DEVELOPMENT OF STRIP TILLAGE CULTIVATION TECHNIQUE FOR MALAYSIA GRAIN CORN PRODUCTION

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ABSTRACT

Heavy rain, unstable weather and poorly drained soils can lead to delayed planting, low and uneven emergence and lower yields for reduced vs. conventional tillage. Strip-till has been proposed as an alternative minimum tillage system for areas and soils that are not well suited for no-till management. Strip tillage, which implies the cultivation of a narrow strip in the row field, has the positive effects of providing an appropriate grain corn seedbed (Zea mays L.) production with minimum energy expenditures, while leaving surface residues in the inter row area to reduce soil erosion. Strip-till is a form of minimum tillage best suited to areas where no-till is not well adapted for corn production due to heavy rain, compacted or poorly drained soils. Local strip tillage was design, constructed and used for grain corn establishment. The implement consists a front disk coulter with a depth wheel cuts through grain corn crop residue, subsoiling shank that operates to a depth of 20cm, a set of coulters for chop and soil till, and press wheel to firm and smooth seedbed.

Key words: Strip tillage, narrow strip, soil erosion, cultivation

INTRODUCTION

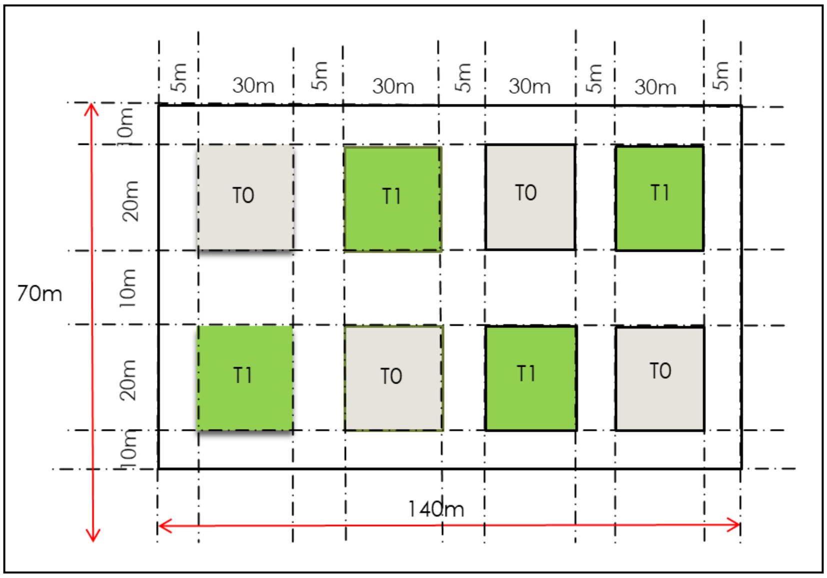
In Malaysia, conservation tillage practices were less applied in many agricultural practices espeacially in grain corn. Farmers are prune to adapt the conventional practices due to lack of knowledge and its normal practices. In 1994 Hoyt reported that conservation tillage has been widely adopted for agronomic crop production. Strip tillage, which implies the cultivation of a narrow strip in the row field, has the positive effects of providing an appropriate grain corn seedbed (Zea mays L.) production with minimum energy expenditures, while leaving surface residues in the inter-row area to reduce soil erosion. Schneider et al. (2009) confirmed the high potential of erosion control of strip tillage in the Middle-German Loess Area. Strip tillage that involves cultivation of narrow bands, or strips in the row area which separated by bands of undisturbed soil. The potential and advantages of this techniques, it has the great potential of providing suitable seedbed for local grain corn crop establishment while leaving surface residues in the inter-row are to reduce soil erosion. In 1993 Vyn and Raimboult reported that strip tillage has the potential to combine the benefits of conventional tillage and no-tillage by intensive tillage of the soil in the area of the plant rows and leaving the inter-row with complete residue cover. Strip tillage equipment commonly consisted of a modified rototiller (rotory strip tiller) (Petersen et al.,1986) or subsoiling (shank and fluted coulter system) (Wilhoit et al., 1990).

