A BLUEPRINT FOR HIGH SUGAR BEET YIELDS IN CANTERBURY

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ABSTRACT

High sugar beet yields are obtainable on most cropping soils in Canterbury. To achieve high yields, crops should be planted in September into a firm, but uncompacted, seedbed. If required, lime, phosphate and sodium should be applied before ploughing and nitrogen after establishment. High yielding northern European cultivars should be precision drilled to establish 70,000 to 100,000 plants/ha. Weeds can greatly reduce yields and both pre and post-emergence herbicide applications are required. Insecticide applications to control aphids will be necessary in most seasons to reduce virus attack. Irrigation will also be necessary in most seasons. Crop rotation will minimise the build up of pests, diseases and weeds.

Additional Keywords: *sowing date, fertiliser, cultivar, plant density, herbicides, rotation, virus, irrigation*

INTRODUCTION

There has been sporadic interest in sugar beet for a sugar industry in New Zealand for over a century and numerous trials have been carried out in the past to examine the yield potential and husbandry requirements of the crop (Greenwood, 1980; Drewitt, 1976).

However, the advocation of a large scale beet ethanol industry in Canterbury to produce liquid transport fuel (NZERDC, 1979) not only aroused considerable public interest but also disclosed major deficiences in our knowledge of beet yield potentials, possible husbandry problems and suitable growing techniques. Accordingly, due to the apparent imminence of such an industry, a comprehensive beet research programme was established in Canterbury to try to overcome these deficiencies.

As a result of this programme, we are now able to produce a number of recommendations to enable the Canterbury farmer to obtain high beet yields. These recommendations will also enable more realistic costings to be made should a beet industry be considered again in the future.

SOILS

High yields of beet have been obtained on both shallow and deep soils when soil moisture has not limited growth (Farrow, 1982; Martin and Drewitt, 1983). However, particularly on lighter soils, irrigation will be needed for high yields (Drewitt, 1976) but this may result in increased leaching of nitrogen through the profile necessitating adjustments to fertiliser rates and application times. Soils which restrict the root development of beet will probably have a reduced potential yield (Webster *et al.*, 1977). Stony soils can cause problems for drilling and harvesting equipment (Farrow, 1982).

SOWING DATE

For high yields, sugar beet needs a long growing season. Combining the results from a series of trials at Templeton and Winchmore, Martin and Drewitt (1983) found that the percentage sugar yield loss from delayed sowing increased from 0.3%/day in late August and early September to 0.8% by early December. For a crop expected to yield 10 t/ha sugar sown in late August, this represents an initial yield loss of 0.2 t sugar/ha for each week delay in sowing. If sown in late November, the same crop will yield less than 5 t/ha sugar and there will be a yield loss of 0.6 t sugar/ha/week delay in sowing.

This yield loss was not made up by delaying harvesting of late sowings. Weekly yield increases due to delayed harvesting after late March were considerably lower than the yield lost by delayed sowing (Martin and Drewitt, 1983). Therefore, to set the foundations for a high yielding crop, it is necessary to drill the crop before the end of September.

However, sowing before September may reduce establishment under cold conditions and also late frost may vernalise the seedlings, causing them to go to seed.

CULTIVATION

Sugar beet needs a firm seedbed that will conserve moisture but which is not too fine to lead to capping or wind blow or which has not been compacted by excessive driving on the paddocks. Establishment problems have occurred in a number of our trials due to seedbeds being too coarse, too dry or too compacted. Therefore, in Canterbury, to get the desired seedbed by September, the land will probably have to be ploughed and levelled in autumn or early winter and allowed to weather over the winter so that the minimum of cultivations are required in the spring.

FERTILISERS

Beet does not establish well in acid soil conditions. Soil with a pH below around 5.5-6.0 should be limed twelve months prior to drilling the beet in order to allow maximum amelioration of acid conditions.

TABLE 1: Root fresh weights and treatment costs from combinations of pre and post emergence herbicides. Data are averages over 6 trials. All rates are expressed as kg ai/ha.

