H_2PO_4$-ions were taken into account) was worth while.

2.18 ADDISCOTT, T. M. (1970) Use of the quantity/potential relationship to provide a scale of the ability of extractants to remove soil potassium. *J. agric. Sci., Camb.* **74**, 119–121.



*https://doi.org/10.23637/ERADOC-1-124* 

This work is licensed under a Creative Commons Attribution 4.0 International License.



Quantity/potential relationships, between gain and loss of K by the soil and K potential $\left(RT \ln \frac{a_K}{\sqrt{a_{Ca+Mg}}}\right)$, were determined on 27 Rothamsted and Woburn soils. K extracted by neutral *N* ammonium acetate, by H-resin and by 0·5 *M* sodium bicarbonate (pH 8·5) were also measured.

The ability of an extractant to remove soil K is equated to a K potential (derived from the quantity/potential curve) the soil attains after removing K equal to that taken out by extractant. Mean values for all soils were −4995 ± 97 cal/eq for the ammonium acetate, −6081 ± 88 cal/eq for the H-resin and −4336 ± 117 cal/eq for the sodium bicarbonate extractants. The first and last extractants were less able to remove K from rich than from poor soils.

Varying the ammonium ion concentration from 0·1 *N* to 1 *N* in ammonium acetate/acetic acid mixtures, *N* in acetate ions, did not greatly affect their ability to remove K.

2.19 ADDISCOTT, T. M. (1970) The uptake of initially available soil potassium by ryegrass. *J. agric. Sci., Camb.* **74**, 123–129.

The potassium potential limiting uptake of K by ryegrass, 'the uptake potential', was derived from the uptakes of K and from the quantity/potential relationships of several soils by a method that avoids exhausting the soil by cropping. This potential was −5600 cal/eq in Rothamsted soils, but the method was unsuitable for Woburn soils. In Rothamsted soils uptake of K was more closely related to quantity than to potential of K, but in Woburn soils it was equally well related to both. From 28 days until 82 days, when the initially available K had been used in most soils, diffusion in the soil seemed to control rate of uptake of K. On longer cropping, much initially non-available K was released, the grass still grew and the mean K potential had fallen to only −5189 cal/eq in Rothamsted and −5336 cal/eq, in Woburn soils.

2.20 ADDISCOTT, T. M. (1970) The potassium *Q*/*I* relationships of soils given different K manuring. *J. agric. Sci., Camb.* **74**, 131–137.

The potassium quantity/intensity (*Q*/*I*) relationships, which relate change in exchangeable K content (*Q*) to change in activity ratio $\left(I = \frac{a_K}{\sqrt{a_{Ca+Mg}}}\right)$, were measured in soil samples from manuring experiments at Rothamsted and Woburn. Within each experiment, *Q*/*I* curves for different K-manuring treatments were super-imposable on each other and on the curve relating exchangeable K to $I_0$, the activity ratio at which the soil neither gains nor loses K. The distances on the ΔK axis between the curves were equal to the differences in exchangeable K.

The buffer capacity, $\frac{dQ}{dI}$, was related to the K saturation of the cation exchange capacity (CEC) by the equations

$$\frac{dQ}{dI} = 112 - (1163 \pm 90)\frac{Q}{CEC} \quad (Q \text{ and } CEC \text{ in me/100 g})$$

for Broadbalk and Hoosfield soils, and

$$\frac{dQ}{dI} = b\left(\frac{Q}{CEC}\right)^{-m}$$

for Barnfield soils ($b = 3{\cdot}08$; $m = 1{\cdot}0$) and for Woburn Market Garden soils ($b = 2{\cdot}41$; $m = 0{\cdot}6$) but for soils from other Woburn experiments, $\frac{dQ}{dI}$ did not vary significantly with *Q*/*CEC*.



https://doi.org/10.23637/ERADOC-1-124 pp 12

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



2.21 BENZIAN, B., BOLTON, J. & MATTINGLY, G. E. G. (1969) Soluble and slow-release PK-fertilisers for seedlings and transplants of *Picea sitchensis* and *Picea abies* in two English nurseries. *Pl. Soil* **31**, 238–256.

In a heathland nursery on an acid sandy podsol and in a nursery on moderately acid agricultural land, four PK fertilisers were compared with superphosphate alone, using seedlings and transplants of Sitka spruce *Picea sitchensis* and Norway spruce *Picea abies* as test crops. The four fertilisers were: (1) a compound prepared from KCl and superphosphate (KCl/superphosphate), (2) the same compound supplemented by three summer top-dressings of potassium nitrate, (3) potassium dihydrogen phosphate, (4) potassium metaphosphate. Except for potassium nitrate all fertilisers were applied in the spring before sowing or transplanting.

Mid-season analyses (confined to Sitka spruce seedlings) showed that the effectiveness of different fertilisers depended on the rainfall pattern during growth. Phosphorus and potassium were leached less and nutrients used more efficiently with potassium metaphosphate than with KCl/superphosphate. Potassium nitrate applied on three occasions during the summer to plots with KCl/superphosphate maintained the best growth and largest K-concentrations in the seedlings. Differences between fertilisers were small for transplants at the heathland nursery and for all crops at the nursery on an agricultural-type soil. Losses of P and K by leaching on the sandy podsol both decreased in the order KCl/superphosphate > or = potassium dihydrogen phosphate > potassium metaphosphate.

2.22 BOLTON, J. (1968) Leaching of fertilisers applied to a latosol in lysimeters. *J. Rubb. Res. Inst. Malaya* **20**, 274–284.

Uncropped lysimeters were used to study fertiliser leaching through a Malayan latosol at two pH values. Chloride leached rapidly. Nitrate derived from ammonium sulphate or urea leached more slowly, especially in the more acid soil. Sulphate leached much more slowly and was strongly adsorbed by the more acid soil (this affected pH measurements). Fertiliser potassium also leached faster from the more acid soil (pH 4·8). At pH 5·2 added potassium remained in the profile but the depth it penetrated depended on the amounts of anions added concurrently. Fertiliser magnesium also leached more quickly when nitrogen or chloride were simultaneously added.

2.23 BRIGGS, G. G. (1969) Molecular structure of herbicides and their sorption by soils. *Nature, Lond.* **223**, 1288.

The sorption of a number of phenylurea herbicides by soil organic matter was shown to be related to the electron-withdrawing power, measured by the Hammett and Taft constants, of substituents on the phenyl ring or the urea side chain. For alkyl-N-phenylcarbamates electronic effects are small and increasing sorption is associated with increasing lipophilicity measured by octanol/water partition.

2.24 MATTINGLY, G. E. G. (1970) Total phosphorus contents of soils by perchloric acid digestion and sodium carbonate fusion. *J. agric. Sci., Camb.* **74**, 79–82.

The total P contents of soils analysed after fusion with sodium carbonate, were consistently larger than after digestion with boiling perchloric acid. For 37 soils from Southern England, values by fusion analysis ($P_f$) were related to values after digestion with perchloric acid ($P_p$) by the following equation:

$$P_f \text{ (ppm)} = \underset{(\pm 6{\cdot}86)}{38{\cdot}8} + \underset{(\pm 0{\cdot}01176)}{1{\cdot}0021} P_p$$



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



The recovery of P, applied to six soils as superphosphate, was the same by both methods of analysis.

2.25 NOWAKOWSKI, T. Z. (1969) Effects of nitrogen and potassium fertilisers on contents of carbohydrates and free amino acids in Italian ryegrass. I. Effects on growth and soluble-carbohydrate contents of leaves, stubble and roots. *J. Sci. Fd Agric.* **20**, 666–670.

Italian ryegrass S22, grown in K-deficient sandy loam in pots under glass, was given 40, 80 and 160 ppm N as ammonium nitrate and 0, 60, 120 and 240 ppm K as potassium chloride. Without K fertiliser, increasing N fertiliser decreased root weights, but with the largest dressing of K, grass given most of N produced more roots than grass given least N. K fertiliser increased root weights and the content of soluble carbohydrates in roots. Irrespective of K supply, roots contained very little fructosan. Adequate K was needed to give maximum amounts of sugars and fructosan in the tops and stubble. Excessive K in relation to N fertiliser was detrimental to the accumulation of fructosan in the stubble. The importance of the effect of K on soluble carbohydrates is briefly discussed.

2.26 RAWSON, R. A. G. (1969) A rapid method for determining the surface area of aluminosilicates from the adsorption dynamics of ethylene glycol vapour. *J. Soil Sci.* **20**, 325–335.

A new method is described for determining the surface area of soils and clays by adsorbing ethylene glycol vapour under continuous evacuation at *c.* $10^{-2}$ cm of mercury. The adsorption of a monolayer of ethylene glycol is inferred from the dynamics of pressure changes in the adsorption chamber. The time at which monolayer adsorption is evaluated is proportional to the total weight of ethylene glycol required to form a monolayer on all samples in the adsorption chamber. This period ranged from 30 to 75 minutes when from 0·39 to 1·56 g of glycol was adsorbed in the experiments. A single 0·75 g sample of Wyoming bentonite required 0·19 g glycol.

2.27 (SINGH, M. M.) & TALIBUDEEN, O. (1969) Thermodynamic assessment of the nutrient status of rubber-growing soils. *J. Rubb. Res. Inst. Malaya* **21**, 240–249.

Schofield's thermodynamic concepts of intensity and quantity were used to measure the potassium and phosphorus status of Malayan rubber-growing soils. For acid soils, intensity and quantity measurements need be done using aluminium as the reference ion instead of calcium used elsewhere. For phosphorus, intensities were measured in dilute ammonium chloride solutions instead of calcium chloride solutions used elsewhere, and quantities were measured by isotopic exchange.

These thermodynamic indices and the conventional indices of acid-extractable and exchangeable values for potassium, and total and available indices for phosphate, which are in current routine use, were related to uptake by *Pueraria phaseoloides* in the glasshouse. This showed that, to assess the potassium status of Malayan soils, the buffer capacity value obtained from the slope of the quantity/intensity relationship curve was better than the conventional acid-extractable and exchangeable values currently used to assess the fertiliser requirements of rubber. For phosphorus, both conventional and thermodynamic quantity indices related directly to glasshouse cropping. More work is necessary for a systematic correlation.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



2.28 WIDDOWSON, F. V. & PENNY, A. (1969) Effects on barley and kale of NPK fertilisers containing differing proportions of urea and ammonium nitrate, and either triple superphosphate or mono-urea phosphate. *J. agric. Sci., Camb.* **73**, 125–132.

Of eight experimental fertilisers (with %N; $\%P_2O_5$; $\%K_2O$ ratios of 2 : 1 : 1) obtained, four contained triple superphosphate and four mono-urea phosphate; all contained muriate of potash. In the first four, urea supplied either 100, 66, 33 or 0% of the total N (ammonium nitrate supplied the remainder); in the second four, urea and ammonium nitrate supplied only the balance of the N, but in the same proportions.

For barley, each fertiliser was combine-drilled to give 0·5 or 1·0 cwt N/acre. In 1965, much rain fell after drilling, early growth was not harmed and yield from each fertiliser was the same. In 1966, dry weather followed sowing and all fertilisers checked growth; those containing urea killed many plants and diminished yields. Also yields from the fertilisers containing urea phosphate were larger than from those containing superphosphate; thus urea phosphate was safer than urea alone. For kale, the fertilisers were broadcast in May to give 1·25 or 2·50 cwt N/acre. None seriously diminished plant number and yield from all was similar.

Increasing the proportion of urea in the fertilisers greatly increased %N in the barley grain in 1966, but not in 1965. The crops recovered more N from ammonium nitrate than from urea.

2.29 WILLIAMS, R. J. B. (1969) The rapid determination of nitrate in crops, soils, drainage and rainwater by a simple field method using diphenylamine or diphenylbenzidine with glass fibre paper. *Chemy Ind.* 1735–1736.

Well known colour reactions given by diphenylamine and diphenylbenzidine with nitrate in the presence of concentrated sulphuric acid were used for spot-testing on glass fibre paper. Nitrate concentrations could be determined semi-quantitatively in plant sap expressed from tissue, in an extract produced by a simple method from soil, or directly in land drainage water, or rainwater.

## Pedology Department

### GENERAL PAPERS

3.1 LE RICHE, H. H. (1968) The location of trace elements in sedimentary rocks and in soils derived from them. *Report of Welsh Soils Discussion Group, No. 9*, 17–30.

### RESEARCH PAPERS

3.2 (BLASCO, M. L.), WEIR, A. H., CATT, J. A. & ORMEROD, E. C. (1969) Mineralogy of the soils of the Rio Cauca Valley, Colombia. *Turrialba* **19**, 332–339.

The mineralogical composition of fine sand (50–250 $\mu$m) and clay (<2 $\mu$m) fractions from surface soils of the Rio Cauca Valley is described. The soils contain variable amounts of essentially basic volcanic material and slightly weathered sediments, derived from the surrounding mountainous areas at various times since the late Tertiary. The composition of the clay fractions is determined partly by differences between the amounts of these two parent materials and partly by soil conditions, particularly pH.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



3.3 BLOOMFIELD, C. (1969) Mobilisation and fixation of iron and trace elements by aerobically decomposing plant matter. *Chemy Ind.* 1633–1634.

Fe, Mn, Cu, Ni, Co, Zn and Pb are mobilised when their oxides or carbonates are incubated aerobically with moist plant matter. The order of ease of mobilisation is quite different from that of the analogous anaerobic system. Only part of the aerobically mobilised metal is dialysable. Mo and V, mobilised by incubating the metals with lucerne, are completely dialysable.

Very little V is retained by the insoluble organic residue, but relatively large amounts of the other elements are thus fixed. Mn mobilised anaerobically was taken up by pea plants, but the non-dialysable fraction of aerobically mobilised Mn was not.

3.4 BLOOMFIELD, C. (1969) Sulphate reduction in waterlogged soils. *J. Soil Sci.* **20**, 207–221.

In studying the factors that influence the release of free $H_2S$, flooded soils were incubated with plant material and either sodium sulphate or elemental sulphur. Residual sulphate, FeS and $H_2S$ were measured throughout the reaction.

Less free $H_2S$ was evolved from a periodically waterlogged soil than from a well-drained soil of comparable HCl- and dithionite-soluble Fe contents. With a readily soluble synthetic $Fe_2O_3$ as the source of Fe, a slight excess of Fe over the $SO_4^{2-}$ equivalent sufficed to prevent loss of $H_2S$. The native organic matter in the well-drained Rothamsted top-soil seemed to have no effect in promoting loss of $H_2S$, but the FeS : $H_2S$ ratio was strongly influenced by the nature of the plant material used as the source of energy. With either $Na_2SO_4$ or S, considerably more free $H_2S$ was evolved with lucerne than with rice blade. With S, the pH of the incubated mixture was close to that of the nominally S-free system, whereas with $Na_2SO_4$ the mixture became quite alkaline. More free $H_2S$ was evolved under the more alkaline conditions obtained with $Na_2SO_4$, which suggests that it is the initial mobilisation of Fe that governs the distribution of the reduced S, rather than the pH-solubility relations of FeS. An oxidised surface layer is very effective in retaining sulphur in the soil.

3.5 BROWN, G. & KANARIS-SOTIRIOU, R. (1969) The determination of sulphur in soils by X-ray fluorescence analysis. *Analyst, Lond.* **94**, 782–786.

A method for determining the total sulphur content of soils is described that is fast (less than 4 minutes per sample) and sensitive enough (lower limit of detection less than 10 ppm sulphur) for survey and soil-fertility investigations. A simple correction for matrix effects caused by large variations (10–90%) of organic matter content is based on the loss of weight at 450°C.

3.6 BROWN, G. & KANARIS-SOTIRIOU, R. (1969) Thin windows for flow proportional counters in X-ray fluorescence spectrometers. *J. scient. Instrum.* (*J. Physics E*) Ser. 2, **2**, 551–552.

Thin windows are required when flow proportional counters are used to determine light elements ($Z = 11$–$16$) by X-ray fluorescence spectrometry. Makrofol KG, the polycarbonate of 4,4′-dihydroxy-diphenyl-2,2′-propane, available as 2 $\mu$m thick film, is suitable. Of the commercially available films it has the largest transmission for the K-radiation of the light elements and when correctly fitted it is quite durable.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



3.7 BROWN, G., CATT, J. A. & WEIR, A. H. (1969) Zeolites of the clinoptilolite-heulandite type in sediments of S.E. England. *Mineralog. Mag.* 1969, **37**, 480–488.

Clinoptilolite-heulandite occurs in Jurassic, Cretaceous and Palaeocene sediments in S.E. England, mainly in 1–20 $\mu$m size fractions; it is associated with abundant montmorillonite and often also with glauconite and amorphous silica or low temperature disordered cristobalite-tridymite. Its mode of occurrence and the associated minerals suggest an authigenic origin, but there is no evidence that the source material was volcanic.

3.8 GREENE-KELLY, R. (1970) The relation of particle morphology and aggregation to specific surface area determinations. In: *Surface area determination.* Proc. Symposium Bristol, 1969, I.U.P.A.C., Butterworths.

Plate-like particles tend to orient and form close-packed aggregates, which make surface area determinations difficult to interpret in terms of particle size. For example, the adsorption of nitrogen can be limited by the impermeability of the sample, and hence the B.E.T. method gives results that are too small. The surface area measured by the Absolute calorimetric method can also be too small because capillary condensation is likely to occur between mutually oriented platelets before the heat of adsorption approaches the heat of condensation of bulk water.

3.9 GREENE-KELLY, R. & MACKNEY, D. (1970) Preferred orientation of clay in soils: the effect of drying and wetting. In: *Soil micromorphology, Tech. Monogr. Soil Surv.* No. 3.

The origin of the optically birefringent oriented clay observed in sections of many fine-textured soils is briefly discussed. Experiments designed to evaluate the effect of drying and wetting remoulded clay soils on the orientation of clay particles showed no significant change in orientation.

3.10 GREENE-KELLY, R., CHAPMAN, S. & (PETTIFER, K.) (1970) The preparation of thin sections of soils using polyethylene glycols. In: *Soil micromorphology, Tech. Monogr. Soil Surv.* No. 3.

The properties of polyethylene glycols are summarised and details are given for the preparation of thin sections of soils using Carbowax 6000 as embedding agent. The advantages and limitations of the technique in limiting the extent of shrinkage during dehydration of the specimen are discussed.

3.11 KANARIS-SOTIRIOU, R. & BROWN, G. (1969) The diminution of sulphur contamination of powder specimens in X-ray fluorescence analysis. *Analyst, Lond.* **94**, 780–781.

The determination of light elements by X-ray fluorescence spectrometry requires minimal absorption in the X-ray path. This is usually achieved by evacuating the spectrometer with a rotary vacuum pump. Backstreaming of vapours from rotary vacuum pump oils causes contamination by the absorption of sulphur-containing compounds on the surface of powder specimens. A method is described for greatly decreasing this contamination by preparing powder specimens with a thin plastic film on the surface to be analysed.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



3.12 KING, H. G. C. & PRUDEN, G. (1969) The colorimetric determination of calcium in silicate minerals. *Analyst, Lond.* **94**, 39–42.

Calcium in silicate minerals is determined with glyoxal bis (2-hydroxy anil) in alkaline solution. Aluminium does not interfere at the pH of the reaction and co-precipitation of calcium with magnesium and iron is prevented by adding mannitol. Fifty $\mu$g of calcium can be determined in the presence of 3000 $\mu$g of magnesium and 2000 $\mu$g of iron; the calibration is linear between 0 and 80 $\mu$g of calcium.

3.13 KING, H. G. C. & PRUDEN, G. (1969) The determination of sulphur dioxide with rosaniline dyes. *Analyst, Lond.* **94**, 43–48.

The compositions of commercial rosaniline and pararosaniline hydrochlorides were investigated in connection with the colorimetric determination of sulphur dioxide. After purification both gave linear calibration curves up to 80 $\mu$g of sulphur dioxide, a considerably greater upper limit than can be obtained with the unpurified materials. Pararosaniline hydrochloride gives a smaller reagent blank, and is therefore preferred. Impurities are readily removed from pararosaniline base by recrystallisation, and in this form the reagent gives reproducible calibration curves.

3.14 NEWMAN, A. C. D. (1969) Cation exchange properties of mica. I. The relation between mica composition and potassium exchange in solutions of different pH. *J. Soil Sci.* **20**, 357–373.

The abilities of ten trioctahedral micas and two dioctahedral micas to release K by cation exchange were compared by repeatedly extracting the micas with NaCl solutions.

For a chosen solution concentration and pH, the quasi-equilibrium concentration of K in contact with a mica is largely independent of the fraction of mica K exchanged. The solution concentration ratio $C_K/C_{Na}$ ranges from $1 \times 10^{-5}$ for dioctahedral micas to $1{\cdot}2 \times 10^{-3}$ for a very reactive biotite, and seems to depend on the number of structural-hydroxyl groups oriented so that the OH transition moment is perpendicular to the mica basal plane. In the phlogopite–biotite series the F content is the most important single constituent of a mica that determines its K releasing properties.

Micas that lose much negative charge when K is exchanged release K more readily to acidic solutions. The pH of unbuffered solutions increases during the exchange of K, confirming the view that sorption of protons decreases the negative charge of the aluminosilicate layers.

3.15 NEWMAN, A. C. D. & BROWN, G. (1969). Delayed exchange of potassium from some edges of mica flakes. *Nature, Lond.* **223**, 175–176.

Abraded edges of mica crystals exchange their potassium more readily than more perfect edges. X-ray diffraction and microscopic observations suggest that the interlayer swelling that follows replacement of K can take place readily only when mica is cleaved into thin flakes. At more perfect edges swelling is delayed until enough hydratable cations are exchanged to develop a swelling stress sufficient to cleave the mica.

3.16 (PENNY, L. F., COOPE, G. R.) & CATT, J. A. (1969) Age and insect fauna of the Dimlington Silts, East Yorkshire. *Nature, Lond.* **224**, 65–67.