Strip tillage consists of seedbed tilth in strips 15–20 cm wide by 15–20 cm deep in correspondence with crop rows alternated to between-row strips of undisturbed soil (Hendrix et al., 2004). The main advantages of no-tillage, a high level of erosion control and a good conservation of soil structure and soil moisture can also be reached with strip tillage (Licht & Al-Kaisi 2005). The advantage of strip tillage is the faster warming of the soil, a higher biological activity in the tilled strips, better germination and often better yields than with no-till have been reported (Overstreet & Hoyt, 2008, Morrrison, 2002). Nash investigated the N2O emissions of corn production with different tillage systems. He determined lower N2O emissions with strip tillage ("deep banded N treatments") compared to no-tillage ("surface broadcast N treatments").

Since 2007 the effects of strip tillage on sugar beet have been investigated (Hermann, 2008) and extended on corn (Hermann et al., 2010). Hermann confirmed the faster warming of the tilled soil in the strips compared to mulch tillage without seedbed preparation. The objective of this experiment was therefore to evaluate strip tillage conducted by an original passive tool for the cultivation of grain corn as representative crop and climate in Malaysia. Strip tillage was measured against conventional practise focused on effects of crop establishment.

MATERIALS AND METHODS

Field tests have been conducted at MARDI Seberang Perai, Pulau Pinang. The experimental design was a paired t test, with two tillage treatments, 1) strip tillage and 2) conventional tillage. Each field served as a replicate, with eight total fields plots. Fields were selected with relatively uniform soil type and vegetative cover for the field, with sandy loam soil types and grain corn with three cropping histories. Plot areas were selected in portions of the field and the tillage treatments randomly assigned as showed in Figure 1.



Grain corn Tillage Evaluation:
2 Test (T0,T1)
T0=Control (Disc plough+Harrow+Rotor)
T1=Strip Tillage
4 Rep for each Experiment
Total experiment plot = 8

Figure 1. Experimental plot layout

The test was done using local made strip tillage was design, constructed and used for grain corn establishment. The testing implement (Figure 2) was designed for four rows of grain corn at 750 cm apart. It consisted of a metal frame having in front the attachments to be mounted on the tractor three hitch point. At the back of the frame a grain corn seeder was attached having planting and fertilizer tools at 1 m apart. Two tines for each row were mounted on the frame. One shallow spring tine working at a depth of 0.12 m and a rigid working at 0.25 m The frame consists of a shallow spring disk coulter at the front working at depth 30 cm to cuts through grain corn crop residue, weeds and soil. A rigid disc harrow working at depth 25 cm was mounted 400 cm in front of the spring disk to avoid any interaction. A spring press wheel mounted 400 cm after the disc plough and work to firm and smooth soil for good grain corn seedbed.

Glyphosate herbicide was used to kill cover crops and existing vegetation in the fields several weeks prior to strip or conventional tillage. In a few fields, however, weed problems occurred in the untilled middle areas in the strip tillage blocks that required mechanical cultivation. In this system, a front disk coulter cuts through crop residue, weeds and soil, followed by a disc harrow operates to a depth of 25 cm. The rigid disc harrow pulverized the upper layer of the soil leaving the field ready for planting by a conventional planter.

Corn stand establishment was estimated in all tillage experiments plots by counting the number of corn plants in a 3 m x 5 m of row at 3 randomly selected locations in each experimental plot. This sampling occurred =14 days after planting when plants were typically 5 to 10 cm tall.

