QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

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EFFECT OF VARIOUS GREEN MANURE CROPS ON THE YIELD AND QUALITY OF POTATOES

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SUMMARY

From 1963 to 1966, six trials, three in autumn and three in spring, were carried out at the Gatton Research Station to determine the effects of several green manure crops on yield and quality of a following potato crop under a short-term rotation. The green manure crops were soybeans, cowpeas, maize, and a maize-cowpea mixture; a bare fallow control was included.

Overall, the use of cowpeas, soybeans, and the maize-cowpea mixture caused little difference in yield and quality in a following potato crop compared with those from a bare fallow. Maize, on the other hand, caused a reduction in yield and quality in all except one trial.

The effect of the green manure crops on scab incidence varied widely.

When ammonium sulphate was added as a side-dressing to the potato crop, increased yields resulted in almost all cases, with varying effects on specific gravity. Scab was slightly reduced by the addition of ammonium sulphate.

I. INTRODUCTION

Potato-growing soils in the Lockyer Valley of south-eastern Queensland are intensively utilized, being commonly double-cropped with spring and autumn potato crops unless soil-borne diseases enforce a change in cropping practice. Some variable rotations with lucerne are practised, while short-term rotations with legumes or gramineous crops (maize, wheat or sorghums) are common.

The series of trials described here was designed to determine the effects of a number of green manure crops, used in short-term rotations, on the yield and quality of potatoes. In order to provide an indication of possible reduction in available nitrogen, ammonium sulphate was applied to half of each potato crop. The trials were conducted at Gatton Research Station.

II. MATERIALS AND METHODS

Two separate rotations with one potato crop each per annum were carried out. In one, October-planted green manure crops were ploughed under in early January and followed in 6 weeks by a potato crop. In the other, a January to April green manure crop was followed after 12 weeks by July-planted potatoes. On two occasions other farm operations precluded adherence to this schedule. The autumn 1965 green manure crop was delayed in planting, and dry weather reduced growth in the early part of the season. Despite irrigation, yields, particularly of maize crops, were low, as the plants were at a considerably earlier stage of development than usual. Ploughing-in of the spring 1965 green manure crops was delayed.

The five treatments—bare fallow, soybeans, maize, cowpeas, and a maize plus cowpea mixture—were laid out in four long-faced randomized blocks, with the two rotation systems side by side in each replication.

Ammonium sulphate at the rate of 30 lb N per acre was applied to half of each potato crop as a side-dressing within 3 weeks of emergence. Irrigation of potatoes was applied by spray, at 1–1½ in. per 7 or 10 days, the amount being gradually reduced towards the end of the growing season.

The soil is a dark brown clay alluvium, classified in the Northcote system as Ug5.16.

III. RESULTS

Data from potato crops are presented in Figures 1–24. As variance ratios were derived from three different sets of degrees of freedom, the more comparable probability factors are shown, as are standard errors. As probability was less than 90% in many cases (non-significant), no further data (L.S.D., etc.) are shown in such cases. A comparison of standard error and results (particularly for yield) indicates that standard errors are high. One source of this high error is considered to be the types of seed used—cut and whole sets of approximately 2 oz weight. Subsequent investigations have shown that under southern Queensland conditions the use of these types of seed leads to very high variation among yields of individual plants.

Variation results from the position of the cut set on the original seed tuber. Plants from basal or stem end sets usually produce lower yields than plants from apical sets, which have more stems and faster early growth due to apical dominance. Small tubers used as whole sets can be derived from diseased parents, and in such case very low yields are produced. As thorough mixing, for random distribution, is impractical with sprouting sets, variation among plots may be high.

Yields for the six trials are shown in Figures 1–6. First grade yields only are shown, as total and first grade yields showed very similar trends for each trial. Figures 19 and 20 show the effect of the addition of nitrogen on total and first grade yields.

Specific gravity data for the six trials are presented in Figures 7–12. Figures 21 and 22 show the effect of the addition of nitrogen on specific gravity.

