THE EFFECT OF TIME OF SOWING AND DENSITY ON POD POSITION AND YIELD OF TWO CULTIVARS OF FIELD BEANS (Vicia faba L.)

S.D. Newton and G.D. Hill
Department of Plant Science
Lincoln College
Canterbury

ABSTRACT

Daffa and Maris Bead, two cultivars of field beans, were sown in autumn and spring at densities from 23 - 76 plants m^{-2}. Autumn-sown Daffa and Maris Bead yielded up to 250 and 500 g m^{-2} (D.M.) respectively. Spring sowing reduced yields substantially. Higher grain yields could be achieved by using higher plant populations. Autumn-sown beans flowered and podded on similar nodes, but when spring sown, the beans flowered from a later node and at fewer nodes.

INTRODUCTION

Field beans (**Vicia faba L.**) have been grown as a stock and human food in Europe and the Mediterreanean since Pythagoras's time (Arie 1959). After the Second World War the area sown in the U.K. declined as other crops gave greater returns than field beans. In 1973 – 75 about 5500 ha were grown each year in the U.K. with an average yield of 2.8 tonnes ha^{-1} (F.A.O. Production Yearbook 1975). Recent increased interest in protein production has led to a revival of interest in the crop. Ishag (1973) reported yields of up to 6.6 tonnes ha^{-1} at densities of 60 plants m^{-2}.

Although a number of New Zealand farmers grow field beans for local stock food markets, there has been little published research directed towards the improvement of yields through agronomic means. Traditionally field beans are sown in autumn so that they emerge after the last aphid flight. Winter growth appears to confer a degree of resistance to the aphid-transmitted diseases, as the plants are well grown before becoming infected. The development of reliable systemic aphicides may allow the crop to be spring sown, freeing land for cool season use. Field beans may provide an alternative crop to peas in the southern areas where climate may limit the growth of other grain protein crops. The aim of the experiments reported here was to examine the effects of density and time of sowing on the grain yield of field beans.

METHODS

The two cultivars, Daffa and Maris were sown in plots of 2.25 m width and 12 m length, at five densities, in 15 cm rows, with a Stanhay Precision Seeder on May 29 and August 21, 1976. There were five replicates. Because of a shortage of seed, Maris Bead was included in only two of the replicates in the autumn-sowing, and their places in the other replicates were sown with a commercial cultivar. All trial plots were sown with seed inoculated with a commercial field bean inoculant.

Thimet at 2 kg a.i. ha^{-1} was incorporated in the soil before sowing. Simazine at 1.20 kg ha^{-1}, and paraquat at 1.0 kg ha^{-1} were applied pre-emergence.

Two hives of bees (**Apis mellifera**) were placed in the experimental area on October 30 at the start of flowering of the autumn sowing and a second group of ten hives was brought in on December 11 for the spring-sown beans.

At harvest, (14 and 24 February, autumn sowings and spring sowings respectively), the plants in two quadrats of 0.5 m^2 were pulled from the central four rows of each plot for yield estimation. From each quadrat twenty plants were taken at random for flower and pod position analysis.

RESULTS AND DISCUSSION

The large seed size of the two cultivars (Daffa 400 mg, Maris Bead 300 mg) meant that the drill was operating at the upper limit of its working range. Thus the densities established, (Table 1), were lower than the theoretical densities, and were not evenly spaced.

TABLE 1: Established populations (plants m^{-2}) of two varieties of field bean sown at five densities in autumn and spring.

	AUTUMN		SPRING	
Density	Daffa	Maris Bead	Daffa	Maris Bead
1	23a	25a	20a	25a
2	32b	42c	41b	44b
3	46cd	59ef	44b	61c
4	52de	67fg	48b	64c
5	60ef	72g	65c	76d

Emergence of the autumn-sown beans took six weeks and most beans emerged after the main autumn aphid (**Acythosiphon solani** (Klth) flights were over. The beans were well grown by the start of the spring aphid flights and Bean Leaf Roll Virus affected less than 5% of the autumn-sown plants. Spring-sown

TABLE 2: Final Grain Yields (g m^{-2}D.M.) of two varieties of field beans sown at five densities in Autumn and Spring.

