THE EFFECT OF WEED INTERFERENCE ON FODDER BEET YIELD

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SUMMARY

The influence of weeds on the final yield of fodder beet (*Beta vulgaris* cv. Trestel) was determined by allowing the natural weed population to interfere with the crop for specific periods, by a series of delayed or prolonged hand-weeding treatments. It was necessary for the initial 8 to 10 week period after crop sowing to be weed-free for maintenance of the maximum yield of beet roots. Weed invasion after this initial period was minimal and did not significantly reduce final yield.

INTRODUCTION

The current research on the agronomy of fodder and sugar beets is aimed at assessing their potential for producing sugar for fermentation to ethanol, which would be used as a liquid fuel extender (Kardos and Mulcock 1977). The concept of an energy crop implies highly efficient production and reference to the substantial overseas literature on beet production suggests that the control of weeds is a critical factor in producing high-yielding crops (Scott *et al* 1979).

The typically slow establishment of beet plants which are traditionally grown in wide rows of 50 cm or more, provides opportunity for weed invasion during early crop establishment (Martin 1981). Thus, in this study, particular attention has been focused on the influence of weeds during the early stages of crop development. The typically dry climate of Canterbury and the major differences in arable farm operations between New Zealand and other countries suggested that an investigation of the effects of natural weed interference on fodder beet growth would be useful. The determination of a critical period for weed interference would assist in determining the most effective use of herbicides, which are undoubtedly a large proportion of the total crop production costs.

METHOD

The trial was carried out at the Research Farm at Lincoln College on a Wakanui silt loam of pH 5.6 - 5.8. The experimental site which had been in pasture from 1975 was cultivated in June 1980 and 4 t/ha lime plus fertilizer (50, 20 and 72 kg of N, P, K/ha respectively) were applied in September 1980. Fodder beet was sown in 50 cm rows on 25 November 1980, and a uniform population of 240,000 plants/ha was established. Trial plots measured 10 x 2 m and were arranged in a completely randomised block design with four replicates. The treatments involved the weekly weeding of plots by shallow hand-hoeing, which was carried out with a minimum of crop and soil disturbance. The prolonged and delayed hand-weeding treatments were imposed directly after sowing and involved allowing or preventing weed interference for 6, 8, 10, 12 or 14 weeks, in addition to controlling or not controlling weeds for the total period of beet growth (see Fig. 2). The beet established to the 4 - 6 leaves stage by four weeks after sowing. The final harvest taken on 25 June 1981 was 30 weeks after sowing.

Plot sampling involved the removal of a 1 m² sample which was sorted into weeds and beet for measurements of plant populations and dry matter determinations. The beet plants were separated into two fractions: the root (root + hypocotyl) and shoot (leaf lamina + petiole). Leaf area determinations were carried out on the lamina fraction and all plant samples were dried to constant weight at 80°C.

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Treatment means were compared using Duncan's New Multiple Range Test ($P = 0.05$) and by calculation of standard errors of the means.

RESULTS AND DISCUSSION

The above average rainfall in November 1980 and use of strategic irrigations in early 1981 resulted in good beet establishment, with a dense and evenly distributed weed population. The weed biomass increased during the 16 weeks after sowing in non-weeded plots, but was substantially reduced at the time of the final harvest, taken on 25 June 1981 (Fig. 1). The previous history of the experimental area no doubt contributed to the dominance of white clover (*Trifolium repens*) and ryegrass (*Lolium* spp.) as the major weed species present; although there were significant numbers of scarlet pimpernell (*Anagallis arvensis*), storksbill (*Erodium cicutarium*) and spurrey (*Spergula arvensis*). The removal of weeds for increasing periods after sowing reduced the subsequent weed population and biomass considerably (Fig. 1). Thus the maintenance of weed-free areas for up to 8 weeks after sowing resulted in poor weed germination and biomass. The results for prolonged hand-weeding treatments greater than 8 weeks are not presented as all weed values were very low. The very effective crop development, with the attainment of a Leaf Area Index (LAI) of 3 by mid-February, and 5 by late March, no doubt contributed to effective weed suppression.

The reduced weed biomass at the time of the June harvest was associated with, first the suppressive effect of high crop LAI values on the weeds, which were predominantly of small stature or had a prostrate growth habit, and secondly the senescence and death of annual weeds by this time.

