AN EVALUATION OF THE REQUIREMENTS OF DIRECT SEEDED MAIZE IN THE WAIKATO

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ABSTRACT

Direct seeded maize yielded significantly less grain than maize sown following cultivation in 3 out of 5 years of continuous production. Using cultivation yields of up to 10380 kg/ha were obtained. In two further trials, direct seeded maize yielded 9600 and 10500 kg/ha.

A low population of established plants was the major reason for low yield in direct seeded maize and reflected the inadequacy of the machinery avaiable to seed maize into uncultivated ground. With direct seeding there was also an increased incidence of Argentine Stem Weevil damage. The common failing in the equipment used for direct seeding was an inability to provide a slot of adequate and constant depth and width to accomodate the following seeder units.

On winter grass and paspalum free pasture 0.56 kg a.i./ha and 1.12 kg a.i./ha paraquat respectively gave complete kill of the sward prior to sowing. In year 1 no further weed control was necessary but in subsequent years the additional use of herbicides for the control of broad leaved weeds and summer germinating grasses was necessary.

Less nitrogen was avaiable from the soil for crop growth where the ground was not cultivated. It was concluded however, that with the addition of 25-30 kg/ha nitrogen over and above the requirement for maize in cultivated soil, an equal yield could be obtained using direct seeding provided an equal plant population could be established.

INTRODUCTION

The system of establishing maize by seeding directly into a chemically killed sod or crop residue has distinct advantages for management over the conventional method of establishment involving ploughing, seedbed preparation and sowing. The total ground preparation can be reduced to a single spraying some four days before planting. Where maize is produced as a summer forage crop within an existing pasture system or where grain or silage is produced in conjunction with Winter grass the time saved by direct seeding allows for further grazing before crop establishment.

Direct seeding lends a greater flexibility to the timing of maize establishment. Because the ground is undisturbed prior to drilling, seeding can be carried out when ground conditions would otherwise prevent seedbed preparation or sowing.

Reduction in the cost of production of maize should be possible with direct seeding. The need to hire or own and operate cultivation equipment is eliminated. Weed control could be less costly because with only the minimum of soil disturbance the prolific germination of weeds, normally associated with full cultivation, should be restricted to a band along the line of seeding.

Studies in the U.S.A. (Blevins *et al.*, Jones *et al.*, 1968, 1969, Moody 1961. Triplett *et al.*, 1968, Shear & Moschler 1969) have shown that maize sown in uncultivated ground can produce equal or greater yields of silage and grain than maize sown following cultivation. Increased yields are considered to result from improved soil moisture storage in uncultivated ground (Blevins *et al.*, 1971, Jones *et al.*, 1968, 1969, Moody 1961, Shear & Moschler 1969) which permits the crop to withstand better periods of rainfall.

The extent of the previous crop residue is important in this respect (Jones *et al.*, 1969, Shear & Moschler 1969) as the surface mulch formed increases water infiltration and reduces evaporation. Because surface run-off is reduced the direct seeding system affords protection from soil erosion on sloping ground.

The success of direct seeding for maizeproduction has arisen from the development of satisfactory herbicides and of seeding equipment capable of planting in uncultivated ground.

The present investigation was set up to evaluate the use of direct seeding for maize production in the Waikato and to examine the technical problems involved.

EXPERIMENTAL

Three trials were conducted in the period 1967-1971.

1. A comparison, over 5 years, of maize grown in cultivated and uncultivated ground on Horotiu Sandy Loam at Rukuhia. Prior to the trial the area had been cropped for 3 years and was in maize and Winter grass in the preceding year.

Maize followed by Winter grass was grown in cultivated and uncultivated ground either continuously for 5 years or in a 2 year rotation with pasture. The 4 main treatment plots were 7.3 x 22 m and replicated 4 times. Rates of nitrogen were applied to sub plots 0, 103, 206 and 309 kg/ha for both maize and grass. Nitrolime (1967, 1968) and Urea (1969-1971) were applied 1/3rd at sowing and 2/3rd when the maize was 60cm high. Adequate levels of soil P and K were maintained by broadcast application prior to cropping as determined by soil test.

Cultivated plots were sprayed with paraquat (0.56 kg ai/ha) 4 weeks prior to sowing and ploughed. Maize, cultivar W575 (1967, 1968) and cultivar PX610(1969, 1970) was sown about November 1, in 76 cm rows. 2-4D amine at 1.12 kg ai/ha (1967), atrazine at 4.8 kg ai/ha (1968) and atrazine at 2.24 kg ai/ha plus prochlor at 3.4 kg ai/ha (1969-1971) were applied for weed control.