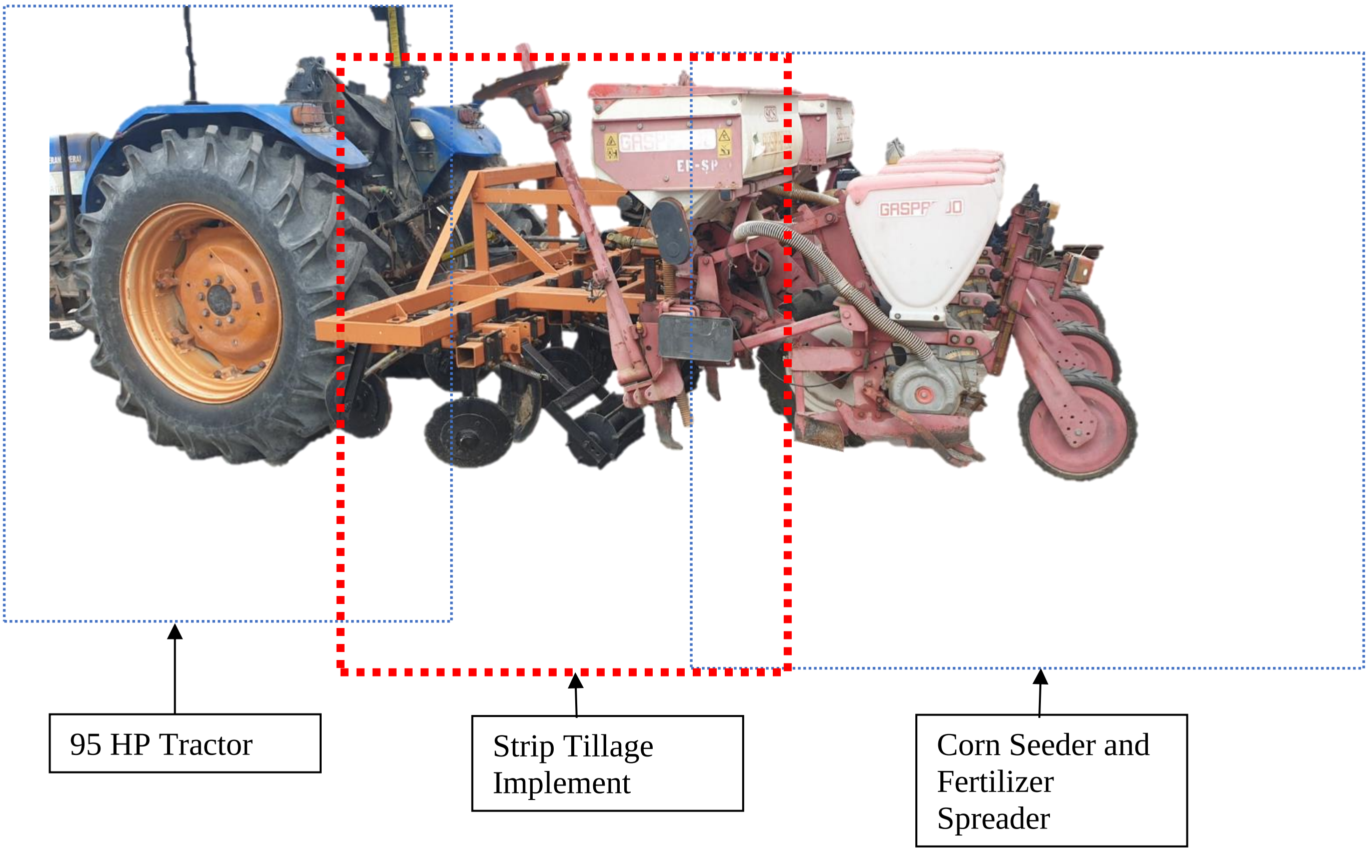


Figure 2. Strip Tillage Implement attach to Gaspardo (row seeder implement) and pull by 95HP tractor

A standard 70.8kW (95 Hp) 4 rubber wheel tractor with 4-wheel drive (4WD) was used for this experiment. This tractor was chosen for its suitability and technical aspects to work in domestic grain corn farm.

Figure 3. Test on experiment plots

The functional test was performed using strip tillage machines to plant grain corn seeds, and the conventional practice was applied to randomly selected sub-plots. The scale of the study plot is 70 m x 140 m while the dimension is 20 m x 30 m for each subplot (Figure 3 and 4).

Figure 4. Functional test for strip tillage implement

RESULTS AND DISCUSSION

Statistical analysis Data were analyzed using SAS (version 9.3; SAS Institute, Cary, NC). Replication was treated as a random factor. Mean separation was performed statements using the LSD method.

