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Short communication

Manually-operated weeders for time saving and weed control in irrigated maize

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Weeds constitute a major component among the bottlenecks for successful crop production. Maize (*Zea mays* L.) is the third most important cereal crop, and no cereal crop on the earth has so much yield potential as that of maize. As the crop is heavily fertilized and sparsely grown, severe weed infestation is experienced, resulting in to a drastic reduction of grain yield (Naidu and Murthy 2014). The traditional weeding operation is arduous, time consuming, back breaking and may not be undertaken at appropriate time due to non-availability of labour during peak period. So, it is not possible to control the weeds timely with the traditional methods like hand weeding. Presently, to substitute manual weeding, more efficient and less energy intensive manually operated weeders have been introduced for weed control in irrigated maize (Mynavathi *et al*. 2009), which are cheaper, more efficient and suitable at farmer's fields to reduce the cost of crop production and improve crop yield to a great extent. In view of the importance of mechanical weed control, a field experiment was conducted during *Kharif* to evaluate the efficiency of manually operated weeders in irrigated maize.

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore to evaluate the efficiency of different manually operated weeders in maize. The soil of the experimental field was sandy-clay-loam in texture, low in available N (137.2 kg/ha) and phosphorus (9.0 kg/ha) and high in potassium (704.0 kg/ha). Maize variety '*Co-1*' was sown in June at a spacing of 60 x 20 cm. The crop was raised with all recommended package of practices. The treatments consisted of four mechanical weedings with manually operated weeders, *viz*. crescent hoe twice at 25 and 45 DAS, multi-tyne weeder twice at 25 and 45 DAS, wheel-hoe twice at 25 and 45 DAS and rotary peg weeder twice at 25 and 45 DAS. The above treatments were compared with hand weeding twice at 25 and 45 DAS, atrazine 0.5 kg/ha as a pre-emergence + one hand weeding at 45 DAS and unweeded control. The experiment was laid out in randomized block design with three replications. Atrazine 50 per cent WP at 0.05 kg/ha was sprayed using knapsack sprayer fitted with fan type WFN 40 nozzel after 3 days of sowing as pre-emergence. The weeds and yield data of maize were recorded along with other parameters related to mechanical weeders for time saving on weeding operation and weed control efficiency. Weeders were tested using standard test procedures as specified by Regional Network for Agricultural Machinery-RNAM 1983. The mechanical weeders were then evaluated against conventional and chemical weed control methods.

Effect on weed control efficiency

The major weed species present in the experimental field were *Echinochloa colona* (44.9%), *Digitaria longiflora* (5.3%), *Dactyloctenium aegyptium* (3.1%), *Cyperus rotundus* (4.5%) and the annual broad-leaved weeds constituted 39.6% of the total weed population comprising of *Parthenium hysterophorus* (27.7%), *Digera arvensis* (4.4%) and *Trianthema portulacastrum* (3.6%).

Weed control efficiency (WCE) indicates the magnitude of effective reduction of weed dry weight by weed control treatments over weedy check. This was highly influenced by different weed control treatments. The efficiency of treatments on control of weeds in terms of dry weight in comparison to control plot was worked out (Table 1). At 25 DAS, higher weed control efficiency of 52.2% was obtained in pre-emergence application of atrazine 0.5 kg/ ha on 3 DAS followed by one hand weeding at 45 DAS. At 45 DAS, hand weeding twice recorded higher WCE of 94.9% followed by pre-emergence application of atrazine 0.5 kg/ha on 3 DAS followed by hand weeding on 45 DAS (94.6 %). However, the

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difference between hand weeding twice, atrazine 0.5 kg/ha on 3 DAS followed by hand weeding PE on 45 DAS and wheel-hoe weeding twice (94.6%) was negligible.

There was a general reduction in weed control efficiency at harvest stage. Among the mechanical weeders, the higher weed control efficiency (34.2%) was reported in wheel-hoe weeding twice. The lower weed control efficiency was obtained in crescent-hoe weeding twice at all the stages. Among the mechanical weeders, wheel-hoe weeding twice produced higher weed control efficiency. (43.1, 94.6 and 34.2% at 25, 45 DAS and at harvest, respectively).

At 25 DAS, all the weed control treatments recorded more than 35% WCE. Pre-emergence application of atrazine 0.5 kg/ha on 3 DAS followed by one hand weeding at 45 DAS recorded higher WCE of 52.2%, followed by hand weeding twice and wheel hoe weeding twice (43.1%). More reduction of weed dry weight by reducing the weed density in these treatments resulted in higher WCE. At 45 DAS, hand weeding twice recorded higher WCE (94.9%), followed by atrazine 0.5 kg/ha PE on 3 DAS followed by one hand weeding on 45 DAS (94.6%), due to the complete removal of weeds by hand weeding. High weed control efficiency (90.7%) in atrazine applied plots was observed. Higher WCE of the treatments and low depletion of nutrients by weeds promoted the yield components of maize.

Time taken for weeding

At 25 DAS, time taken for weeding ranged from 71.4 to 256 hr/ha. The typical work rate for hand hoe is 32 mandays/ha (256 man hours/ha). The operation of rotary-peg-weeder along with rows required 20.8 man days/ha, whereas wheel hoe required, 10.9 man days/ha. The maximum number of mandays/ha required for weeding was recorded with hand weeding twice (Table 2).