Scab data for the six trials are presented in Figures 13–18. Scab ratings are summations, for 20 tubers, of the percentage surface affected. Figures 23 and 24 show the influence of added nitrogen on scab rating.

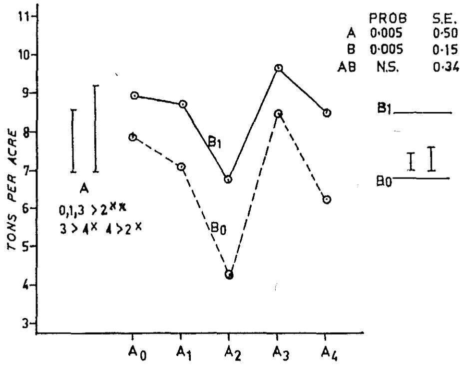

FIGURE 1. SPRING 1963

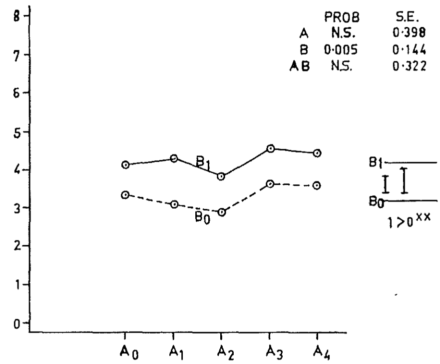

FIGURE 2. AUTUMN 1964

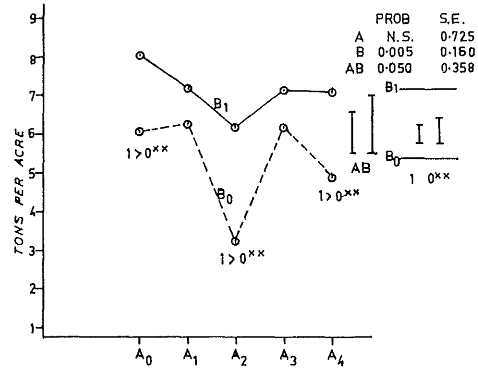

FIGURE 3. SPRING 1964

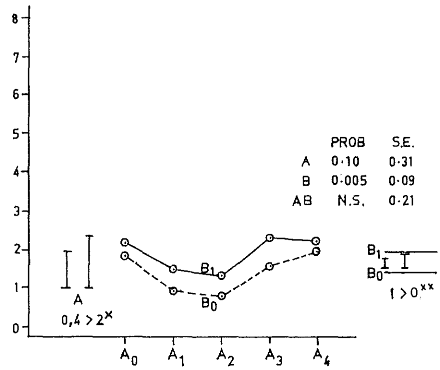

FIGURE 4. AUTUMN 1965

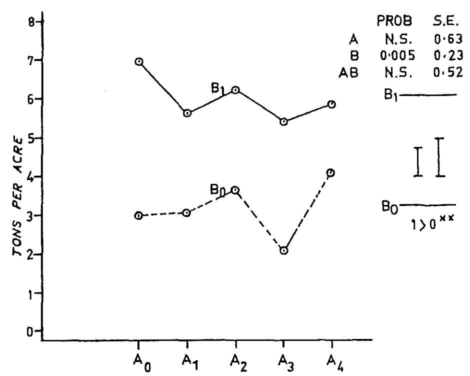

FIGURE 5. SPRING 1965

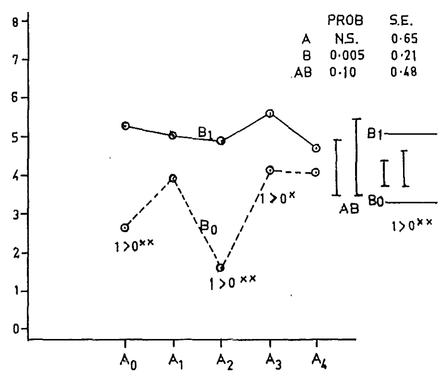

FIGURE 6. AUTUMN 1966

Figs. 1–6.—Effect of treatment on yield.

