A MAIZE *(Zea mays L.)* CROP ROTATION STUDY IN POVERTY BAY

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SUMMARY

In the first four years of a trial on a Matawhero heavy silt loam at Manutuke Research Station on the Gisborne plains, nitrogenous and phosphatic fertiliser had little effect on maize grain production in the first two crops following pasture. In the two subsequent years there was a greater response to both fertilisers with the requirement being higher for nitrogen than for phosphate. This is in agreement with earlier results (Cumberland and Douglas, 1970).

Response by maize to applied fertilisers was affected by crop rotation. In soya bean and annual pasture rotations maize showed a smaller response than in the continuous maize rotation. The former rotations also gave the highest overall maize grain yields. Continuous maize with a winter cover crop gave the lowest yield. One reason for this appeared to be a detrimental effect produced by cultivation of the ground in winter.

In the fourth year an invasion of grass weeds in the maize crops occurred and was not controlled by chemicals.

INTRODUCTION

While maize has been grown for a considerable number of years in the Poverty Bay, research on the effects of fertilisers and rotations on grain production have been largely unexplored. Fertiliser research prior to 1970 was reviewed by Cumberland and Douglas, (1970). The conclusions reached were that the soils of the Gisborne plain showed a good capacity for supplying phosphorus and even third and fourth year maize could be grown without added superphosphate. Nitrogen was not required early in a cropping rotation after pasture, but under extended cropping rotations nitrogen shortages appeared before those of phosphorus.

No responses were recorded to potassium applications.

No previous rotation studies with maize have been reported in New Zealand. In 1968 a maize rotation x fertiliser trial was begun at Manutuke Research Station near Gisborne.

METHODS

Experimental Design:

The trial was laid down on a Matawhero heavy silt loam which had previously been in permanent pasture. No fertiliser had been applied in the period 1954-1967 but owing to an apparent decline of pasture production from 1963 to 1966, sulphur fortified superphosphate, 375 kg/ha (178 kg S/ton) was applied in the autumns of 1967 and 1968.

Two replicates of the following rotations were used:-

1. Annual maize crops with winter fallow.
2. Annual maize crops with a winter crop.
3. Maize in alternate years with soya beans and each with a winter fallow.
4. Maize in alternate years with temporary pasture.

   On each maize crop the following fertiliser subplots, replicated four times, were superimposed.

   (a) No fertiliser applied.

   (b) Superphosphate 375 kg/ha sown through the maize planter.

   (c) Urea 110 kg/ha sown through the planter.

   (d) Treatments (b) and (c) above sown through the planter.

   (e) Treatment (d) plus a side dressing of Urea 170 kg/ha applied approximately one month after sowing.

The subplots were permanent in the sense that the same fertiliser was applied to the same plots each year the area was in maize, and the position of the plots did not vary.

Individual plots consisted of four rows, at 76 cm centres, 30.5 metres long. The centre two rows of each plot were handpicked in mid-May for yield comparisons. The remaining rows were then machine harvested as soon as possible thereafter but the time of this depended on the availability of a contractor's machine. Handpicked cobs were crib dried and shelled in the following spring.

Cultural Methods:

The trial was sown each year about the 20th October except in the first year when it was sown on the 5th November. Plant populations of the hybrid W 575 ranged from 50 to 55,000 plants per hectare. In the first year fertiliser rates varied due to the use of an innaccurate planter but subsequently a new planter gave accurate sowings. Difficulty was experienced with the urea-superphosphate mixture becoming hygroscopic and in the fourth year nitrolime was used instead of urea.

Weed control in the maize crop was achieved by use of atrazine 1.1 kg/ha a.i. and propachlor 3.4 kg/ha a.i. applied after sowing at early weed emergence. In 1971-72 butylate 3.4 kg/ha a.i. soil incorporated prior to planting was also applied. Except for some unavoidable cultivations caused by side dressing of fertiliser no inter-row cultivation was done.

The soya bean plots were sown through a maize planter in 51 cm rows in 1968, 76 cm rows in 1969, 38 cm rows in 1970 and drilled in 53 cm rows through a grain drill in 1971. Weed control was attempted by use of trifluralin 1.1 kg/ha a.i. soil incorporated prior to planting with the addition of the pre-emergence sprays of linuron 1.1 kg/ha a.i. in the 1970-71 and 1971-72 seasons and alachlor 2.2 kg/ha a.i. additionally in the latter season.