	AUTUMN		SPRING	
Density	Daffa	Maris Bead	Daffa	Maris Bead
1	154.06a	291.59cd	35.47a	160.39c
2	164.72a	355.21de	53.58ab	175.34cd
3	203.99abc	426.16e	71.73b	205.58e
4	250.44bc	379.17de	61.23ab	218.34e
5	193.13ab	430.33c	53.75ab	203.08de

beans emerged three weeks after sowing and were more affected by the virus. Daffa appeared more susceptable to B.L.R.V. than Maris Bead. Appearance of the black colonising aphid (**Aphis craccivora** Koch) was delayed until mid December, probably by the late spring (Fig. 1), by which time there were few plants from either sowing with young growing tips suitable for colonisation.

Highest yielding plots were closest to the bee hives. The bees began to rob flowers 10 – 14 days after the hives were placed in the paddock.

In field beans, autumn-sowing produced greater yields than did spring-sowing. In both cases Maris Bead outyielded Daffa. The yields reported here (Table 2) are lower than the 6.6 tonnes ha^{-1} reported by Ishag, but are higher than the average British commercial yields. A commercial crop autumn-sown in 1976 at Lincoln College yielded 3.9 tonnes ha^{-1} field dressed (B. Scott pers comm). The non limiting plant population has yet to be determined.

Regression equations, yield (Y) and density (X), were:-

Autumn	Daffa	$y = 73.39 + 2.54x$	***	$r = 0.63$
	Maris Bead	$y = 226.49 + 2.48x$	*	$r = 0.75$
Spring	Daffa	$y = 34.54 + 0.42x$	*	$r = 0.38$
	Maris Bead	$y = 137.14 + 0.98x$	**	$r = 0.58$

It is apparent from the slopes of the equations that at each time of sowing density affects each cultivar in a similar manner. It is the initial facility of the

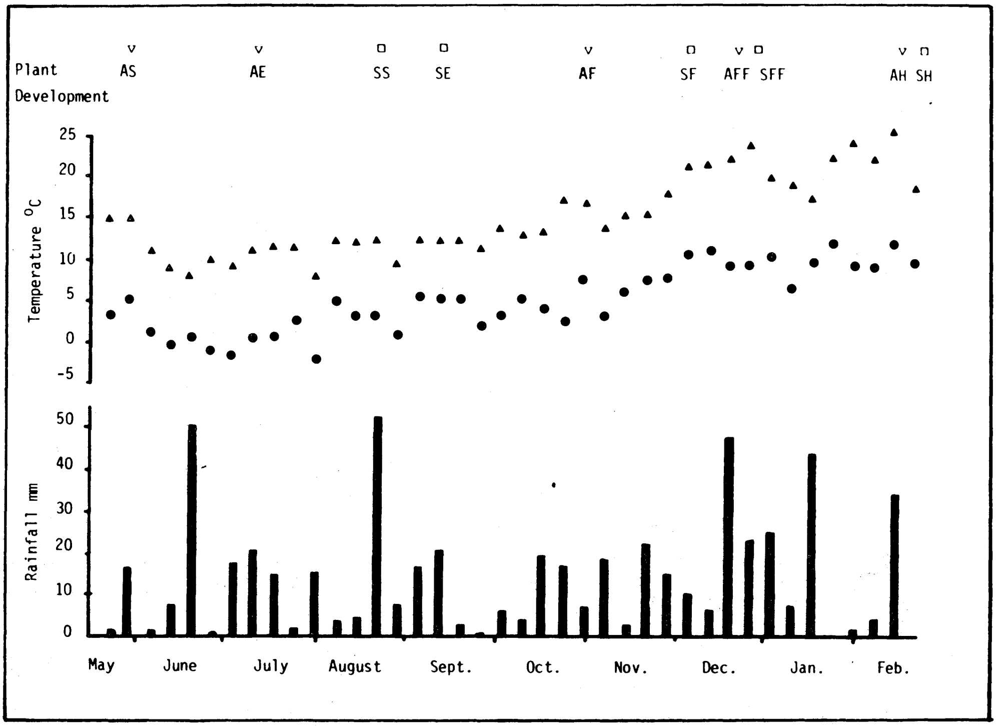

FIG. 1: Weekly distribution of Maximum and Minimum temperature and rainfall over the growing season of 2 cultivars of field bean.

