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EFFECT OF SEEDLING TRANSPLANTING AND SOWING DATE ON BOLTING, YIELD AND QUALITY OF SUGAR BEET

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The effect of transplanting and sowing date on bolting of sugar beet (cv. Amazon) was investigated from 1981 to 1983 at Lincoln College, Canterbury, New Zealand. In addition, the effect of bolters on the yield and quality was also examined. Evidence from these experiments indicated a higher bolting percentage from the mid-August sowing compared to mid-September or early October sowing. The extent of bolting also varied with different planting methods; the older the plants were at the time of planting, the higher was the percentage of bolters produced. The early bolters reduced the sugar yield by 23.6% compared with the normal plants. Conversely, the late bolters increased sugar yield by 20.4% compared with the normal plants.

INTRODUCTION

Sugar beet is a biennial crop. Temperature and day-length are known to play a major role in the bolting behaviour of sugar beet. Beet seedlings exposed to cold conditions will be vernalised, and will bolt. Therefore, crops sown earlier in the growing season are more at risk than those sown later (Jaggard *et al.*, 1983). Transplanted beet are especially at risk as increased plant size has been reported to influence the proportion of bolting (Smit, 1983).

The development of bolters is considered undesirable because they reduce the total sugar yield by reducing both the sugar content and the root yield (Nelson and Deming, 1952; Wood and Scott, 1975). Jaggard *et al.* (1983) reported a sugar loss at a rate of 0.7% for every 1% of bolters. In addition, bolters can cause difficulties in harvesting and processing because of the woody nature of roots. Bolters also produced viable seeds which can lead to weed beet infestation (Hornsey and Arnold, 1979). The objective of this study was to obtain information on bolting and yield resulting from transplanting and sowing date under New Zealand conditions.

MATERIALS AND METHODS

The experiments were conducted at the Lincoln College Research Area from 1981 to 1983 Full details of the experimental design, the treatments and the crop husbandry were given in Hussain (1990).

A plant was considered to be a bolter when the stem elongation was 5 cm or greater (Smit, 1983). Bolters were identified as suggested by Nelson and Deming (1952):

i) Normal plants: Plants not bolted
ii) Early bolters: Plants with

seed–stalks and seed production comparable to second year growth.

iii) Late bolters: Short leafy seed stalk with no flowers.

Plants in each plot were counted on 19 May in 1981/82 and on 15 April and 15 May in 1982/83. Plots of 4–leaf stage transplants sown in mid–August (1982/83) were harvested, to evaluate the effects of bolters on the yield and the quality. Samples of bolted (early or late) plants were collected from areas that had full stands (i.e. normally spaced plants) and were compared with the non–bolted plants, harvested on 16 May 1983. Each sample consisted of 6 plants and 10 plants from the respective population plots. Estimates of the fresh weight of roots sugar percentage and the total sugar yield were made similar as described previously (Hussain, 1990).

RESULTS AND DISCUSSION

In this study, there were three sowing dates, i.e. mid–August, mid–September (1982–83) and early October (1981/82). No bolting was found in the October sowing and was less than 1% in the mid–September sowing. This was due to relatively mild temperatures during these sowings (Table 1). Subsequently the temperature was increased during the growth and a higher temperature is known to favour vegetative development of the plants, thus suppressing the bolting tendency which may have been acquired (Wood and Scott, 1975). The long term average temperatures at Lincoln during September and October were 9.4°C and 11.7°C, respectively (Table 1). These temperatures were above those normally reported for effective vernalisation (Smit, 1983). A long period of vernalisation is, therefore, unlikely to occur when sugar beet is sown in the Canterbury region in September.

Significant differences were found in the percentage of bolted plants between the planting methods (Table 2) when the sowing date

Table 1. Mean monthly air temperatures during 1981 and 1982

Year	Month	Temperature (°C)	
1981			
	October	11.5	(11.7)*
	November	13.5	(13.6)
	December	17.1	(15.4)
1982			
	August	8.2	(6.7)
	September	8.6	(9.4)
	October	9.9	(11.7)
	November	15.0	(13.6)
	December	13.7	(15.4)

*Figures in parenthesis are long term means.

was advanced from mid-September to mid-August in the 1982/83 season. A direct relationship between the bolting percentage and the number of cool days (temperature < 12°C) after sowing has been reported by both Jaggard *et al.* (1983) and Smit (1983). Similar effects of sowing dates on bolting percentage were reported by others (Wood and Scott, 1975; Jaggard *et al.*, 1983).

The results showed that the extent of bolting varied with different planting methods (Table 2). The transplanted beet, especially at the 4–leaf stage, bolted significantly more than the seed–sown beet, i.e. 7.8% and 1.8% respectively at the final count. The effect of low temperature was probably more apparent on older plants, in bringing about bolting. Both Lasa (1977) and Smit (1983) have reported a higher receptivity of older plants.

The early bolters decreased sugar yield by 23.6% compared with the normal plants. This may be due to reductions in both the root weight and the sugar percentage (Table 3). In contrast, the late bolters increas-

Table 2. Effect of planting method on bolting percentage

Planting Method	Bolting (%)	
	15 April	15 May
Seed–sown	0.9	1.8
2–leaf	1.3	2.6
4–leaf	5.2	7.8
Mean	2.4	4.1
LSD 5%	0.93**	0.78**

** = Significant at P = 0.01

Table 3. Effect of bolters on root fresh weight, sugar percentage and sugar yield

Bolters	Roor fresh weight (g plant $^{-1}$)	Sugar percentage	Sugar Yield (g plant $^{-1}$)
Normal plants	1225	16.32	199
Early bolter	1033	14.79	152
Late bolter	1710	14.56	250
Mean	1323	15.22	200
LSD 5%	237**	0.91**	36**

** = Significant at P = 0.01

ed sugar yield by 20.4% compared with the normal plants. This increase in the sugar yield appeared to be due to greater root fresh weight in the former than in the latter (Table 3). Similar effects of bolters (early or late) on sugar yield have been reported by others (Nelson and Deming, 1952; Smit, 1983). It is notable that the higher sugar yield (22.8%) was produced by the 4–leaf stage transplants which bolted significantly more than the seed–sown beet (Table 2). The reduction in sugar yield by the early bolters was 23.6% which is similar to the increase in yield achieved in non–bolting populations. This suggests that an increase in early bolters associated with delaying harvest date will reduce the sugar yield almost proportionately. However, the results (Table 2) have indicated that when bolting was not profuse (< 5%), early sown crops (transplanted or seed–sown) may not necessarily have reduced final yield. Rather it may increase the sugar yield due to greater root fresh weight of the late bolters (Smit, 1983). Results showed that later bolters increased sugar yield over the control by 20.4%, which might have counterbalanced the loss in yield by the early bolters. Therefore, it can be concluded that the highest yields will be produced when transplanting is carried out during early September, the optimum sowing date for seed– sown beet in Canterbury.

In conclusion, the study indicated higher bolting percentage in the August sowing compared with September or October sowing. The transplanted beet, especially the 4–leaf stage, was at greater risk than the seed–sown beet. However, the proportion of bolting was not profuse enough to affect the sugar yield adversely. It is, therefore, suggested that sugar beet, irrespective of planting method, can be sown safely from the beginning of September.

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