The Dimlington Silts occupy hollows on the surface of the Saale till and are overlain by the Weichsel tills of Holderness, East Yorkshire. Radiocarbon dates



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



of fossil moss from the silts indicate that they were deposited approximately 18 500 years ago. The ice that deposited the Weichsel tills therefore invaded Holderness between this time and approximately 13 000 years ago; this advance was contemporaneous with the main phase of the Weichsel Glaciation on the continent of Europe and in N. America. Fossil Coleoptera from the silts indicate that they were deposited in a pond with little aquatic vegetation, surrounded by open expanses of sand; it is an impoverished mid-Weichsel fauna, suggesting that climatic conditions were too harsh for all but the most hardy species, probably because the ice was then quite close.

3.17 PRUDEN, G. & BLOOMFIELD, C. (1969) The effect of organic matter on the determination of ferrous iron in soils and rocks. *Analyst, Lond.* **94**, 688–689.

In the determination of ferrous iron in silicates, ferric iron is reduced by organic matter when the sample is dissolved in hydrofluoric acid. Acidic reagents, such as aqueous aluminium chloride solution, that have been proposed for extracting labile ferrous iron from waterlogged soils, suffer from the additional defect of causing partial dissolution of ferrous sulphide, with the consequent risk that yet more ferric iron may be reduced by the liberated hydrogen sulphide.

3.18 PRUDEN, G. & KING, H. G. C. (1969) A scheme of semi-micro analysis for the major elements in clay minerals based on modifications to conventional methods of silicate analysis. *Clay Min.* **8**, 1–13.

A scheme is presented for the semi-micro analysis for the major elements in clay minerals, based mainly on improvements to conventional colorimetric methods. Silica and alumina are determined after fusing a 50 mg sample with sodium hydroxide. Titanium, total iron, calcium, magnesium, phosphorus and manganese are determined colorimetrically on a hydrofluoric–sulphuric acid digest of a 50 mg sample; sodium and potassium are determined flame photometrically on the same digest. Ferrous iron is determined separately. Additional methods for the determination of total water, total sulphur and fluorine are indicated.

3.19 RAYNER, J. H. (1969) The numerical approach to soil systematics. In: *The soil ecosystem. Systematics Association Publication*, No. 8, 31–39.

Numerically coded descriptions of soil horizons can be used to classify soils. The calculated similarities of 91 Glamorganshire soil horizons are submitted to a principal co-ordinates analysis. The first component separates the horizons into two groups, all the horizons from the brown earth soils and all the horizons from the acid brown earth soils. The second component depends on the depth of the horizon regardless of the type of soil. This treatment is compared with others in which soil rather than horizon similarities are found and the advantage of principal co-ordinates analysis over ordination is shown by a recalculation of Bidwell and Hole's data for soil similarities. The extension of these methods to much larger groups of soils is discussed.

3.20 WEIR, A. H. & CATT, J. A. (1969) The mineralogy of Palaeogene sediments in northeast Kent (Great Britain). *Sediment. Geol.* **3**, 17–33.

The Palaeogene deposits of northeast Kent are approximately 700 ft thick and consist of unconsolidated clays and loamy sands that are mainly of marine origin. The mineralogical composition of fine sand (50–250 $\mu$m), silt (2–5 $\mu$m, 5–20 $\mu$m and 20–50 $\mu$m) and clay (<2 $\mu$m) fractions from samples representing



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



the main subdivisions of the succession is described, and possible sources of the detritus and mode of origin of some non-detrital minerals are discussed. The detritus was derived ultimately from three main sources: (*a*) the Chalk; (*b*) metamorphic rocks (containing staurolite and kyanite) and granites, possibly of Armorican massifs; (*c*) metamorphic rocks containing garnet, epidote and amphiboles. In most of the deposits the clay fractions are composed of montmorillonite with subsidiary mica, but kaolinite occurs in beds containing abundant detritus from possible Armorican sources. The main non-detrital minerals are glauconite, jarosite, pyrites, low-temperature tridymite and clinoptilolite; detrital clay micas in the sandy sediments have authigenic growths of a layer silicate mineral. The main clay-rich subdivision of the succession (the London Clay) is weathered to great depths; the mineralogical effects of this weathering include oxidation of pyrites, alteration of detrital biotite and formation of selenite and jarosite.

## Soil Microbiology Department

### Paper in Rothamsted Report, Part 2

4.1 Nutman, P. S. & Ross, G. J. S. (1969) *Rhizobium* in the soils of the Rothamsted and Woburn farms. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 148–167.

This paper reports counts made of *Rhizobium trifolii*, *R. leguminosarum*, *R. meliloti* and *R. lupini* in some of the arable fields of Rothamsted and Woburn and in selected plots of the Park Grass experiment.

### Research Papers

4.2 Brown, M. E. & Walker, N. (1970) Indolyl-3-acetic acid formation by *Azotobacter chroococcum*. *Pl. Soil.* **32,** 250–253.

Small amounts (up to 2·5 $\mu$g/ml) of indolyl-3-acetic acid (IAA) were detected in aerated cultures of *Azotobacter chroococcum* grown with or without L-tryptophane in the medium but in agar cultures only when L-tryptophane was present. Most IAA occurred in 7-day-old cultures. Washed cells did not convert L-tryptophane enzymically to IAA.

4.3 Dart, P. J., (Birch-Andersen, A. & Jensen, H. J.) (1970) Observations on the fine structure of *Rhizobium*. *Arch. Mikrobiol.* (In the press.)

The fine structure of *Rhizobium meliloti* and *R. phaseoli* grown in broth or on agar is well preserved by prefixation in glutaraldehyde or formaldehyde. Much more of the cytoplasmic matrix is retained than with $OsO_4$ fixation alone, so the boundary between the nucleoid region and the rest of cytoplasm is more difficult to differentiate.

A ribosome-free space, usually at the cell poles, sometimes contained an amorphous material of intermediate electron density. The cytoplasm also contained whorled inclusions, and electron-transparent regions, presumably poly-$\beta$-hydroxybutyrate. An intermediate layer, closely appressed to the cell wall membrane of 1-day cultures gives it an asymmetric appearance. The plasma membrane often invaginates into the cytoplasm and, after glutaraldehyde fixation, there is an electron-dense material, distinct from the intermediate layer, between the two peripheral membranes. Some cells also contain an intracytoplasmic tubular profile.



*https://doi.org/10.23637/ERADOC-1-124* 

This work is licensed under a Creative Commons Attribution 4.0 International License.



4.4 DART, P. J., ROUGHLEY, R. J. & CHANDLER, M. R. (1969) Peat culture of *Rhizobium trifolii*: an examination by electron microscopy. *J. appl. Bact.* **32**, 352–357.

Peat cultures of *Rhizobium trifolii* strain TA1 were examined by electron microscopy of thin sections and scanning reflection electron microscopy of the peat particle surfaces. The Badenoch peat used contained: plant cell-wall fragments, membranes with dense-light-dense appearance in vesicular or linear form, tubular structures, other unidentified wall-like fragments, all usually surrounded by a matrix of varying electron density and granularity. Electron density was generally considerable, even in plant-wall fragments, although the matrix has some electron-transparent spaces. Remains of bacteria and actinomycetes often occurred within the peat particles. Particle shape varied a great deal; the surface was irregular with many crevices. *Rhizobium* cells were found on the surfaces, and sometimes in crevices of the particles. Rarely >10 cells were found together and the cells were usually several microns apart. The rhizobia were structurally similar to broth-cultured log phase cells, but the region between cell wall membrane and plasma membrane in many was very electron dense. The rhizobia were usually enmeshed in a fibrillar matrix connecting them to the peat particles; this was probably the film seen to cover the bacteria in scanning surface pictures. The pictures show that most of the peat surface is free of rhizobia, and that many more bacteria could be added when the peat culture is prepared.

4.5 DART, P. J. & (WILDON, D. C.) (1970) Nodulation and nitrogen fixation by *Vigna sinensis* and *Vicia atropurpurea*: the influence of concentration, form and site of application of combined nitrogen. *Aust. J. agric. Res.* **21**, 45–56.

Nitrogen fixation by *Vigna sinensis* nodulated effectively by either *Rhizobium* QA323 or CB441 is little restricted by applications at sowing of $NH_4NO_3$ up to 24 mg N/plant. The growth patterns of these two associations are differentially affected by N, and both differ considerably from unnodulated plants given combined nitrogen. Nitrogen fixation by *V. sinensis*—SU318 can be stimulated by small amounts of combined nitrogen at sowing but all amounts of combined nitrogen used in these experiments depressed fixation by *Vicia atropurpurea*.

Primary root nodulation of *V. atropurpurea* by the effective *Rhizobium* strain V27E, or the ineffective strain NA6, and of *V. sinensis* by the effective *Rhizobium* strain SU318, is influenced by the form and amount of the combined nitrogen applied ($NH_4NO_3$, $KNO_3$, $(NH_4)_2SO_4$ or $CO(NH_2)_2$), and of *V. atropurpurea* is also influenced by *Rhizobium* strain. These forms of combined nitrogen restrict primary root nodulation on both hosts similarly except that urea has little effect on *V. atropurpurea*. Both plants formed many more nodules on the secondary roots than on the primary, but numbers on secondary roots, were little affected by the combined nitrogen.

Immersing the first leaves of *V. sinensis* seedlings in solutions of combined nitrogen depressed nodulation, but urea slightly stimulated top dry weight.

4.6 HAYMAN, D. S. (1970) *Endogone* spore numbers in soil and vesicular-arbuscular mycorrhiza in wheat as influenced by season and soil treatment. *Trans. Br. mycol. Soc.* **54**, 53–63.

Numbers of *Endogone* spores in soil changed little from December to June, greatly increased during July, and began to decrease in September. Formalin applied to soil in 1967 made spores fewer in 1968, and had more effect in soil not previously given formalin than in soil given formalin in 1964 and 1965. Plots without nitrogen and other fertilisers consistently contained more spores than plots with



https://doi.org/10.23637/ERADOC-1-124 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



fertilisers. Vesicular-arbuscular mycorrhizal infection was sparse during May and increased during the summer to a peak in September. It was most abundant in plots containing most *Endogone* spores. The number of spore types differed in different wheat fields. The increases in spore numbers and mycorrhizal infection during the summer suggest that *Endogone* has little effect on the wheat during the period of rapid root and shoot development before flowering.

4.7 KLECZKOWSKA, J. (1969) The mutation of some virulent rhizobiophages into the temperate form. *Can. J. Microbiol.* **15**, 1055–1059.

Lysogenic bacteria carrying temperant mutants of virulent rhizobiophages were isolated from some of the cultures which phage resistant survivals of host bacteria had coexisted with the virulent phages for several weeks at 25°.

4.8 MOSSE, B. (1970) Honey-coloured, sessile *Endogone* spores: I. Life history. *Arch. Mikrobiol.* **70**, 167–175.

The life history of a mycorrhizal *Endogone* sp. with honey-coloured, sessile resting spores is described. The spores originate as lateral outgrowths from the subtending hypha of a previously formed mother spore that collapses when its contents migrate into the resting spore. Before the resting spore germinates, dense regions develop within it and the wall splits. Peripheral compartments with normal cytoplasmic contents develop within the split wall. Several germ tubes, originating in these compartments, penetrate the outer wall when the spore germinates. The possibility is discussed that the resting spore may be a zygospore, and the peripheral compartments analogous to a sporangium.

4.9 MOSSE, B. (1970) Honey-coloured, sessile *Endogone* spores: II. Changes in fine structure during spore development. *Arch. Mikrobiol.* (In the press.)

The fine structure of honey-coloured, sessile *Endogone* spores is described from initiation of the mother spore to dormancy of the resting spore. Three unusual organelles occur, viz. pigment granules, large crystals and self-duplicating bacteria-like structures. The first two are very numerous, and are specifically associated with spore formation. The pigment granules are involved in the deposition of the honey-coloured wall, and change into myelin-like figures when cytoplasm moves from the mother into the resting spore. The crystals, the function of which is not known, are most conspicuous just before the resting spore reaches dormancy. The bacteria-like organisms, which may be actinomycete spores living symbiotically in the fungus, multiply greatly as the spore enters dormancy. The dormant spore contains very little cytoplasm, which is compressed into a fine network between very large polygonal oil globules and large round bodies thought to contain a storage polysaccharide.

4.10 MOSSE, B. (1970) Honey-coloured, sessile *Endogone* spores: III. Wall structure. *Arch. Mikrobiol.* (In the press.)

Honey-coloured, sessile *Endogone* spores develop as lateral outgrowths from the subtending hypha of a previously formed, short-lived parent spore. Cytoplasm migrates from the parent spore into the rapidly expanding resting spore, which is full-grown after 3 days and then develops its characteristic honey colour. The rigid, coloured, outer wall of the mature resting spore can easily be dissected from a thin transparent inner wall. Before germination the multi-layered wall of the resting spore splits, cytoplasm moves into the split, and new radial and tangential walls are laid down. This produces a series of peripheral compartments within the split wall, and germ tubes arise from these.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



4.11 MOSSE, B., HAYMAN, D. S. & IDE, G. J. (1969) Growth responses of plants in unsterilised soil to inoculation with vesicular-arbuscular mycorrhiza. *Nature, Lond.* **224**, 1031–1032.

Seedlings infected with vesicular-arbuscular mycorrhizal endophytes can grow better in unsterilised soil than non-mycorrhizal seedlings and almost as well as mycorrhizal seedlings in sterilised soil.

4.12 ROUGHLEY, R. J. (1969) The influence of root temperature, *Rhizobium* strain and host selection on the structure and nitrogen fixing efficiency of the root nodules of *Trifolium subterraneum*. *Ann. Bot.* (In the press.)

Low root temperatures greatly affected the structure and $N_2$-fixing efficiency of root nodules. More nodule tissue was formed per plant at 11° and 15° than at 7° and 19°C. Low root temperatures either prevented or slowed bacteroid differentiation; the differentiation zone was 19% of the total nodule tissue at 7° but only 5% at 19°C.

The amount of bacteroid tissue formed at the different root temperatures by the two fully effective strains TA1 and SU297 reflected the environment from which they originated. Both formed the same amount at 15° and 19°C but only TA1, which originated from a cold environment formed bacteroids at 7°C. At 7°C a bacteroid-filled cell did not degenerate until after 20 days, c.f. less than 10 days at 19°C. At 7°C and 11°C all strains formed more bacteroids in the abundantly nodulating than in the sparse host independently of nodule number. Strain 0403 was most sensitive to both temperature and host; it formed bacteroids in nodules on the sparse host at 19°C only, but formed bacteroids in the abundant host between 7°–19°C.

The amount of bacteroid tissue formed by TA1 and SU297 depended directly on nodule number and was approximately constant between 20–40 days only at 19°C when nodule formation had almost stopped.

The optimum temperature for maximum fixation of nitrogen was not necessarily that for maximum efficiency of fixation, which for these experiments was 51 $\mu$g N/mm$^3$ bacteroid tissue/day.

4.13 ROUGHLEY, R. J. & DART, P. J. (1969) Root temperature and root-hair infection of *Trifolium subterraneum* L. cv. Cranmore. *Pl. Soil* **32**. (In the press.)

The infection of root hairs and nodulation of *T. subterraneum* L. cv. Cranmore by *Rhizobium trifolii* strain TA1 was extremely sensitive to root temperature. Within the range 11°–19°C infection was progressively delayed as root temperature decreased. At 7°C, root hairs were not infected by 40 days, and lateral roots formed in the zone where nodules formed at 19°C.

4.14 ROUGHLEY, R. J. & DART, P. J. (1969) Reduction of acetylene by nodules of *Trifolium subterraneum* as affected by root temperature, *Rhizobium* strain and host cultivar. *Arch. Mikrobiol.* **69**, 171–179.

The nitrogenase activity (measured by reduction of $C_2H_2$ to $C_2H_4$) of nodules on *Trifolium subterraneum* grown at root temperatures from 7°–19°C was broadly correlated with nitrogen fixation. Root temperature did not affect enzyme activity *per se* but did affect the amount of enzyme formed. Exposure of nodules to 7°C for 24 hours did not decrease activity compared with 19°C. Activity was greatest when nodules were about 4 days old, before swollen bacteroid forms were produced, and then declined. The effectiveness of a bacterial strain at a given temperature was related to the amount of enzyme produced and to its persistence. Nitrogenase activity should be measured throughout the plant-growth cycle for valid comparisons of strain effectiveness.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



4.15 ROUGHLEY, R. J. & DART, P. J. (1970) Growth of *Trifolium subterraneum* L. selected for sparse and abundant nodulation as affected by root temperature and *Rhizobium* strain. *J. exp. Bot.* (In the press.)

Root temperature greatly affected plant growth whether or not plants depended on symbiotic nitrogen fixation. Plant yield was significantly decreased by each 4° fall in temperature from 19° to 7°C, by amounts that depended both on the host and *Rhizobium* strain. Symbiosis with strain TA1, originally isolated from a cold environment, was most tolerant of a root temperature of 11°C.

Root temperature affected the number, rate of formation and distribution of nodules on the root system. At 7°C fewer nodules formed than between 11°–19°C. At 7°C nodules did not form on secondary roots by 40 days but at 11°C the secondary roots nodulated rapidly between 30–40 days. Nodule formation at 19°C was almost completed at 20 days, when secondary root nodules accounted for 60% of the total. Within the range 15°–19°C, at which the original selections for sparse and abundant nodulation were made, plants nodulated true to selection, but not at 11°C. At 7° and 11°C plants nodulated with TA1 yielded more with increasing number of nodules.

4.16 ROUGHLEY, R. J., DART, P. J., NUTMAN, P. S. & CLARKE, P. E. (1970) The infection of *Trifolium subterraneum* root hairs by *Rhizobium trifolii*. *J. exp. Bot.* **21**, 186–194.

Both host cultivar and *Rhizobium* strain influence the number of infected root hairs of *Trifolium subterraneum* seedlings. Yarloop had fewer infections than Cranmore, Mount Barker or Tallarook and *Rhizobium trifolii* strain 5 infected fewer hairs than strain TA1. Hybrid lines bred for sparse or abundant nodulation had similar numbers of infected hairs, but, as in the cultivars, these always greatly exceeded the number of nodules formed. More infection threads aborted early during growth in the root hairs of Cranmore than other hosts and early abortion was more common with strain 5 than with strain TA1.

On all hosts and with all *Rhizobium* strains, infection began on day 3 and was initially restricted to one or two zones along the root, with later infections extending these zones or initiating new ones. The exponential rate of infection (least for Yarloop) slowed sharply when nodules appeared. Early nodules and lateral roots formed at different places in different hosts, and in most cultivars and hybrid lines nodules and laterals occurred in mutually exclusive zones. Primordia arising above the first nodule failed to develop further.

4.17 ROUGHLEY, R. J., DART, P. J., NUTMAN, P. S. & (RODRIGUEZ-BARRUECO, C.) (1970) The influence of root temperature on root-hair infection of *Trifolium subterraneum* by *Rhizobium trifolii*. *Proceedings of the XI International Grassland Congress, Surfers Paradise, Australia.* (In the press.)

The infection of the root hairs of young seedlings of *T. subterraneum* by nodule bacteria was examined at root temperatures of 7°, 19° and 7° for 9 days before transfer to 19°C. Infection at 19°C began when seedlings were 3 days old but was delayed at 7°C till 13 days. At 7°C the rate of subsequent infection was also slower; 17 days elapsed before infections reached the number attained in 3 days at 19°C.

When seedlings were transferred to 19°C from 7°C, infection began within 24 hours and continued faster for a time than in plants grown continually at 19°C, but it stopped sooner, so that the final number of infections was not significantly increased.

The oldest portion of the root hair zone was not always the first infected, and at 7°C this part commonly remained uninfected. At 19°C the length of the



*https://doi.org/10.23637/ERADOC-1-124* 

This work is licensed under a Creative Commons Attribution 4.0 International License.



younger uninfected zone, extending from the root tip, increased with plant age. The pattern of the distribution of infected root hairs was commonly either uni- or bi-modal independently of root temperature.

4.18 WALKER, N. & HARRIS, D. (1969) Aniline utilisation by a soil pseudomonad. *J. appl. Bact.* **32**, 457–462.

A *Pseudomonas* sp., isolated from soil, grew with aniline as its sole carbon source. Washed cells oxidised aniline by an induced enzyme system and liberated ammonia. Washed, aniline-grown organisms oxidised without lag aniline, catechol, *p*-aminophenol and *o*- and *m*-toluidine.

4.19 WALKER, N. & HARRIS, D. (1970) Metabolism of 3-chlorobenzoic acid by *Azotobacter* species. *Soil Biology and Biochemistry* **2**, 27–32.

Washed, benzoate-grown *Azotobacter vinelandii* organisms, and, at a lesser rate, benzoate-grown *A. chroococcum* organisms oxidised 3-chlorobenzoic acid to produce 3-chlorocatechol. Neither species grew with 3-chlorobenzoate as carbon source.

## Botany Department

### BOOK

5.1 BRENCHLEY, W. E. & WARINGTON, K. (1969) *The Park Grass Plots at Rothamsted, 1856–1949.* Harpenden: Rothamsted Experimental Station (originally published 1958; reprinted with some revision), 144 pp + 31 pp, figs. and tables.

### GENERAL PAPERS

5.2 HUMPHRIES, E. C. (1969) New roles for growth regulators. *Arable Farmer.* February, 50–51.

5.3 THORNE, G. N. (1969) Physiology of grain yield. *N.A.A.S. q. Rev.* No. 85, 42–46.

### PAPER IN ROTHAMSTED REPORT, PART 2

5.4 HUMPHRIES, E. C. (1970) Chemical control of plant growth. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 135–147.

A summary of work done at Rothamsted on the effects of growth regulators on crop plants.