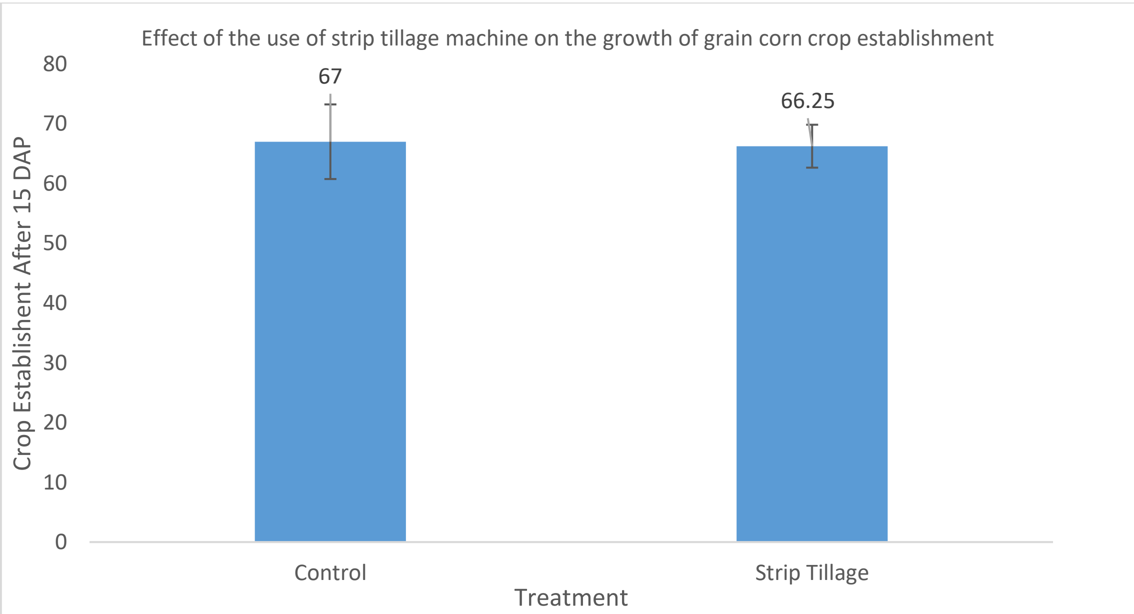


Figure. 5 Effect of using strip tillage machine on the growth of grain corn crop establishment

The effect of using strip tillage machine on the growth of grain corn crop establishment show in Figure 5. Conventional tillage or control treatment showed slower growth compared to strip tillage due to the delay of emergence but finally gave with the strip tillage the highest plants. However statistical analysis gave no significant differences for plant population for both treatments.

Table 1. Plant emergence and populations (plants · 3m x 5m quadrat) for the three years

Treatment	Rep 1	Rep 2	Rep 3	Rep 4	Mean	Std Dev
Control	74	65	67	62	67	6.2449
Strip tillage	61	68	67	69	66.25	3.5939

Table 1 shows grain corn crop establishment 15 DAP (days after planting) in 3 m x 5 m quadrat. No significant differences were found for control and strip tillage treatment. The use of strip tillage is a better planting method because it can minimise operational costs but can also have a positive effect on the cultivation and development of grain corn. Strip tillage will cut down on operational or ground preparation costs such as ploughing, harrowing, and rotor. The cost is approximately RM900-RM1000 for each activity. Moreover, this approach will raise farmers' and grain operators' incomes by minimizing production costs

CONCLUSIONS

From the research obtained it can be inferred that strip tillage can replace conventional tillage in grain corn production and potentially have a beneficial effect on grain yield. It provides great opportunity for conserving energy and reducing costs. Additional environmental benefits are expected from the adoption of tillage strips which might help farmers adapt to the conditions. This involves environmental, agronomic and economic benefits such as minimizing runoff and soil erosion, sustaining soil water and organic matter material, protecting soil bearing efficiency improvement in biodiversity, and tractor traction in the undisturbed inter-row line, minimizing inputs (traction, fuel, labour) and costs.

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