▲= Maximum temperature
●= Minimum temperature

AS = Autumn sowing; AE = Emergence of autumn-sown beans; SS = Spring sowing; SE = Emergence of spring-sown beans; AF = Start of flowering, autumn-sown beans; SF = Start of flowering, spring-sown beans; AFF = End of flowering, autumn-sown beans; SFF = End of flowering, spring-sown beans; SH = Harvest of spring-sown beans; AH = Harvest of autumn sown beans

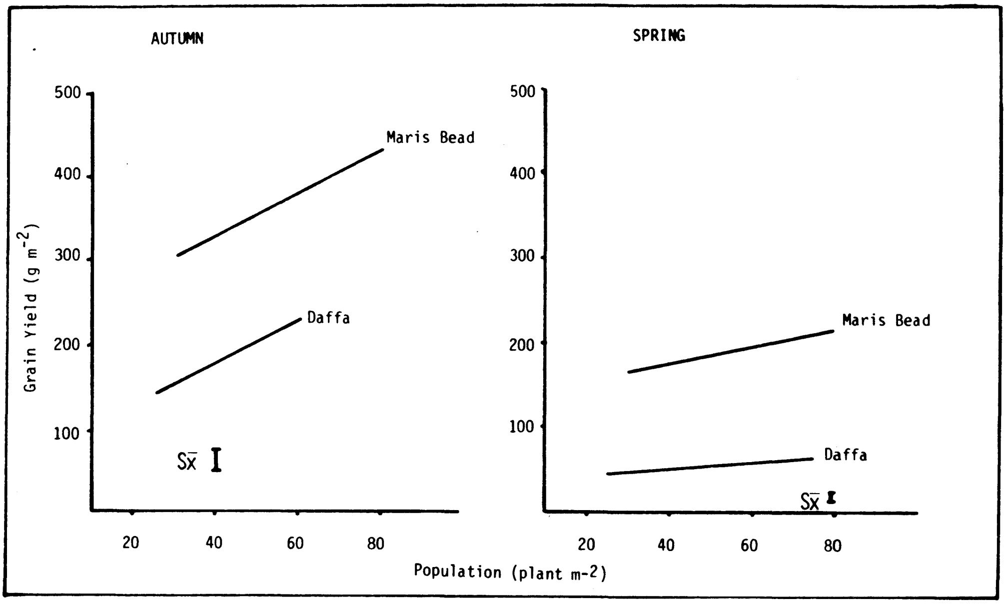

FIG. 2: Effect of plant population and time of sowing on grain yield of Daffa and Maris Bead.

individual plant to set pods irrespective of density which is the main determinant of grain yield. When spring-sown, it is evident from the co-efficient that density is less important in determining grain yield. At both times of sowing Daffa yielded less than Maris Bead.

Yield per plant is thus the main determinant of yield. It is a function of the number of flowering sites, the number of these sites that develop pods, and the number of pods at each of these sites. The effect of the number of seeds per pod and the mean seed weight upon grain yield will be discussed in a further paper.

Yield component analysis of 20 plants gave sufficient replication to allow valid comparison of Daffa and Maris Bead at both times of sowing. The effect of time of sowing and density on flower and pod position of each cultivar can be seen in Figures 3-7. An overall representation of each to final grain yield, irrespective of density, is given in Figure 8. Higher grain yields from autumn-sowings were attributed to a higher proportion of flower sites carrying pods. Spring-sown beans started to flower after the autumn-sown beans had finished flowering. Rate of growth of both cultivars was similar at both times of sowing (Newton unpublished data).

