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Rothamsted Experimental Station Report for 1969 Part 2

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A. E. Johnston (1970) *The Value of Residues from Long-period Manuring at Rothamtsed and Woburn I. Introduction ;* Rothamsted Experimental Station Report For 1969 Part 2, pp 5 - 6 **- DOI: https://doi.org/10.23637/ERADOC-1-34860**

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The Value of Residues from Long-period Manuring at Rothamsted and Woburn
I. Introduction

A. E. JOHNSTON

Lawes and Gilbert (1873) found that giving a crop only as much phosphorus and potassium as it took up failed to give large yields and in their experiments they always applied more P and K than the maximum taken up by the crop. Provided the excess was not leached from the soil, it remained as a residue and Lawes and Gilbert (1884) wrote, 'The recent legislative enactments giving the cultivator of the soil a claim for the manure ingredients possessing a pecuniary value which he has applied, and left in the land, add greatly to the interest of all investigations which have a bearing upon this important subject'. As Cooke (1967) recently pointed out, Lawes and Gilbert became closely involved with this important aspect of farming and the legislation whereby outgoing tenants were compensated for the residual value of improvements.

Lawes and Gilbert modified some of their experiments, and later Hall made some further changes, to measure the residual value of dressings of farmyard manure (FYM) and fertilisers. These experiments showed that, when manuring continued for many years and then ceased, soils with residues yielded better than unmanured soils and the effect of P and K residues often lasted many years. More recently, many experiments have shown that the responses of crops to a single dressing of P fertiliser have diminished rapidly after the first year, unless large amounts were applied. By the third and fourth year the effects were usually too small to measure accurately, even though as much as three-quarters of the P added as fertiliser remained in the soil. Although a crop can obtain only a little P from the residue of a single dressing applied three or four years before, the total residues from many dressings may supply much, or all, of the P needed. Similarly useful residues can accumulate from repeated dressings of K fertilisers.

In the Exhaustion Land experiment at Rothamsted, which last received P and K fertilisers in 1901, barley grown between 1949 and 1953 with adequate N, yielded twice as much on the plots given P and K last century as on those not. However, the crop recovered only an extra 4–5 lb more P and 15–20 lb more K/acre/year. This was a very small (less than 0·5%) recovery of the *total* P and K applied between 1856 and 1901, but acute deficiency of one nutrient may have been limiting the recovery of the other. Even so, such small recoveries would not justify a policy of *intentionally* building up residues in the soil unless they have merits not possessed by new annual dressings at usual amounts.

https://doi.org/10.23637/ERADOC-1-4

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Possible merits of residues in soil are:

1. When thoroughly incorporated in the soil, residues provide nutrients throughout the ploughed layer, the low levels of which remain moister during the summer.
2. Large fresh dressings, which may damage germinating seeds, are not needed.
3. Residues insure against the poor response to a new fertiliser dressing, which broadcast on the surface, may not have been worked in deeply.

This series of papers gives the results of experiments made to value the residues from long-period manuring at Rothamsted and Woburn. Paper II summarises the results of experiments started by Lawes and Gilbert and later by Hall. It includes the results of those that have continued to the present. Papers III, IV and V give, respectively, the forms of the experiments made between 1957 and 1962 and the results of the tests measuring the value for arable crops of the residues of many dressings of P and of K fertilisers.

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