Planting pattern and weed control method influence on yield production of corn (Zea mays L.)

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Abstract. Field experiment was carried out to evaluate the influence of planting patterns and weed control methods on the growth and yield of corn. The effect of the planting pattern and weed control method was studied in a split plot design. The main plots were that of planting pattern single row (25cm x 60cm), double row (25cm x 25cm x 60cm) and triangle row (25cm x 25cm x 25cm). Subplot was that of weed control method consisted five methods namely weed free throughout the growing season, hand weeding, sprayed with glyphosate, sprayed with paraquat, and no weeding. Result showed that both planting pattern and weed control method did not affect the growth of corn. However, planting pattern and weed control method significantly affected yield production. Yield resulted from double row and triangle planting pattern was 14% and 41% higher, consecutively, than that of single row pattern. The triangle planting pattern combined with any weed control method produced the highest yield production of corn.

1. Introduction
Various efforts to improve agricultural technology such as improvements to varieties and how to grow crops are continually developed in order to meet the needs of food for global consumption. Research on varieties continues to be done to improve the resistance to pests and diseases, response to fertilization, shorter harvest age and so forth. While improvement of cultivation techniques include the amount and type of fertilizer, time and weeding method, plant point pattern, the number of plants per hectare, water stress or drought and others.

The area of maize in North Sumatra Province and Indonesia in 2015 is 3787367 ha and 243770 ha with production of 15,19407 and 19,612,435 tons respectively [1]. The productivity of maize in Indonesia (5.07 tons / ha) in 2015 is above the average production per hectare of ASEAN (4.29 tons / ha) [2].

Increased maize production can be carried out with increasing population through plant spacing system. The commonly used spacing system is one-row pattern, and as the demand for maize increases, two-row pattern begins to be applied for greater yield [3]. The triangle pattern is also a concern for farmers to increase production per unit of land. The larger population on the triangle line increased production by 8.98% over one-row and 4.59% with two-row [4].

The presence of weeds can significantly reduce the growth and production of crops as a competitor in the fight for nutrients and sunlight, thus reducing production by 48% [5]. Weed control method has
been adopted varies such as mechanical control by pulling or clearing, burning, flooding, using mulch, natural enemies, crop rotation and spraying herbicides [6]. Each of these methods has advantages and disadvantages, but farmers often implement manual weeding and the use of herbicides. The objective of the study was to evaluate the system of plant-spacing pattern and appropriate weed control methods on the growth and production of maize (*Zea mays* L.)

2. Materials and Methods
The study investigating two factors, firstly, planting pattern consist of three patterns: one-row (60 cm x 25 cm), two-row ((25 cm x 25 cm) x 60 cm), and triangle ((25 cm x 25 cm x 25 cm) x 60 cm) whilst the second factor is weed control method: manual weeding, spraying with glyphosate at 4 weeks after planting (WAP), spraying with paraquat 4 WAP, weed-free along the growing season, and unweeded for a comparison. All treatments were arranged in a split plot design with three replicates.

On plot size of 275 cm x 275 cm, seeds of corn DK3 variety were planted one seed per planting point according tp the planting patterns. The corn was fertilized with nitrogen (135 kg N/ha), P2O5 (36 kg /ha) and K2O (25 kg K2O/ha) (Warisno,1998)

Weed was controlled by using herbicides, glyphosate or paraquat, as much of 960 g ,a.i. and 600 g a.i consecutively at 4 WAP but for manual weeding at 2 WAP. One treatment was kept weed free as long as growing season and the remaining treatment, unweeding, let weed grew as long as growing season.

3. Results and Discussion
Plant heights at different weed control were shown in Table 1. At 6 and 8 WAP, corn height where the weed was controlled was significantly higher compared to those of no-weed control. No difference of corn height when the weed was controlled by herbicides, glyphosate or paraquat (Table 1). On the other hand, corn height grown in one-row pattern (267.4cm) was higher than those in two-row and triangle planting patterns.

Table 1. Average of plant height on different planting pattern and weed strategy management 2, 4, 6, and 8 weeks after planting