Total dry matter yield and grain yield were determined from 6.1 m of rows at the ensilage stage. The maize crop was removed and the following Winter grass grazed with sheep.

2. A direct seeded trial on permanent pasture on Ohaupo Silt Loam at Te Awamutu in 1970. Paraquat alone(1.12 kg ai/ha) or paraquat plus atrazine (2.24 kg ai/ha) was applied to the closely grazed pasture 4 days prior to drilling. Maize, cultivar W575, was established at two populations (low and high) and in two row spacings.(33 and 66 cm). The 8 treatments had a plot size of 3 x 24 m and were replicated 4 times.

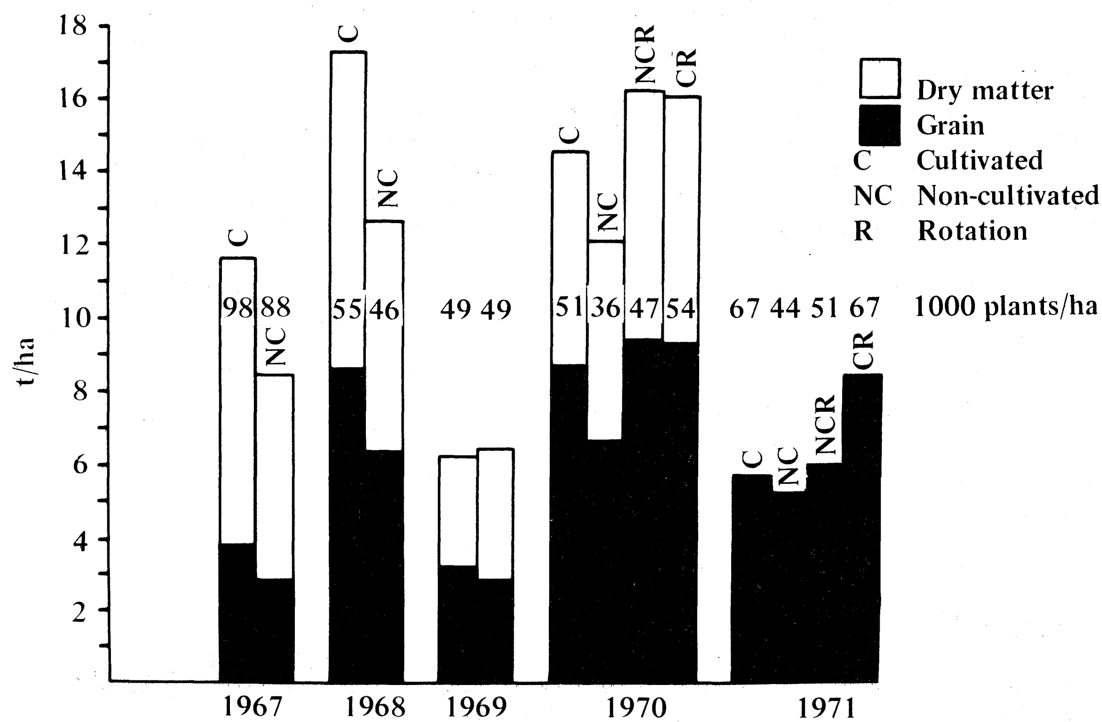
Maize was sown with 100 kg/ha of side banded 10-18-8 fertiliser and 2.24 kg ai/ha ethyl parathion in 2nd week November using a modified John Deere, plateless, precision seeder. Total fresh weight yield was determined on February 11 from 2.33 m^2 and grain yield at harvest from 14 m^2.

3. A direct seeded trial comparing grain yield response to rates of nitrogen application. The trial was conducted at the same site and with the same general procedure as trial 2. Nitrolime was broadcast at sowing at rates of 0. 30. 60 and 120 kg N/ha and broadcast at sowing at 60 kg N/ha with side dressings of 60 and 120 kg N/ha applied on December 9.

RESULTS AND DISCUSSION

Direct seeded maize, under continuous production, yielded less total dry matter and grain than maize sown in cultivated ground in all 5 years of production and significantly less in three out of the five years. (Fig. 1). The lower yield was associated in four out of the five years with a lower population of established plants.

Figure 1: Yield grain and dry matter with and without cultivation over 5 years.