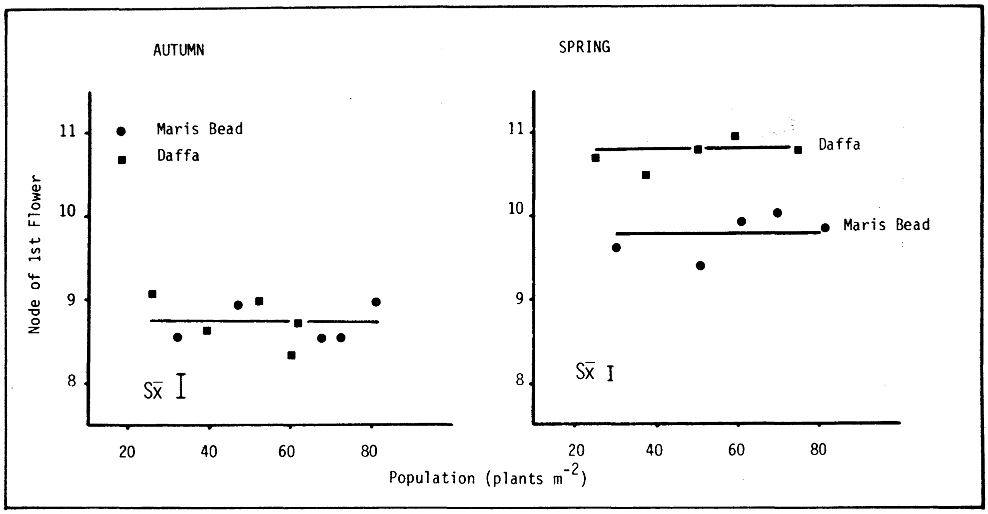

FIG. 3: Effect of plant population and time of sowing on position of first flower in Daffa and Maris Bead.

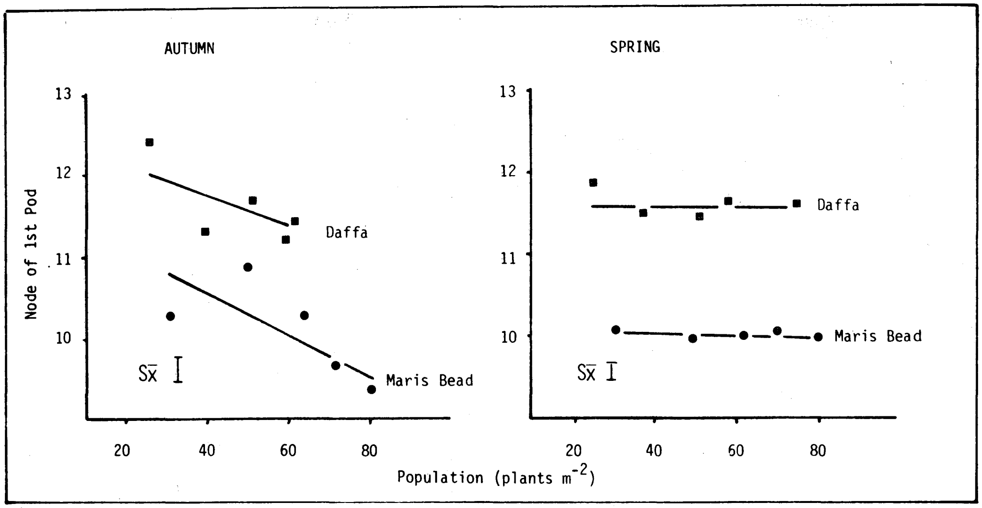

FIG. 4: Effect of plant population and time of sowing on position of first pod in Daffa and Maris Bead.

All autumn-sown beans flowered at the same node (8.6). Spring sown Maris Bead flowered at a lower node (Figure 3) and set its first pod 1.6 nodes below Daffa. Daffa produced only half the number of flowers of Maris Bead in the first week of flowering, but there were still more flowers produced than later developed into pods. Lower basal pod set in Daffa can not be attributed to lack of suitable pollinators.

Lower pod set at the earliest flowering nodes has also been reported by Ishag (1973), and, in the runner bean (**Phaseolus coccineus L.**), by Williams and Free (1975). Williams and Free suggest that it may be partially due to a greater reliance of the plant upon self pollination, there being insufficient flowers available early in flowering to allow widespread cross pollination. In addition they suggest that there may be insufficient assimilates available to the plant for pod development.