| Time of measurement (WAS) | Weed Management Strategy | One row | Two-row | Triangle | Average |
|--------------------------|--------------------------|---------|---------|----------|---------|
|                          |                          | cm      | cm      | cm       |         |
| 2                        | Unweeded                 | 54,96   | 54,43   | 55,05    | 54,81   |
|                          | Weed free                | 55,04   | 55,85   | 55,25    | 55,38   |
|                          | Manual                   | 54,99   | 56,67   | 54,37    | 55,34   |
|                          | Glyphosate               | 54,14   | 55,25   | 54,13    | 54,51   |
|                          | Paraquat                 | 54,68   | 55,57   | 55,86    | 55,37   |
|                          | **Average**              | 54,76   | 55,56   | 54,93    |         |
| 4                        | Unweeded                 | 108,09  | 106,88  | 107,00   | 107,32b |
|                          | Weed free                | 112,25  | 109,98  | 110,27   | 110,83a |
|                          | Manual                   | 109,65  | 107,97  | 108,50   | 108,71ab|
|                          | Glyphosate               | 108,32  | 106,98  | 106,29   | 107,20b |
|                          | Paraquat                 | 108,40  | 106,35  | 106,15   | 106,92b |
|                          | **Average**              | 109,34  | 107,63  | 107,64   |         |
| 6                        | Unweeded                 | 173,07  | 172,00  | 173,00   | 172,69b |
|                          | Weed free                | 186,63  | 186,43  | 186,03   | 186,37a |
|                          | Manual                   | 186,47  | 185,40  | 185,90   | 185,92a |
|                          | Glyphosate               | 185,87  | 184,03  | 184,07   | 184,66a |
|                          | Paraquat                 | 185,30  | 183,77  | 183,63   | 184,23a |
Grain production per plant of corn on weed-free is not difference than that of manual weeding, ranging from 190,5 to 197,1 g per plant. The grain per plant of corn where the weed was controlled with glyphosate is similar with those of plant using paraquat which is ranging from 174,4 to178.9 g /plant. The lowest grain production per plant (164 g) was found in unweeded area.

Grain production per plant of corn with one-row planting pattern (190,9 g/plant) is not different compared to that of triangle planting pattern (184,1 g/plant) but higher than that of two-row planting pattern (160,2 g/plant). (Table 2).

Grain production of corn per hectare planting in one-row, two-row, and triangle patterns with different weed control methods is shown on Table 3.

### Table 2. Dry weight of grain production per plant from one-row, two-row and triangle planting pattern of corn

| Weed Management Strategy | Planting Pattern | Average |
|--------------------------|------------------|---------|
|                          | One-row          | g/ plant|         |
| Unweeded                 | 170,20           |         | 164,42 c|
| Weed free                | 205,80           | 160,65  | 197,09 a|
| Manual                   | 200,75           | 180,46  | 190,51 a|
| Glyphosate               | 193,12           | 157,00  | 178,90 b|
| Paraquat                 | 184,72           | 152,43  | 174,35 b|
|                          | **Average**      | **190,92 a** | **160,16 b** | **184,08 a** |

\*Numbers followed by the same letters on the same column and treatment category are not significantly different at the level of 5% based on least significant difference.

### Table 3. Dry weight of grain production per hectare per plant from one-row, two-row and triangle planting pattern of corn

| Weed Management Strategy | Planting Pattern | Average |
|--------------------------|------------------|---------|
|                          | One-row          | ton/ha  |         |
| Unweeded                 | 11,35 ex (G)     | 15,04 by(D) | 15,83 bz(CD) | 14,07 c|
| Weed free                | 13,72 ax(EF)     | 17,81 ay(AB) | 19,03 az(A) | 16,85 a|
| Manual                   | 13,38 abx(FG)    | 16,89 ay(BC) | 18,55 az(A) | 16,28 a|
| Glyphosate               | 12,87 abx(FG)    | 14,69 by(D) | 18,19 az(AB) | 15,25 b|
| Paraquat                 | 12,31 bex(FG)    | 14,27 by(DE) | 18,12 az(AB) | 14,90 b|
|                          | **Average**      | **12,73 c** | **15,74 b** | **17,94 a** |

\*Numbers followed by the same letters on the same column and treatment category are not significantly different at the level of 5% based on least significant difference. Letters followed by x, y, and z are compared in the same main plot whilst letters in brackets are compared in general.
are not significantly different at the level of 5% based on the least significant difference.

Dry weight of grain production of corn per hectare is presented on Table 3. The highest grain production (17.9 ton/ha) is found in triangle planting pattern followed by two-row planting pattern (15.7 ton/ha) and single-row planting pattern (12.7 ton/ha). In other words there is 40.9% and 23.6% increase in triangle and two-row planting pattern consecutively compared to one-row planting pattern. Grain production per hectare from different weed management strategies is presented on Table 3. The highest production (16.3 to 16.8 ton/ha) was found in area where the area is weed free or manually controlled. Grain production of corn where weed control was spraying with glyphosate (16.3 ton/ha) is no difference from that of spraying with paraquat (15.3 ton/ha). On the top of all, corn planted in triangle pattern combined with any of those weed control method tested produce the highest grain production compared to any other treatments (Table 3).

4. Conclusion

The triangle planting pattern produced the highest corn grain production followed by two-row and one-row planting patterns. The triangle pattern increased grain production as much of 40.9% and 14.0% compared to those of one-row planting pattern and two-row planting pattern consecutively. Weed control by spraying with herbicides, glyphosate or paraquat, increased the corn production as much of 5.9 to 8.4% whereas by manual weeding about 19.4% in triangle planting pattern.

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