Visually, direct seeded maize was equal in vigour to maize sown in cultivated ground and it was considered that the difference in plant population was the major reason for the difference in yield. Averaged over the five years, grain yield from the direct seeded maize was 24% less while plant population was 22% less. An adjustment of yields, using regression analysis, indicated that with equal plant populations similar grain yields would have been obtained. However, little weight could be given to the result of the analysis, because, though there was a good correlation between yield and plant population the extent of extrapolation necessary to determine yields at equal plant populations was too great.

In the one year (1969) when equal plant populations were established, the Summer was extremely dry and yields of both dry matter and grain were low. Direct seeded maize did not have the advantage over maize in cultivated ground that might have been expected from the U.S.A. work.

The rotation of maize with pasture had a marked effect on the performance of direct seeded maize. In the year following pasture (1970) the yields of dry matter and grain were equal to those obtained from maize in cultivated ground. While the general effect of the pasture break was to restore soil nitrogen fertility, for direct seeded maize it led also to a rise in the population of plants established. The higher plant population was the direct result of improved ground penetration during drilling. The increase in yield obtained in direct seeded maize from the pasture break can be accounted for largely on the basis of increased plant population.

In the direct seeded trial on Ohaupo Silt Loam grain yields averaged 9420 and 9600 kg/ha. Grain yields equalled that produced in the adjacent paddock in cultivated ground. It is significant that in each trial the plant population was high, 78.5 thousand plants/ha and that the trials were sown into pasture.

Sward control and crop weed control

In trial 1, 0.56 kg ai/ha paraquat sprayed onto the closely grazed grass or grass-clover sward gave a complete kill. Separate treatment of perennial weeds, Dock (*R. obtusifolius*) and thistle (*C. arvense*) was necessary in two out of the five years of continuous, direct seeded, maize. After permanent pasture paraquat at 1.12 kg ai/ha gave a complete kill except where Paspalum (*P. dilatatum*) was present.

Further weed control in the maize crop following permanent pasture appeared to be unnecessary (Table 1). However, in the continuous production trial, probably because of the previous history of cropping, broad leafed weed control was necessary in the first year. In subsequent years spraying was required to control both broad leafed weeds and Summer germinating grasses (*D. sanguinalis* and *Panicum spp.*)

TABLE 1: Fresh weight and grain yield t/ha in relation to herbicides used, row spacing and plant population.

	Herbicide		Row		Population	
Yield	Par	Par+Atr.	38cm	76cm	Low	High
F.W. crop	67.2A	71.2A	74.3A P	64.3B Q	66.2A	72.3A
Grain	9.56A	9.63A	9.62A	9.58A	9.45A	9.74A

Crop establishment

The failure to establish plant stands in uncultivated ground equal to those established in cultivated ground was mainly due to inadequacies in the seeding equipment used and to a lesser extent to increased soil insect damage.

1. Seeding equipment

In the first three years of the five year trial a Duncan combine drill, equipped with cutting disc mounted in front of narrow seed coulters, was used for drilling (Fig 2). The drill was unsatisfactory for the following reasons:

a) A constant depth of sowing could not be maintained in uncultivated ground and seed was frequently sown on the surface.

b) No control over seed spacing was possible.

c) Inadequate cover of the seed was obtained in the slot torn out by the rigid seed coulter.

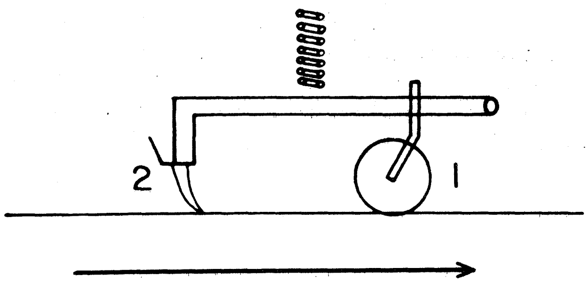
d) No provision could be made for side banding fertiliser or the application of granular insecticides with the seed.

In the subsequent years a John Deere precision maize seeder was used. The seeder which had double disc openers for both seed and fertiliser, was adapted for direct sedding by the addition of 40 cm diameter, spring loaded, wavy edged, cutting discs mounted in front of the fertiliser and seed units and independently of them (Fig 2). So adapted, the drill cut a clean slot and gave good ground penetration, particularly in pasture, with individual units closely following the contour ot the ground. Seed was well covered in the slot cut by soil loosened from the slot sides by the action of the disc coulters. A mechanical problem of maintaining alignment between the cutting discs and the seed units was not fully overcome.