Fig. 1: The change in weed numbers and dry weight with time following prolonged weeding for 6 or 8 weeks, or no weeding.

Two harvests taken at 15 and 30 weeks after sowing revealed that the pattern of beet yield associated with the various weeding treatments was established by the earlier harvest, although only data for the final harvest are presented in this paper. Hand-weeding for a period 6 - 8 weeks after sowing controlled weeds effectively (Fig. 1) and only marginally reduced the final yield of roots and shoots (Fig. 2). The control of weeds for the initial 10 weeks after sowing, or for longer periods, did not significantly change final yield. Obviously, fast-growing weeds that established more rapidly than the beet were effective competitors at a crucial stage in crop development. In this trial, the successful removal of early competition resulted in the maintenance of high yields. It should be noted that in none of the prolonged weeding treatments was the weed biomass at final harvest large enough to seriously interfere with efficient harvesting.

When weeds were allowed to grow from the outset of the experiment they had a serious effect on beet yield (Fig. 2). Thus, while no significant reduction in beet yield occurred if weeds were allowed to compete for up to 8 weeks, there was a significant reduction in root and shoot yield when weeds were allowed to compete for longer periods. In this trial, weed control during the 8 week period following crop sowing was critical for the attainment of maximum beet yield (Fig. 2). The seasonal pattern of weed germination and growth was such that increasing the period of weed interference from 10 to 12 or 14 weeks did not further reduce beet yield, although there was evidence of a greater yield reduction when weeds were allowed to compete freely throughout the trial period.

All weed treatments affected the growth of beet roots and shoots equally, there being no major differences in root:shoot mass ratio at final harvest, despite some significant changes in total yield between treatments. The one possible exception was the treatment that involved no weed control until 6 weeks after sowing where the reduction in shoot growth was proportionately greater than the reduction in root growth giving a higher root:shoot mass ratio than for other treatments. Certainly, this appeared to be a critical treatment in relation to weed invasion as it was the only prolonged hand-weeding treatment where a significant weed biomass was established (Fig. 1). Thus, in some respects, this treatment behaved similarly to the delayed hand-weeding treatments, although the initial 6 week weed-free period obviously allowed for good initial crop establishment, which was reflected in the high final root yield (Fig. 2).

Fig. 2: The effect of prolonged or delayed weeding on the yield of fodder beet shoots and roots. Hatched area represents period of weed control.

One of the objectives of this experiment was to determine the timing of a critical period for weed control in fodder beet. The data presented in Fig. 2 do not reveal a precise critical period, although when weeds were allowed to compete freely with crop during the 10 week period following sowing, a yield reduction was obtained. Scott *et al* (1979) also demonstrated no critical period for weed control in sugar beet grown under dry weather conditions, with a single weeding, 2-8 weeks after crop emergence, preventing a yield reduction. However, beet is not a good competitor and weed interference for periods greater than 10 weeks did contribute to yield reductions. The reduced yields in this experiment were associated with changes in per plant weight as none of the weed treatments significantly affected beet establishment and subsequent plant populations.

In prolonged hand-weeding treatments, or where weeds were not controlled, there was a slight reduction ($< 5\%$) in plant populations by the time of the final harvest. In the former case, damage associated with hand-weeding may have been a problem while physical interference by weeds may have accounted for the slightly reduced population in the latter treatment.

The low growth stature of the majority of weeds in this experiment no doubt contributed to the relatively small effects of the natural weed population on root yield, with a 51% yield reduction being the greatest. This is in contrast to the work of Dawson (1965) who demonstrated a 94% reduction in sugar beet yield when in competition with uncontrolled fathen.

CONCLUSION

The results of this experiment did not reveal a short, critical period when the control of weed competition was necessary for high beet yield. However, beet was susceptible to early weed competition and the uncontrolled growth of weeds during the first 8-10 weeks following sowing markedly reduced the final yield of roots. The delayed weeding treatments, when weeds were allowed to commence growth 8 weeks or later after sowing the crop they had no effect on yield.

ACKNOWLEDGEMENTS

The authors wish to thank the Liquid Fuels Trust Board for financial assistance.

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