FERTILIZERS FOR CULINARY BEAN SEED PRODUCTION IN NORTHERN QUEENSLAND

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SUMMARY

Best yields were recorded from a basal fertilizer containing 70 lb N, 50 lb P_2O_5 and nil K per ac, followed by a side-dressing of 50 lb N per ac. A reduction in the plant stand in the high basal N plots is attributed to fertilizer burn, but this did not depress yields, which were roughly proportional to the amount of sulphate ammonia applied.

Low levels of P in the basal fertilizer conferred some measure of frost tolerance on the bean crop.

Seed size in the variety Saluggia was increased by nitrogen, particularly when applied in the basal fertilizer mixture.

I. INTRODUCTION

The fertilizer requirements of culinary beans in Queensland have been studied in relation to pod yields, but seed yields have received little attention. It has been the usual practice for seed crops to receive applications similar to those for snap bean crops. The recommendations for snap beans were based on work reported by Summerville (1941, 1942) and Prest (1956). For rows 2 ft 6 in. apart, the standard schedule is 6–8 cwt of a 4:15:2 mixture per acre as a basal dressing and 1 cwt of ammonium sulphate applied as a side-dressing about two weeks after emergence. Field experience suggested that this schedule was not optimum for irrigated seed crops grown in the Lower Burdekin district. A comprehensive fertilizer trial was therefore carried out at Millaroo Research Station in 1963, using Saluggia culinary bean as the test variety. This trial compared three different levels each of nitrogen, phosphorus and potassium in the basal dressing, and three levels of nitrogen applied as side dressings.

II. EXPERIMENTAL AND CULTURAL DATA

The treatments employed were as follows:—

Basal nitrogen	N0—nil
(as ammonium sulphate)	N1—35 lb N per ac
	N2 70 lb N per ac

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Basal phosphorus (as superphosphate)	P0—nil P1—50 lb P_2O_5 per ac P2—100 lb P_2O_5 per ac
Basal potassium (as potassium chloride)	K0—nil K1—17½ lb K_2O per ac K2—35 lb K_2O per ac
Side nitrogen (as ammonium sulphate)	S0—nil S1—25 lb N per ac S2—50 lb N per ac

Each factorial combination of treatments was represented once in a 3^4 quasi-latin square. Datum plots comprised 2 rows each 32 ft long. Each datum plot was separated from adjacent plots by guard rows at the sides and buffer areas at the ends.

The trial was carried out in Borders A 20–22 at Millaroo Research Station. Here the soil type is a Glenalder sandy loam which contained very low total N (0·3 per cent.), fair available P_2O_5 (70 p.p.m.) and very fair available K (0·33 m-equiv. %). The pH was 6·1.

Furrows spaced 3 ft 6 in. apart were irrigated two days before the application of fertilizer treatments. On May 10, fertilizer was applied by hand to the bottom and sides of the furrows and covered with 1–2 in. of soil by hoe. Seeds of the variety Saluggia were planted 4 in. apart by hand on May 13. On June 5, side-dressings were applied in a 3-in. band directly alongside the plant rows.

Relatively dry weather occurred during the main growing period and furrow irrigations were necessary on June 6, July 2 and July 30. Weather data are presented in Table 1.

TABLE 1

WEATHER DATA

—	Rainfall (in.)	Mean Maximum Temp. (°F)	Mean Minimum Temp. (°F)
May 10–31	0·18	82·9	57·8
June	0·07	78·3	50·6
July	0·09	77·5	45·2
August	2·41	79·4	54·6
September 1–9	0	82·8	47·4

In the last week of June, some cold injury was apparent when screen temperatures dropped to 34°F, and this occurred when the crop was just past its flowering peak. An even lower temperature (32°) was recorded on July 15, when the upper parts of plants and the young pods were scorched. However, the peak of pod-setting had been reached before this date.

Pests and diseases were not serious. Bean fly was well controlled with 0·1 per cent. DDT, but thrips control was only moderate. Disease incidence was confined to a few seedling rots, chiefly ashy stem blight.

Plants were ready for harvesting in the first week of September, although harvesting operations extended from September 4 to 13.

III. RESULTS

Yield.—It is clear from the yield data presented in Table 2 that a liberal application of nitrogen is required for good yields. A basal application which supplied 70 lb N per acre and a side-dressing which supplied 25 lb N per acre would be justified in commercial practice.

The effects of basal and side-dressings of nitrogen were independent of each other. Even with heavy basal applications, yield responses to a side-dressing were obtained. It is quite probable, therefore, that heavier basal dressings may be worth while, unless, of course, timing of the side-dressing in irrigated crops is critical.