### RESEARCH PAPERS

5.5 FRENCH, S. A. W. & HUMPHRIES, E. C. (1969) Persistent effects of seedling treatment on growth of sugar beet in pots. *Ann. appl. Biol.* **64**, 161–175.

Further evidence is provided that the environment of sugar-beet seedlings, or growth substances applied to seedlings, continue to influence growth when the plants are later in other environments.

Sugar-beet seeds were germinated at 20°C in 8, 16 or 24 hour photoperiods of constant light intensity, i.e. with different amounts of total radiation. When the seedlings had two leaves (15–18 days old) they were transferred to large pots in the glasshouse. Some were treated with (2 chloroethyl)trimethylammonium chloride either sprayed on the leaves or applied to the soil at different times.



https://doi.org/10.23637/ERADOC-1-124 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



The treatments affected the areas of individual leaves throughout the growing period; plants raised in 24 hour photoperiod had the largest leaves, and those in 8 hour photoperiod the smallest. Consequently, 24 hour plants had most dry matter and 8 hour plants least. Plants given most radiation produced leaves fastest and CCC applied early increased the rate, but as the leaves were smaller, except late in 1967, and died sooner, the leaf area duration was less and so yields were less. CCC applied later did not affect leaf production. There was no interaction between amount of radiation and CCC treatment.

Twenty-four hour plants had the greatest net assimilation rate ($E$) early. CCC decreased $E$ early, but increased it later and more when sprayed on the leaves than when applied to the soil.

5.6 HUMPHRIES, E. C. & BOND, W. (1969) Experiments with CCC on wheat: effects of spacing, nitrogen and irrigation. *Ann. appl. Biol.* **64**, 375–384.

In experiments with spring and winter wheat at Rothamsted and Woburn during 4 years, CCC increased yield at close spacing (4 in., 10 cm) more than at usual spacing (8 in., 20 cm), but there was no interaction between spacing and yield.

Some experiments tested up to 2·4 cwt N/acre (300 kg/ha) to see whether yields continued to increase with more than usual amounts of N, when CCC prevented lodging. There was no evidence of this.

When a short dry spell occurred at ear emergence, yield of spring wheat was increased by 6 cwt/acre (750 kg/ha) by CCC and 10 cwt (1250 kg) by irrigation. CCC probably improves yield in these conditions because the larger root system it causes enables more ear-bearing shoots to survive.

CCC increased yield in two ways, either by increasing ears or grains per ear. In an unlodged crop, CCC usually makes the grains smaller, but by preventing lodging it can also increase grain size. Usually CCC decreases the leaf area per shoot. The flag leaf may be smaller, unchanged, or larger than those of untreated plants. There was no obvious connection between flag-leaf area and grain yield; when CCC decreased flag-leaf area duration by 25%, grain yield was unchanged.

The results suggest that using CCC gives a more than even chance of a profitable yield increase.

5.7 HUMPHRIES, E. C. & FRENCH, S. A. W. (1969) Photosynthesis in sugar beet depends on root growth. *Planta* **88**, 87–90.

Sugar-beet plants, germinated in growth cabinets at 20°C and transplanted into the field after 3 weeks, developed much larger roots than plants grown from seed drilled directly into the soil. At the end of the season, the roots of transplants were 39% greater than from drilled seed—an increase of 14 tonnes/ha. The increased yield was mainly from a sustained increase in photosynthesis because of the larger sink for carbohydrates provided by plants from the growth cabinets.

5.8 HUMPHRIES, E. C. & FRENCH, S. A. W. (1969) Effect of seedling treatment on growth and yield of sugar beet in the field. *Ann. appl. Biol.* **64**, 385–393.

Sugar-beet seeds were germinated (1) in a growth cabinet at 20°C lit continuously by fluorescent tubes (L); (2) in a cabinet at 20°C lit by fluorescent tubes for 16 hours per day (S); (3) in a cage with glass roof and open sides with natural



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



illumination (N); or (4) in the open ground (D). The seedlings from the cabinets and cage were transplanted to the field when they had two true leaves. Samples were taken on six occasions during growth, and leaf areas and dry weights determined.

There was no difference between treatments in total number of leaves produced or leaf area duration. Leaf area per plant increased fastest on L plants at first, but from mid-June till end of July drilled plants had the largest leaf surface. From August onwards S plants had the largest area. Although treatment had little effect on growth of the tops, roots grew fastest throughout the season on the plants raised in growth cabinets, and the final mean root dry weight of L and S plants was 39% greater than of N and D plants. Throughout the season L and S plants had a larger root : top ratio than plants raised in the cage or drilled directly in the field. The larger roots of plants raised in the cabinets evidently provided a larger sink for carbohydrate and increased the mean photosynthetic efficiency of the leaves over the whole season by 11% and increased yield of roots by 6 tons/acre (14 tonnes/ha).

5.9 HUMPHRIES, E. C. & PETHIYAGODA, U. (1969) Effect of morphactin on growth of potatoes. *Ber. dt. bot. Ges., Vortr. GesGeb. Bot. N.F.* No. 3, 139–147.

Morphactin IT 3456 (methyl-2-chloro-9-hydroxyfluorene-(9)-carboxylate) inhibited the growth of stems and young leaves of potato and stimulated growth of basal axillary branches and underground stolons.

It decreased transpiration and delayed tuber development so that the fastest bulking rate occurred later than in untreated plants. The delay in tuber development was reflected in increased tuber water content.

More small tubers were produced by morphactin.

Potato seed pieces soaked in morphactin solution for 1 hour grew slowly but after considerable delay developed into normal plants. Treatment with gibberellic acid, indolylacetic acid or kinetin, singly or in all combinations, did not counteract the morphactin effect.

5.10 LEACH, G. J. (1969) The relation of photosynthesis by phytometers in the profiles of kale crops to leaf area index above them. *J. appl. Ecol.* **6**, 499–505.

To estimate the effect of the foliage at different positions in the profiles of kale crops on the rate of photosynthesis below it, the leaf area index ($L$) of the crops was varied either by removing some of the plants or by cutting off all the leaves above specified heights from the ground (topping). The net assimilation rates ($E$) of phytometers (sugar-beet seedlings supplied with nutrient solution), placed at different depths in the profiles were then measured.

Phytometer $E$ at a given height in the profile increased as the plant population was decreased by thinning, or as the height of the crop above the phytometers was decreased by topping to lower levels. The changes in $E$ were almost completely explained by the changes in $L$ above the phytometers. However, leaves near the bottom of crop canopies decreased phytometer $E$ slightly less than equal areas of leaves higher in the crop, although they did not intercept less light. Phytometer $E$ was zero when crop $L$ above the phytometer was approximately 4. Watson obtained a similar value for the optimal leaf area index of kale by other means.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



5.11 SLOPE, D. B., HUMPHRIES, E. C. & ETHERIDGE, J. (1969) Effect of CCC on eyespot (*Cercosporella herpotrichoides*) of winter wheat. *Pl. Path.* **18**, 182–185.

CCC applied to winter wheat crops sometimes lessened lodging and increased grain yield, but had no effect on the incidence of eyespot or severity of the lesions.

5.12 WILLIAMS, E. D. (1969) Effects of time of sowing of spring wheat and defoliation of *Agropyron repens* (L.) Beauv. on competition between them. *Weed Res.* **9**, 241–250.

Spring wheat, sown at three different times, and *Agropyron repens*, defoliated at the same three times, were grown separately or together in pots kept in an open-sided cage. The pots were widely spaced and adequately watered. Early sowing of wheat gave a greater grain yield than late sowing, and lessened the loss from competition with *Agropyron*. Early defoliation of *Agropyron* slowed its subsequent growth more than did late defoliation, and plants defoliated early suffered more from competition with wheat. Competition, probably mainly for nitrogen, decreased tillering and the number of ears produced by wheat, more when sowing was late than early, but grain dry weight per ear was decreased equally at the three times of sowing. The rate at which wheat produced leaves was affected by competition only at the last date of sowing. In competition with wheat, *Agropyron* produced fewer shoots and ears, had lighter shoots and rhizomes, and ear emergence was slightly delayed.

## Biochemistry Department

### GENERAL PAPERS

6.1 PIRIE, N. W. (1969) Complementary ways of meeting the world's protein need. In: *Proteins as human food. Proc. 16th Easter Sch. agric. Sci., Univ. Nott., 1970*; *Proc. Nutr. Soc.* **28**, 255–263.

6.2 PIRIE, N. W. (1969) The EMBO question debated. *Nature, Lond.* **224**, 829.

6.3 PIRIE, N. W. (1969) The nature, origins and distribution of life. *Scinteia* (*Rumania*). (In the press.)

6.4 PIRIE, N. W. (1969) Plants as sources of unconventional protein foods. In: *Symposium on World Food Supply*. XI International Botanical Congress: Seattle.

6.5 PIRIE, N. W. (1970) Potential protein sources for human food. In: *Community health* **1**, 207–214.

6.6 PIRIE, N. W. (1969) Retrospect on the biochemistry of plant viruses. *Biochemical Society publication on the occasion of its 500th meeting*. (In the press.)

### RESEARCH PAPERS

6.7 ARKCOLL, D. B. (1969) Preservation of leaf protein preparations by air drying. *J. Sci. Fd Agric.* **20**, 600–602.

Air-dried leaf protein has hitherto been dark and gritty, but by drying in two stages, initially to between 20 and 30% moisture, then fine grinding before



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



completing air drying, a product can be made with as good an appearance and texture as that made by freeze-drying. The keeping quality and digestibility of this material are also similar to freeze-dried protein.

6.8 BACON, M. F. & HOLDEN, M. (1970) Chlorophyllase of sugar-beet leaves. *Phytochemistry* **9**, 115–125.

The chlorophyllase of sugar-beet leaves was characterised and partly purified by gel-filtration and ion-exchange chromatography on various types of Sephadex. A rapid method was developed for determining the chlorophyllase activity of fractions from columns. Indications of more than one form of the enzyme may be explained by its tendency to associate or aggregate with itself or with other substances. Association is greater in 0·02 *M* citrate than in citrate containing 0·5 *M* sodium chloride. The enzyme is strongly adsorbed to negatively charged materials, which may explain its improved extractability when the sodium chloride concentration of the medium is increased. Measurements of some properties of the enzyme are affected by insolubility of the substrate.

6.9 HOLDEN, M. (1970) Lipoxidase of leaves. *Phytochemistry* **9**. (In the press.)

The peroxidation of linoleic acid by leaf extracts is shown to be catalysed by a lipoxidase-type enzyme.

6.10 JERVIS, L. & (HALLAWAY, H. M.) (1969) Isolation of ribosomes from cell walls of barley (*Hordeum vulgare*). *Biochem. J.* **114**, 62P.

Highly purified cell walls of barley seedlings were suspended in a ribosome isolation medium and passed through a French press. The resulting suspension was centrifuged at 30 000 g for 30 minutes and the supernatant fluid was re-centrifuged at 100 000 g for 2 hours. Particles were obtained which, when re-suspended had a characteristic ribosomal absorption spectrum, with a peak at 260 nm and a minimum absorption at 242 nm.

## Plant Pathology Department

### THESIS

7.1 HIDE, G. A. (1969) The occurrence, development and control of skin spot (*Oospora pustulans*) disease of potatoes. Ph.D. Thesis, University of London.

### GENERAL PAPERS

7.2 BAWDEN, F. C. (1970) Plant virus research. In: *Symposium on potentials in crop protection*. New York: Cornell University.

7.3 BAWDEN, F. C. (1970) Musings of an erstwhile plant pathologist. *Ann. Rev. Phytopath.* **8**. (In the press.)

7.4 BAWDEN, F. C. (1970) *The contribution of research to agriculture*. The George Scott Robertson Memorial Lecture. Belfast: The Queen's University.

7.5 LACEY, J. (1969) Health hazards from mouldy fodder. *World Crops* **21**, 211–215.



*https://doi.org/10.23637/ERADOC-1-124* 

This work is licensed under a Creative Commons Attribution 4.0 International License.



7.6 SLOPE, D. B. (1968) The benefits and limitations of breakcrops for the control of soil-borne diseases of cereals. *J. natn. Inst. agric. Bot.* **11** (Suppl.), 54–57.

RESEARCH PAPERS

7.7 AMMAR, E. D., MILNE, R. G. & WATSON, M. A. (1970) Virus-like particles in the plant hopper *Javesella pellucida* Fab. *J. gen. Virol.* **6**, 315–318.

Bacilliform virus-like particles 30 nm wide and 65 nm long occurred in the salivary glands, gut walls and brains of a stock of the plant hopper *Javesella pellucida* Fab. maintained at Rothamsted, but not in a stock from Sutton Bonington, Nottinghamshire. The particles seemed harmless to the hoppers and to plants on which the hoppers fed.

7.8 CARPENTER, J. M. & KLECZKOWSKI, A. (1969) The absence of photoreversible pyrimidine dimers in the RNA of ultraviolet-irradiated tobacco mosaic virus. *Virology* **39**, 542–547.

Pyrimidine dimers of cyclobutane type formed in the RNA of tobacco mosaic virus when irradiated free (about 1·0 dimer per photoreactivable lesion), but not in the RNA irradiated inside the virus. Photoreactivable lethal damage also occurs only in the free RNA, so it coincides with the formation of the dimers.

7.9 GOVIER, D. A. & KLECZKOWSKI, A. (1969) Residual infectivity and the extent of photoreactivation in three different host plants of u.v.-irradiated potato virus X. *J. gen. Virol.* **4**, 347–354.

Residual infectivities of u.v.-irradiated preparations of potato virus X were assayed on three different kinds of plants. When the plants were kept in darkness to prevent photoreactivation of the inactivated virus, the residual infectivity seemed the same whether *Chenopodium amaranticolor* or either of two varieties of tobacco was used for assay. When the plants were exposed to daylight, photoreactivation occurred in all three kinds of plants, possibly rather more in *Chenopodium* than in tobacco. Thus, in contrast to the results previously obtained with tobacco necrosis virus, no evidence was obtained for dark reactivation of u.v.-inactivated potato virus X in *Chenopodium*.

Without photoreactivation, the quantum yields for inactivation were about $0{\cdot}8 \times 10^{-3}$ and $1{\cdot}3 \times 10^{-3}$ for the whole virus and for the RNA inside the virus, respectively

7.10 HIDE, G. A., HIRST, J. M. & GRIFFITH, R. L. (1969) Control of potato tuber diseases with systemic fungicides. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **1**, 310–315.

Fungus and bacterial diseases are increasing causes of complaint about the health of potato seed tubers and are not effectively controlled by contemporary fungicides. Tubers formed by rooted stem cuttings are usually initially free from these pathogens but do not remain so through the years of multiplication to commercial use. However, seed tuber stocks from stem cuttings can be maintained in good health by fungicides that can be applied to dormant tubers and are effective against various pathogens that affect seed tubers and the growing crop; two benzimidazoles showed the most promise.



https://doi.org/10.23637/ERADOC-1-124 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



7.11 HIDE, G. A., HIRST, J. M. & MUNDY, E. J. (1969) The phenology of skin spot (*Oospora pustulans* Owen & Wakef.) and other fungal diseases of potato tubers. *Ann. appl. Biol.* **64**, 265–279.

Underground stems and roots of the potato varieties King Edward and Majestic became more severely infected by *Oospora pustulans* (skin spot) as the growing season advanced. Tubers became infected at their initiation in June and July but the proportion of infected eyes usually increased during both the growth of the crop and bulk storage. Some buds on tubers in bulk stores died in December, but few were killed until after January, when attacks increased until by March about a quarter of Majestic eyes were usually dead. Boxing (chitting) not only prevented most eyes from dying but also prevented much skin spotting on tubers. At High Mowthorpe, Majestic seed unboxed or boxed in March yielded, respectively, 3 and 1 ton/acre less than seed boxed by January. Early boxing increased the yield of seed-sized tubers but did not affect the infection of progeny tubers. Dipping Majestic seed tubers in organo-mercurial fungicide and then boxing soon after lifting decreased their infection by *O. pustulans*; it also lessened infection on plants they produced and increased the yield of progeny seed-sized tubers. However, dipping, even in successive years, had little effect on the infection of progeny tubers by *O. pustulans*.

*Rhizoctonia solani* and *Helminthosporum atrovirens* became increasingly prevalent on tubers during growth after July and during bulk storage. *H. atrovirens* was decreased by early boxing or dipping tubers in fungicide. Verticillate conidiophores often grew on incubated tuber plugs but their prevalence was affected by past storage.

The results suggest that some of the benefit of chitting may be from disease control, but how much could not be measured.

7.12 HORNBY, D. (1969) Quantitative estimation of soil-borne inoculum of the take-all fungus (*Ophiobolus graminis* (Sacc.) Sacc.). *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **1**, 65–70.

A maximum likelihood estimation of the number of infective units ($\lambda$) of *Ophiobolus graminis* inoculum in soil can be obtained from host-infection tests using dilutions of either whole soil or the organic debris extracted from it. Details of procedure, suggested test conditions and experimental examples are given. Estimates of $\lambda$ were small (e.g. 5 per 150 $cm^3$ of a sandy loam immediately after harvesting spring wheat and 1 per 150 $cm^3$ in the February following) and in 3-week tests on whole soil depended on the number of seedlings/pot (optimum = 2/pot). For land growing spring barley sampled in May, estimates were greater with dilutions of extracted organic debris than of whole soil. Soil from within the barley rows had 0·59 infective units/150 $cm^3$ and soil from between rows only 0·37. Practical application of the method is discussed.

7.13 HORNBY, D. (1969) Methods of investigating populations of take-all fungus (*Ophiobolus graminis*) in soil. *Ann. appl. Biol.* **64**, 503–513.

Attempts to isolate *Ophiobolus graminis* directly from infested soils failed, so host-infection techniques were used to study soil-borne populations of the fungus. Extracting organic debris from soils and grading it by wet sieving through standard meshes concentrated the fungus. Fractions were tested for infectivity either as layers in pots of sand or by packing into short lengths of polyvinyl chloride tubing, through which wheat seedlings were grown. Coarse debris (retained by 420 $\mu$ aperture sieves) were most infective and usually caused lesions within 3 weeks; whole soil and especially fine debris ($<420$ $\mu$) caused fewer and less severe infections, which often became apparent only after 3 weeks. Slight



*https://doi.org/10.23637/ERADOC-1-124* 

This work is licensed under a Creative Commons Attribution 4.0 International License.



infectivity of the sediment fractions was attributed to imperfect separation of debris. Soil sampled in crop or stubble rows caused more infections than soil from between rows.

Usually seedling infection was made manifest by root lesions and runner hyphae, but these symptoms were not always plain or conclusive. Many seedling roots that rotted when kept moist and in the light produced perithecia within 6 weeks. Although perithecia formed on some roots where neither lesions nor hyphae were found, they did not form on all diseased roots. More needs to be known about the factors influencing perithecial formation before it can be used as a reliable confirmatory test.

7.14 KASSANIS, B. & WOODS, R. D. (1969) Properties of some defective strains of tobacco mosaic virus and their behaviour as affected by inhibitors during storage in sap. *Ann. appl. Biol.* **64**, 213–224.

From the type strain of tobacco mosaic virus, defective strains were isolated that produced chlorotic or ringspot type symptoms in tobacco and were difficult to transmit without carborundum in the inoculum. Their concentration was less than 0·1 μg/ml of sap instead of the usual 2 mg/ml with the type strain. Phenol extracts of infected leaves were a little more infective than extracts in buffer, whereas phenol extracts of leaves infected with type strain were very much less infective than extracts in buffer. Electron microscopy of infective sap rarely showed any virus particles, but preparations concentrated by ultracentrifugation did, many of which were broken or seemed inadequately assembled.

Changing the ambient temperature at which infected plants were kept from 20 to 35°C did not increase the amount or improve the appearance of the virus. Some of the strains were inactivated during heating for 10 minutes between 70 and 80°C.

Undiluted sap lost its infectivity in 3 days at 20°C, as did the type strain when diluted to 0·1 μg/ml in sap from healthy leaves. This is because substances that inhibit infection were produced by microbes in the sap. The ability of sap from healthy leaves to inhibit infection increased by more than twenty-five times when left 3 days at 20°C. Infectivity of appropriate mixtures of type strain and aged sap was restored by diluting them in buffer. Sodium azide at 0·02% in sap prevented formation of the inhibitor. The infectivity of the defective strains increased when inoculated together with the type strain.

7.15 KASSANIS, B. & LEBEURIER, G. (1969) The behaviour of tomato bushy stunt virus and bromegrass mosaic virus at different temperatures *in vivo* and *in vitro*. *J. gen. Virol.* **4**, 385–395.

The multiplication and inactivation of tomato bushy stunt virus (TBSV) and of bromegrass mosaic virus (BGMV), both of which have spherical particles, differed greatly at different temperatures. TBSV was inactivated in and disappeared from infected plants at 36°; BGMV maintained its content and virus produced at 36° was as infective as that produced at 20°. Infectivity of TBSV was lost *in vivo* or *in vitro* without any apparent change in the physical properties of the particles or of the nucleic acid.

BGMV was unaffected by heating *in vitro* for an hour at 45° at pH 5·8, but at pH 7·0 lost its infectivity within an hour at 36°. Even at 20° the particles were unstable and, in the presence of pancreatic ribonuclease, some but not all particles disintegrated to produce two new components. BGMV from plants infected for 1 week was, weight for weight, more infective than virus from plants infected for 3 weeks, and contained proportionally more 27 S nucleic acid than non-infective 22 S or 14 S. When virus was heated at 31° in buffer pH 6·8 the



https://doi.org/10.23637/ERADOC-1-124 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



amounts of S 27 and S 22 nucleic acid diminished, but amounts of 14 S nucleic acid diminished only at higher temperatures. Thus inactivation of BGMV, but not of TBSV, may reflect breaking of the nucleic acid.