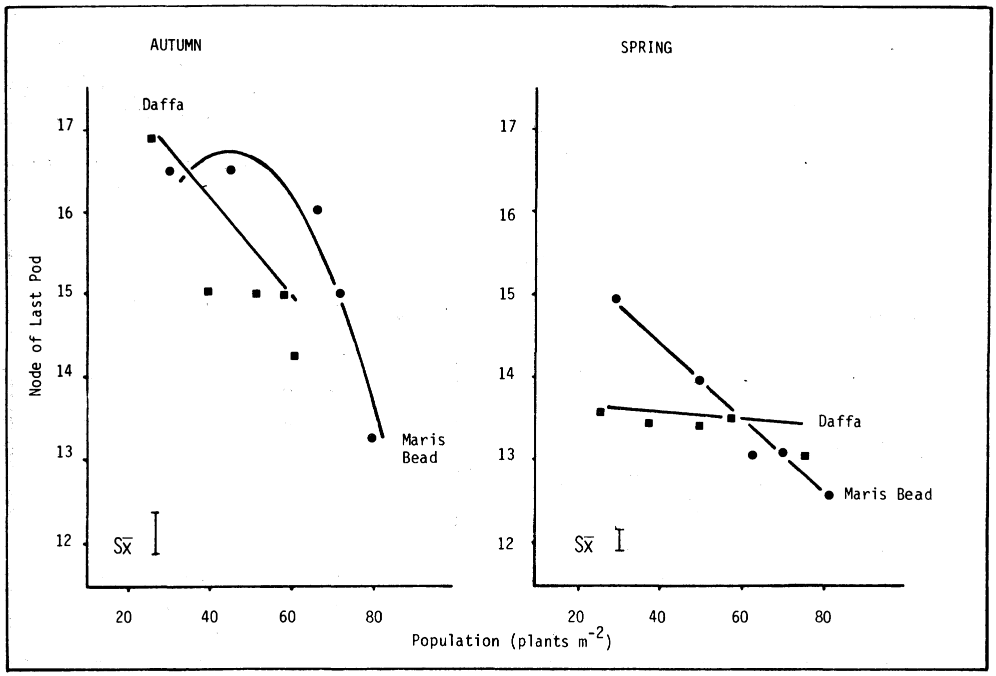

FIG. 5: Effect of plant population and time of sowing on position of last pod in Daffa and Maris Bead.

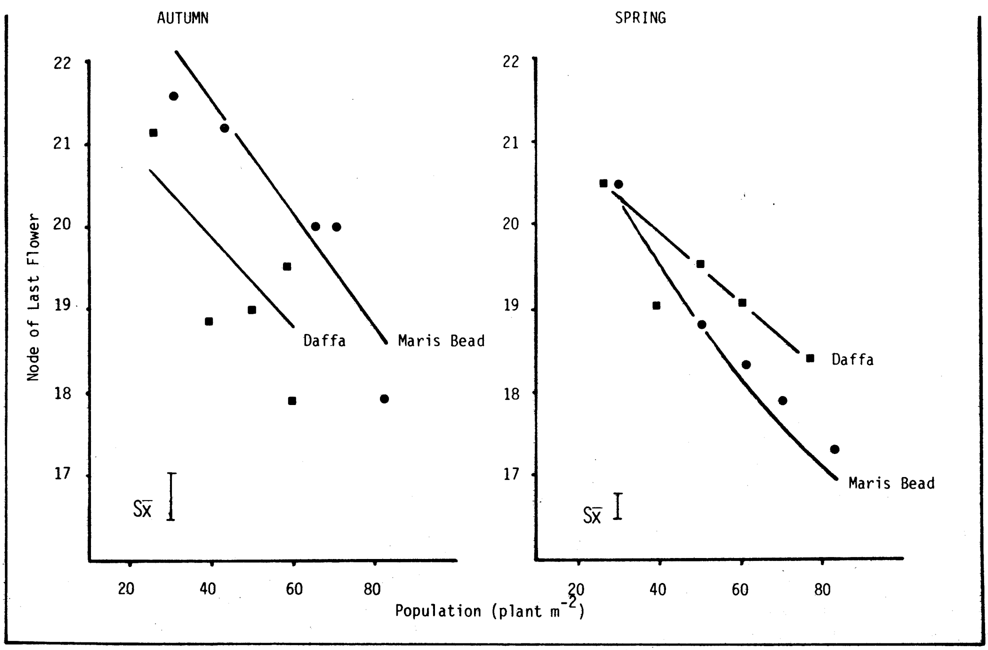

FIG 6: Effect of plant population and time of sowing on position of last flower in Daffa and Maris Bead.