Annual pastures were sown with Grasslands Manawa ryegrass 22 kg/ha and GrasslandsHuia White Clover 2.2 kg/ha and stocked at 20 sheep per hectare when the feed supply permitted. Following the 1970-71 year this rotation was changed to one of two years maize and two years pasture because of the difficulty in establishing pasture from winter sowings.

The winter cover crop was Grasslands Paroa ryegrass sown at 36 kg/ha in the first winter, and Amuri oats at 134 kg/ha in the second winter. The winter cover crop was not sown in the third season because of an excessively wet winter.

RESULTS AND DISCUSSION

Rotations:

Maize after soya beans or pasture gave the highest yields with the winter cover crop rotation inferior to the continuous maize with the winter fallow (Table 1). Crop yields in the first three years were very high for this hybrid (W 575). The reduced yields in the fourth year were not considered to be due to the trial treatments but to adverse seasonal effects. Many maize growers in the Gisborne district had yields 25% less than expected.

The soya bean - maize rotation appears a promising one for the district provided a satisfactory method of growing a clean crop of soya beans can be established.

Yields from the cultivar Amsoy were between 2700-3000 kg/ha machine harvested, although in 1971 there was very poor establishment following heavy rainfall soon after planting, which necessitated resowing. In both 1969-70 and 1970-71 severe competition from black nightshade (*Solanum nigrum*) was not controlled by the weed control methods used. In the first season the beans were completely smothered, and in the second they were only recovered for harvest by hand weeding. The subsequent use of alachlor has reduced but not completely overcome this problem.

The low yields of the winter cover crop rotation appeared to be related to the cultivation of the ground while it was wet rather than to the removal of nutrients by the winter crop. Little feed was produced by the winter crops mainly due to the late sowings. Grazing was obtained in 1969 only and was restricted to the period between 19 August and 15 September. The area was then worked for the ensuing crop. After cultivation in that year the seed bed of the winter cover crop rotation was noticeably more cloddy than those of the other rotations and the resultant plant establishment was 12,300 plants/ha lower than for the continuous maize. This sort of effect was also noted by Austin et al (1962) who found that the surface strength of the recent soils of the Gisborne plains was weak in winter. Machinery or stock tended to puddle the surface which on subsequent ploughing gave cloddy, difficult to work, seed beds.

TABLE 1 : YIELDS KG/HA OF MAIZE IN THE CONTINUOUS MAIZE ROTATION AND DIFFERENCES IN THE GRAIN YIELD OF THE OTHER ROTATIONS FROM THAT OF THE CONTINUOUS MAIZE ROTATION. 1968-72.

Rotation	1968-69	1969-70	1970-71	1971-72
1. Continuous maize	11920 a	11800 abA	11080 aBC	8290*
2. Winter cover	-160 a	-1050 bA	-790 cC	-690
3. Soya bean	-180 a	+ 470 aA	+650 aAB	+1580
4. Pasture	-180 a	- 420 abA	+890 aA	+1280
C.V.%	3.3	3.2	3.6	-

* Estimated grain yield from cob production.

While this rotation performed poorly some of the restraints imposed by the experimental procedure were not in its favour. Machine harvest of many maize crops in the district would be possible in April, but these are usually left standing as long as possible for natural drying. Harvest of the guard rows in the trial was at times delayed because of the unavailability of headers, with a resultant delay in working the ground for the winter cover crop.

However, the winter cover crop rotation has shown that by cultivation of the Matawhero heavy silt loam at the wrong time, the resultant crops can be affected by what appear to be changes in soil structure. It would be desirable to measure such changes but this has not been done.

Because of the difficulties of working the ground in winter and the lack of success in growing winter stock feed the winter crop was deleted from the rotation and replaced with lupins grown as a green manure in 1972. The ploughing in of green crops to maintain organic matter has been previously recommended (Austin et al 1962, Chamberlain 1962). Winter feed crops would possibly be more successful between the soya bean and maize crops because the soya beans are harvested in early April and leave the ground in a friable state, but the problem of stock puddling the ground in winter would remain.

The maize-pasture rotation was slightly inferior to the continuous maize rotation in 1969-70 but superior in 1970-71 and 1971-72. In 1969-70 the slightly inferior yield of the maize-pasture rotation can be related to a lower plant establishment of 3200 plants/ha than in the continuous maize due to the cloddy nature of the seed bed. The 1971-72 yield is from a second year maize crop following the change in rotation to two years pasture and two years maize.

