FRENCH BEAN VARIETY AND SPACING TRIAL.

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SUMMARY.

As part of a regional testing programme, two new rust-resistant varieties of French bean—Redlands Belle and Redlands Beauty—were compared with recognised commercial varieties in a plant and row spacing trial at the Maroochy Experiment Station.

Yields from both new varieties were considerably greater than those of Brown Beauty and comparable with those of St. Andrews.

Plant weight at maturity and number of flowers per plant increased with increments in plant spacing within the row from 2 in. up to a maximum of 6 in.

Differences in percentage pod set were obtained for varieties but not for plant spacings in and between rows. Maximum pod set occurred in St. Andrews.

Weight loss in cased beans during a 6-days storage period was influenced by variety rather than the tightness of the pack.

I. INTRODUCTION.

For some years past, the green bean industry has been based primarily on the old-established variety, Brown Beauty. Types of lesser importance are St. Andrews at Gympie and Hawkesbury Wonder at Stanthorpe.

The varietal pattern remained fairly stable until 1954, when bean rust (Strain 17A) was first recorded in Queensland. The existing commercial varieties proved highly susceptible to the disease and plant breeders therefore took immediate steps to produce substitute varieties with agronomic properties comparable with those of Brown Beauty, and with the added character of resistance to rust. Their appreciation of the threat implicit in the introduction of rust proved sound, and by 1957 the disease had become a major limiting factor to bean production in certain districts during the winter and spring months.

One outcome of the plant-breeding project was the production of two new varieties, known respectively as Redlands Belle and Redlands Beauty, both of which were bred at the Department's Redlands Experiment Station. These were listed for regional testing in 1957 and one of several trials was assigned to the Maroochy Experiment Station, near Nambour, which is an important green bean growing district on the Near North Coast, some 75 miles north of Brisbane. In order to get the maximum amount of information from the trial, the scope of the work was extended to permit an investigation of the effects of row spacing and plant spacing in the row. Both vary considerably in commercial plantings and are influenced by soil type, the implements used for cultivation and the availability or otherwise of water for irrigation.

II. EXPERIMENTAL METHODS.

(1) Treatments and Design.

Row spacings were 2 ft. and 2½ ft.; and plant spacing in the row 2 in., 4 in. and 6 in.

The varieties used were Brown Beauty, Redlands Beauty, Redlands Belle, St. Andrews and Langshaw Beauty.

The layout was a (2 x 3 x 5) x 3 factorial with split plots for row spacings. Sub-plots comprised 4 x 11 ft. rows in the 2½ ft. spacing and 5 x 11 ft. rows in the 2 ft. spacing. Adjacent plots were separated by buffer areas at the ends and by guard rows at the sides.

(2) Cultural Data.

The land selected for the trial was a red-brown sandy loam which had been previously under pigeon pea for several years. Pre-planting tillage brought the soil into a good tilth before the seed was sown on Apr. 24, 1957.

Crop management followed standard practice. Planting furrows were opened up at the prescribed spacings before planting and a 4:15:2 complete fertilizer distributed by hand along the bottom and sides of the furrow at the rate of 8 cwt. per acre. The fertilizer was covered with 2 in. of soil by hand-hoe immediately. The seed was sown by hand at the specified spacings to a depth of 1 in. and the land irrigated shortly afterwards. A side-dressing of sulphate of ammonia at the rate of 1 cwt. per acre was applied on May 10, some two weeks after germination.

Weeds developing in the row were smothered by drawing soil into the plant row from the inter-row space. Weed growth in the inter-row spaces was controlled by hand-tillage implements.

The crop was grown in relatively dry weather with supplementary irrigation as and when necessary (Table 1).

Table 1.

CLIMATIC DATA.

Month.	Rainfall (in.).	Irrigation (in.).	Mean Maximum Temperature (°F.).	Mean Minimum Temperature (°F.).
From Apr. 24	·02	3	81·5	60·8
May	·09	7	75·5	51·1
June	1·56	4	70·0	51·3
To July 17	1·74	Nil	66·5	42·0

Pests and diseases were not troublesome. Bean fly (*Melanagromyza phaseoli*) was effectively controlled with DDT (0·1 per cent.) sprays applied at intervals of approximately three days for a period of four weeks after germination. Bean rust was present, though not in sufficient quantity to reduce yield in the more susceptible varieties.