TABLE 2

YIELD OF DRY BEANS (BUS/AC)

—	S0	S1	S2	Means	—	K0	K1	K2	—	P0	P1	P2
N0	10·72	12·64	13·05	12·15	N0	12·41	12·79	11·21	N0	12·00	12·60	11·81
N1	14·32	15·49	16·20	15·34	N1	15·04	16·20	14·77	N1	14·59	15·79	15·34
N2	14·81	16·87	17·85	16·50	N2	16·42	16·46	16·61	N2	15·94	17·85	16·50
P0	12·94	14·17	15·45	14·17	P0	13·50	15·00	14·02				
P1	14·25	15·34	16·69	15·41	P1	15·07	16·20	14·96				
P2	12·71	15·52	14·96	14·40	P2	15·34	14·25	13·61				
K0	13·05	15·67	15·15	14·62								
K1	13·84	14·74	16·91	15·15								
K2	12·97	14·59	15·04	14·21								
Means	12·94	15·00	15·71	14·66								

Means	s.e.	Necessary Differences for Significance	
		5%	1%
Marginal	0·38121	1·099	1·477
Individual	0·66029	1·901	2·557

N2 > N1 ≫ N0

P1 > P0

S1, S2 ≫ S0

The response to phosphorus was evident only at the medium level of 50 lb P_2O_5 per ac. No response to potash was obtained. This result is in line with results from other trials carried out on snap beans.

Plant Height.—Plant height measurements (Table 3) were made on a random sample of 10 plants per plot on August 1. Measurements were made from ground level to the height of the youngest flower truss. Both nitrogen and phosphorus at medium levels caused marked increases in plant height when applied in combination with each other. Nitrogen side-dressings produced no increase in height, although a yield response was obtained.

TABLE 3

PLANT HEIGHTS (in.) AS AT AUGUST 1, 1963

—	S0	S1	S2	Means	—	K0	K1	K2	—	P0	P1	P2
N0	17·1	17·8	17·8	17·6	N0	17·8	17·9	17·0	N0	16·9	18·2	17·6
N1	22·1	21·7	22·3	22·0	N1	21·1	22·3	22·7	N1	18·7	23·7	23·8
N2	21·6	22·8	22·8	22·4	N2	21·9	22·9	22·3	N2	19·4	23·3	24·3
P0	18·1	17·9	19·0	18·3	P0	18·3	19·0	17·7				
P1	20·9	22·0	22·3	21·7	P1	20·6	22·6	22·1				
P2	21·8	22·3	21·6	21·9	P2	21·9	21·6	22·2				
K0	19·9	20·7	20·2	20·3								
K1	20·7	20·4	21·7	21·0								
K2	20·2	22·0	20·7	20·7								
Means	20·3	20·7	21·0	20·7								

Means	s.e.	Necessary Differences for Significance	
		5%	1%
Marginal	0·2923	0·84	1·13
Individual	0·5062	1·46	1·96

N1, N2 > N0

P1, P2 > P0

(N x P) interaction significant at 1% level.

Plant Stand.—Although there was a non-significant error regression between yield and stand, some treatment effects on stand were recorded (Table 4).

A reduction in plant stand caused by the basal N fertilizer was roughly proportional to the amount of sulphate of ammonia applied. The initial depth of the planting furrows may have been inadequate and injury to the seed is attributed to an insufficient soil cover over the fertilizer at the time of sowing. In spite of the reduction in the plant stand, basal fertilizers containing nitrogen increased seed yields.

TABLE 4

NO. OF PLANTS PER PLOT

—	S0	S1	S2	Means	—	K0	K1	K2	—	P0	P1	P2
N0	198	200	203	201	N0	197	207	198	N0	200	201	201
N1	160	155	157	157	N1	165	155	152	N1	155	163	153
N2	104	107	116	109	N2	112	110	106	N2	104	118	106
P0	149	148	162	153	P0	155	154	150				
P1	161	164	157	161	P1	158	165	159				
P2	152	151	157	153	P2	161	153	147				
K0	148	163	162	158								
K1	160	154	158	157								
K2	154	146	156	152								
Means	154	154	159	156								

Means	s.e.	Necessary Differences for Significance	
		5%	1%
Individual	3·741	10·8	14·5
Marginal	6·480	18·7	25·1

N0 ≫ N1 ≫ N2

Frost Damage.—Low temperatures in June and July caused plant injury to some plots and, in particular, scorching of the upper leaves. Frost damage ratings for treatments (Table 5) indicate that a deficiency of phosphorus in the presence of basal nitrogen conferred some measure of frost tolerance on the crop Phosphate-deficient plants were characterized by harsh, coarse-textured leaves.

TABLE 5

FROST DAMAGE AS AT AUGUST 15, 1963 (RATED FROM 0 TO 10)

—	S0	S1	S2	Means	—	K0	K1	K2	—	P0	P1	P2
N0	5·2	3·7	4·9	4·6	N0	4·3	5·3	4·1	N0	5·2	4·4	4·1
N1	5·2	4·8	4·6	4·9	N1	4·8	4·8	5·0	N1	3·2	6·6	4·8
N2	4·0	4·3	4·3	4·2	N2	4·1	4·4	4·1	N2	3·2	5·2	4·2
P0	4·6	3·1	4·0	3·9	P0	3·9	4·7	3·1				
P1	5·2	5·7	5·3	5·4	P1	5·3	5·1	5·8				
P2	4·7	4·0	4·4	4·4	P2	4·0	4·8	4·3				
K0	4·8	4·0	4·4	4·4								
K1	4·9	4·0	5·7	4·9								
K2	4·8	4·8	3·7	4·4								
Means	4·8	4·3	4·6	4·6								

Means	s.e.	Necessary Differences for Significance	
		5%	1%
Marginal	0·6145	1·02	1·37
Individual	0·3548	1·77	2·38

P0 ⩽ P1

(N x P) interaction significant at 5% level.