2. Insect damage

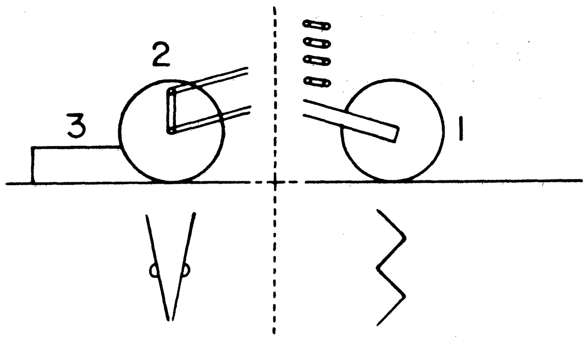
Argentine Stem Weevil was a problem in both cultivated and uncultivated ground in the five year trial because of the grass grown each Winter between maize crops. More damage occurred in the direct seed maize because of the lack of soil disturbance.

Figure 2 : Diagramatic outline of direct drilling equipment



1 Cutting disc

2 Seed and fertilizer coulter



1 Cutting disc

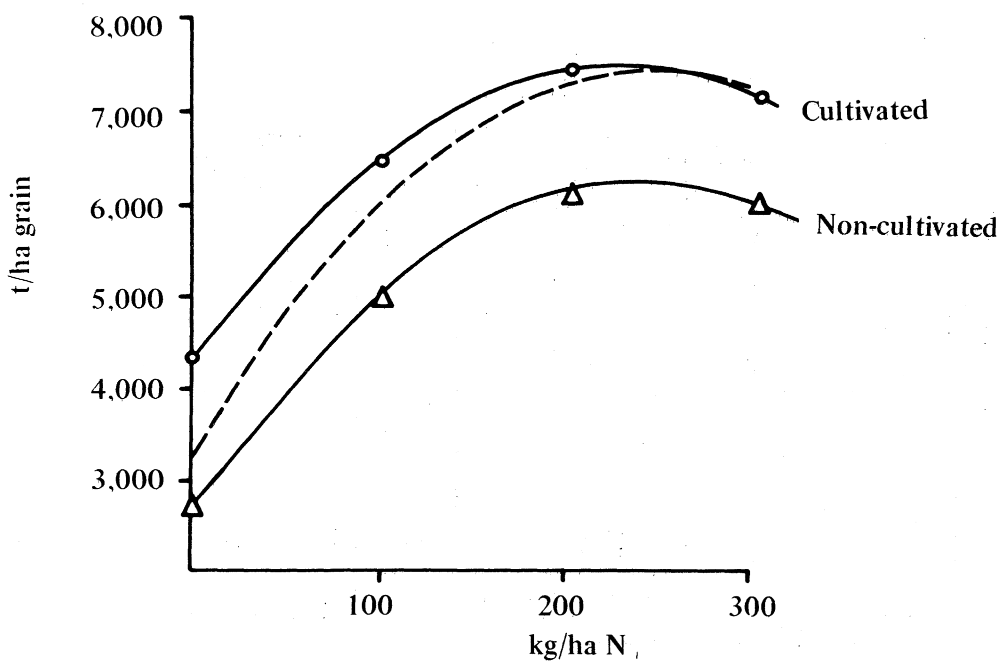
2 Double disc openers (seed)

3 Seed boot

Nitrogen response

In each of the five years of the continuous maize production the maximum yield of grain from direct seeded maize was obtained with 150-200 kg/ha of applied nitrogen. Similar rates of nitrogen were required for maximum yields of grain from maize is cultivated ground but maximum yields of grain were higher (Fig 3).

Figure 3: Grain yield in response to nitrogen



Whether a higher application of nitrogen is required on uncultivated soil to achieve an equal grain yield was difficult to assess because of the difference in the plant population. If the grain yields of direct seeded maize are corrected on a pro rata for population the pattern of response to nitrogen suggests that less nitrogen is avaiable from uncultivated soil and that a higher rate of nitrogen would be required to achieve equal yield (Fig. 3 broken line). The corrected pattern of response was to some extent confirmed when yields fo the two treatments were corrected to a median plant population using regression analysis. (Fig. 4). However the extrapolation was not particularly reliable.