Fertiliser:

The response to superphosphate did not increase over the four year period in the soya bean and temporary pasture rotations but there was an increasing response in the two continuous maize treatments (Figure 1). The response to superphosphate in the second year in the winter cover and pasture rotations was in part due to superphosphate aiding plant establishment. The fertiliser effect was not adjusted for plant population differences.

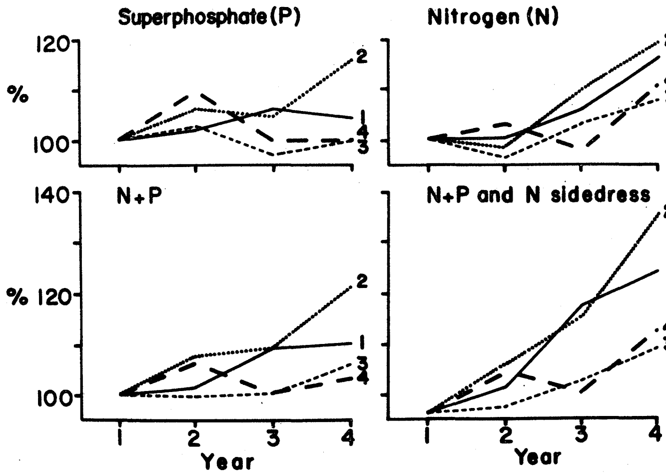

FIG. 1: Effects of fertilizers on maize yields in rotations 1, 2, 3 and 4.

Nitrogen fertiliser was not needed in the first two crops out of pasture but thereafter there was an increasing demand, particularly in the continuous maize rotations. The extra side dressed nitrogen gave a significant depression in yield in the first year but it was of benefit in the third and fourth years. (Figure 1). Maize following soya beans or pasture gave smaller responses to added nitrogen than the continuous maize rotations.

Weeds in Maize:

In the first three years almost complete weed control was obtained by the use of chemicals. However, grass weeds were evident in localised patches in the 1970-71 season and by 1971-72 there was a significant infestation throughout the trial area. Chemical sprays gave good control of the broad leaf weeds (Amaranthus sp. Chenopodium sp).

An assessment of grass weed infestation was conducted in 1971-72 by recording the number of grasses rooted inside, and those not rooted but overlaying, a 15 cm diameter ring placed 40 times at 60 cm intervals between the centre rows of the control (a) and complete fertiliser treatment (e) plots. The results are presented in Table 2.

TABLE 2 : GRASS WEED INFESTATION IN THE CONTROL AND COMPLETE FERTILISER TREATMENTS OF EACH ROTATION. 1971-72.

Rotation		(1)	(2)	(3)	(4)
Number of grass plants rooted in 160 ring placements					
Control	(a)	88	172	19	46
Fertiliser	(b)	38	72	5	34
Number of ring placements overlayed by grass in 160 ring placements.					
Control	(a)	134	157	70	133
Fertiliser	(b)	109	144	28	103

The three grasses recorded were summer grass (*Digitaria sanguinalis*), barnyard grass (*Echinochloa crus-galli*), and rough bristle grass (*Setaria verticillata*). The soyabean rotation with its associated weed control had the least grass and the continuous maize with the winter cover crop the most. The cultivation associated with side dressing the nitrogen in treatment (e) also reduced the grass weed population. The trial does not allow measurement of the influence of the grass weeds on the maize but it is interesting to note the negative relationship between the grass weed infestation and the maize yields of the rotations.

It was abnormally wet during the establishment period in the 1971-72 season and this could account for some inefficiency in chemical activity. Nevertheless two grass killing chemicals were applied and the resultant failure suggests that the use of inter-row cultivation may have to be reconsidered.

CONCLUSIONS

First and second crops of maize following permanent pasture require no nitrogenous fertiliser and little or no phosphatic fertiliser on the Matawhero heavy silt loam. Further crops have a greater need for phosphatic and nitrogenous fertiliser with the side dressing of nitrogenous fertiliser becoming more important. To some extent this effect has been confounded in the fourth year by the failure to control grass weeds in the crops with chemicals.

The Matawhero soil may be puddled by machinery or stock in winter and subsequent cultivation may result in cloddy seed beds and poor plant establishment. For this reason a rotation integrating a winter crop appears undesirable.

Soya beans had a beneficial effect on the following maize crops and this rotation appears to be a promising one for the district. Further research is required on weed control, crop establishment, and plant populations in soya beans.

Grass weeds in maize were not adequately controlled by the chemicals available and further research is also required in this field.

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