Seed Size.—At the completion of harvest, random samples of seed from each plot were collected. The number of seeds contained in a 90·8 g (1/5 lb) composite sample was counted and the equivalent number per oz calculated (Table 6). The data suggest that applications of nitrogen increased seed size, and that the increases were due primarily to basal applications of sulphate of ammonia. Seeds from plots receiving basal nitrogen at 35 lb per ac were 6·8 per cent. heavier and at 70 lb N per ac 18·3 per cent. heavier than in plots receiving no basal nitrogen. The N $\times$ K interaction indicates a reduction in seed size for the medium level of K (K1) in the presence of high basal N (N2). A co-variance analysis of yield and seed size gave a non-significant error regression, indicating no relationship within treatments for overall yield and seed size.

TABLE 6

NO. OF SEEDS PER OUNCE

—	S0	S1	S2	Means	—	K0	K1	K2	—	P0	P1	P2
N0	56·1	54·4	54·6	55·0	N0	54·5	54·3	56·3	N0	54·8	54·7	55·6
N1	52·2	52·2	50·3	51·5	N1	51·5	51·2	52·0	N1	50·8	51·0	52·8
N2	48·0	46·2	45·2	46·5	N2	45·9	48·2	45·3	N2	47·2	46·2	46·0
P0	52·4	50·0	50·4	50·9	P0	50·3	51·3	51·2				
P1	51·5	50·7	49·8	50·7	P1	50·5	50·3	51·2				
P2	52·4	52·1	49·9	51·5	P2	51·0	52·1	51·3				
K0	52·0	50·4	49·4	50·6								
K1	51·7	51·6	50·3	51·2								
K2	52·6	50·8	50·3	51·2								
Means	52·1	50·9	50·0	51·0								

Means	s.e.	Necessary Differences for Significance	
		5%	1%
Marginal	0·4002	1·15	1·55
Individual	0·6932	2·00	2·69

$N0 \gg N1 \gg N2$

$S0 > S1$; $S0 \gg S2$

(N x K) interaction significant at 5% level.

IV. DISCUSSION

The greatest yields were obtained from a fertilizer schedule based on a basal mixture containing 70 lb N, 50 lb P_2O_5 and nil K per ac, followed by a side-dressing containing 25 lb N per ac. The equivalent basal fertilizer is a 4½ cwt per ac application of a 14:10:0 mixture. The standard side-dressing of 1 cwt of ammonium sulphate per ac normally used in southern Queensland is apparently equally necessary in the Burdekin district.

The adverse effect of basal fertilizers high in nitrogen on the stand of plants was well demonstrated in the trial. The reduction in stand did not, however, reduce yields. On the contrary, high yields were obtained from plots with a substandard plant stand. It follows, therefore, that some plant loss can be tolerated in commercial plantings unless obvious gaps occur within the row.

In high basal N plots, the plant stand was less than in the low N plots, and the number of seeds per plant correspondingly greater. The recorded increase in seed size would appear to be a direct response to the nitrogen status of the plants rather than differences in plant size. Phosphorus increased the size of plants but had no obvious effect on seed size.

Under high nitrogen regimens, increased seed size must have contributed to yields. Twenty-six per cent. of the yield increment recorded for N1 over N0 was due to increase in seed size, while the yield increment for N2 over N1 was entirely due to the larger seed harvested. Fifteen per cent. of the yield increase from side-dressing (S1) can be attributed to the larger seed size. Increased number of seeds per plant was an important factor in the yield increment up to the N1 level, whereas increased seed size was mainly responsible for the further increment in yield recorded from the highest level for basal nitrogen (N2).

Large seed is probably desirable in the culinary bean market. The influence of fertilizer schedules on seed size shown in this trial suggests that cultural practices may be adapted to produce a type of bean for which premium prices are payable.

V. ACKNOWLEDGEMENTS

Thanks are due to Messrs. D. A. Griffin and J. C. Rahder, who did much of the field work associated with this trial; also to the management and staff of Millaroo Research Station for executing the routine cultural operations. The Biometrics Branch carried out the statistical analyses.

REFERENCES

PREST, R. L. (1956).—Side-dressing French beans. *Qd Agric. J.* 82:377.

SUMMERVILLE, W. A. T. (1940).—Bean fertilizer investigations during 1940. *Qd Agric. J.* 55:288-90.

SUMMERVILLE, W. A. T. (1941).—Bean fertilizer investigations during 1941. *Qd Agric. J.* 56:374-7.

(Received for publication April 30, 1964)