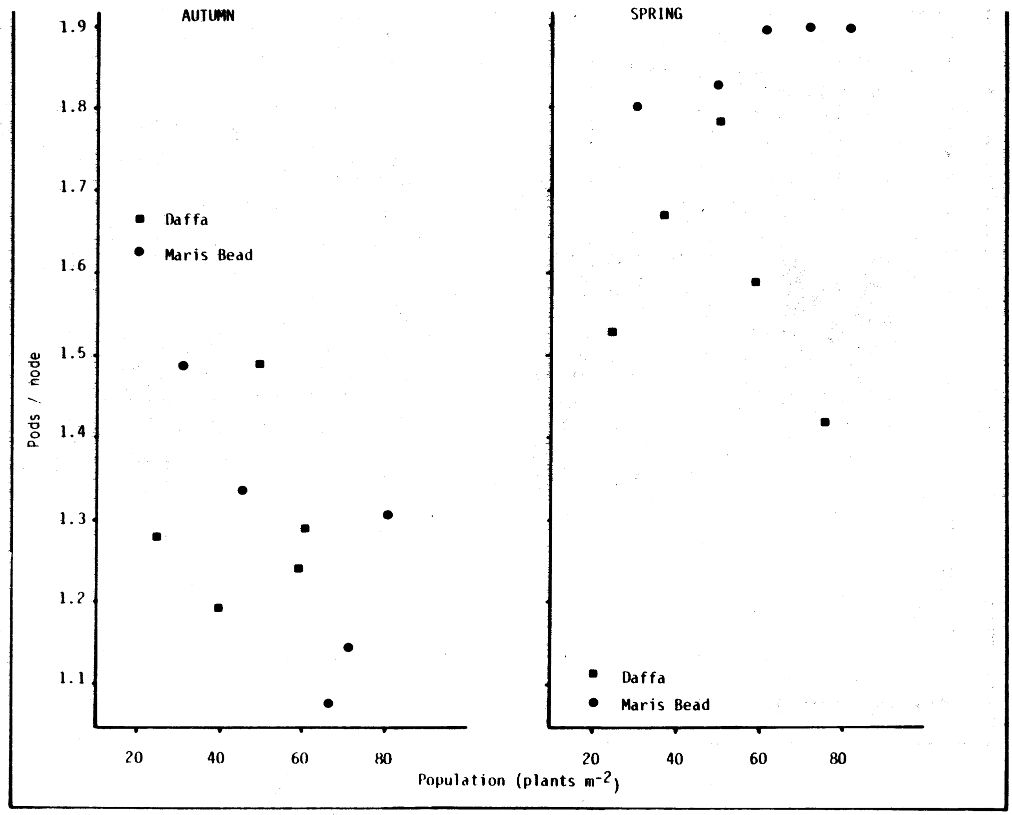

FIG 7: Effect of plant population and time of sowing on number of pods at each podded node in Daffa and Maris Bead.

There is no information on the pattern of movement of pollinators within the crop. Bond and Hawkins (1967) working with alternate rows of male fertile and male sterile field beans found that bees continued to pollinate the row of fertile flowers, rather than cross the space between rows. It is possible that the autumn-sown beans, which were taller than the spring sown beans, restricted movement of the bees. This effect would be more frequent at the higher densities, and may partially account for the marked density effect on the position of the first pod (Fig.4).

Density effects on the position of the last pod are also well characterised (Fig. 5). Spring sowing lowered the position of the last pod. It is interesting to note that in autumn, and similarly in spring sowings, both varieties produced their last pod at the same node (Fig. 8) irrespective of the number of pods carried by the plant. This may indicate that some environmental factor such as photoperiod, may limit the number of pods formed, or fertile pods carried to maturity.

Time of sowing had no effect upon the position of the last flower of Daffa, but Maris Bead produced its last flower at a lower node in spring (Fig. 7) but as it yielded more heavily in autumn sown beans, it is unlikely that this can be explained in terms of internal competition between flowers and developing pods.

Daffa had fewer pods/podded node in both autumn - and spring-sown beans. In spring both varieties podded over a smaller number of nodes, but partially compensated by carring more pods at each of these nodes (Fig. 8). This compensation within the plant may indicate, as Williams and Free 1975 suggested, that pod development is limited by availability of assimilates. Both Daffa and Maris Bead yielded poorly when spring-sown. The plants flowered over a small number of nodes, podded at fewer flowering nodes, and only partially compensated for this by the increased number of pods set at each node. The contribution of seed number/pod, and seed weight to final yield will be presented at a later date.