	Untreated	Post Emergence Phenmedipham/ Desmedipham (1.0 kg/ha)	P/D (1.0 kg/ha) + Ethofumesate (1.0 kg/ha)	Metamitron (4.2 kg/ha)	Metamitron (4.2 kg/ha) + Ethofumesate (1.0 kg/ha)
Pre Emergence			Mean root fresh weight (t/ha)		
Untreated	26.0	58.1	64.5	50.9	61.3
Propham/Chlorpropham /Fenuron (2.2 kg/ha)	38.9	63.5	68.9	61.6	66.8
Lenacil (2.0 kg/ha)	49.3	68.2	67.5	64.9	66.4
Chloridazon (4.2 kg/ha)	34.9	65.1	67.6	63.4	67.8
			Treatment cost ($)		
Untreated	0	128	228	250	349
PCF	83	211	311	333	432
Lenacil	89	217	317	339	438
Chloridazon	180	308	408	430	529

The most common nutrient deficiencies limiting beet yields in Canterbury arable soils are nitrogen, phosphorus and sodium (Stephen *et al.*; 1980). Where soil analysis indicates that applications of these nutrients are required, no less than 70 kg/ha nitrogen, 15 kg/ha phosphorus and 75 kg/ha sodium should be applied. The phosphorus and sodium fertilisers should be worked into the seedbed before drilling, preferably before ploughing, to avoid soil compaction. The nitrogen should be applied between the crop rows after the crop has established.

SOWING RATES AND METHODS

Planting monogerm seed at an even spacing using a precision drill, thereby eliminating thinning and singling, has produced very high yielding crops in Canterbury (Farrow, 1982; Martin and Drewitt, 1983). An established plant population of around 70,000-100,000 plants/ha appears adequate (Amin, 1982), with rows up to 50 cm apart and plants 15-20 cm apart in the row. Good establishment is important as uneven and irregular stands, even at high populations, can reduce yields by 20% or more (Scott and Jaggard, 1980). Guides for farmers overseas (e.g. SBREC, 1980) stress thorough drill maintenance and correct drilling techniques to ensure good establishment.

CULTIVARS

There is little difference in sugar yield between high yielding sugar beet and fodder beet (Martin, 1980). Therefore, because of its higher sugar content and hence lower harvesting and transport costs per tonne of sugar, sugar beet would be the preferred beet to grow. Of the cultivars examined, sugar beets on the United Kingdom recommended list (Kimber, 1980) or equivalent high yielding cultivars from other northern European countries have given the highest sugar yields (Martin, 1983).

WEED CONTROL

The two to three months taken by beet to form a closed leaf canopy enables rapidly growing weeds to 'swamp' the crop if control measures are not taken. Root yield losses in herbicide trial control plots ranged from 13% at a 'lightly' infested site to 97% at a site heavily infested with *Capsella bursa-pastoris* (shepherds purse), *Polygonum aviculare* (wireweed) and *Viola arvense* (field pansy).

A series of herbicide trials has shown that post-emergence herbicides are necessary for high beet yields (Table 1). For maximum yields, pre-emergence herbicides are also required to keep weeds in check until the post-emergence herbicides can be applied safely. All pre and post-emergence herbicide sequences gave rather similar yields, indicating that they all gave adequate control of annual dicotyledonous weeds but the treatment costs varied substantially (Table 1). Greatest net return increases were obtained from lenacil pre-emergence, phenmedipham/desmedipham post-emergence or the propham/chloropham/fenuron pre-emergence, phenmedipham/desmedipham + ethofumesate post-emergence sequences. Either of these can be recommended as a basic weed control programme for Canterbury provided that the label rates and times of application are strictly adhered to. Lenacil, however, may cause some thinning on 'light' soils and may fail to control weeds if the seedbed is dry.

Perennial and other problem weeds will require additional herbicide treatments. Limited Canterbury trials have shown good control of *Agropyron repens* (couch) by fluazifop butyl, *Avena fatua* (wild oat) by alloxydim sodium and *Cirsium arvense* (Californian thistle) by lontrel.