7.16 KLECZKOWSKI, A. & GOVIER, D. A. (1969) Action spectrum for inactivation of the infectivity of potato virus X by U.V. radiation. *Photochem. Photobiol.* **10**, 53–59.

Quantum yields for inactivation of infectivity of potato virus X by monochromatic ultraviolet radiation of wavelengths ranging from 230 to 290 nm, were measured with reference to energy absorbed by (a) the whole virus and (b) the virus RNA. The yields depended on the wavelength, but those with reference to energy absorbed by the RNA varied much less (with extreme values of $10^{-3}$ and $1{\cdot}9 \times 10^{-3}$) than those with reference to whole virus. Consequently the action spectrum for inactivation of a dilute solution of the virus resembled the shape of the absorption spectrum of the RNA, but not closely enough to allow coincidence by adjusting the scales. The amount of photoreactivation increased as the wavelength increased and also as the year progressed from May to July; the extreme values of the photoreactivable sector were 0·43 and 0·86.

7.17 MILNE, R. G. (1970) An electron microscope study of tomato spotted wilt virus in thin sections and negative-stain preparations. *J. gen. Virol.* **6**, 267–276.

Mature particles and the early stages of growth of tomato spotted wilt virus (TSWV) were examined by electron microscopy in thin sections and by negative staining. Early evidence of infection included: (a) amorphous, darkly-staining material in the cytoplasm; (b) spherical virus-like particles 100 nm in diameter, with two concentric membranes; (c) configurations interpreted as membranes budding to form the particles in (b); (d) mature virus particles resembling the inner membranes plus cores of the particles in (b). Similar structures were seen in thin sections of developing local lesions. Local and systemic infections more than 5 days old contained only mature particles and not structures (a), (b) and (c).

A possible virus-maturation sequence is proposed, though lack of synchrony in infected cells makes this tentative. The evidence here provided does not support the suggestion that TSWV is a myxovirus.

7.18 REES, M. W., SHORT, M. N. & KASSANIS, B. (1970) The amino acid composition, antigenicity and other characteristics of the satellite viruses of tobacco necrosis virus. *Virology*. (In the press.)

Three strains of the satellite (SV) of tobacco necrosis virus (TNV) were compared antigenically and in their ability to multiply with the help of different strains of TNV. Their antigenic specificity was not influenced by the strain of TNV but depended on the particular strain of SV used in the mixture. Antigenically the three strains were distinctly different and this was reflected in the 49 changes in the amino acid composition of $SV_1$ and $SV_2$. $SV_1$ and $SV_2$ multiplied well in mechanically inoculated leaves, whereas $SV_3$ did best in tobacco roots infected by the aid of the vector *Olpidium brassicae*. Ambient temperature of 36°C which inhibited the multiplication of TNV, also affected SV. All strains crystallised readily and virus was lost in crystals during purification unless care was taken.

From amino acid analysis and two-dimensional peptide maps, the molecular weight of the protein sub-unit of $SV_1$ was found to be 22 800 and to contain 208 amino acid residues. 182 out of the 208 amino acid residues were accounted for



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



in tryptic peptides separated by ion exchange and Sephadex chromatography. In the TNV and SV association, the RNA of SV codes for its coat protein. On the basis of the triplet code the coding for the coat protein would require 624 of the 1200 nucleotides and therefore SV can code for another protein. The help required by SV from TNV is discussed.

7.19 SALT, G. A. (1969) Effects of soil fumigation on cereal foot and root pathogens. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **1**, 39–44.

On soil where cereals had been grown frequently a formalin drench applied a few weeks before sowing spring wheat greatly decreased root infection by *Ophiobolus graminis* and significantly increased yield. Unless formalin was re-applied for the subsequent crop, take-all and cereal cyst-nematode infection increased greatly and yield decreased. On soil recently ploughed from grass, a formalin drench neither increased the yield of spring wheat nor prevented take-all increasing in subsequent crops.

Formalin applied during September for winter wheat decreased take-all in the spring where applied after ploughing, but not where applied to stubble: by harvest it had little effect on take-all incidence or yield.

Formalin had little effect on the incidence of brown foot rot (*Fusarium* spp.), or brown root rot (*Pythium* spp.) but often decreased eyespot (*Cercosporella herpotrichoides*).

7.20 SLOPE, D. B., HUMPHRIES, E. C. & ETHERIDGE, J. (1969) Effect of CCC on eyespot (*Cercosporella herpotrichoides*) of winter wheat. *Pl. Path.* **18**, 182–185.

CCC applied to winter wheat crops sometimes lessened lodging and increased grain yield, but had no effect on the incidence of eyespot or severity of the lesions.

7.21 VARMA, A., GIBBS, A. J. & WOODS, R. D. (1970) A comparative study of red clover vein mosaic virus and some other plant viruses. *J. gen. Virol.* (In the press.)

Red clover vein mosaic virus (RCVMV) was compared with other viruses, in particular, white clover mosaic virus (WCMV) and clover yellow vein virus (CYVV). All three have filamentous particles, those of RCVMV are 645 nm long and have a sedimentation coefficient ($S_{20}$, w) of 160S, those of WCMV are 460 nm long (119S), and those of CYVV between 700 nm and 800 nm long (about 140S). Particles of RCVMV and WCMV have an axial canal of about 3·5 nm diameter. RCVMV and WCMV contain about 6% ribonucleic acid with nucleotide compositions of G31·5, A24·1, C22·7, U21·7 and G15·5, A31·8, C26·9 and U25·7 respectively. RCVMV is photoreactivable; after exposure to ultraviolet radiation, preparations of the virus caused more lesions in *Chenopodium amaranticolor* when the inoculated plants were kept in the light than in darkness; this is the first virus with seemingly rigid helically-constructed particles to show photoreactivation. RCVMV is distantly serologically related to five viruses of the potato virus S group, CYVV to eight viruses of the potato virus Y group, and WCMV to potato virus X.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



## Nematology Department

### Thesis

8.1 Mojica, M. L. (1969) The effect of soil type, crop and nematicides on populations of migratory root-parasitic nematodes. M.Phil. Thesis, University of Reading.

### General Papers

8.2 Clark, S. A., Doncaster, C. C., (Flegg, J. J. M.), Hooper, D. J., Shepherd, A. M. & (Southey, J. F.) (1970) *Laboratory methods for work with plant and soil nematodes. Tech. Bull. Minist. Agric. Fish. Fd* No. 2, Ed. J. F. Southey, 5th edition, rewritten. London: H.M.S.O. (In the press.)

8.3 Jones, F. G. W. (1969) Integrated control of the potato cyst-nematode. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **3**, 646–655.

8.4 Jones, F. G. W. (1969) Potato cyst eelworm: its biology and the outlook for control by resistant varieties and nematicides. *Arable Farmer*, May 1969, pp. 45–47, 49.

8.5 Williams, T. D. (1969) Chemical control of the cereal cyst nematode—can it be economic? *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **1**, 169–176.

### Research Papers

8.6 (Anderson, R. V.) & Hooper, D. J. (1970) A neotype for *Cephalobus persegnis* Bastian, 1865, redescription of the species, and observations on variability in taxonomic characters. *Can. J. Zool.* (In the press.)

A neotype for *Cephalobus persegnis*, selected from specimens from the type locality, is described and observations made on the probolae, ovary and tail. The probolae of topotypes and their progeny reared on agar and in sand ranged from low rounded, to asymmetrically bifurcate; some were conoid, ending in a single point. The ovary of some females was straight whereas that of others was flexed from one to six times. The significance of the shape of probolae in the taxonomy of *Cephalobus* and its relationship to the Acrobelinae, particularly *Chiloplacus* and *Paracephalobus*, is discussed.

8.7 Corbett, D. C. M. (1969) *Pratylenchus pinguicaudatus* n. sp. (Pratylenchinae: Nematoda) with a key to the genus *Pratylenchus*. *Nematologica* **15**, 550–556.

*P. pinguicaudatus*, a new species associated with wheat at Rothamsted, is distinguished from other *Pratylenchus* species by having three head annules, no males, a long narrow oesophageal overlap and a broadly rounded smooth tail tip. A key is given separating 36 species in the genus.

8.8 Corbett, D. C. M. (1969) Spermatheca shape in *Trophurus* spp. *Nematologica* **15**, 429–430.

The spermatheca in *Trophurus* spp. has two lobes, one at each side of the gonad projecting forward from a central subspherical part, and not a small oblong spermatheca as first described.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



8.9 CORBETT, D. C. M. (1970) Cereal *Pratylenchus* spp. in England and Wales and their recognition. *Pl. Path.* **19**, 6–10.

*Pratylenchus* spp. were the commonest plant-parasitic nematodes found during a survey of fields in England and Wales growing barley or wheat. *P. minyus* occurred in all soil types, often together with *P. thornei* in heavy soil and with *P. crenatus* and/or *P. fallax* in light soil. *P. pinguicaudatus* was found only in heavy soil in a field at Rothamsted carrying wheat. Drawings, descriptions and a key are given to enable the five species to be identified.

8.10 CORBETT, D. C. M. (1970) Maintaining nematode cultures under mineral oil. *Nematologica* **16**, 156.

Nematodes in lucerne callus cultures on agar were alive and subcultured successfully after 19 months under mineral oil.

8.11 CORBETT, D. C. M. & WEBB, R. M. (1970) Plant and soil nematode population changes in wheat grown continuously in ploughed and in unploughed soil. *Ann. appl. Biol.* **65**, 327–335.

Few migratory plant parasitic nematodes increased more in the soil under cereals drilled in unploughed land sprayed with weed killer than under crops drilled after ploughing, but some non-parasitic nematodes did. Spraying a mixture of potent insecticides on the soil before drilling did not affect populations of nematodes in the soil.

8.12 EVANS, K. (1969) Apparatus for measuring nematode movement. *Nematologica* **15**, 433–435.

A simple and easy-to-use apparatus for measuring nematode movement is described. The apparatus consists of polythene rings assembled inside a glass tube containing moist sand. Moisture content of the sand and temperature are easily controlled, and this apparatus was used to investigate movement of *Heterodera rostochiensis* males and their responses to females. *H. rostochiensis* females secrete a chemical that both activates and attracts males of this but not of other species.

8.13 EVANS, K. (1969) Changes in a *Heterodera rostochiensis* population through the growing season. *Ann. appl. Biol.* **64**, 31–41.

Changes in the numbers of all stages of *Heterodera rostochiensis* in plants and soil were studied in a potato crop growing on infested land. Hatching and invasion occurred early in the season, when plants were young and temperatures below those necessary for hatching and invasion in Long Island, U.S.A. More larvae hatched from cysts near to than away from potato roots. Males were abundant during June and July, when fertilisation probably occurs. Many new cysts appeared during late June and early July. In May/June, there were many larvae in the roots of young plants but later there were few; a slight increase during August probably indicated a small second generation. The larvae for this second invasion may have come from the most recently formed cysts, which may have been stimulated to hatch either by root exudates or by substances from other soil organisms.

8.14 FRANKLIN, M. T. (1969) *Heterodera latipons* n. sp., a cereal cyst-nematode from the Mediterranean region. *Nematologica* **15**, 535–542.

*H. latipons*, found on wheat and barley in Israel and Tripoli, can also infest oats and rye. The cysts and larvae differ morphologically from those of *H. avenae*, the cereal cyst-nematode commonly found in Europe.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



8.15 GREEN, C. D. & PLUMB, S. C. (1970) The interrelationships of some *Heterodera* spp. indicated by the specificity of the male attractants emitted by their females. *Nematologica* **16**, 39–46.

The attractiveness of the secretions from females of ten *Heterodera* spp. to males of the same and of the other species suggests the division of the genus into at least three sub-groups: (1) *H. schachtii*, *H. glycines* and *H. trifolii*; (2) *H. carotae*, *H. cruciferae* and *H. goettingiana*; (3) *H. rostochiensis*, *H. mexicana*, *H. tabaccum* and possibly *H. avenae*. Females of species within these groups always attract males within the same group and the interactions between groups can be explained only by postulating at least six distinct attractive substances. Possibly females of ancestral forms secreted a wide range of attractants and their males responded to all of them. Decreases in the number of attractants secreted by the females, or in the number to which the male responds, indicate increasing specialisation. Females of one species could be attractive to males of another in a different group even though females of the latter species did not attract males of the former.

8.16 KYROU, N. C. (1969) *Tylenchorhynchus dubius* (Bütschi, 1873) Filipjev; 1936: an injurious root ectoparasite of potatoes? *Eur. Potato J.* **12**, 215–218.

Observations on a field trial at Woburn done to study the effects on *H. rostochiensis* populations of growing susceptible and resistant potato varieties, suggested that the root ectoparasite *Tylenchorhynchus dubius* was important. When different numbers of this nematode were added to potted potato plants, the nematodes had multiplied after 10 weeks and potatoes grew less well in proportion to the numbers of *T. dubius* added. Fumigation decreased the number of *Tylenchorhynchus*, which were more numerous after ley and lucerne than after arable crops. Brief irrigation and the planting of varieties differing in the resistance to the cyst eelworm had no effect on nematode numbers of *Tylenchorhynchus*.

8.17 ROSS, G. J. S. & TRUDGILL, D. L. (1969) The effect of population density on the sex ratio of *Heterodera rostochiensis*; a two-dimensional model. *Nematologica* **15**, 601–607.

A model was based on the hypothesis that the second stage larvae of *H. rostochiensis* arrive at their feeding sites within the host plant roots at random, and become female only when they have room to produce a large enough group of giant cells. The circumference of the stele of 1 cm of root was represented as a rectangle in which larvae formed groups of giant cells at random. The size of the giant-cell group that a larva needed to become a female was changed in different tests. A larva arriving in an unoccupied space large enough to accommodate such a group was designated female, whereas one whose giant cells overlapped one or more already present was designated male. Results calculated from the model agreed reasonably with those from experiments. To simplify the relationship between population density and the number of females produced, an exponential curve was fitted to the results.

8.18 (TIMM, R. W.) & FRANKLIN, M. T. (1969) Two marine species of *Aphelenchoides*. *Nematologica* **15**, 370–375.

The first species of *Aphelenchoides* to be described from marine habitats are *A. gynotylurus* from the Bay of Bengal and *A. marinus* from Biscayne Bay, Florida. They have the morphological characters typical of the genus, with specific differences in the shapes of the tails and male spicules.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



8.19 TRUDGILL, D. L. (1970) Survival of different stages of *Heterodera rostochiensis* at high temperatures. *Nematologica* **16**, 94–99.

When potato plants infested with *H. rostochiensis* were kept for 24 or 96 hours at temperatures above the optimum for the eelworm, fewer of the larvae became adult as the temperature increased and as the age of the larvae increased. The most sensitive stage was the late fourth or early fifth stage male, and 26°C for 24 hours significantly decreased the number that became adult. Heat seemed not to influence sex determination.

8.20 TRUDGILL, D. L. & PARROTT, D. M. (1969) The behaviour of nine populations of the potato cyst-nematode *Heterodera rostochiensis* Woll. towards three resistant potato hybrids. *Nematologica* **15**, 381–388.

Three hybrid potato varieties incorporating resistant genes from *Solanum tuberosum* s. sp. *andigena*, or *S. multidissectum*, or both, and the susceptible variety, Arran Banner, were inoculated with larvae from nine populations of *Heterodera rostochiensis*. The numbers of larvae that invaded and became adult in the roots depended on both the host and the population used. There were three main types of behaviour: (1) most larvae survived and many males and females were produced; (2) most larvae survived, but most became male and few became female; (3) many larvae died, almost all the survivors became male and only a very few became female. These differences were probably determined by the size of the giant-cell groups the larvae were able to induce in the potato roots.

8.21 WILLIAMS, T. D. (1969) The effects of formalin, nabam, irrigation and nitrogen on *Heterodera avenae* Woll., *Ophiobolus graminis* Sacc. and the growth of spring wheat. *Ann. appl. Biol.* **64**, 325–334.

In 1964, nabam (sodium ethylene bisdithiocarbamate), water and three amounts of nitrogen fertiliser were applied to spring wheat on soil treated and untreated with formalin. The experiment lasted for 3 years during which there were eight different formalin, no-formalin sequences. The nabam and irrigation treatments were discontinued when it was found they did not affect the principal pathogens present, the cereal cyst-nematode, *Heterodera avenae*, and the take-all fungus, *Ophiobolus graminis*. Formalin increased gain and straw yields in the year when it was applied but *H. avenae* populations increased and adversely affected the succeeding crop. Formalin controlled *O. graminis* in the year it was applied except on land treated for the first time in 1966. *H. avenae* seemed to be the main check to growth until about June, and *O. graminis* later. At the end of the experiment, total grain yields and populations of *H. avenae* were greatest in the plots treated with formalin each year and least in those never treated with formalin. Yield loss from either *O. graminis* or *H. avenae* alone could not be assessed because formalin usually controlled both during the season in which it was applied and both were present in untreated plots. A doubling of total grain yield over 3 years was accompanied by an eightfold increase in *H. avenae* in sequences of continuous formalin or formalin 1964 and 1965, whereas yield increases caused by extra nitrogen were not accompanied by such an increase in *H. avenae*. This suggests that formalin may affect *H. avenae* through factors other than increased plant size and vigour, which in themselves would tend to encourage larger nematode populations. Without formalin treatment, *H. avenae* populations either decreased or failed to increase.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



8.22 YEATES, G. W. (1970) The diversity of soil nematode faunas. *Pedobiologia* **10,** 104–107.

To indicate the relative importance of the species of soil nematodes, it is suggested they be listed in order of decreasing abundance, and that the total number of species, the fewest species required to comprise 75% of the fauna and the number of species comprising at least 2% of the fauna be noted. Five faunas from the Orkney Islands are presented in this way. The 36 nematode faunas from natural or near natural terrestrial habitats analysed contain an average of 24 species, of which six are required to comprise 75% and nine species comprise at least 2% of the fauna.

8.23 YEATES, G. W. (1969) Two terrestrial nematodes from McMurdo Sound Region, Antarctica, with a note on *Anaplectus arenicola* Killick, 1964. *J. Helminth.* **43.** (In the press.)

*Plectus murrayi* n. sp. is distinguished from other species by possessing 12 lips; stoma, amphid and excretory system are 'plectoid' rather than 'anaplectoid'. *Eudorylaimus antarcticus* (Steiner, 1916) n. comb. is proposed for *Dorylaimus antarcticus*, Steiner 1916 and the species is re-described. Both species were collected from mosses from the McMurdo Sound Region, Antarctica. *Anaplectus arenicola* Killick, 1964, has only six lips; stoma and excretory system are 'anaplectoid'.

8.24 YEATES, G. W. (1970) Four Dorylaimina (Nematoda) from Wicken Fen, Cambridgeshire. *Nematologica* **16.** (In the press.)

*Thornenema wickeni* n. sp., has labial cuticularisations, very prominent post-labial cuticularisations, a lip region distinctly narrower than adjacent body and a spear about twice as long as lip region is wide. Females of *Eudorylaimus rhopalocercus* (de Man, 1876) Andrássy, 1959, are described. *Tylencholaimus feni* n. sp. is closest to *T. coronatus* Thorne, 1939, but is readily distinguished by its unsclerotised labial disc and the prevulval sac being two rather than one body width long. *Dorylaimellus globatus* n. sp., collected from Wicken Fen, Redgrave Fen, Rothamsted and Orkney Island, is characterised by anucleate globules at the front of the oesophageal bulb, in both living and dead specimens; it resembles *D. virginianus* Cobb, 1913, and *D. demani* Goodey, 1963. Specimens of *Boledorus thylactus* Thorne, 1941, from Wicken Fen had a relatively longer tail than previously recorded.

8.25 YEATES, G. W. (1970) Failure of *Heterodera carotae*, *H. cruciferae*, and *H. goettingiana* to interbreed. *Nematologica* **16,** 153–154

Although *H. carotae*, *H. cruciferae* and *H. goettingiana* seem to be related serologically and the females attract each other's males, they did not interbreed when single male–female crosses were attempted *in vitro*.

8.26 YEATES, G. W. (1970) The oesophago-intestinal junction in the Dorylaimoidea (Nematoda). *J. nat. Hist.* **4.** (In the press.)

The oesophago-intestinal junction of 58 species of Dorylaimoidea (*sensu* Goodey, 1963) are illustrated from whole mounts and eight from sections. In the Dorylaimidae the oesophago-intestinal valve fits into the base of the oesophagus, has a narrow lumen and its posterior end has a non-perforate, non-muscular sheath in the intestine. Seven basic patterns of junction are proposed: dorylaimid; leptonchid (valve lumen wider, no sheath); longidorid (valve reduced); belondirid (valve lumen wide, no sheath); nygolaimid (three oesophago-intestinal



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



glands); aporcelaimid (oesophago-intestinal disc, sheath sometimes present; actinolaimid (basal oesophageal shield, sheath sometimes present). Changes from the dorylaimid junction are correlated with factors such as presence of an oesophageal sheath or shortening of the oesophageal bulb.

## Insecticides and Fungicides Department

### General Papers

9.1 Elliott, M. (1969) Structural requirements for pyrethrin-like activity. *Chemy Ind.* 776–781.

9.2 Needham, P. H. & Stevenson, J. H. (1969) Bee poisoning in 1968. *Bee World* **50** (1), 7.

9.3 Stevenson, J. H. (1969) Laboratory and field assessment of pesticide poisoning of honeybees (*Apis mellifera*). *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969* **3**, 378–385.

9.4 Sawicki, R. M. (1969) Some problems of monitoring for resistance. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **3**, 635–640.

### Research Papers

9.5 Arnold, A. J. (1969) Radial outflow turbine for volumetric sporetraps. *Lab. Pract.* **18**, 1067–1073.

The many advantages of this type of unit over the positive displacement pump normally used for this type of service include small initial cost, easy maintenance, quiet operation and small power consumption. The elimination of the shaft seals in the spore trap and pump, and of rubbing surfaces, improve operation and reliability. The stable air flow of the turbine makes the critical orifice unnecessary. This is an advantage in polluted atmospheres where fouling of the orifice can diminish air flow from 10 litres per minute to almost zero in a few hours.