Figure 4: Grain yield in response to nitrogen

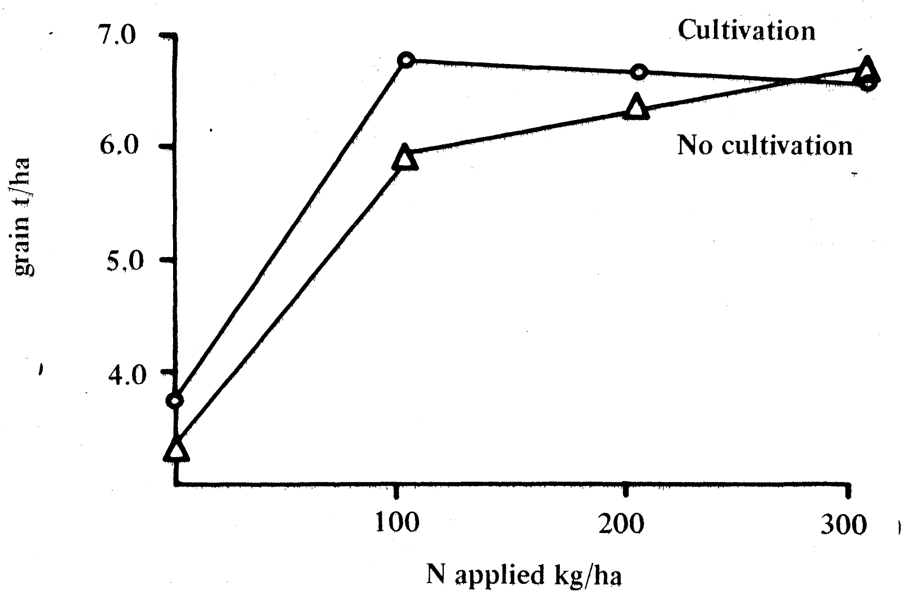
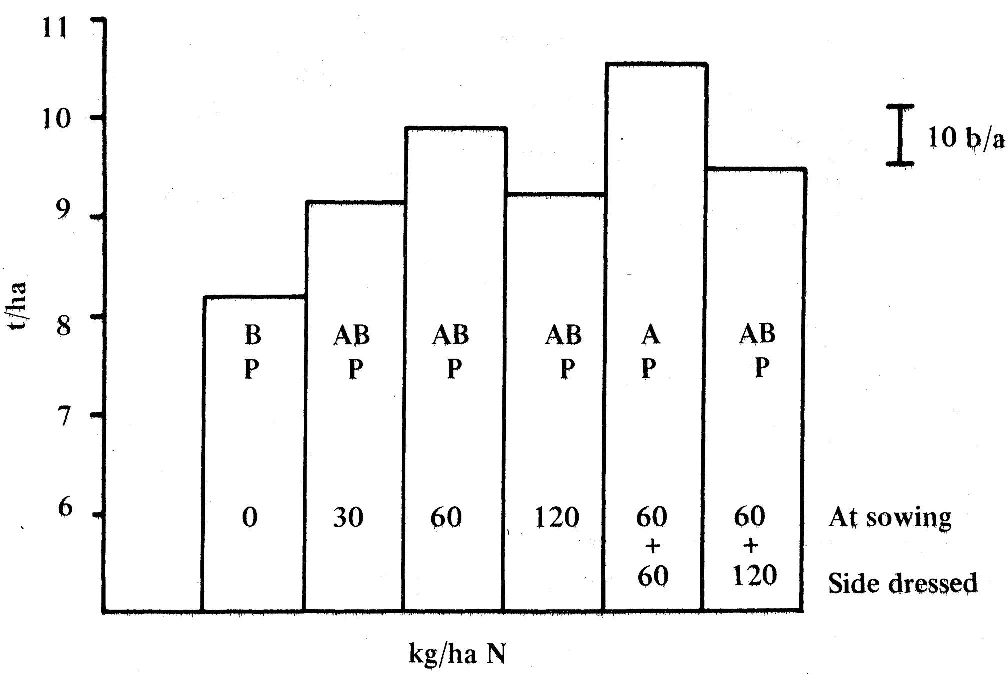


Figure 5: Grain yield t/ha in relation to nitrogen rate and time applid



Following the pasture rotation the maximum yield of direct sown maize (9800 kg/ha) was achieved without additional nitrogen. In contrast, where maize was direct seeded into permanent pasture (Trial 3) grain yield increased with application of nitrogen up to 60 kg/ha at sowing and 120 kg/ha where an additional 60 kg/ha was applied as a side dressing. (Fig. 5).

It is generally realised that direct seeded crops following pasture require additional nitrogen because of the slow mineralisation of inorganic nitrogen. The more rapid availability of the accumulated soil nitrogen after the short term ley is of importance for rotational cropping.

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