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Effects of tillage practices on maize yields

(Kesan amalan pembajakan terhadap hasil jagung)

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Key words: tillage, ploughing depth, maize yields

Abstrak

Turutan pembajakan semasa penyediaan tanah telah dinilai. Dua intensiti pembajakan (dua kali dan tiga kali pembajakan) serta dua kedalaman (40 cm dan 50 cm) diuji. Hasil daripada kajian menunjukkan tiada perbezaan yang bererti antara perlakuan yang diuji. Walau bagaimanapun dari segi hasil bagi setiap ringgit kos penyediaan tanah, dua kali pembajakan memberi hasil yang lebih tinggi iaitu 34.28 kg dibandingkan dengan 19.73 kg bagi tiga kali pembajakan. Kedalaman membajak tidak mempengaruhi hasil. Oleh yang demikian, cara penyediaan tanah yang disyorkan ialah sekali pembajakan cakera sehingga kedalaman 40 cm, diikuti dengan sekali pemutaran tanah.

Abstract

Different sequences of ploughing during land preparation were evaluated. Three rounds of ploughing were tested against two rounds in maize cultivation, together with two ploughing depths of 40 cm and 50 cm. The results indicated no significant yield differences among treatments tested. However, in terms of kilograms of maize produced per ringgit cost of land preparation, two rounds of ploughing resulted in significantly higher yields at 34.28 kg compared with 19.73 kg for the check (disc ploughing-disc ploughing-rotovation sequence). Ploughing depths did not affect yield. As such, the recommended land preparation practice would be one round of disc ploughing up to 40 cm depth followed by one round of rotovation.

Introduction

In grain maize cultivation, land preparation accounts for over 20% of the operating cost (Leong 1996). As such, any reduction in the cost of land preparation will contribute greatly to the economic viability of grain maize production. At present, land preparation in maize cultivation consists of two rounds of disc ploughing followed by a final rotovation.

Anderson (1986) found no significant correlation between grain yield and density under different tillage practices. Dhillon et al. (1987) compared three tillage practices and found no significant yield differences in maize. However, Hallauer and Colvin (1985) reported higher maize hybrid yields using the ploughing and disking tillage method compared with strip tillage and no tillage. Due to the various contradictory findings on tillage effects on yields, it is imperative that such tillage effects be documented for grain maize cultivation under local conditions. This study will

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evaluate the advantages or disadvantages of using a two-tillage land preparation sequence instead of the normal three. Due to the frequent presence of a plough pan in most cultivated soils, the effects of different tillage depths will also be studied.

Materials and methods

The experiment was carried out at MARDI, Seberang Perai. The soil is a deep gravelly sandy clay loam that is moderately well drained. It is classified as an Oxic Dystropept. The two treatments were as follows:

- Three-tillage operations comprising
  i) disc plough-disc plough-rotovator (check),
  ii) disc plough-disc plough-disc harrow,
  iii) mouldboard plough-disc plough-rotovator, and
  iv) mouldboard plough-disc plough-disc harrow.
- Two-tillage operations comprising
  i) disc plough-rotovator,
  ii) disc plough-disc harrow,
  iii) mouldboard plough-rotovator, and
  iv) mouldboard plough-disc harrow.

The two ploughing depths were effected by the use of different ploughing implements, i.e. disc plough (40 cm) and mouldboard plough (50 cm). The particular disc plough used was a 3-disc model TDPE 48/D with a 65-cm disc diameter while the mouldboard plough was a 2-furrow Dowdeswell DP5L. These implements were pulled by a high power John Deere 4WD tractor with 109 hp. The disc harrow has eight discs, each with a diameter of 55 cm.

Randomized complete block design (RCBD) was used with four replications. Since tractors were used in land preparation of the different treatments, plot sizes were made relatively larger, i.e. 7.5 m x 20 m.

The maize variety used was Suwan 1. Seeds were manually planted at a planting distance of 50 cm x 75 cm. Three seeds were used per point and this was later thinned to 2 plants/hill at 10 days after planting, giving a population of 53 300 plants/ha.

An application of compound fertilizer (15:15:15) at 400 kg/ha was carried out at planting as basal dressing. Top dressing with urea at 130 kg/ha was applied 30 days after planting. All fertilizers were banded along the planting rows.

The experimental area was sprayed with the pre-emergence herbicide atrazine at 3 L/ha one day after planting. Harvesting was carried out 105 days from seeding.

Results and discussion

Plant height and yield

Plant height taken at harvest showed little difference between the treatments. The two-tillage treatments gave an average plant height of 230.5 cm compared with 231.2 cm for the three-tillage treatments. The average plant heights for the 40 cm and 50 cm ploughing depths were 231.0 cm and 230.7 cm respectively. Thus the different ploughing orders and methods used had no significant effect on plant height *(Table 1).* This was consistent with the findings of Newhouse and Crosbie (1986) which indicated that various hybrids did not respond differently to different tillage systems.