The green pods were harvested in five picks from June 27 to July 17, and sold on the fresh vegetable market.

III. VARIETAL CHARACTERISTICS.

All five of the varieties under test have distinctive features. Brief descriptions are given below:—

Brown Beauty.—Bush relatively small with rather dense foliage; crop borne mostly near the centre of the plant and close to the main stem; pods of fine quality when picked at the right stage of maturity, flat and dark-green in colour. Cropping period comparatively short.

Redlands Belle.—Derived from Langshaw Beauty (a string bean locally selected in 1954 from Brown Beauty at Gympie) and Florida Belle (a stringless bean introduced to Queensland some years ago). Bush semi-erect and compact but somewhat larger than that of Brown Beauty; pods borne mainly in the centre of the plant, semi-flat in cross section and tending to develop fibre in transit to distant markets. Matures ahead of Brown Beauty; short cropping period. Resistant to rust but somewhat susceptible to stem rot.

Redlands Beauty.—Derived from Brown Beauty x Californian Small White (a navy bean). Bush erect and open with spreading laterals and somewhat distinct, narrowly hastate leaves; pods uniformly flat in cross section, dark-green in colour and rather disperse on the plants. Moderately long cropping period. Resistant to rust and anthracnose.

St. Andrews.—The strains currently grown in Queensland are mainly local selections which differ somewhat from the type. Plant with an erect bush and strong laterals; pods long, flattish, pale-green in colour and tending to cling to the plant when mature. Long cropping period. Reputed to be tolerant of low temperatures and low soil fertility.

Langshaw Beauty.—A selection from Brown Beauty but quite distinct from that variety. Bush large, semi-open, with dark-green leaves; pods very long, carried well out from the centre of the plant and dark-green in colour. Long cropping period.

IV. RESULTS.

(1) Yields.

Yield data from the trial are summarised in Table 2.

Yields from Redlands Belle, Redlands Beauty and St. Andrews were 32 per cent. greater than those from Brown Beauty, while Langshaw Beauty produced 17 per cent. more beans than Brown Beauty. Differences were significant at the 1 per cent. level and were independent of plant spacing or row spacing.

Table 2.

MEAN YIELDS (oz./plot).

Variety.	Plant Spacing.				Row Spacing.		
	2 in.	4 in.	6 in.	Mean.	2 ft.	2½ ft.	Mean.
1. Brown Beauty	329	325	284	313	322	304	313
2. Redlands Belle	415	410	412	412	423	401	412
3. Redlands Beauty ..	430	409	400	413	408	419	413
4. St. Andrews	412	432	389	411	422	399	410
5. Langshaw Beauty ..	351	357	391	366	372	361	366
Mean	387	387	375	..	389	377	..

Significant differences: 2, 3, 4>> 5>> 1

Yield differences are an expression of varietal characteristics such as plant size, cropping habit, pod weight and climatic adaptability. The pattern of yields for the varieties under test followed expectations, but the recorded differences may be accentuated by the relatively low yield from the standard variety, Brown Beauty. This variety may be under-valued by the data, for the seed was slow to germinate (Table 3) and this may indicate lack of vigour in the stock due to factors such as age of the seed and/or storage conditions prior to planting.

Table 3.

FIELD GERMINATION OF VARIETIES.

Time.	Brown Beauty.	Redlands Belle.	Redlands Beauty.	St. Andrews.	Langshaw Beauty.
Within 7 days ..	35	80	75	71	78
,, 14 ,, ..	77	89	86	84	83

The lack of significant differences in yield for plant spacings in the row is surprising. Overseas plant-spacing experiments with lima beans and dwarf French beans indicate that increased yields per acre were obtained with closer planting and increased seeding rates. The results of this trial suggest that the ability of the plants to exploit the environment is much the same at 2, 4 and 6 in. spacings. The environment sets a limit to plant development, and plant development, in turn, is frequently directly correlated with productivity.