CONCLUSIONS

The grain yields obtained indicate that **Vicia faba L.** has the potential to yield well under Canterbury conditions. Work is continuing to determine the densities required to maximise grain yield, the varieties to be sown and the most suitable time of autumn sowing. The factors limiting yields of spring-sown beans are also under further investigation.

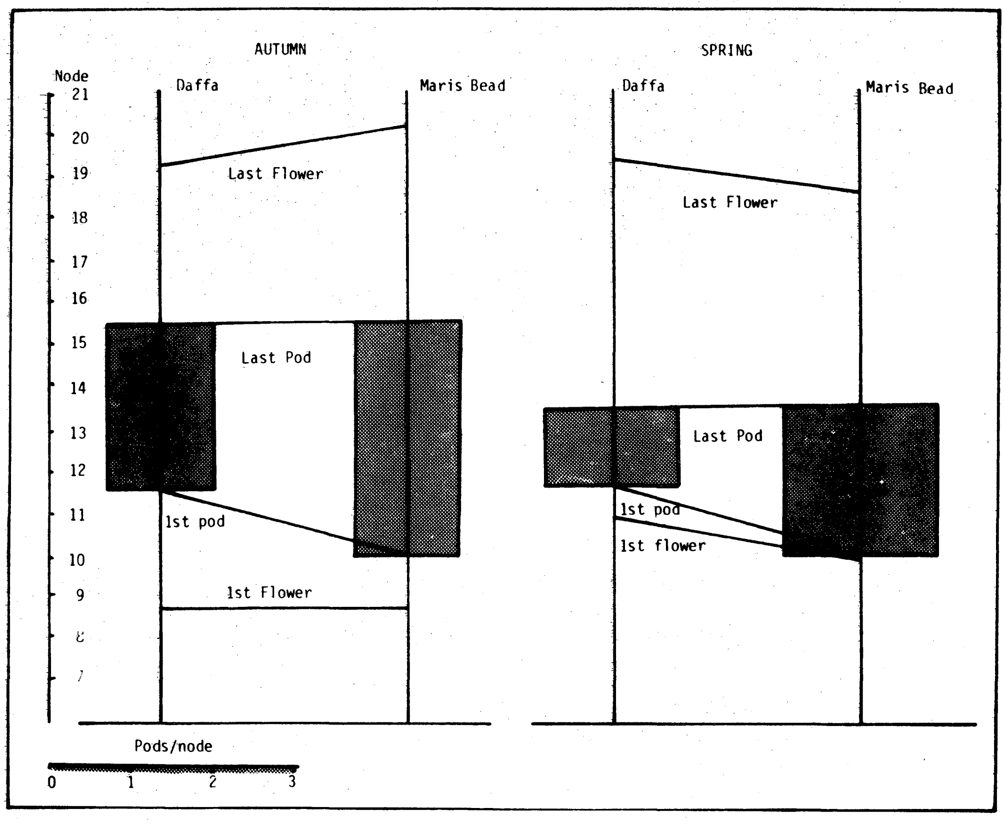

FIG. 8: A generalised view of the factors contributing to grain yield of Daffa and Maris Bead sown in autumn and spring.

ACKNOWLEDGEMENTS

Lincoln College Research Committee and the New Zealand Federation of University Women for funding, Dalgety (New Zealand) Ltd who supplied the seed, R.D. Close for aphid identifications and G.J. Meijer, A.V. Jones and the team for assistance in the field.

REFERENCES

Arie, R.H.D. 1959. Pythagoras and beans. Oxford Medical School Gazette **2:** 75 – 81.

Bond, D.A. and Hawkins R.P. 1967. Behaviur of bees visiting male sterile field beans (**Vicia faba L.**). Journal of Agricultural Science. **68:** 243 – 247.

F.A.O. Production Yearbook 1975.

Ishag, H.M. 1973. Physiology of seed yield in field beans I Yield and yield components. Journal of Agricultural Science. **80:** 181 – 189.

Williams, I.H. and Free J.B. 1975. The pollination and set of the early flowers of runner bean (**Phaseolus coccineus L.**) Journal of Horticultural Science. **50:** 405 – 413.