Inter-row cultivations in addition to the herbicide programme are unlikely to increase profitability, unless the pre-emergence herbicide fails. Band spraying on the rows with inter-row cultivation may reduce costs but has not been evaluated in these trials.

PEST RELATED PROBLEMS

There has been some localised damage to emerging beet plants from insects and birds. However, by far the major insect related problem in Canterbury beet trials has been the aphid transmitted virus disease beet western yellows (Kyriakou *et al.,* 1983) and beet mosaic virus (Hills, 1983). Beet western yellows is the more serious and has caused reductions in root fresh weights of up to 33% (Goldson and Pearson, 1982). This virus is found in many common weed and crop species such as shepherds purse, chickweed, speedwell, docks, turnips and rape and it is transmitted by the green peach aphid *Myzus persicae* (Sulzer).

Numbers of aphids, mainly *M. persicae,* varies greatly between years but their occurence is always restricted to between early October and late December. However, strategic monthly spraying with synthetic pyrethroid insecticides during this period has controlled aphids as effectively as more intensive spray regimes based on overseas recommendations (Goldson and Pearson, 1982). The use of an effective systemic insecticide such as aldicarb at drilling (F.J. Hills pers. comm.) combined with monthly spraying with synthetic pyrethroids (e.g. fenvalerate) would cost around $250. Yield increases at Templeton from insecticide treatments in beet crops for 3 of the past 4 years have exceeded 15% so that, in most years, aphid control should be economic.

DISEASES

Two disease problems have been experienced in our trials. Firstly, "damping off" fungal diseases of seedlings have reduced plant populations. These fungi have usually attacked seedlings weakened by soil acidity or herbicide damage.

Secondly, violet root rot (*Helicobasidium purpureum* Pat.) has badly affected some beet trials at Templeton (Martin, 1983). This disease depresses root sugar content and greatly reduces the storage life of beet. It is controlled by avoiding growing beet on land infested with perennial weeds or by adequate weed control in previous crops and suitable cultivation techniques (Hull, 1960).

IRRIGATION

Irrigation will be necessary in most years for high beet yields in Canterbury. Irrigation responses of up to 161% have been obtained on light soils (Drewitt, 1976). In the dry 1980-81 and 81-82 season, unirrigated crops in Canterbury yielded poorly (e.g. Martin *et al.,* 1982b; Farrow, 1982). Under dry conditions, early irrigation ensures satisfactory performance of pre-emergence herbicides. Beet is most susceptible to drought at establishment and a dry seed bed can lead to erratic and delayed establishment (Martin *et al.,* 1982b). Tolerance to drought increases through the season. Irrigation during dry spells in spring and summer promotes rapid growth and sugar accumulation. Irrigation in autumn has little effect on sugar yield and overwatering at this time has aided the spread of violet root rot (Martin, 1983).

ROTATIONS

Overseas, sugar beet is grown in a 1 in 3 years or longer rotation to control beet cyst nematode. Although this nematode has not been found in Canterbury, such a rotation is still recommended to prevent a build up of virus-carrying aphids in crop residues (Hills, 1983), diseases such as violet root rot (Hull, 1960) and problem weeds, including weed beet (SBREC, 1980).

Beet should not follow crops leaving a legacy of weed control problems such as run-out lucerne (Martin *et al.,* 1982b), potatoes or brassicas, nor one where herbicide residues, e.g. atrazine, damage the beet (SBREC, 1980).

YIELD POTENTIAL

New Zealand, with it mild temperatures and relatively high solar radiation, should be capable of producing high yields of sugar (Martin *et al.,* 1982a).

Highest yields of sugar in Canterbury from small scale hand harvested plot trials have been 110 t/ha of topped roots with a sugar percentage of 17.8% giving 19.6 t/ha of total sugar (19.1 t/ha sucrose) (Martin *et al.,* 1982a). Large scale machine harvested field trials have yielded over 98 t/ha with over 17% sugar (Farrow, 1982) giving over 16.5 t/ha of sugar.

The recommendations we have given in this paper should enable farmers to grow crops which will yield well over the 7-8 t/ha suggested as the potential average yields for sugar beet in Canterbury (Farrow, 1982).

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