Assuming an effective lateral root penetration of 8 in. into the inter-row space, the mean area occupied by each plant ranged from 32 sq. in. for the 2 in. spacings to 92 sq. in. for the 6 in. spacing where the rows are 2 ft. apart.

The absence of significant differences in yield for row spacings ranging from 2 ft. to 2½ ft. may reflect the restricted lateral root spread in a quick-growing crop produced under irrigation.

(2) Plant Weight.

Within the limits set by the constitution of the variety, plant weight at any given spacing is a measure of land utilization. It was determined in this trial from 4-plant per plot samples taken at random immediately before plants had shown any obvious signs of senescence. The results are summarised in Table 4.

Table 4.

GREEN WEIGHT AFTER HARVESTING (oz./4 plants).

Variety.	Plant Spacing.				Row Spacing.		
	2 in.	4 in.	6 in.	Mean.	2 ft.	2½ ft.	Mean.
1. Brown Beauty	7·8	11·5	11·6	10·3	9·7	10·9	10·3
2. Redlands Belle	7·1	13·9	16·8	12·6	11·9	13·4	12·6
3. Redlands Beauty ..	8·8	14·8	15·9	13·2	13·5	12·8	13·2
4. St. Andrews	8·3	13·9	16·6	12·9	12·0	13·9	12·9
5. Langshaw Beauty ..	7·6	11·0	15·8	11·5	11·0	11·9	11·5
Mean	7·9	13·1	15·3	..	11·6	12·6	..

Significant differences:
Varieties: 3,4 >> 1; 2 > 1.
Plant spacing: 6 in. >> 4 in. >> 2 in.

The plant-weight data draw attention to varietal differences in plant size. Redlands Beauty, St. Andrews and Redlands Belle plants were 9 per cent. larger than Langshaw Beauty and approximately 25 per cent. larger than Brown Beauty. Both Redlands Beauty and St. Andrews normally develop strong laterals. Redlands Belle has a more erect bush which is morphologically similar to that of Brown Beauty. Its good showing in Table 4, which is indicative of greater plant size, may reflect greater tolerance of cold temperatures during the growing period than is characteristic of Brown Beauty.

The effect of plant density in the row on vegetative development was very marked. Doubling the space between plants from 2 in. to 4 in. increased plant weight by some 65 per cent., and trebling it from 2 in. to 6 in. by 93 per cent. The initial increase in plant weight of the first increment (2–4 in.) in spacing is much greater than for the second (4–6 in.).

(3) Number of Flowers.

Each flower represents a potential pod and the flowering characteristics of a variety are therefore of considerable importance in beans as in other horticultural crops. The fate of the flowers will, of course, depend on environmental factors such as climate, nutrient status of the soil and soil moisture, but differences in the capacity of the plant to produce flowers could materially affect yields under any given set of conditions. Flower counts were therefore made on four plants taken at random from each plot. The data are summarised in Table 5, which expresses the results in terms of equivalent numbers.

Table 5.

NUMBER OF FLOWERS (PER 4 PLANT SAMPLE).

Variety.	Plant Spacing.				Row Spacing.		
	2 in.	4 in.	6 in.	Mean.	2 ft.	2½ ft.	Mean.
1. Brown Beauty	98	135	166	130	139	122	130
2. Redlands Belle	79	146	180	127	133	122	127
3. Redlands Beauty ..	99	168	173	142	136	148	142
4. St. Andrews	97	158	194	144	138	150	144
5. Langshaw Beauty ..	98	144	207	146	147	144	146
Mean	94	150	185	..	138	137	..

Significant differences: 6 in. >> 4 in. >> 2 in.

The number of flowers per plant was much the same in all varieties but significant differences were recorded for the three plant spacings used in the row. Increasing the spacing from 2 in. to 4 in. was followed by a 59 per cent. increase in the number of flowers per plant, and from 2 in. to 6 in. by a 95 per cent. increase. The product of "number of flowers per plant" and "number of plants per unit distance" was much the same at 2 in. and 4 in. spacings.

Soil moisture and nutrient levels were for practical purposes uniform throughout the experimental area. Vegetative growth and flower production could, however, vary at different levels of soil moisture and nutrient supply as there is some evidence with other crops that plant density and utilization of applied nutrients are correlated.