9.6 Arnold, A. J. (1970) An oscillating insect barrier. *Ann. appl. Biol.* (In the press.)

A wide range of insects can be confined on the horizontal surface of areas surrounded by oscillating rings or chambers. The ability to retain insects on a selected surface may be useful in the bioassay of insecticides using residual film and other techniques, by diminishing the amount of anaesthesia required and any unwanted fumigant effects.

9.7 Banks, C. J. & Macaulay, E. D. M. (1970) Effects of varying the host plant and environmental conditions on the feeding and reproduction of *Aphis fabae* (Scop.). *Ent. exp. appl.* (In the press.)

The reproduction of apterous virginoparae of *A. fabae* on field beans is primarily controlled by nutrition of both the larvae and adults. The kind of host plant and the lighting conditions under which it is grown affect the aphid's fecundity and reproductive rate. Plants grown under mercury fluorescent lamps apparently provide the aphids with better or more nutrients of the right kind so that they reproduce better than aphids living on plants grown in daylight in glass houses.

Nutrition during larval life also affects the early reproductive rate and fecundity



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



of the aphids. Some aphids that developed faster than others had a greater reproductive rate in early adult life than slow developers. Fast developers were heavier and larger but did not contain more embryos than slow developers as adults and probably received a more nutritious food supply during their larval lives.

9.8 (BRAMWELL, A. F., CROMBIE, L., HEMESLEY, P., PATTENDEN, G.), ELLIOTT M. & JANES, N. F. (1969) Nucear magnetic resonance spectra of the natural pyrethrins and related compounds. *Tetrahedron* **25**, 1727–1741.

The NMR spectra of the natural pyrethrins, allethrin, and the alcohols and acids from which these esters are separately constituted are presented and discussed.

9.9 CALAM, D. H. (1969) Species and sex-specific compounds from the heads of male bumblebees (*Bombus* spp.). *Nature, Lond.* **221**, 856–857.

The major components of extracts from heads of five species of male bumblebees were identified and shown to be sex and species-specific. It is thought that bees may use these compounds to mark out their territory.

9.10 CALAM, D. H. & SCOTT, G. C. (1969) The scent gland complex of the adult cotton stainer bug, *Dysdercus intermedius*. *J. Insect Physiol.* **15**, 1695–1702.

The main components of the reservoir contents of the paired ventral metathoracic glands of adult *Dysdercus intermedius* are hex-2-en-1-al, oct-2-en-1-al, together with octanal, a monoterpene hydrocarbon $C_{10}H_{16}$, and acetaldehyde. Traces of two other compounds are often present. Water was identified but is considered to be an artifact. Material from females and from males is largely the same and is thought to function as a defensive secretion. It is less complex and more volatile than the defensive secretion from the posterior abdominal gland of fifth instar larvae. An explanation for this is discussed.

Contrary to previous ideas, adults also possess three dorsal abdominal glands, corresponding to those present in larvae. The anterior two seem to be functional but the posterior one, associated with defence in the larvae, is not.

9.11 (EASTOP, V. F.) & BANKS, C. J. (1970) A suspected insecticide resistance mechanism in the peach-potato aphid. *Nature, Lond.* (In the press.)

Winged forms of resistant populations of the peach-potato aphid, *Myzus persicae* (Sulzer), have better developed lateral abdominal tubercles on segments 2 and 4 than susceptible populations. As their siphunculi are concerned with wax secretion and there is circumstantial evidence that this is also true of the abdominal tubercles, it is proposed that resistance in the populations studied reflects the increased rate these organs excrete the insecticide in association with wax or lipid.

9.12 ELLIOTT, M., JANES, N. F. & JEFFS, K. A. (1969) Condensation of ketones with dimethyl dimethylmaleate. A synthesis of calythrone. *J. Chem. Soc.* (*C*) 1845–1847.

Condensation of 4-methylpentan-2-one with dimethyl dimethylmaleate by use of sodium hydride gives calythrone (2-isovaleryl-4,5-dimethyl-cyclopentene-1,3-dione) (*ca.* 5%) but the main product is an ester, shown to be methyl 4-isovaleryl-2-methyl-3-oxycyclopentanecarboxylate and not as previously suggested. Reactions with acetone and acetophenone give only the corresponding cyclopentanone derivatives.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



9.13 ELLIOTT, M., JANES, N. F., JEFFS, K. A. (CROMBIE, L., GOULD, R. & PATTENDEN, G.) (1969) Oxidative dimerization of 2-Alkenyl-2-cyclopentene-1,4-diones by manganese dioxide. *Tetrahedron Letters* **25**, 373–374.

Allethrolone and pyrethrolone are oxidised smoothly by manganese dioxide in carbon tetrachloride to the corresponding cyclopentenediones. A minor product of the reaction, shown to have a dimeric structure, is formed by oxidative coupling of the side-chains.

9.14 ELLIOTT, M., NEEDHAM, P. H. & POTTER, C. (1969) Insecticidal activity of pyrethrins and related compounds. II. Relative toxicity of esters from optical and geometrical isomers of chrysanthemic, pyrethric and related acids and optical isomers of cinerolone and allethrolone. *J. Sci. Fd Agric.* **20**, 561–565.

The relative toxicities of esters related to the natural pyrethrins and to allethrin were evaluated against *Phaedon cochleariae* (mustard beetle), *Tenebrio molitor* (yellow mealworm beetle), *Dysdercus fasciatus* (cotton stainer) and *Plutella maculipennis* (diamond-back moth) and the results compared with those of workers who used *Musca domestica* (housefly).

With the insect species used here there were no outstanding reversals of the toxicity ratings established in the studies with *M. domestica*. However, the toxicities of the esters depended more on the nature of the alcohol when two acids were compared and on the acid component with different alcohols. (+)-Allethrolone and (+)-cinerolone gave more toxic esters than their optical isomers but there was less difference than had been found with other insect species between esters from *trans*- and *cis*-chrysanthemic acids.

9.15 ETHERIDGE, P. & GRAHAM-BRYCE, I. J. (1970) Influence of soil moisture on the performance of granular systemic insecticides applied to soil. *Ann. appl. Biol.* **65**, 15–23.

Control of aphids by the four systemic insecticides, dimethoate, disulfoton, menazon and phorate, applied as granules below seed potatoes at planting was investigated under different soil moisture conditions. Results confirmed previous conclusions that dimethoate and menazon are more effective in wet than in dry soils, whereas disulfoton and phorate are equally effective in both. However, even with dimethoate and menazon effects of moisture were small and were probably the result of several different interacting factors.

9.16 EVELING, D. W. (1969) Effects of spraying plants with suspensions of inert dusts. *Ann. appl. Biol.* **64**, 139–151.

An examination of possible harmful effects to plants caused by spraying leaves with inert dust suspensions showed that Stockalite (kaolin), talc, silica or Tiona W.D. (titanium oxide), suspended in water and sprayed on excised leaves of three species, significantly ($P > 0{\cdot}05$) increased water loss and penetration of gaseous ammonia; these increases were not caused by soluble chemicals in the sprays, but depended on intimate contact of the dust particles with the epidermis. With a given dust, epidermal permeability increased with increasing concentration and with decreasing size of particles. The increased permeability persisted for at least 4 weeks and was unaltered by partial removal of deposits; deposits on bean leaves caused more visible damage in dry than in humid air. Water



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



losses from sprayed adaxial and abaxial leaf surfaces were similar, but more was lost when deposits dried on turgid leaves than when they dried on flaccid ones.

Spraying potted *Coleus* plants with Stockalite suspension increased transpiration and, in one test, decreased the fresh weight of the *Coleus* shoots.

9.17 GRAHAM-BRYCE, I. J. (1969) Diffusion of organophosphorus insecticides in soils. *J. Sci. Fd Agric.* **20**, 489–494.

Diffusion of disulfoton and dimethoate at different concentrations was studied in a silt loam soil containing different amounts of moisture. Apparent diffusion coefficients were calculated from the distribution of insecticide in a column of soil after diffusion from one half of the column to the other for a known time. The distribution was determined by slicing the column into narrow sections using a specially constructed diffusion cylinder. Diffusion coefficients of either insecticide changed little with concentration, but for dimethoate they increased rapidly with increasing moisture content, from $3{\cdot}31 \times 10^{-8}$ cm²/sec at 10% volumetric moisture content to $1{\cdot}41 \times 10^{-6}$ cm²/sec at 43% moisture content. In contrast, for disulfoton, which is more volatile, less soluble and more strongly sorbed than dimethoate, diffusion coefficients were smaller ($2{\cdot}83 \times 10^{-8}$ cm²/sec at 41% moisture content) and changed little as the soil became drier ($2{\cdot}74 \times 10^{-8}$ cm²/sec at 8% moisture content). The influence of partition between solid, solution and vapour phases in the soil, and of the geometry of the pathway through the soil pores on the apparent diffusion coefficient, are discussed. The likely behaviour of other pesticides is considered in the light of the results.

9.18 GRIFFITHS, D. C. (1969) Some laboratory tests of feeding deterrents and baits against wireworms (*Agriotes* spp.). *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969* **3**, 398–404a.

Filter paper discs soaked in nutrient solution containing 10% glucose : 1% peptone : 1·8% triolein were bitten more often by wireworms than discs soaked in larger concentrations of glucose, peptone or triolein alone; omitting one component from the mixture could not be compensated for by doubling the amount of either of the others. Small discs dipped in a thick suspension of glucose, peptone and triolein and placed in tins of soil were found and bitten by wireworms, but discs lost their attractiveness in a few days. More work is needed to increase the persistence of food baits and to choose the insecticide they should contain, before tests can be done in the field.

Wireworms were deterred from biting nutrient discs treated with some commercial insect repellents or feeding deterrents. Three of these, MGK 874 (2-(octylthio) ethanol), DEET (*N*,*N*-diethyl-*m*-toluamide) and Cyanamid 24055 (4′(Dimethyltriazeno) acetanilide), were applied to soil at 100 ppm to weight of soil, but did not affect the wireworms. Applied to seed, MGK 874 and Cyanamid 24055 protected some germinating plants of Cappelle wheat from attack by wireworms during early but not during later plant growth.

9.19 GRIFFITHS, D. C., SCOTT, G. C., LOFTY, J. R. & (ROBERTS, P. F.) (1969) Laboratory and field tests in 1966–67 on chemical control of wireworms (*Agriotes* spp.). *Ann. appl. Biol.*, **64**, 21–29.

Of 16 compounds applied to soil in laboratory tests, azinphos-ethyl, P2188 (*O*,*O*-diethyl *S*-chloromethyl phosphorothiolothionate), 'Dursban' (*O*,*O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothionate), P1973 (*S*-(-*N*-methoxycarbonyl-*N*-methylcarbamoylmethyl) dimethyl phosphorothiolothionate), B77488 (*O*,*O*-diethylphosphorothioate *O*-ester with phenylglyoxylonitrile oxime) and



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



R42211 (*O*,*O*-diethyl *O*-(2-diethylamino-6-methylpyrimidin-4-yl) phosphorothioate) killed wireworms when first tested, but in second tests with the same soils only 'Dursban', P2188 and B77488 did so. Treating seeds with 'Dyfonate' (*O*-ethyl *S*-phenyl ethyl phosphonodithioate) or with ethion/$\gamma$-BHC mixtures killed few wireworms.

Three field trials compared the organophosphorus insecticides 'Dursban', 'Dyfonate' and phorate with organochlorine standards. In trials with barley and potatoes the standard was 3 lb a.i./acre (3·36 kg/ha) of aldrin. The organophosphorus compounds increased plant stands of barley almost as much as did aldrin, although they killed fewer wireworms; they protected fewer potato tubers from wireworm damage. The third trial compared the organophosphorus compounds with 0·5 lb a.i./acre (0·56 kg/ha) $\gamma$-BHC sprayed on a site drilled with sugar beet seed dressed with dieldrin. The $\gamma$-BHC increased plant stands almost as much as did 3 lb a.i./acre of the organophosphorus insecticides, and killed as many wireworms.

9.20 GRIFFITHS, D. C., SCOTT, G. C., (MASKELL, F. E. & ROBERTS, P. F.) (1969). Trials of organophosphorus and carbamate seed dressings against wheat bulb fly *Leptohylemyia coarctata* in 1966–68. *Pl. Path.* **18**, 34–37.

Seed dressings of organophosphorus and carbamate insecticides, at 0·1% and 0·5% active ingredient to weight of seed, were compared with heptachlor and ethion standards for control of wheat bulb fly during 1966–68. Short rows of treated seeds were sown in autumn on sites infested with wheat bulb fly eggs, and sample plants were examined in spring. The effective new materials, judged by the percentage of damaged shoots and the percentage of plants containing live larvae, were R42211 (*O*,*O*-diethyl *O*-(2-diethylamino-6-methyl-pyrimidin-4-yl) phosphorothioate), B77488 (*O*,*O*-diethyl phosphorothioate *O*-ester with phenylglyoxylonitrile oxime), B80833 (*O*-methyl *O*-3,4-dichlorophenyl methyl phosphonothionate), 'Dursban' (*O*,*O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate) and bromophos-ethyl. However, both doses of 'Dursban' and bromophos-ethyl, and the larger dose of B80833 damaged young seedlings. There was only slight damage with the large dose of B77488 and none with R42211, so these two compounds were the most promising new materials tested.

9.21 HENDERSON, I. (1970) The fumigant effect of metaldehyde on slugs. *Ann. appl. Biol.* (In the press.)

The fumigant effect of metaldehyde on slugs was confirmed in laboratory tests with *Agriolimax reticulatus* (Müller) and *Arion hortensis* Ferussac, and shown to be most probably from the release of acetaldehyde vapour. The lethal concentration of acetaldehyde vapour for these species is given.

9.22 (HOFFMANN, H. M. R.) & JANES, N. F. (1969) Allylfurans. *J. Chem. Soc.* (*C*), 1456–1458.

Allylic iodides react with silver trichloroacetate in the presence of furans to form allylfurans in up to 40% yield in a general reaction. In contrast prop-2-ynyl iodide gave methyl 5-prop-2-ynyl-3-furoate (9) from methyl 3-furoate (1) in *ca.* 1% yield. A hydroxymethyl group attached to C-3 favours substitution at C-2 rather than C-5, whereas a methoxycarbonyl group exerts the reverse orientational effect.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



9.23 JANES, N. F. (1969) Nuclear-magnetic-resonance spectrum of a sulphone derivative of chlorogenoquinone. *Biochem. J.* **112**, 609. (Appendix to a paper by W. S. Pierpoint, *ibid.*, p. 567.)

The NMR spectrum of one of the oxidation products isolated is analysed, and used to show its structure.

9.24 LEWIS, J. B. (1969) Detoxification of diazinon by subcellular fractions of diazinon-resistant and susceptible houseflies. *Nature, Lond.* **224**, 917.

Six strains of housefly were used to see whether the genetics of their resistance to organophosphorus compounds was related to their ability to detoxify these insecticides. Subcellular fractions decomposed diazinon and diazoxon by several mechanisms, of which one in the microsomes was common to all strains. Two other mechanisms, one soluble and another in the microsomes, were associated with resistance factors on chromosomes II and V, respectively.

9.25 LEWIS, J. B. & LORD, K. A. (1969) Metabolism of some organophosphorus insecticides by strains of housefly. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **2**, 465–471.

Attempts to relate the genetics of the resistance of houseflies to organophosphorus compounds to their detoxification of these insecticides with whole flies gave inconclusive results, but subcellular fractions decomposed diazinon, diazoxon and ethyl chlorthion by several mechanisms. One mechanism was common to all strains, and two others, one soluble and another in the microsomes, depended on specific genetic factors on chromosomes II and V. The effect of the synergists sesamex and S,S,S-tributylphosphorotrithionate on these mechanisms partly explains their effect on toxicity to the different strains.

9.26 MCINTOSH, A. H. (1969) Soil-treatments for control of potato tuber-blight. *Eur. Potato J.* **12**, 219–221.

In eight field trials in 1965–68, single applications of various formulations of 14 fungicides to the soil ridges during the growing season nearly always failed to control potato tuber-blight (*Phytophthora infestans*). Single sprayings of the lower parts of the stems only, or of the tops of the haulms in the conventional way, were no more successful. Spraying the ridges with skin-forming materials, with the aim of preventing spores from entering the soil, seemed to favour tuber infection.

9.27 MCINTOSH, A. H., EVELING, D. W. & (MELVILLE, S. C.) (1969) Effect of paraffin wax on field control of potato blight by copper oxychloride. *Pl. Path.* **18**, 187–191.

A formulation of copper oxychloride, containing emulsified paraffin wax, was compared with a commercial wettable powder in conventional field spraying trials for control of potato blight (*Phytophthora infestans*). Spraying with the wax formulation usually gave a significant increase in yield under conditions where the wettable powder did not. However, differences in copper residues on the foliage, and in control of blight, were slight. The wax may offset the effects of damage done to the plants by the copper oxychloride.

9.28 PHILLIPS, F. T. (1969) A small laboratory apparatus for measuring accelerated loss rates of pesticide deposits by 'rainwashing'. *Chemy Ind.* 414–415.

A small apparatus, simply constructed from glass and 'Perspex', with a moving jet powered by a small electric motor, is used to 'rainwash' insecticide deposits from various surfaces. Fractions are continually collected over timed periods.



*https://doi.org/10.23637/ERADOC-1-124* 

This work is licensed under a Creative Commons Attribution 4.0 International License.



Reproducible results, obtained from two different DDT formulations on both glass and leaf surfaces, are described. Double exponential curves of the type, $y = Ae^{-kt} + Be^{-k't}$ can be fitted to the results.

9.29 SAWICKI, R. M. & FARNHAM, A. W. (1970) Examination of the isolated autosomes of the SKA strain of house-flies (*Musca domestica* L.) for resistance to several insecticides with and without pretreatment with sesamex and TBTP. *Bull. ent. Res.* (In the press.)

The factors of resistance to many insecticides were located and isolated in a homozygous condition from the diazinon-selected SKA strain of house-flies (*Musca domestica* L.) by inbreeding each of the five autosomes of the SKA strain into a susceptible multi-marker strain *ac*; *ar*; *bwb*; *ocra* SRS. The insecticides were: DDT, methoxychlor, tri-butyl tin, the methoxy and ethoxy analogues of parathion, chlorthion and malathion and their corresponding phosphates, diazinon and diazoxon.

The SKA flies' autosomes had the following factors of resistance: autosome I—very slight resistance to ethyl-chlorthion; autosome II—gene *a* for low ali-esterase activity which conferred weak to moderate resistance against all organophosphates tested, and *Deh* (DDT-dehydrochlorinase) which gave great resistance to DDT, but none against methoxychlor; autosome III—*Pen*, which delayed knock-down by slowing the entry of insecticides into the flies and had a negligible effect at death except against tri-butyl tin and methoxychlor, and a factor of resistance to Zectran unaffected by sesamex; autosome IV—*Dld*, the major factor of resistance to dieldrin; autosome V—*Ses*, a sesamex-suppressed factor, which gave weak to moderate resistance against ethyl-malaoxon, diazoxon, diazinon, DDT and methoxychlor, but was ineffective against the other organophosphates tested.

TBTP (S,S,S tri-butyl phosphorotrithionate), an ali-esterase inhibitor, greatly synergised organophosphates only against insects with gene *a*. Pretreatment with sesamex, an inhibitor of microsomal activity, elicited two types of response: antagonism with most of the thioates, most pronounced in flies with gene *a*, and synergism with the phosphates, especially evident with flies with factor *Ses*. The possible reasons for differences in the response to organophosphates after pre-treatment with TBTP or sesamex, and the nature of the resistance factors, are discussed. Strong resistance in SKA flies against organophosphates arises through the interaction of resistance factors that singly give only weak to moderate resistance.

9.30 SAWICKI, R. M. & LORD, K. A. (1970) Some properties of a mechanism delaying penetration of insecticide into house-flies. *Pesticide Science*, **1**. (In the press.)

The penetration of insecticides into houseflies with and without the penetration delaying factor was studied by measuring the amounts of the insecticides on the surface of the flies at intervals after treatment.

The factor delaying penetration slowed the entry of all the insecticides tested, but its effect depended on the dose, and was small with large doses (20 $\mu$g/fly). Penetration in all strains, susceptible and resistant, increased but not proportionally to the size of the dose. The rate the insecticides were lost from the surface slowed with time. It was larger in males than females, and was always greater in flies without the penetration factor.

With all strains rate of loss from the surface was least with dieldrin. Diazinon, parathion and chlorthion ethyl were lost at about the same rate; diazoxon penetrated fastest.



https://doi.org/10.23637/ERADOC-1-124 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



## Entomology Department

### General Papers

10.1 Banks, C. J. & Macaulay, E. D. M. (1968) Cannibalism and predation by aphids. *Nature, Lond.* **218**, 491.

10.2 Edwards, C. A. (1970) The problem of insecticidal residues in agricultural soils. *N.A.A.S. quart. Rev.* No. 86, 47–54.

10.3 Edwards, C. A. (1970) Persistent insecticides in the environment. *C.R.C. Critical Reviews in Environmental Control.* (In the press.)

10.4 French, R. A. (1969) Recent developments in the study of immigrant Lepidoptera in Great Britain. *Nature in Wales* **10**, 69–73.

10.5 French, R. A. & Taylor, L. R. (1963) A survey of British moths. *Bull. amat. Ent. Soc.* **22**, 81–83.

10.6 Lewis, T. (1970) How shelter affects insect pests. *New Scientist* 12 February, No. 688, 300–301.

10.7 Lewis, T. & (Siddorn, J. W.) (1970) Measurement of the physical environment. In: *Aphid technology*. Ed. H. F. van Emden, London and New York: Academic Press.