Table 1. Effects of tillage practices on mean plant height and grain yield

Treatment	Plant height (cm)	Yield* (t/ha)
DP + R	230.18	6.23
DP + DH	231.92	5.93
MP + R	231.75	5.91
MP + DH	228.12	5.38
DP + DP + R	227.15	5.28
DP + DP + DH	234.65	5.19
MP + DP + R	235.59	5.89
MP + DP + DH	227.28	5.31
Mean	230.83	5.64
SE	6.27	0.82
LSD (5%)	13.04	1.70

DP = disc plough; R = rotovator;
DH = disc harrow; MP = mouldboard plough
*yield was calculated at 14.5% moisture content

The average grain yield for the experiment was 5.64 t/ha *(Table 1)*. Two-tillage treatments resulted in a yield of 5.87 t/ha compared with 5.42 t/ha for the three-tillage operations *(Table 2)*. Blevins et al. (1986) found that maize yields were generally increased by tillage reduction. Among the two-tillage treatments, the use of disc plough as the first ploughing operation gave a yield of 6.08 t/ha compared with 5.65 t/ha when mouldboard plough was used instead. Similarly, there was another 6.8% yield increase when the second ploughing operation was carried out with rotovator instead of a disc harrow (6.07 t/ha compared with 5.66 t/ha).

Different ploughing depths of 40 cm and 50 cm did not result in any yield differences with yield levels at 5.66 and 5.62 t/ha respectively *(Table 2)*. As there were non-significant differences in both plant heights and yield for all treatments tested *(Table 1)*, a tillage depth of 40 cm is sufficient for grain maize cultivation. This depth could be obtained by either using the common disc plough pulled by high power tractors (>100 hp) or medium power tractors (60–80 hp) pulling mouldboard ploughs to achieve the desired ploughing depth. The average ploughing depths for the disc and mouldboard ploughs were 41.5 cm and 48.4 cm respectively.

These results showed that reducing the number of tillage rounds during land preparation from the normal three to two would not affect subsequent yields; in fact yields actually increased from 5.42 to 5.87 t/ha *(Table 2)*. This could be due in part to greater loss of soil structure from three rounds of tillage instead of two, particularly in previously cultivated areas. This reduction in the number of tillage practices would result in substantial savings in land preparation costs in maize production.

Yields in relation to land preparation costs

To project accurately the effects of the number of tillage practices on yield, the cost factor has to be considered. Contract land preparation costs as obtained in the Ladang Lambor large-scale grain maize production project (Leong 1995) were used. These costs were related to the yield obtained. The returns in terms of kilograms of maize yield for every ringgit invested in land preparation is shown in *Table 3*.

Table 2. Effects of ploughing depths and number of tillage operations on grain yield

Ploughing depth (cm)	Yield (t/ha)		
	2-tillage	3-tillage	Mean
40	6.08	5.23	5.66
50	5.65	5.60	5.62
Mean	5.87	5.42	

Table 3. Effects of tillage practices on mean yields based on returns invested

Treatment	Yield (kg/RM)
DP + R	34.28a
DP + DH	34.62a
MP + R	32.55a
MP + DH	31.41a
DP + DP + R	19.73b
DP + DP + DH	20.17b
MP + DP + R	22.02b
MP + DP + DH	20.65b
Mean	26.93
SE	3.90
LSD(5%)	8.11

DP = disc plough; R = rotovator;
DH = disc harrow; MP = mouldboard plough
Means with the same letter are not significantly different from one another at 5% level

The data indicated that a two-tillage operation gave significantly higher returns in terms of yield per ringgit cost of land preparation than the three-tillage operation. Among the two-tillage operations, there was no significant yield difference whether disc plough or mouldboard plough was used as the first tillage practice, or if the second tillage practice was carried out using rotovator or disc harrows. This also meant that different tillage depths of 40 cm or 50 cm would not affect the yields obtained. This could be due to the fact that the

experiment was sited on soils where the 4–6 cm compacted layer (plough pan) was located 30 cm from the soil surface. It was thus removed even by the shallower ploughing depth tested. Also a 40-cm ploughed zone appeared adequate to support a high yielding maize crop. Anderson (1987) found that 82% of total maize root development were present in the top 60 cm of the soil after harvest.

The highest mean yield obtained was 6.23 t/ha with a two-tillage ploughing sequence made up of an initial disc ploughing followed by rotovation. This compared favourably with 5.28 t/ha from the standard two rounds of disc ploughing followed by rotovation (check). In terms of yield per ringgit invested, the disc ploughing followed by rotovation gave high returns of 34.28 kg/RM compared with only 19.73 kg/RM for the check. Since ploughing depth has no significant effect on yield, the use of disc plough followed by rotovator is recommended for grain maize cultivation.

It was observed that a two-tillage land preparation method would result in larger soil clod sizes compared with a three-tillage operation. This could reduce planting efficiency in mechanized production of maize. However, planting machines can be modified to enable effective seeding under relatively large clod sizes so as to take advantage of this cost-saving feature of the two-tillage operation.

Conclusion

No yield differences between a two and three-tillage sequence during land preparation favoured the use of the two-tillage method. Furthermore the returns in terms of ringgit invested was much higher at 34.28 kg compared with 19.73 kg respectively. A ploughing depth of 40 cm was favoured since increasing the depth to 50 cm did not increase yields. The recommended land preparation package for maize production would be one round of disc ploughing followed by one round of rotovation.

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