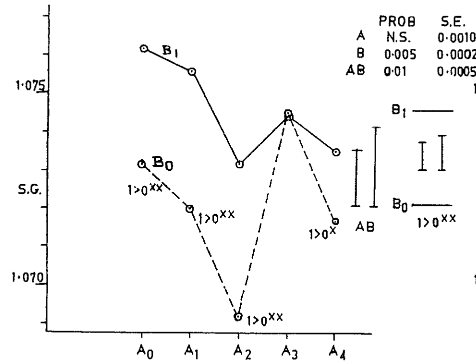

FIGURE 7. SPRING 1963

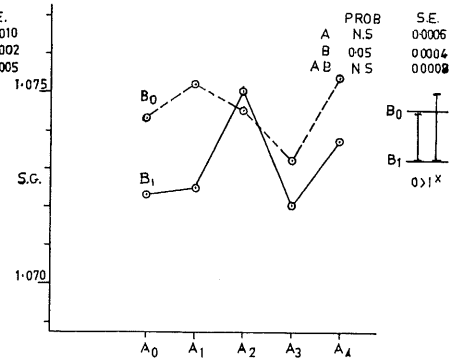

FIGURE 8. AUTUMN 1964

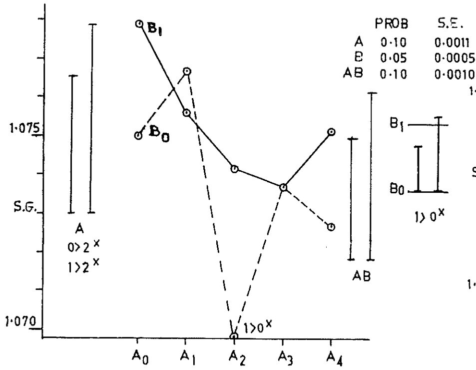

FIGURE 9 SPRING 1964

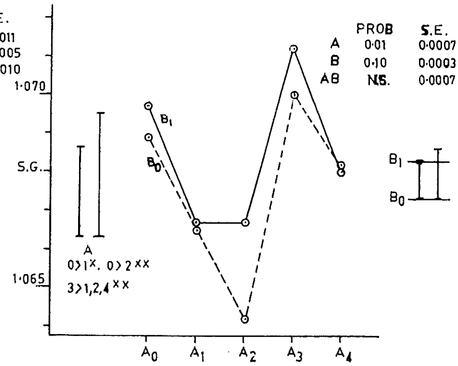

FIGURE 10 AUTUMN 1965

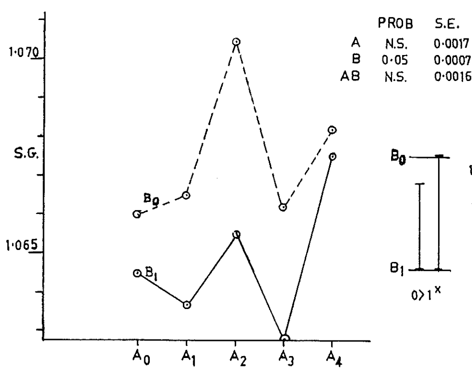

FIGURE 11. SPRING 1965

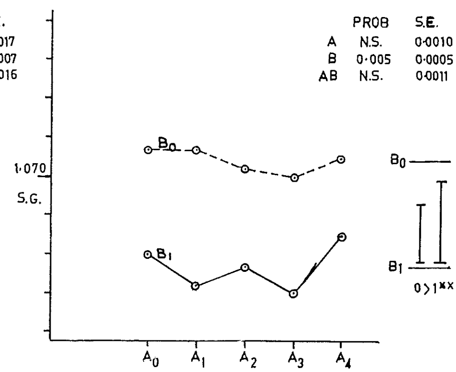

FIGURE 12. AUTUMN 1966

Figs. 7–12.—Effect of treatment on specific gravity.