10.8 Taylor, L. R. (1969) The optimum population for Britain. *Biologist* **16**, 163–171.

10.9 Taylor, L. R. (1970) Introduction. In: *The optimum population for Britain*, Ed. L. R. Taylor. London and New York: Academic Press (xxiii + 182 pp.) pp. xi–xxiii.

10.10 Taylor, L. R. (1970) Aggregation as a species characteristic. In: *Statistical ecology*, Ed. Patil, Pielou & Waters, University Park.

10.11 Taylor, L. R. & Palmer, J. M. P. (1970) Aerial sampling. In: *Aphid technology*, Ed. H. F. van Emden, London and New York: Academic Press.

### Paper in Rothamsted Report, Part 2

10.12 Taylor, L. R. & French, R. A. (1970) Rothamsted Insect Survey. *Rep. Rothamsted exp. Stn for 1969*, Part 2, 168–185.

Tables are given of 4-week totals of 34 species, or groups, of aphids of economic or other interest in survey suction traps at 11 sites in Wales, Scotland, England and Holland from 23 April to 4 November 1969. One-year totals of 26 species of moths of economic interest in Rothamsted light traps at 28 sites in Wales, Scotland and England for 1967 and in 47 sites for 1968 are also tabulated.

### Research Papers

10.13 Banks, C. J. & Macaulay, E. D. M. (1970) Effects of varying the host plant and environmental conditions on the feeding and reproduction of *Aphis fabae* (Scop.). *Ent. exp. appl.* (In the press.)
(For summary see No. 9.7).



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



10.14 BARDNER, R., (MASKELL, F. E.) & ROSS, G. J. S. (1970) Measurements of infestations of Wheat Bulb fly, *Leptohylemyia coarctata* (Fall.) and their relationship with yield. *Pl. Path.* (In the press.)

In experiments done in eastern England from 1957–66 to control Wheat Bulb fly in winter wheat (Cappelle), up to 70% of the variation in yield was accounted for by regressions of yield on density of plants and larvae and on plant development, as measured during March. The possibility of using such measurements to forecast crop yield is discussed.

10.15 BARDNER, R., FLETCHER, K. E. & HUSTON, P. (1969) Recent work on Wheat Bulb fly. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **2**, 500–504.

Plants of Cappelle wheat attacked by Wheat Bulb fly larvae grew more slowly and had fewer shoots and ears than unattacked plants. Attacked plants that died were killed directly by larvae, not by competition with unattacked plants. Only unattacked plants showed compensatory growth and in late-sown crops the numbers of ears/undamaged plant was negatively correlated with the density of the plant population surviving attack.

10.16 BARDNER, R. & TAYLOR, W. E. (1970) Effects of flea beetles on the yield of radish. *Entomologia exp. appl.* (In the press.)

The yield of dry matter of radish attacked by adult flea beetles in the field was negatively and linearly related to the number of feeding lesions/unit area of leaf, when both sets of values were transformed logarithmically.

10.17 (BEYNON, K. I., EDWARDS, M. J.), THOMPSON, A. R. & EDWARDS, C. A. (1970) Persistence of chlorfenvinphos (diethyl 1-(2,4-dichlorophenyl)-2-chlorovinyl phosphate) in natural waters. *Pesticide Science* **1**. (In the press.)

Chlorfenvinphos EC was sprayed on to the surface of a pond as a dilute emulsifiable concentrate so that the total water contained the insecticide at a concentration of 6·1 ppm. This decreased to 2·0 ppm after 5 hours and to 0·12 ppm after 1 month. Residues were detected in the mud after 5 hours, increased rapidly up to 8 hours after treatment and reached a maximum of only 0·32 ppm, 114 hours after treatment.

It seems unlikely therefore that contamination of ponds by aerial spraying at commercial dosages (up to 5 kg/ha), or from run-off and leaching of chlorfenvinphos from treated soils, would be a serious hazard to free swimming aquatic animals. Chlorfenvinphos persisted in the mud for at least 27 days, but there was no evidence of any significant effect on animals living in the mud.

10.18 (DRY, W. W.) & TAYLOR, L. R. (1970) Light and temperature thresholds for take-off by aphids. *J. Anim. Ecol.* **39**, 493–504.

Median take-off thresholds for light intensity of eight lines of five species of alate alienicolae were between 15 and 100 ft-candles (162 and 1080 m-candles). Distributions were skew and corrected by adding a constant, between 1 and 20 ft-candles (10·8 and 208 m-candles) to light intensity before taking logs. Small proportions of the population of *R. maidis KS*-2 and *M. granarium* responded to light equivalent to civil twilight (0·1 ft-candles: 1·05 m-candles). *S. graminum* required the brightest light (1350 ft-candles: 14 580 m-candles) for full response. These aphids are unlikely to take flight at night.



*https://doi.org/10.23637/ERADOC-1-124* *pp 48*

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



Temperature thresholds were unexpectedly high; no aphids took flight below 14°C. Some aphids only flew at temperatures near the upper tolerance limit.

Migratory flight is not a necessary concommitant of the alate conditions of these aphids.

10.19 EDWARDS, C. A., (REICHLE, D. E. & CROSSLEY Jr., D. A.) (1969) Experimental manipulation of soil invertebrate populations for trophic studies. *Ecology* **50** (3), 495–498.

Pesticides were applied so that populations of soil microarthropods, earthworms and the other fauna were killed differentially to study their role in litter and soil turnover. The technique employs a soil fumigant (dichloropropene, 'D-D'), an insecticide (aldrin) and an earthworm extractant (formalin), to eliminate different biotic groups. 'D-D' fumigation effectively eliminated earthworms and decreased microarthropod populations by 98·3%. Periodic application of aldrin to fumigated soil caused little change in numbers of microarthropods for 8 months, when they were 6·7% of the mean density in untreated plots. Repeated extraction of earthworms by formalin had lessened the population by 80% 6 months after treatment and the formalin had no significant effect on soil microarthropods. This report presents the methods of treatment, population changes after treatment and rates of repopulation of soil by various invertebrate species.

10.20 EDWARDS, C. A. & THOMPSON, A. R. (1970) Control of wireworms with organophosphorus and carbamate insecticides. *Pesticide Science* **1**. (In the press.)

Carbaryl, chlorfenvinphos, diazinon, disulfoton, parathion, phorate, fenitrothion, thionazin and trichlorphon were each tested at least once for their effect on numbers of wireworms in three field trials one with wheat and two with potatoes. Many more larvae were killed by phorate and parathion at 4 lb a.i./acre (4·48 kg a.i./ha) than by other insecticides; thionazin and diazinon were intermediate and the other insecticides relatively ineffective.

10.21 EDWARDS, C. A., THOMPSON, A. R., (BEYNON, K. I. & EDWARDS, M. J.) (1970) The movement of dieldrin in soils. I. From arable soils in ponds. *Pesticide Science* **1**. (In the press.)

Dieldrin at 22·4–44·8 kg a.i./ha was applied to strips each 3·6 m wide and 3·6–4·5 m away from the edges of four ponds. There were shallow to steep slopes from the treated strips towards the ponds. In three experiments, the insecticide was lightly raked into the soil and in the fourth cultivated to a depth of 10 cm. Dieldrin was found in untreated soil on the surface of the slopes between the treated strips and the ponds but not in the pond water. Very small amounts (maximum 0·3 ppm) occurred in the bottom mud and on the sides of the ponds opposite to the treated sides, but only in experiments where the insecticide was not incorporated into the soil.

10.22 EDWARDS, C. A., WHITING, A. E. & (HEATH, G. W.) (1970) A mechanised washing method for separation of invertebrates from soil. *Pedobiologia*. (In the press.)

A machine is described that can wash four soil samples simultaneously with fan-shaped jets of water, one across each sample as it rotates in a wire basket. Its efficiencies in separating invertebrates from fallow, pasture and woodland soils were compared. With all soils, it was most efficient with earthworms,



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



molluscs, larger arthropods and deep living Collembola. The main advantages of the method are its speed, elimination of tedious labour and the consistency of the treatments.

10.23 (EDWARDS, M. J., BENYON, K. I.), EDWARDS, C. A. & THOMPSON, A. R. (1970) The movement of chlorfenvinphos (diethyl 1-(2,4-dichlorphenyl)-2-chlorovinyl phosphate) in soil. *Pesticide Science* **1**. (In the press.)

The amount of chlorfenvinphos leaching through soil was studied by applying it to arable land in two fields at 22·4 kg a.i./ha and following its movement down a slope. Only very small quantities of the insecticide later appeared lower down the slope. A comparable amount of chlorfenvinphos was applied to the first compartment of a trough divided into six compartments by transverse partitions so that the soil sloped with a gradient of 1 in 3·7. Leachates were collected at the bottom of each compartment. Most of the chlorfenvinphos in the leachates was collected during the first 63 days from the first compartment. Only 0·18% of the amount applied was leached through the soil but this was nine times as much as with dieldrin in similar conditions. Only small amounts moved down the sloping surface of the soil and most was in the soil at the bottom of the slope after 118 days. More chlorfenvinphos leached into the drainage water vertically than moved laterally over the soil surface.

10.24 JOHNSON, C. G. (1970) Methodology of field testing and of control of capsids in Ghana. *Proceedings of the 3rd International Cocoa Research Conference, Accra.* (In the press.)

The results of field trials made between 1957 and 1960 were analysed and the method of assessing the effect of spraying by counting capsids to hand height was compared with the method of counting the percentage of newly damaged trees. Continued counting each fortnight of either factor is unnecessary; the mean of the first two counts satisfactorily indicated the immediate effects of spraying. Counting the percentage of trees with different degrees of damage to the canopy every 6 months satisfactorily assessed the long-term effect. The coefficient of variation, both with capsid counts and with the percentage of newly damaged trees, averaged about 100%; with the number of replicates that were practicable, differences between insecticidal treatments, in any one trial, could be detected with confidence only when they differed by a factor of two or more.

10.25 JOHNSON, C. G. (1970) Predictable aggregation of capsids and damage; its significance in the tactics of control. *Proceedings of 3rd International Cocoa Research Conference, Accra.* (In the press.)

Distributions of damage to trees and of capsids between and within plots were analysed with the variance-mean ratio. The amount of new damage associated with a capsid population of a particular size is predictable and became increasingly aggregated when the percentage of newly damaged trees/fortnight exceeded about 1%. The formation of capsid pockets should be studied with this in mind. The regression coefficient of log variance ($s^2$) on log mean ($m$), for capsids and for newly damaged trees, is about 2, which indicates that a log transformation is appropriate for both.

The relation between new and old damage suggests a self-compensating system in which capsids may become fewer and the canopy may partially recover naturally in some very badly damaged areas. The pattern of distribution of new and old damage in relation to capsid populations suggests that spraying only some areas



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



might eventually be effective, but also that a good canopy can act as a reservoir for large capsid populations and that some apparently healthy cocoa must not be neglected in a spraying scheme.

10.26 JONES, M. G. (1969) The effect of weather on frit fly (*Oscinella frit* L.) and its predators. *J. appl. Ecol.* **6**, 425–441.

Weather at the critical time of oviposition, larval penetration and emergence determines the number of frit flies on oats. In unfavourable weather females shelter in spaces in the soil. Ground predators are also less active during cold wet weather.

Predation occurs only to a small extent on the insects when they are in the exposed stages of the life history. Small non-specific egg feeders such as *Bembidion lampros*, *Tachyporus* spp., *Trechus quadristriatus* and the mite *Pergamasus longi cornis* may eat frit fly eggs. All stages of the panicle generation may be preyed on by *Anthocoris nemorum*.

Frit flies of all generations may be caught by dipterous predators normally present in the habitat. The commonest were *Tachydromia* spp. (Empididae), *Scatophaga stercoraria* (Cordyluridae) and *Medeterus truncorum* (Dolichopodidae).

When the weather is good for oviposition of frit fly the combined activity of predators and parasites is not enough to protect late-sown oats. Spraying twice with parathion at the 2–3 leaf stage is effective; alternatively the sprays can be applied to the soil before the crop is sown.

10.27 JONES, M. G. (1969) Oviposition of frit fly (*Oscinella frit* L.) on oat seedlings and subsequent larval development. *J. appl. Ecol.* **6**, 411–424.

When undisturbed in a breeding chamber, female frit flies may lay many eggs behind a single coleoptile of the 2–4 leaf oat seedling. In the field this happened only in plots freed from predators and when fine weather at the end of May coincided with the 2–4 leaf stage. In other conditions, with predators and other disturbing factors operating, 60% of all eggs were laid singly on the 2–4 leaf seedling.

When more than one larva penetrates the shoot, they compete for food, and some fail to survive to pupation. Larvae can move between plants or tillers but most that move in the field are probably killed by predators: *Bembidion lampros*, *Agonum dorsale*, *Notiophilus biguttatus* and *Trechus quadristriatus*. These predators may also prevent larvae, hatched from eggs on the soil, from penetrating a nearby oat seedling.

Dense stands of cereals favour ovipositing females less than sparse stands, probably because the flies find it more difficult to position themselves and there are fewer acceptable crevices.

Counting eggs on plants in May is a better and simpler method of assessing populations than sampling by the Cardiff grab or by assessing damaged shoots in June.

10.28 JUDENKO, E. (1969) Further results on the effects of phorate on losses of sweet corn (*Zea mays* L.) caused by frit fly (*Oscinella frit* L.). *PANS.* **15** (4), 553–557.

Phorate (1·5 lb a.i./acre (1·68 kg a.i./ha)) applied as granules in the seed furrows at planting significantly lessened both shoot attack by frit fly and losses in numbers and value of marketable cobs, although it did not control the pest completely. Phorate also increased yield in another, unknown, way, in addition to its effect on the frit fly. Contrary to the results in 1967, phorate significantly



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



increased actual yield in 1968. Had the pest on these plots been completely controlled, yield would have been a third more than it was. Results confirmed the danger of estimating the losses caused by a particular pest by measuring the effect of an insecticide on the actual yield.

10.29 JUDENKO, E. (1969) A method of assessing losses in spring oats from frit fly (*Oscinella frit* L.) shoot attack. *Bull. ent. Res.* (In the press.)

Grain losses in oats following shoot attack by frit fly (*Oscinella frit* L.) were assessed at Rothamsted. Individual plants were marked, and two categories of attacked plants (tillers only and main shoots plus tillers attacked) distinguished; losses in the former were small or negligible compared with those in the latter. There was no evidence of compensatory growth for lost or damaged plants; losses could therefore be assessed by comparing actual yield with expected yield had no plants been attacked. The percentage loss, weighted according to incidence and effect of attack in the two categories, was calculated from hand-harvested samples. The loss/unit area was then estimated from the actual yield obtained by combine-harvesting. Estimates of actual yield were affected by the method of harvesting, so that estimates of loss were not precise.

10.30 (KNUTSON, L. V.), STEPHENSON, J. W. & BERG, C. O. (1970) Biosystematic studies of *Salticella fasciata* (Meigen), a snail killing fly (Diptera: Sciomyzidae). *Proc. R. ent. Soc. Lond.* (*Ser. A*). (In the press.)

The Salticellinae (Diptera : Sciomyzidae) consists of *Prosalticella succini* Hennig (found in baltic amber), *Salticella stuckenbergi* Verbeke (southern Africa), and *S. fasciata* (Meigen) (central and southern Europe, northern Africa). Eggs of *S. fasciata* are laid in the umbilici of terrestrial snails, living on dunes and in other dry habitats; as many as 331 eggs are produced by each female, and the incubation period is 1–3 days. Larvae have a broad food range. Although larvae have been found feeding in nature only on *Theba pisana* (Müller), *Helicella candicans* (Pfeiffer), *H. virgata* (da Costa) and *Helix hortensis* (Müller), (all Helicidae), they killed and fed on snails of many other families and on other dead invertebrates while being reared in the laboratory. Larvae may feed as solitary internal parasites within a living snail and eventually kill it, or they may feed saprophagously, from hatching to puparium formation, on dead tissues. The duration of larval life ranges from 13 to 28 days. Puparia are formed outside the shell; the pupal period lasts 21–30 days.

The immature stages superficially resemble those of many Sciomyzini. Larvae are robust and non-pigmented, with transparent spinules and have an unusual arrangement of minute lobes and papillae at the posterior end. Oral grooves and pharyngeal ridges are present. Distinctive features of the third-instar cephalopharyngeal skeleton include a denticle on the mouthhook, no accessory teeth, few teeth on the central arch, paired ligulate sclerites, a pair of bars above the parastomal bars, a dorsal ridge between the pharyngeal sclerites, windows in the dorsal and ventral cornua, and an indentation index of 61–67. The reddish, slightly wrinkled puparium has 8–10 transversely arranged papillae on the anterior spiracle and the conical, elongate posterior spiracular rubes have three simple slits.

Although some biological and morphological features of the adult and immature stages are specialised, many are primitive. The Salticellinae belong to the same monophyletic group as the Sciomyzinae and Phaemyiinae and seems closest to the Sciomyzini. Many characteristics, but especially the food and feeding behaviour of the larvae and the presence of pharyngeal ridges, indicate that *S. fasciata* is phylogenetically close to the acalyptrate progenitors of the Sciomyzidae.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



10.31 LEWIS, T. (1969) The distribution of flying insects near a low hedgerow. *J. appl. Ecol.* **6**, 443–452.

The distribution patterns of insects flying over pasture, to leeward of a mixed hedge, were measured by suction traps. Insects in the hedgerow and neighbouring fields were sampled with a vacuum sampler to show the probable origin of some taxa present in the aerial population.

The patterns for insects drifting over the hedge from distant sources resembled patterns near artificial windbreaks of similar permeability, with accumulations extending about ten times the height of the hedge to leeward. Patterns for insects originating in the hedge were quite different, with accumulations extending a shorter distance to leeward and with greatest densities immediately behind the hedge.

Whatever their origin, fewer insects accumulated in slow than in fast winds, which suggests that accumulations near hedges occur largely because the patterns of air-flow created by the hedge concentrate insects from the passing aerial population, not because the hedge itself supplies the greater population.

10.32 LEWIS, T. (1969) The diversity of the insect fauna in a hedgerow and neighbouring fields. *J. appl. Ecol.* **6**, 453–458.

The insect communities on vegetation in a mixed hedgerow and in neighbouring fields of pasture and field beans were sampled with a vacuum sampler, and the aerial populations above the vegetation with suction traps. For terrestrial and aerial samples, the frequency distribution of the number of individuals, in each of 76 taxa identified, fitted a logarithmic series; therefore $\alpha$ was used as an index to compare the relative diversity of communities in and above these habitats.

Of the terrestrial communities, that in the hedge was the most diverse, less so in the beans and least in the pasture. The diversity of the aerial population decreased with increasing distance from the hedge, and the resulting pattern of diversity resembled the pattern of shelter produced by the hedge. The presence of the hedge enriched the aerial population nearby for a distance of three to ten times its height to leeward and one to two times to windward.

10.33 LEWIS, T. (1970) Patterns of distribution of insects near a windbreak of tall trees. *Ann. appl. Biol.* **65**. (In the press.)

The distribution of shelter to leeward of a windbreak of tall trees was compared with the pattern of distribution of insects above and within a wheat crop.

The pattern for flying insects blown from elsewhere resembled the shelter profile, in contrast to insects originating in the windbreak, which accumulated immediately behind the trees, and those originating a few metres to windward, which accumulated in a zone between $\frac{1}{2}$ and 1 H to leeward. These patterns were more distinct in direct than in oblique incident winds.

The pattern of infestation of a breeding population of cereal thrips in the wheat resembled the distribution of airborne primary migrants 1–2 months earlier; the pattern of scatophagid flies on the crop also resembled that of airborne populations of other dung feeders originating slightly to windward of the trees.

10.34 LEWIS, T. & (SMITH, B. D.) (1969) The insect fauna of pear and apple orchards and the effect of windbreaks on their distribution. *Ann. appl. Biol.* **64**, 11–20.

Two coir netting windbreaks, each 7 m tall and 46 m long, were erected in a pear and an apple orchard, to try to increase the number of insect pollinators present



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



at blossom time. The flying insects were sampled with suction traps and insects visiting trees were sampled by examining marked clusters of blossom.

The mean aerial density was calculated for each of the 42 taxa, mainly families, identified from the aerial population. There were about 50% more insects flying in the pear than in the apple orchard. The distribution of flying insects was greatly affected by the windbreaks, and the sheltered zone contained three times as many Chironomidae, Psychodidae and Bibionidae, as elsewhere.

Small flies were the most abundant insects in the air, in both orchards. In the pear orchard only about 7% of the total aerial population were large insects of which honeybees constituted 0·7% and wild bees 0·3%.

By contrast, large insects accounted for a greater proportion of the population on blossom. The reasons for this are discussed. Syrphids and honeybees were the insects most often seen on pear blossom and Bibionidae and Mycetophilidae on apple blossom.

10.35 MACAULAY, E. D. M. (1969) A device for controlling humidity in small insect-rearing chambers. *Lab. Pract.* **18**, 652.

An apparatus is described that brings a stream of air to a specified relative humidity before passing it through the culture chamber.

10.36 STEPHENSON, J. W. & (KNUTSON, L. V.) (1967) The distribution of snail-killing flies (Sciomyzidae) in the British Isles. *Entomologist's Rec. J. Var.* (In the press.)

The world and western Palearctic distribution of Sciomyzidae are summarised briefly. The British Sciomyzid fauna, consisting of 63 species in 23 genera and three sub-families, is compared with those in continental (European) areas. Causes to which the general paucity of the British fauna may be attributed, additional to those already put forward, are suggested.

The known distribution of the British fauna is summarised and a request made for further information or specimens to be sent to the authors. Distribution maps of the type shown will be published in collaboration with Biological Records Centre of the Nature Conservancy.