Row spacing had no significant effect on the number of flowers produced. With normal methods of inter-row cultivation, root competition between plants in adjacent rows is unlikely to take place when, as in this trial, water is supplied in adequate amounts and fertilizer is placed in a readily accessible position.

(4) Pod Setting.

As the bean plant is normally self-pollinated, variations in pod set are due primarily to the effect of climate and nutrition on pollination. Responses to these factors may be inherent in the variety. Pod set (Table 6) was determined from random samples of four plants per plot.

Plant spacing in the row and spacing between rows had no effect on the percentage pod set.

Significant differences were, however, recorded between the varieties grown, pod set being lowest in Brown Beauty (58·4 per cent.) and highest in St. Andrews (79·6 per cent.). The other varieties occupied intermediate positions. The differences may reflect varietal reactions to low temperatures, for poor setting is a common aftermath of chilling winds during the winter months.

Table 6.

POD SET (PERCENTAGE/4 PLANTS/PLOT).

Variety.	Plant Spacing.				Row Spacing.		
	2 in.	4 in.	6 in.	Mean.	2 ft.	2½ ft.	Mean.
1. Brown Beauty	62·0	64·4	48·6	58·4	56·0	60·7	58·4
2. Redlands Belle	71·0	67·6	70·5	69·7	67·6	71·8	69·7
3. Redlands Beauty ..	63·4	67·6	61·5	64·2	63·8	64·5	64·2
4. St. Andrews	86·1	76·9	75·8	79·6	81·8	77·4	79·6
5. Langshaw Beauty ..	63·7	66·8	62·0	64·1	63·3	65·0	64·1
Mean	69·2	68·6	63·6	..	66·5	67·9	..

Significant differences: Variety 4 >> 2, 3, 5 >> 1.

(5) Storage Losses.

A considerable proportion of the Queensland bean crop is consigned to distant markets in hessian sacks or wooden cases. Weight loss between packing on the farm and display at markets may therefore be high. Such losses affect returns to growers partly because weight has a direct influence on market values, and partly because shrinkage tends to expose the beans to greater injury in transit. Weight losses were therefore determined in loose, medium and tightly packed cases during a 6-days storage period.

Each case contained a 4 lb. sample of each variety packed in random order. Cases were also packed top and bottom with extra beans in order to adjust weight to 59 lb. (loose), 64 lb. (medium), 68 lb. (tight), and held at room temperatures. The results are summarised in Table 7.

Table 7.

PERCENTAGE WEIGHT LOSS IN CASES AFTER 6 DAYS.

Variety.	Pack.			
	Lower.	Medium.	High.	Mean.
1. Brown Beauty	8·5	9·6	8·0	8·7
2. Redlands Belle	10·0	10·2	7·3	9·2
3. Redlands Beauty	7·1	6·8	7·9	7·3
4. St. Andrews	8·5	7·2	7·6	7·8
5. Langshaw Beauty	8·9	10·9	6·5	8·8
Mean	8·6	9·0	7·5	8·3

Significant differences: 2, 5 > 3.

Weight loss bore no significant relation to the type of pack, although trends in the data strongly suggest that the tighter the pack the less the loss in weight during storage. This would be expected owing to the reduced air movement in and through the cases.

There are, however, significant differences in weight losses between Redlands Belle and Langshaw Beauty on the one hand and Redlands Beauty on the other. It is of interest in this connection to recall that Langshaw Beauty is one of the parents used in the production of Redland Belle and that Redlands Belle, unlike other varieties used in this trial, has pods with an oval rather than a flat cross-section. Percentage weight loss was lowest in Redlands Beauty.

V. ACKNOWLEDGEMENTS.

Thanks are due to Mr. J. Harold Smith for his assistance in preparation of the manuscript, to Mr. R. C. Cannon for assistance in planning of the project, to Mr. P. B. McGovern for help in analysing the experimental data, to Mr. P. Mitchell, Manager of Maroochy Experiment Station, and his staff for growing the crop, and to other officers of the Department of Agriculture and Stock who helped in recording experimental data.

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(Received for publication Apr. 2, 1959.)