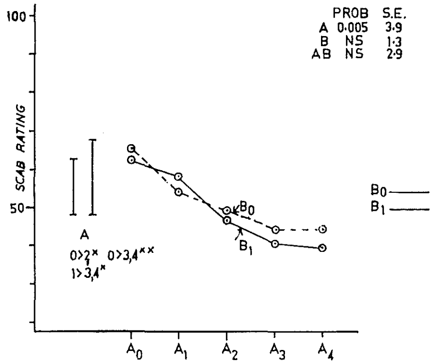

FIGURE 13. SPRING 1963

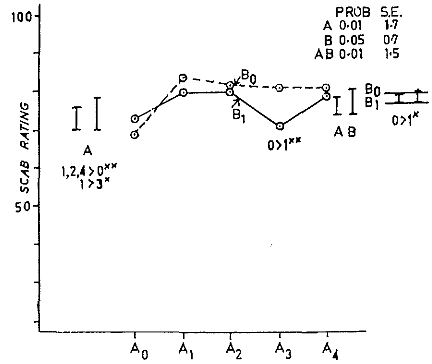

FIGURE 14. AUTUMN 1964

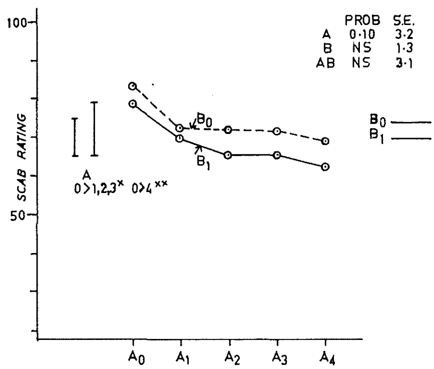

FIGURE 15. SPRING 1964

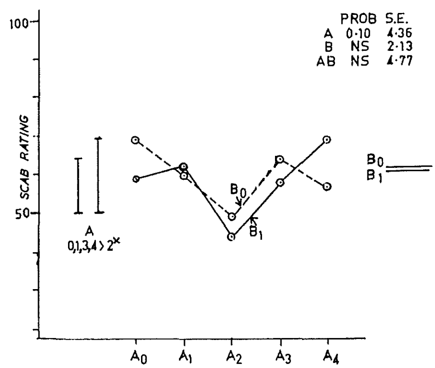

FIGURE 16. AUTUMN 1965

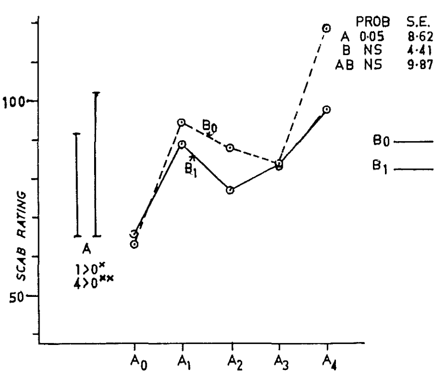

FIGURE 17. SPRING 1965

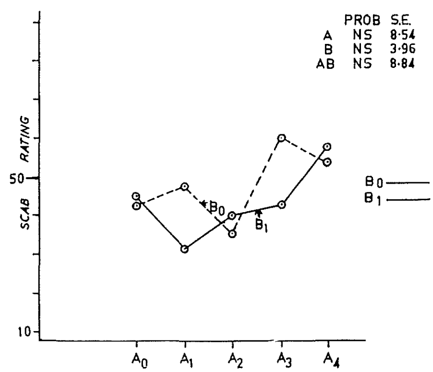

FIGURE 18. AUTUMN 1966

Figs. 13–18.—Effect of treatment on scab rating.

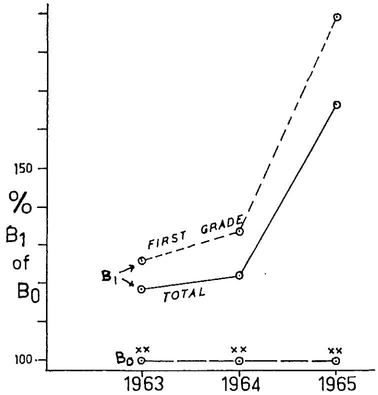

FIGURE 19. SPRING TRIALS.