10.37 TAYLOR, L. R. (1970) Variance and the transformation of counts of *Aphis fabae* Scop. on beans. *Ann. appl. Biol.* **65**, 181–189.

In several sets of counts of *A. fabae* colonies on bean stems, obtained with different sampling methods, variance was always proportional to the same power of the mean, $s^2 = am^b$ where $b = 1{\cdot}72$; $a$ differed according to different sampling methods. The resulting standard transformation for *A. fabae* on beans, $z = x^{0{\cdot}2}$, is marginally more effective than $z = \log(x + 1)$.

## Bee Department

### GENERAL PAPERS

11.1 BUTLER, C. G. (1969) Some pheromones controlling honeybee behaviour. *Proc. VI Congr. IUSSI, Bern 1969*, 19–32.

11.2 BUTLER, C. G. (1969) Some chemical and other factors controlling the behaviour of honeybees. *Rep. Cent. Ass. Br. Beekeep. Ass.* pp. 1–12.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



## Research Papers

11.3 Bailey, L. (1968) The measurement and interrelationship of infections with *Nosema apis* and *Malpighamoeba mellificae* of honey-bee populations. *J. Invert. Path.* **12**, 175–179.

The numbers of spores of *Nosema apis*, or cysts of *Malpighamoeba mellificae* in samples of honeybees (*Apis mellifera*) were correlated with the percentage of bees infected. Colonies infected with both parasites were more than expected by chance and contained more bees infected with *N. apis* than usually occur in colonies with *N. apis* alone. *M. mellificae* multiplies less than *N. apis* in individual bees and does not cause obvious sickness.

11.4 Bailey, L. (1968) The multiplication of sacbrood virus in the adult honeybee. *Virology* **36**, 312–313.

Infectivity tests on larvae showed that sacbrood virus multiplied when injected into adult bees that were protected against acute bee-paralysis virus with antiserum, or when fed to very young bees.

11.5 Bailey, L. (1969) The multiplication and spread of sacbrood virus of bees. *Ann. appl. Biol.* **63**, 483–491.

Sacbrood virus multiplied without causing symptoms in adult bees when it was injected into them or when it was fed to young individuals. More virus accumulated in heads of infected bees than elsewhere in their bodies, and much was in their hypopharyngeal glands. The extract of each infected head contained about $10^2$ medial lethal doses (LD 50s) of sacbrood virus for larvae when given in their food. The infective dose of sacbrood virus by injection for adults was about $10^{-4}$ of the LD 50 in food for larvae. The infective dose by mouth for adults was about $10^2$ LD 50s for larvae, but bees older than 4–8 days could not be infected in this way. Infection did not spread between adults but is probably transmitted in nature from infected adults to larvae and back to young adults that ingest remains of larvae killed by sacbrood. The youngest adult bees infected with sacbrood ate little pollen and lived only about 3 weeks in the laboratory, as did bees receiving no pollen, whereas bees fed with ample pollen lived 9 weeks.

11.6 Bailey, L. (1969) The signs of adult bee diseases. *Bee Wld* **50**, 66–68.

Most colonies producing many crawling individuals in England and Wales were suffering from paralysis caused by chronic bee paralysis virus. Laboratory tests and field observations over many years have shown that this virus causes crawling and early death of bees whereas bees infected with *Acarapis woodi*, *Malpighamoeba mellificae* or *Nosema apis* do not.

11.7 Bailey, L. (& Locher, N.) (1968) Experiments on the etiology of European foulbrood of the honeybee. *J. apicult. Res.* **7**, 103–107.

A pure culture of *Streptococcus pluton* isolated in Denmark from larvae there with European foulbrood (E.F.B.) caused the disease when inoculated into healthy colonies. Bacteria-free filtrates of E.F.B. larvae from either Denmark or England did not cause E.F.B., and the English filtrate did not contain the virus-like particles seen in similar filtrates elsewhere. All strains of *S. pluton* examined, which had been isolated in many parts of the world, were closely related serologically. Inoculating colonies with bacteria from E.F.B. larvae did not cause E.F.B. during late summer, and endemically diseased colonies recovered spontaneously when removed to areas usually free from E.F.B.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



11.8 BUTLER, C. G., (FLETCHER, D. J. C.) & WATLER, D. (1969) Nest-entrance marking with pheromones by the honeybee, *Apis mellifera* L., and by a wasp, *Vespula vulgaris* L. *Anim. Behav.* **17**, 142–147.

Crawling worker honeybees, apparently involuntarily, deposit a 'footprint substance' that attracts other workers and stimulates them to enter the hive. Homecoming honeybees are also attracted by an odour in the hive atmosphere which may be that of 'footprint substance'. This 'footprint' pheromone, which is certainly perceived olfactorily and possibly also chemotactically, is persistent but probably not colony-specific. Although deposited by the feet, it is probably produced by glands on most parts of a bee's body. Workers of the social wasp, *Vespula vulgaris*, also deposit a 'footprint' pheromone that attracts homecoming wasps but not worker honeybees. Similarly, the 'footprint' pheromone of honeybees does not attract worker wasps. It is suggested that many kinds of social insects, and perhaps some solitary ones, involuntarily mark the entrances of their nests with 'footprint' pheromones.

11.9 FREE, J. B. (1968) The conditions under which foraging honeybees expose their Nasonov gland. *J. apicult. Res.* **7**, 139–145.

'Scout' honeybees searching for food were attracted by the odour from the Nassanoff glands of other foragers. Foragers did not usually expose their Nassanoff glands until after they had visited a source of food several times, even when the food was abundant and attractive. Some foragers exposed their glands more often and for longer than others.

The tendencies of bees to expose their Nassanoff glands was not influenced by: the presence of Nassanoff gland odour at the source of food; changing the food from sucrose syrup to honey; putting obvious visual orientation marks or certain scents (e.g. benzyl acetate, methyl benzoate) near the food. Adding geraniol to odourless food discouraged bees that collected it from exposing their Nassanoff glands, although some did so even when foraging on natural flowers to which sucrose syrup had been added.

11.10 FREE, J. B. (1968) Engorging of honey by worker honeybees when their colony is smoked. *J. apicult. Res.* **7**, 135–158.

After smoke was blown among the bees of a small colony, the amount of food in their honey-stomachs soon increased greatly, and then decreased slowly. The amount bees ingested was not related to their age but the honey-stomachs of bees 10 days old (likely to be feeding brood and building comb) were fuller than those of other bees before their colony was smoked, so they were also fuller afterwards. Bees that stung a provocative object tended to have less food in their honey-stomachs than bees that did not sting it.

11.11 FREE, J. B. (1969) Influence of the odour of a honeybee colony's food stores on the behaviour of its foragers. *Nature, Lond.* **222**, 778.

The odour of a honeybee colony's food stores is one of the factors that influences a forager's choice of crop, even when they are conditioned to other food sources and the food is not being transferred during the process of direct crop communication by successful foragers.

11.12 FREE, J. B. & PREECE, D. A. (1969) The effect of the size of a honeybee colony on its foraging activity. *Insectes soc.* **16**, 73–78.

Deterioration in foraging conditions discourages foraging relatively more from large than from small colonies.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



11.13 FREE, J. B. & RACEY, P. A. (1968) The pollination of runner beans (*Phaseolus multiflorus*) in a glasshouse. *J. apicult. Res.* **7**, 67–69.

In glasshouses honeybees were as successful as bumblebees at pollinating runner beans, and their use produced earlier crops.

11.14 SIMPSON, J. (1969) The amounts of hive space needed by colonies of European *Apis mellifera*. *J. apicult. Res.* **8**, 3–8.

The sizes of colonies and the amounts of space particular numbers of bees occupied were investigated, to deduce how much hive space beekeepers need for their colonies. The large variation in colonies' maximum sizes suggested that it might be more useful in selective breeding to aim for more uniform colonies than for bigger ones.

11.15 SIMPSON, J. & CHERRY, S. M. (1969) Queen confinement, queen piping and swarming in *Apis mellifera* colonies. *Anim. Behav.* **17**, 271–278.

The factor responsible for deciding whether or not a colony that rears young queens prevents them from emerging from their cells was shown to be either congestion of adult bees in the hive or simply large numbers of adult bees. Nevertheless, depriving colonies of their flying bees made them more likely to destroy queen cells. Worker bees seemed not only to imprison young queens in their cells, but also to inhibit them from cutting open their cell cappings. Swarming by uncrowded colonies was invariably preceded by queen piping. There was some evidence that piping sound plays a part in making colonies swarm.

11.16 WILDING, N. (1969) Effect of humidity on the sporulation of *Entomophthora aphidis* Hoffman and *E. thaxteriana* Hall and Bell. *Trans. Br. mycol. Soc.* **53**, 126–130.

*Entomophthora thaxteriana* and *E. aphidis* on pea aphids sporulate most at 100% relative humidity and not at all below 90% relative humidity. *E. thaxteriana* sporulates relatively more than *E. aphidis* below 100% relative humidity. Both, but especially *E. aphidis*, seem to sporulate more when the infected aphid is on a wet substrate in a saturated atmosphere than when it is in a saturated atmosphere only.

## Statistics Department

### RESEARCH PAPERS

12.1 ANDERSON, A. J. B. & LOWE, B. I. (1970) A multivariate analysis computer program. *Appl. Statist.* **19**, 18–26.

The computer program described for the analysis of multivariate data is interactive in that its control structure is designed to facilitate a step-by-step process of analysis extending over several computer runs. Especially comprehensive input routines allow the user flexibility in data presentation. A group structure can be imposed, and within- and between-group analyses are possible. The program includes all the usual multivariate techniques, but in addition provides a wide repertoire of operations useful in multiple regression analysis.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



12.2 (ANDERSON, E. C., CAPSTICK, P. B., MOWAT, G. N.) & LEECH, F. B. (1970) A comparison between the use of cattle and a tissue culture system for safety testing of inactivated foot-and-mouth disease vaccines. *J. Hyg., Camb.* (In the press.)

The susceptibility of the tissue culture system to small amounts of residual live virus was not influenced by the inactivated antigen present. The depth of inoculum over the cell sheet did not affect results. Negative cultures frequently gave positive first, but not second or later, sub-cultures.

BHK cells were always more sensitive than cattle tongues to infection with any of the strains used.

Confidence in the safety test depends on the number of vaccination doses used; the tissue culture test can be made much more reliable than the cattle test, because it is not limited to the 15 ml of inoculum that restricts the cattle test.

12.3 BARDNER, R., (MASKELL, F. E.) & ROSS, G. J. S. (1970) Measurements of infestations of Wheat Bulb fly (*Leptohylemia coarctata* (Fall.) and their relationship with yield. *Pl. Path.* (In the press.)
For summary see No. 10.14.

12.4 BOYD, D. A., TINKER, P. B. H., DRAYCOTT, A. P. & LAST, P. J. (1970) Nitrogen requirement of sugar beet grown on mineral soils. *J. agric. Sci., Camb.* **74**, 37–46.

On most of 170 experiments during 1957–66, nitrogen increased sugar yields sharply and almost linearly up to an optimum beyond which they changed little; 1·8 cwt N/acre was the largest amount tested. Usually 0·4–0·8 cwt N/acre was enough for maximum yield; more was needed on a few sites, but about a fifth gave no response.

Most site-to-site and year-to-year differences in response between 0·9 and 1·8 cwt N/acre were no greater than could be expected from experimental error alone. There were substantial between-site differences in response up to 0·9 cwt N/acre, but attempts to explain them in terms of weather, soil and husbandry factors had little success.

The recommended dressing is 1·0 cwt N/acre, more than is usually needed to obtain maximum yield. More should be given on soils of the Hanslope and Stretham Series and on light sands poor in organic matter; less is needed where crop residues can supply much nitrogen.

12.5 CHURCH, B. M., (HAMPSON, C. P. & FOX, W. R.) (1970) The quality of stored maincrop potatoes in Great Britain. *Eur. Potato J.* **13**. (In the press.)

Surveys of stored maincrop potatoes in Great Britain (1965 and 1966) provide estimates of the distribution of various defects in the crop.

About 40% reached premium Grade I standard, and 20–25% of stores contained 60% or more of Grade I potatoes and might profitably be dressed out to this grade. A quarter of the crop failed Grade I because of mechanical damage to the surface. Mechanical damage, diseases (mostly scab, silver scurf and blight) and greening each caused rejection of 13–18%; 16% of Majestic and 6% of other varieties were of unacceptable shape. Majestic suffered more than other varieties from most defects, except blight, which was common in 'red' varieties. Observed disease blemishes (particularly silver scurf) increased over the storage season.

Percentages complying with alternative grade specifications can be estimated from the tabulated information.



*https://doi.org/10.23637/ERADOC-1-124* *pp 58*

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



12.6 (CORBET, G. B., CUMMINS, J., HEDGES, S.) & KRZANOWSKI, W. J. (1970) The taxonomic status of British water voles, genus *Arvicola*. *J. Zool. (Lond.)*. (In the press.)

Samples of skulls of *Arvicola* were studied from several regions of Britain to test the hypothesis that more than one species of the genus might be present. Analysis of cranial measurements and of quasi-discontinuous variants of the skull provide no grounds for recognising more than one species, and comparison with samples from continental Europe support the view that all the British samples represent *A. terrestris* rather than *A. Sapidus*.

12.7 FREE, J. B. & PREECE, D. A. (1969) The effect of the size of a honeybee colony on its foraging activity. *Insectes soc.* **16**, 73–77.

Deterioration in foraging conditions discourages foraging relatively more from large than from small colonies.

12.8 GOWER, J. C. (1969) Evaluation of marginal means. *Appl. Statist.* **18**, 63–65.

This procedure takes the values of an *n*-way table, allotting space for margins, and then fills the marginal cells with marginal means. It uses the sub-routine package described in AS1 (Gower, 1968) for handling multiway tables as though they were one-way.

12.9 GOWER, J. C. (1969) Analysis of variance for a factorial table. *Appl. Statist.* **18**, 65–68.

Given an *n*-way table with marginal means, this procedure produces tables of corrected sums of squares, and associated degrees of freedom, for all main effects and interactions. The subroutine package AS1 (Gower, 1968) for handling multi-way tables as if they were one-way is used.

12.10 GOWER, J. C. (1969) Calculation of effects. *Appl. Statist.* **18**, 79–82.

Two associated algorithms are described. The main algorithm, *effects*, is a procedure for calculating all main effects and interactions for a factorial layout, given specified ortho-normal contrast matrices for each factor. The subsidiary algorithm *Yates* does the single transformation for a specified factor.

12.11 GOWER, J. C. (1969) Autocodes for the statistician. In: *Statistical Computation*, pp. 37–62. New York: Academic Press.

Statisticians have been forced to write statistical systems of programs because existing algebraic autocodes are inadequate. Statistical systems have disadvantages and the alternative approach of improving the autocodes is considered. It is suggested that a few extensions, especially in the direction of accepting more types of operand and in storing and recovering program and data, would greatly improve the power and flexibility of autocodes. Recent language specifications have already included many of these improvements. With improved autocodes, special statistical systems will no longer be necessary; they will be replaced by subroutine packages linked by programming at the autocode level itself.

12.12 GOWER, J. C. (1970) Classification and geology. *Revue Inst. int. Statist.* **38**, 35–41.

Multivariate methods for cluster analysis and hierarchical cluster analysis are briefly reviewed. The importance is emphasised of considering the sampling



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



properties of any objects to be classified. Multivariate mapping procedures are discussed and formulae given for the methods most likely to be useful in geology; modern developments are reviewed.

12.13 GOWER, J. C. & PREECE, D. A. (1970) Generating successive incomplete blocks with each pair of elements in at least one block. *J. Combinatorial Theory*. (In the press.)

This paper examines solutions to the following combinatorial problem: Produce an ordered set of blocks of M elements chosen from N such that (i) any pair of the N elements occurs together in at least one block; (ii) the total number of element changes in forming each new block from the previous one is minimised. For certain values of N and M, the only known solutions have no known generalisation. However, several general algorithms are described that produce sets of blocks satisfying (i) and either satisfying or nearly satisfying (ii). Other, related combinatorial problems are outlined; all are relevant to organising a certain type of data in a computer.

12.14 KRZANOWSKI, W. J. (1970) Transposing multiway structures. *Appl. Statist.* **19**, 115–118.

An algorithm is given for overwriting an ordered set of data values $x[1 : n]$ with the re-ordered set defined by the transposition $x[\mathbf{i}] \rightarrow x[\mathbf{j}]$. Re-ordering a matrix stored as upper triangular by rows into lower triangular form, and re-ordering the values of an $n$-way table when the order of factors classifying the table is changed, are given as examples.

12.15 LEECH, F. B. & (MACRAE, W. D.) (1970) Surveys of sheep dipping in Britain. *Pesticide Science*. (In the press.)

Surveys of sheep dipping and spraying during 1965–66 showed that, after the end of 1965, the use of organochlorine formulations decreased greatly and the use of organophosphorus formulations and formulations containing both organochlorine and organophosphorus compounds increased. Methods of disposal of toxic residues and the hazards, are summarised.

12.16 (MUIR, J. M., HARDIE, H. G. M., INKSON, R. H. E.) & ANDERSON, A. J. B. (1970) The classification of soil profiles by traditional and numerical methods. *Geoderma*. (In the press.)

Sixty-three soil profiles, which are recognised members of four long-established series, are also classified by numerical methods so that the results of the numerical and traditional approaches can be compared. The numerical groupings clearly resemble the soil series, even to the extent of showing which series are clearly different and which can be easily confused. The discussion attempts to explain why such different approaches give similar results.

12.17 NELDER, J. A. (1969) The description of statistical data structures for statistical computing. In: *Statistical Computation*, pp. 13–36. New York: Academic Press.

The paper describes how the structures of experimental and survey data can be built up by combining single items by the use of certain structural operators. These operators may, for example, join items in a chain, or define cross or nested classifications.

The structure formulae derived with these operators can be used to describe the various ways data can be ordered, both inside and outside the computer, and hence how it can be accessed inside the computer



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



12.18 NELDER, J. A. (1969) The efficient formation of a triangular array with restricted storage for data. *Appl. Statist.* **18**, 69–72.

The formation of a sums-of-squares-and-products matrix from a set of experimental variates requires arithmetic operations on all possible pairs of variates. When a computer store cannot hold all variates simultaneously, suitable subsets of them must be brought in sequentially. An algorithm is given that organises this efficiently.

12.19 (PATTERSON, H. D.) & LOWE, B. I. (1970) The errors of long-term experiments. *J. agric. Sci.* **74**, 53–60.

Yields from crops recurring on the same plots in long-term experiments are correlated. When these plot correlations are ignored treatment effects may be estimated less efficiently and estimates of error are biased.

Serial plot correlations are calculated from 12 experiments on arable crops in England and Wales, for yields 4, 6 or 8 years apart. They are usually positive, with average value 0·2. In one set of experiments the losses in efficiency are shown to be small, but some of the biases in the estimates of error are large. Biases in the variances of treatment means can be wholly or partly eliminated by separating two components of error, plot error and plot × year error.

12.20 PREECE, D. A. (1969) Near-cyclic representations for some resolution VI fractional factorial plans. *Ann. Math. Statist.* **40**, 1840–1843.

Draper and Mitchell (1968) gave the complete set of even 512-run designs of resolution $\geqslant 6$ and the complete set of 256-run designs of resolution $\geqslant 5$. The authors showed that each of these designs can be obtained from one or other of five Reference Designs, all of resolution 6. The present note gives near-cyclic representations of the complete sets of interactions in the identity relationships of the Reference Designs. Some of these sets are shown to be related to certain incomplete block designs, including a new type of resolvable balanced incomplete block design.

12.21 PREECE, D. A. (1970) Iterative procedures for missing values in experiments. *Technometrics.* (In the press.)

A revised version of the Rothamsted General Factorial Program described by Yates and Anderson (1966) was used to assess the merit of modifying the iterative missing value procedure of Healy and Westmacott (1956). Results of the investigation are described. The algebra of the general iterative procedure is given, and the range of convergence discussed.

12.22 ROSS, G. J. S. & TRUDGILL, D. L. (1969) The effect of population density on the sex ratio of *Heterodera rostochiensis*: a two-dimensional model. *Nematologica* **15**, 601–607.
(For summary see No. 8.17.)

12.23 (WILLIAMS, J. H.), BOYD, D. A. & (FARRAR, K.) (1970) Residual phosphate experiments on Experimental Husbandry Farms. *Tech. Bull. Minist. Agric. Fish. Fd.* (In the press.)

The results are described of six long-term experiments done on N.A.A.S. Experimental Husbandry Farms between 1951–53 and 1962–64 to estimate the immediate and cumulative residual value of four phosphorus fertilisers.

For each crop, average responses in the year of application and, especially in the two residual years, were greater in the second period of 5 years than in the



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



first period of 6 years, probably because of P residues in the soil. Results for potatoes, swedes and kale, which usually responded well to P fertiliser, could be accounted for if the fractions of a direct dressing available in the 1st, 2nd and 3rd–10th residual years were about one-third, one-fifth, one-tenth, suggesting that the residual value of a dressing of P fertiliser diminishes rapidly in the first year or two but that small fractions may be available for many subsequent crops.

On most crops on neutral soils, rock phosphate was much inferior to other forms, and the larger dressing sometimes decreased yield.

Large direct dressings of superphosphate and dicalcium phosphate usually gave similar responses, somewhat greater than those of basic slag. Residues of basic slag were much the same as those of the more soluble forms. With few exceptions small annual dressings gave a similar average yield to the same total quantity given triennially.

## Field Experiments Section

### Research Papers

14.1 Dyke, G. V. (1968) Field experiments and increases in yield of crops. *J. natn. Inst. agric. Bot.* **11**, 329–342.

The results of field experiments may be used to predict the consequences of changes in growers' methods; the precautions needed are discussed. The changes in yield of wheat on three areas between 1949 and 1964 are examined. These are:

(1) Broadbalk permanent wheat experiment
(2) Rothamsted ley-arable experiment
(3) All wheat-fields in England and Wales.