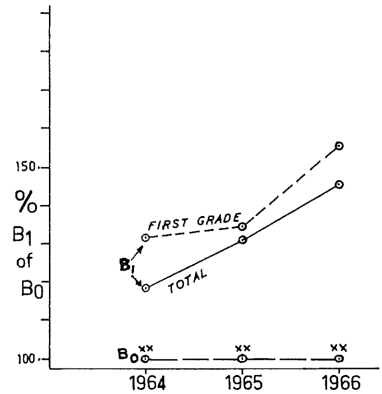

FIGURE 20. AUTUMN TRIALS.

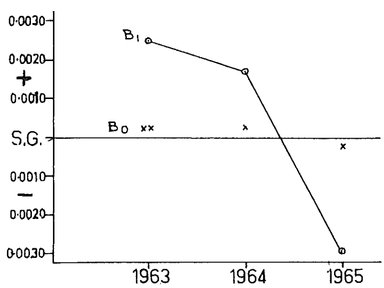

FIGURE 21. SPRING TRIALS.

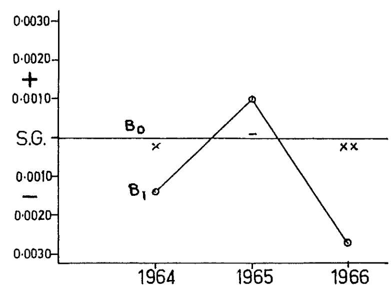

FIGURE 22. AUTUMN TRIALS.

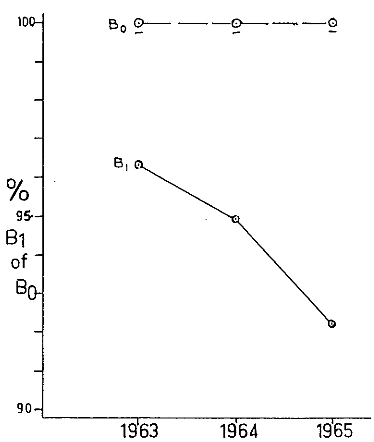

FIGURE 23. SPRING TRIALS.

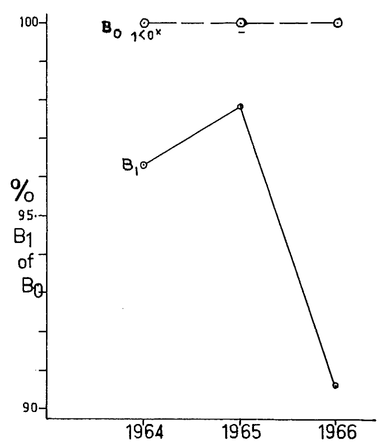

FIGURE 24. AUTUMN TRIALS.

Figs. 19–20.—Influence of ammonium sulphate on yield.
Figs. 21–22.—Influence of ammonium sulphate on specific gravity.
Figs. 23–24.—Influence of ammonium sulphate on scab rating.

Yields of green manure crops are given in Table 1.

TABLE 1

YIELD OF GREEN MANURE CROPS
Tons per acre

SEASON		SOYBEANS		MAIZE		COWPEAS		MAIZE + COWPEAS	
Green Manure Crop	Potato Crop	Green Weight	Oven-dry Weight	Green Weight	Oven-dry Weight	Green Weight	Oven-dry Weight	Green Weight	Oven-dry Weight
Aut. 63	Spr. 63	Eaten by hares		17·70	2·65	10·65	1·20	21·30	2·62
Spr. 63	Aut. 64	5·90	0·95	16·94	3·64	12·35	1·45	19·29	3·05
Aut. 64	Spr. 64	7·20	0·90	18·20	2·60	9·50	1·10	21·00	2·70
Spr. 64	Aut. 65	6·31	1·10	17·35	2·83	11·28	1·91	20·36	3·11
Aut. 65	Spr. 65	2·52	0·61	13·32	1·51	7·65	1·07	14·21	1·76
Spr. 65	Aut. 66	5·39	1·42	15·98	4·79	10·06	2·14	19·28	4·34

IV. DISCUSSION

These trials indicate that, so far as yield and specific gravity are concerned, green manure crops have no beneficial effect on a following potato crop when compared with bare fallow.

In four of the five trials when maize was ploughed in at the soft dough stage, this treatment actually reduced the yield in comparison with bare fallow. This adverse effect was lessened when maize was ploughed in at an earlier stage, as was the case with the autumn 1965 green manure crop (Figure 5). Waksman (1929) and Hill (1934) reported increased release of nitrogen from young succulent plant material in comparison with older plants when used as green manures.

Other green manure crops in this trial series appeared to affect tuber yield similarly to a bare fallow. Soybeans throughout had an effect on yield similar to cowpeas. Legumes normally affect yield more than treatments involving maize. This is believed to be due as much to the fact that they are more succulent when ploughed in as to their leguminous nature.

In three of the five trials when maize was ploughed in at the soft dough stage, tuber specific gravity in the following potato crop was reduced. This effect, similar to the adverse effect on yield, tended to be reversed when maize was ploughed in at a more succulent stage (Figure 11).

Several workers (Schonemann, 1955; Timm *et al.* 1960; Simpson 1962) have reported that excessive amounts of nitrogen cause decreases in yield and specific gravity of potatoes. Although no yield decreases due to the addition of ammonium sulphate were recorded in these trials, specific gravity decreases were observed in some cases. Adverse effects on specific gravity due to the addition of ammonium sulphate were noted in the potato crops in autumn 1964 and spring 1965. This was more evident in the cowpea than in the maize treatments. In autumn 1964 the growth period of the crop was curtailed by a heavy wind-borne infection of target spot (*Alternaria solani*). The green manure crop preceding the spring 1965 potato crop was ploughed in at an early stage, and material broke down more rapidly. In these cases the effect of the cowpea treatment plus the nitrogen side-dressing was similar to that of excessive nitrogen and a decrease in specific gravity was noted.

In all trials the effect of added nitrogen (Figures 19 and 20) was greater on first grade yields than on total yields. Also evident was a definite cumulative effect. This could be due to a direct accumulation of nitrogen, or to a cumulative effect of the added nitrogen causing increased mineralization of soil nitrogen, as suggested by Broadbent (1965), who found that the addition of fertilizer nitrogen to soils results in greater mineralization of soil nitrogen than occurs in unfertilized soil. It is possible that the sulphate ion could also have an influence. Steward, Porter and Viets (1966) found that the rates of glucose and cellulose decomposition, in soils having adequate P and N, were dependent on the level of sulphur. In view of this finding, it must be pointed out that work by T. Dickson (unpublished data) has shown this soil type to respond to sulphur under perennial lucerne when irrigation water low in sulphur is applied, as was the case in this trial series.

In the spring trials, the general effect of adding ammonium sulphate was to cause an apparent cumulative decrease in specific gravity over the 3-year period (Figure 21). This is not shown so clearly in the autumn trials (Figure 22). Possibly the premature haulm death due to disease outbreak in the autumn 1964 trial resulted in reduction of specific gravity to a greater extent than might have occurred had the crop matured.

So far as scab incidence is concerned, the use of green manure crops in this trial series had no consistent effects. McAllister (1963) reported that scab was reduced by the addition of sulphur, this effect being greater following a green manure crop. In all trials reported here a small but definite decrease in scab resulted from the addition of ammonium sulphate, but only in autumn 1964 was this reduction significant ($P<0 \cdot 05$.). Data presented in Figures 23 and 24 suggest a cumulative decrease in scab from the addition of ammonium sulphate. The findings of McAllister (1963) suggest that the sulphate ion is largely responsible for this reduction.

V. ACKNOWLEDGEMENTS

The author wishes to thank officers and staff of the Gatton Research Station of the Department of Primary Industries, in particular Mr. T. Dickson, for their assistance in conducting this series of trials. Thanks are offered also to officers of the Biometry Branch for statistical analyses of data.

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