In each case the effects of many of the known changes of practice can be estimated from experiments and the total so estimated is compared with the total change during the period, after smoothing seasonal differences.

On Broadbalk there were no important changes in methods and no trend is detected. On the ley arable experiment the linear regressions on time suggest the yields had doubled (from 25 to 50 cwt/acre). A better interpretation is that when allowance is made for the effects of known changes of method (estimated to total about 12–15 cwt) no trend remains. In England and Wales the yield of wheat increased by 11 cwt/acre; 7 cwt of this is ascribed to changes in varieties and manuring.

14.2 McEwen, J. (1969) Fertiliser nitrogen and growth regulators for field beans (*Vicia faba* L.). I. The effects of seedbed applications of large dressings of fertiliser nitrogen on field beans (*Vicia faba* L.) and the residual effects on following winter wheat. *J. agric. Sci., Camb.* **74**, 61–66.

The largest mean response by beans to fertiliser nitrogen, broadcast in the seedbed came from the largest rate tested (3 cwt N/acre). These responses ranged from 1·9 cwt grain/acre in 1967 to 3·1 cwt grain in 1966; although larger than responses obtained in previous experiments testing small quantities of fertiliser nitrogen, the results suggest there is no prospect for the economic use of fertiliser nitrogen in the seedbed for spring beans.

The nitrogen applied to beans at Rothamsted increased the yield of the following winter wheat by about as much as a direct application of one-sixth the amount (one-twelfth at Woburn).



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



14.3 McEwen, J. (1969) Fertiliser nitrogen and growth regulators for field beans (*Vicia faba* L.). II. The effects of large dressings of fertiliser nitrogen, single and split applications, and growth regulators on field beans (*Vicia faba* L.). *J. agric. Sci., Camb.* **74**, 67–72.

The responses to the largest dressings of fertiliser nitrogen were increased by dividing them, the maximum gain was 4·0 cwt grain/acre.

CCC (chlormequat) had no effect on the growth of plants. B9 shortened stems by as much as 30%, depending on how much and when it was applied. B9 increased yield in 1966 and 1968 (by 2·5 cwt grain) but decreased it in 1967 (by 2·1 cwt grain).

In 1968 both B9 and 1·5 cwt N increased yield by increasing the number of stems and pods per acre. B9 decreased 1000 grain weight; 1·5 cwt N slightly increased it. A further 1·5 cwt N decreased number of stems per acre but this was more than compensated for by an increased number of pods per stem.

The effects of season were large and exceeded the effects of any of the treatments.

## Broom's Barn Experimental Station

### General Papers

16.1 Byford, W. J. (1969) Downy Mildew. *Br. Sug. Beet Rev.* **38**, 23–26.

16.2 Byford, W. J. (1969) Health of the sugar beet crop. *Farming World*—Plant Health Supplement. February.

16.3 Cooke, D. A. & Draycott, A. P. (1969). The effect of soil fumigation and nitrogen on Docking disorder of sugar beet. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, 260–264.

16.4 Draycott, A. P. (1969) Counter moves to adopt where crops rob soil magnesium. *Farming World* (Sugar beet supplement). March. p. 11.

16.5 Draycott, A. P. & Durrant, M. J. (1969). Magnesium fertilisers for sugar beet (Part 1). *Br. Sug. Beet Rev.* **37**, 175–179.

16.6 Heathcote, G. D. (1969) Cultural factors affecting colonisation of sugar beet by different aphid species. *Ann. appl. Biol.* (*Proceedings*) **63**, 330–331.

16.7 Heathcote, G. D. (1969) The defence of aphids against predators and parasites. *Trans. Suffolk Nat. Soc.* **15**, 55–58.

16.8 Hull, R. (1969) The spray warning system for control of virus yellows. *Br. Sug. Beet Rev.* **37**, 169–172.

16.9 Hull, R. (1969) Research on sugar beet in Suffolk. *Eastern Daily Press*—Agricultural Supplement. 17 September.

16.10 Hull, R. & Dunning, R. A. (1969) Pests and diseases of sugar beet, fodder beet and mangolds. In: *Insecticide and Fungicide Handbook*. 3rd edition. Ed. H. Martin. Oxford: Blackwell Scientific Publications. Chapter 7. pp. 125–137.



*https://doi.org/10.23637/ERADOC-1-124* *pp 63*

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



16.11 LONGDEN, P. C. (1970) A machine for rubbing small samples of sugar beet fruit. *I.I.R.B.* (*Journal of the International Institute for Sugar Beet Research*). (In the press.)

16.12 LONGDEN, P. C. (1970) Manuring the beet seed crop grown in England. *N.A.A.S. q. Rev.* (In the press.)

RESEARCH PAPERS

16.13 BOYD, D. A., TINKER, P. B. H., DRAYCOTT, A. P. & LAST, P. J. (1970) Nitrogen requirement of sugar beet grown on mineral soils. *J. agric. Sci., Camb.* **74**, 37–46.
(For summary see No. 12.4.)

16.14 BYFORD, W. J. & REEVE, G. J. (1969) Entomophthora species attacking aphids in England, 1962–66. *Trans. Brit. mycol. Soc.* **52**, 342–346.

*Entomophthora aphidis*, *E. planchoniana*, *E. fresenii*, and *E. thaxteriana* were common on *Myzus persicae* and *Aphis fabae* infesting sugar beet, and on many other aphid species, but seldom killed all the aphids on a plant. Individual aphids overwintering in mangold clamps were infected.

16.15 DRAYCOTT, A. P. (1969) The effect of farmyard manure on the fertiliser requirement of sugar beet. *J. agric. Sci., Camb.* **73**, 119–124.

Thirty-eight experiments on commercial farms determined the fertiliser requirement of sugar beet grown with farmyard manure (FYM). One group (1961–63), with uniformly applied FYM, tested the value of additional nitrogen, phosphate and potash, with and without agricultural salt (crude sodium chloride). Another group (1964–67) tested the value of fertiliser N and agricultural salt with and without FYM.

The average economic optimum dressings of fertilisers with FYM were 0·6 cwt/acre N, 0·3 cwt/acre $P_2O_5$, 0·5 cwt/acre $K_2O$, with agricultural salt, which largely replaced the need for potash. Chemical analyses of samples of FYM used in the second group of experiments gave no reliable guide to the requirement of additional nitrogen or sodium. With adequate $P_2O_5$ and $K_2O$, the FYM increased sugar yield at all except one site, on average equivalent to the increase from 0·3 cwt/acre N. Agricultural salt increased yield economically at most sites except on the silts round the Humber and the Wash. No clear relationship was found between soil analysis for sodium and sugar yield response to agricultural salt, but where the exchangeable soil sodium was less than 25 ppm Na, a response was likely.

16.16 DRAYCOTT, A. P. & DURRANT, M. J. (1970) The relationship between exchangeable soil magnesium and response by sugar beet to magnesium sulphate. *J. agric. Sci., Camb.* (In the press.)

Fifty-three experiments made between 1959 and 1968 tested the response to magnesium sulphate by sugar beet on fields where magnesium deficiency symptoms were expected. Soil samples, taken before applying fertilisers, were analysed for exchangeable magnesium by four methods. Sodium, potassium and calcium in the soil extracts were also measured to determine whether they influenced response to magnesium.

Results of different methods of analysing soil for magnesium were related to each other and to the percentage yield-response to magnesium fertiliser. The concentration of other soil cations did not affect response to magnesium fertiliser,



*https://doi.org/10.23637/ERADOC-1-124* 

This work is licensed under a Creative Commons Attribution 4.0 International License.



but giving other cations, especially sodium, as fertiliser decreased the concentration of magnesium in the crop. Nevertheless, even on fields deficient in magnesium, the largest yield was from plots given sodium and potassium fertiliser together with a dressing of magnesium.

Sugar beet grown on soils containing less than 20 ppm Mg extracted with ammonium nitrate usually gave a profitable response to magnesium fertiliser. When soil magnesium was 20–35 ppm, yield of sugar beet on some fields was increased slightly. Plants in some experiments had poorly-developed root systems and response to magnesium was then always larger than expected from soil analysis.

16.17 DRAYCOTT, A. P. & LAST, P. J. (1970) Effect of previous cropping and manuring on the nitrogen fertiliser needed by sugar beet. *J. agric. Sci., Camb.* **74**, 147–152.

Six field experiments made between 1960 and 1968 determined the effect of previous cropping and manuring on the nitrogen requirement of sugar beet. Three were at Silsoe in Bedfordshire on soils developed over Lower Greensand and Gault Clay and three were at Broom's Barn (Suffolk) on Calcareous Drift soils over Chalk. Each experiment lasted 2 years, a preparatory crop followed by sugar beet.

Spring barley and potatoes were treatment crops in all the experiments and winter wheat, a ryegrass ley and barley undersown with trefoil were included in the Suffolk experiments. Nil, 0·6 or 1·2 cwt N/acre was tested on the sugar beet in the first three experiments and 0, 0·5, 1·0 or 1·5 cwt N/acre in later ones.

All the experiments showed that previous cropping influenced the nitrogen requirement of the sugar beet. There was a linear relationship ($r = -0{\cdot}86$) between the amount of fertiliser nitrogen given minus that removed by the preparatory crop, and the quantity of nitrogen fertiliser needed by the sugar beet for maximum sugar yield.

Sugar beet grown after barley or potatoes (each given 0·5 cwt N/acre) needed on average 1·0 cwt N/acre at both Broom's Barn and Silsoe for maximum sugar yield. Sugar beet after winter wheat or a ryegrass ley also needed 1·0 cwt N/acre at Broom's Barn. When the previous crop was given 1·5 cwt N/acre, 0·5 cwt/acre sufficed for maximum yield of sugar at both centres; also, after ploughed-in trefoil, sugar beet needed only 0·5 cwt N/acre.

16.18 DRAYCOTT, A. P. & (HOLLIDAY, R.) (1970) Comparisons of liquid and solid fertilisers and anhydrous ammonia for sugar beet. *J. agric. Sci., Camb.* **74**, 139–145.

Six field experiments (1963–68) in Eastern England compared solid with liquid fertiliser or anhydrous ammonia for sugar beet. Two glasshouse experiments investigated the interaction between depth of placement of fertiliser and soil moisture.

Yields of sugar were the same from broadcast solid and sprayed liquid in all the experiments, but the crop took up less nitrogen from liquid than from solid. Three experiments tested placement of liquid 4 in. to the side and either 2 in. or 6 in. below the seed. Plants with deep-placed fertiliser consistently out-yielded those with shallow-placed fertiliser, but yields were never significantly different from those with broadcast solid fertiliser. Dry matter yields of sugar beet grown in containers indoors showed that the crop responded to deep placement when the surface soil was watered infrequently.

With anhydrous ammonia injected during seedbed preparation, sugar yield and nitrogen uptake were the same as with solid fertiliser in the seedbed, and



https://doi.org/10.23637/ERADOC-1-124 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



were greater than with anhydrous ammonia injected in the ploughed land during early spring. A side-band injection of anhydrous ammonia before singling gave a crop containing as much nitrogen at harvest as, but less sugar than, nitrogen applied in the seedbed.

16.19 DRAYCOTT, A. P., MARSH, J. A. P. & TINKER, P. B. H. (1970) Sodium and potassium relationships in sugar beet. *J. agric. Sci., Camb.* (In the press.)

Three field experiments with sugar beet grown on a light calcareous soil tested a wide range of amounts of sodium and potassium fertiliser with either magnesium or nitrogen. Both sodium and potassium increased sugar yield and there was a large negative interaction between them. Magnesium also increased sugar yield, but the larger dressing of nitrogen decreased it. Sodium, potassium and nitrogen fertiliser also affected the concentration of impurities in the root juice at harvest.

Plant samples were also analysed in August when the crop usually contains most sodium. Sodium fertiliser greatly increased the sodium and decreased the potassium concentration in the dry matter of the tops but the composition of the roots changed little. Potassium dressings slightly increased potassium in the tops but did not affect the root composition.

Exchangeable sodium in the top soil of plots given sodium fertiliser decreased rapidly early in the season, but increased again from August, probaby because sodium was taken up rapidly early in the summer and returned later in dead leaves. Soil potassium decreased throughout the season on plots where potassium was applied, but did not change on plots without potassium fertiliser; this is explained by fixation and release from non-exchangeable forms.

On this soil there was no reason to regard sodium affecting yield, other than as a replacement for potassium, but its behaviour in the soil and effect on the composition of the plant was quite different.

16.20 DUNNING, R. A. & WINDER, G. H. (1969) Trials on the control of Docking disorder in sugar beet; seed and row treatment with nematicides. *Proceedings of the 5th British Insecticide and Fungicide Conference, 1969*, **1**, 265–273.

Field trials in 1964 and 1966 to 1969 tested 'curative' and 'preventive' use of pesticides to improve growth and yield of sugar beet. Curative treatments, applied as soon as possible after the crop symptoms of Docking disorder appeared, were of little value. Preventive treatments applied during sowing on sites prone to Docking disorder sometimes prevented nematode damage and improved growth and yield. Treating seed with pesticide, or incorporating pesticide in the pelleting material, partially controlled damage. Applying greater amounts of the pesticides as liquids or granules with the seed in the furrow was the most effective method. Extra nitrogen in the soil improved growth. There was always a risk that seedlings would be injured by materials placed near the seed, so not more than about 1 lb of active ingredient/acre was used. Current trials show aldicarb to be the most effective pesticide applied in the furrow with the seed.

16.21 HEATHCOTE, G. D. (1969) Notes on some plant bugs and predators of aphids caught on sticky traps in sugar beet fields in southern England, 1965–68. *I.I.R.B.* (*Journal of the International Institute for Sugar Beet Research*) **4**, 25–29.

Many aphids were trapped although the sugar beet fields in which the traps were sited were sprayed with aphicide. Few delphacids, piesmids or jassids, compared with aphids, were caught and, although members of all these groups of plant



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



bugs can act as virus vectors, only aphids are known to carry virus diseases of sugar beet in England. Few individuals of some groups of insects that prey upon aphids (anthocorids, syrphids, coccinellids, chrysopids or hemerobiids) were caught and, although more coccinellids than any other predators were caught in June, most were caught after late July when the aphid population had declined.

16.22 SCOTT, R. K. (1969) The effect of sowing and harvesting dates, plant population and fertilisers on seed yield and quality of direct-drilled sugar-beet seed crops. *J. agric. Sci., Camb.* **73**, 373–385.

Sixteen field experiments, made between 1963 and 1967 on direct-drilled sugar-beet seed crops, compared the effects of cultural practices on the yield and quality of seed. Sowing in July gave earlier flowering and ripening than sowing in August and usually increased yields, cluster size and percentage germination. Downy mildew was sometimes more prevalent in late sowings.

Seed yields increased as the crop changed colour from green to yellow and percentage germination increased greatly as more clusters contained 'mealy' rather than 'milky' perisperm. Because of natural shedding and bird damage, seed yields then decreased and losses of 0·6 cwt/acre/day were recorded for early ripening treatments. Cluster size and percentage germination continued to increase while yield was decreasing. Crops ripened a month earlier in 1967, the 'earliest' year, than in 1965, the latest year.

Crops grown in rows 10 in. apart lodged less than those sown 20 in. apart, ripened earlier and produced, on average, 3 cwt/acre more seed, which was slightly smaller. In one experiment rows 5 in. apart gave similar yields but smaller clusters than rows 10 in. apart. Row width had little effect on percentage germination. Increasing the distance between plants in the row gave smaller yields with wider spaced rows, but with narrow rows plants 6 in. and 12 in. apart yielded more than those 2 in. apart. Yields from a plant population of 52 200 plants/acre were 4 cwt/acre greater when plants were 12 in. apart in narrow (10 in.) rows rather than 6 in. apart in wide (20 in.) rows. Spacing further apart in narrow rows increased seed side. In wide rows many plants 12 in. apart lodged, made secondary growth and produced small, late maturing clusters, of which few germinated.

Response to fertiliser nitrogen applied in spring was less, and less was needed for maximum yield on the thin Cotswold soils than on the silty clay loam in Lincolnshire, where it doubled yield in 1966. Phosphate and potash applied in spring had little effect on yield. Usually fertilisers had no effect on cluster size or germination percentages, but 1·6 cwt/acre N given to a late-ripening crop in 1965 decreased seed size and germination.

Ramularia leaf spot, which defoliated crops in the Cotswolds, was worst on early sown and closely spaced plants, and was unaffected by fertiliser.

16.23 TINKER, P. B. H. (1970) Fertiliser requirements of sugar beet on fen peat soils. *J. agric. Sci., Camb.* **74**, 73–77.

Eighteen trials tested factorial combinations of N, P, K and Na fertilisers on sugar beet over 3 years on deep, light peat soils in the area surrounding the Wash. The average yield responses to all fertilisers were very small, and only rarely profitable, except to sodium. Nitrogen increased yield on a few sites, but there was no obvious way of distinguishing these, and on average, there was no justification for using this fertiliser, which depressed sugar percentage. The difference from earlier work, which showed good responses to P and K, is ascribed to repeated heavy dressing of fertiliser given to these soils during the last two decades.



*https://doi.org/10.23637/ERADOC-1-124* 

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



## Soil Survey

### General Papers

17.1 Ashley, G. D. & (Wheatcroft, W. P.) (1969) Improvement of upland grazing, west Greenridge, Hexham. *Northumbrian Farmer*, 32–35.

17.2 Crampton, C. B. (1968) Changes in hill vegetation revealed by selected British soils. *Scott. geogr. Mag.* **84**, 179–84.

17.3 Johnson, P. A. (1969) Soils and land use on Chalky Boulder Clay. *E. Midld Geogr.* **4**, 447–53.

17.4 (Milford, M. H., Olsen, G. W.) & Bullock, P. (1969) Apparent water table in soils. *New York's Food and Life Sciences*, **2**, 18–19.

17.5 Publications on Soil Survey (1969) (Ed. D. W. King). Harpenden.

17.6 The Soil Survey (1969) (Ed. D. W. King). Harpenden.

### Research Papers

17.7 (Bibby, J. S.) & Mackney, D. (1969) Land use capability classification. *Soil Survey Technical Monograph*, No. 1. Harpenden.

A system of classifying land is described, mainly for agriculture, using the relatively unchangeable characters of the environment. Land is graded in seven capability classes according to its potentialities and the severity of the physical limitations affecting crop growth and management.

17.8 Jarvis, M. G. (1969) Terrain and soil in north Berkshire. *Geogrl J.* **135**, 398–403.

The value of a terrain map made from air photographs as an aid in soil survey was studied in three areas of differing relief. It is concluded that such maps are most likely to be of help in mapping soil associations. At larger scales, information about the soil pattern is most likely to be obtained in drift-free areas.

17.9 King, D. W. (1969) Soils of the Luton and Bedford district. *Soil Survey Special Survey* No. 1. Harpenden.

A reconnaissance survey of O.S. 7th Ed. Sheet No. 147 (Luton and Bedford) covering an area of 1800 km² largely in Hertfordshire and Bedfordshire. Twenty-two soil associations are briefly described with their component series.

17.10 Pritchard, D. T. (1969) An osmotic method for studying the suction/moisture content relationships of porous materials. *J. Soil Sci.* **20**, 374–83.

Zur's osmotic method was simplified by placing 2 g samples of 1–2 mm maximum particle size in 6·5 mm diameter sacs of semi-permeable membrane tubing and suspending these in solutions of polyethylene glycol (PEG), molecular weight approx. 20 000. Moisture content was measured daily by weighing the sacs.

PEG solutions of small pF were calibrated by hanging sacs containing water in them, and observing the difference between the height of the liquid surfaces at equilibrium. The range was thus extended from pF 3·0–4·2 to pF 1·5–4·1.



*https://doi.org/10.23637/ERADOC-1-124* *pp 68*

*This work is licensed under a Creative Commons Attribution 4.0 International License.*



Wetting over the whole range takes 8 days and drying, from saturation, 16 days. Six polythene boxes (each holding 3·25 l of PEG), used simultaneously, give the equivalent of wetting curves for 24 samples per day.

By the isopiestic method, used for comparison over the range pF 3·5–4·0, nickel crucibles containing 1 g samples were partly immersed in control solutions of sodium chloride, in vacuum desiccators, in a temperature controlled double water-bath.

Structural stability is a problem with some soils, and more durable membranes are desirable.

17.11 THOMASSON, A. J. (1969) Soils of the Saffron Walden district. *Soil Survey Special Survey* No. 2. Harpenden.

A reconnaissance survey of O.S. 7th Ed. Sheet No. 148 (Saffron Walden), covering an area of 1800 km² mostly in Essex but including parts of east Hertfordshire and south Cambridgeshire. Twenty-one soil associations are described with their component series.

MAPS

17.12 CRAMPTON, C. B. (1969) Soil Map, 3rd Edition Sheets 261 and 262 (Bridgend) 1:63 360, Southampton: Ordnance Survey.

17.13 CRAMPTON, C. B. (1969) Soil Map, 3rd Edition Sheet 263 (Cardiff) 1: 63 360, Southampton: Ordnance Survey.

17.14 RUDEFORTH, C. C. (1969) Soil Map, 3rd Edition Sheet 163 (Aberystwyth) 1: 63 360, Southampton: Ordnance Survey.

17.15 RUDEFORTH, C. C. (1969) Soil Map, 3rd Edition Sheet 178 (Llanilar) 1:63 360, Southampton: Ordnance Survey.

17.16 KING, D. W. (1969) Reconnaissance Soil Map, 7th Edition Sheet 147 (Luton and Bedford) 1:63 360, Harpenden.

17.17 THOMASSON, A. J. (1969) Reconnaissance Soil Map, 7th Edition Sheet 148 (Saffron Walden) 1:63 360, Harpenden.



*https://doi.org/10.23637/ERADOC-1-124* *pp 69*