At 45 DAS, number of man days required to complete the weeding operation was less compared to 25 DAS (Table 2). Time taken for weeding ranged from 35.1 to 144.0 hr/ha. Pre-emergence application of atrazine 0.5 kg/ha at 3 DAS followed by one hand weeding at 45 DAS required 18 mandays/ha, whereas hand weeding twice required 13 mandays/ha. Among the mechanical weeders, wheel hoe required only 5.4 mandays/ha. Among the mechanical weeders, the maximum number of labourers per hectare was required for rotary peg weeder (9.8 mandays/ha). The maximum number of man days was recorded with pre-emergence application of atrazine 0.5 kg/ha at 3 DAS followed by one hand weeding at 45 DAS (18 mandays/ha) followed by hand weeding twice at 45 DAS.

The increase in crop yield was recorded higher in pre-emergence application of atrazine 0.5 kg/ha at 3 DAS followed by one hand weeding at 45 DAS (173.7%) over control (Table 1). It clearly indicated the importance of weeding. Increase in yield was reported as a result of putting in human labour hours, which ranged from 71.4 to 256 hr/ha at 25 DAS. Wheel-hoe and multi-tyne weeder recorded higher yields of 4.8 and 4.6 t/ha, respectively, the corresponding time utilization for weeding by these devices was low (*i.e.*) 71.4 and 83.3 hr/ha, respectively at 25 DAS and 35.71 and 43.4 hr/ha, respectively at 45 DAS. Hand weeding required 256 man hours/ ha at 25 DAS and 104 man hours/ ha at 45 DAS. These findings corroborate with the finding of Yadav and Pund (2007). This shows that weeding is a labour intensive and tiresome operation.

Wheel-hoe utilized lower time probably due to rotational movement of the front wheel, which helps in ease of operation causing less fatigue to the operator and also recorded at yield of 4.8 t/ha which was 154% increase over control. Further, this hoe reported maximum area coverage (Table 2) with minimum cost of operation (` 714.3/ha) which as

Table 1. Effect of different weed control treatments on weed control efficiency, grain yield and economics in irrigated maize

Treatment	Weed control efficiency (%)			Grain yield (t/ha)	B:C ratio
	25 DAS	45 DAS	At harvest		
Weeding with crescent-hoe (25 and 45 DAS)	36.3	67.5	18.4	4.0	2.08
Weeding with multiweeder (25 and 45 DAS)	40.9	93.4	21.0	4.6	2.39
Weeding with wheel-hoe (25 and 45 DAS)	43.1	94.6	34.2	4.8	2.60
Weeding with rotary peg-weeder (25 and 45 DAS)	36.3	83.4	19.7	4.3	2.18
Hand weeding twice (25 and 45 DAS)	43.1	94.9	52.6	5.2	2.40
Atrazine 0.5 kg/ha as pre-emergence + HW at 45 DAS	52.2	94.6	72.3	5.4	2.87
Unweeded control	-	-	-	3.1	1.95
LSD (P=0.05)	0.51	0.72	0.68	0.45	0.21

Table 2. Effect of different weed control treatments on time taken for weeding at 25 and 45 DAS in irrigated maize

Treatment	25 DAS				45 DAS			
	Time taken		Manual weeding in intra rows (Mandays/ha)	Total time taken for weeding (Mandays/ha)	Time taken		Manual weeding in intra rows (Mandays/ha)	Total time taken for weeding (Mandays/ha)
	Hr/ha	Man days/ha			Hr/ha	Man days/ha		
Weeding with Crescent-hoe (25 and 45 DAS)	111.1	13.8	5.0	18.8	50.0	6.2	2.0	8.2
Weeding with Multiweeder (25 and 45 DAS)	83.3	10.4	4.0	14.2	43.4	5.4	3.0	8.4
Weeding with Wheel-hoe (25 and 45 DAS)	71.4	8.9	2.0	10.9	35.1	4.4	1.0	5.4
Weeding with Rotary peg-weeder (25 and 45 DAS)	142.9	17.8	3.0	20.8	58.8	7.3	2.5	9.8
Hand weeding twice (25 and 45 DAS)	256.0	32.0	-	32.0	104.0	13.0	-	13.0
Atrazine 0.5 kg/ha as pre-emergence + HW at 45 DAS	-	-	-	-	144.0	18.0	-	18.0
LSD (P=0.05)	12.53	2.24	0.12	0.92	15.6	0.44	0.66	0.25

such seems to be the most promising weeding tool for those areas where labour is costly and not easily available. This finding is in accordance with Singhal (1998) that wheel-hoe can cover about 0.2 ha/day during weeding operation.

Wheel-hoe covered more area at both the stages of crop growth in comparison to the remaining weeders. The time taken to complete the weeding operation decreased in wheel-hoe weeding twice (71.4 and 35.7 hr/ha at 25 and 45 DAS, respectively) with the increased width (20 cm) of blades.

The usage of manually operated weeders reduced the cost spent on weeding resulted in least cost of cultivation. Experimental results, conducted by Singh and Sahay (2001) confirmed the above findings.

The results of this study indicated that the use of wheel-hoe not only proved economical (4.8 t/ha of grain and B: C ratio of 2.6) but also useful for completing the weeding operation at a lesser time.

SUMMARY

A field experiment was conducted to evaluate the weed control efficiency and time saving on weeding operation of different manually operated weeders in irrigated maize. Among the manually operated weeders evaluated, wheel hoe registered an yield increase of 154% over control, took less time (71.4 hr/ha), covered maximum area with minimum cost of operation (` 714.3/ ha) and also required less number of mandays to complete the weeding operation (5.46 man days/ha). Among the mechanical weeders, the highest grain yield of 4.8 t/ha was recorded with wheel hoe weeding twice on 25 and 45 DAS and on par with pre-emergence application of atrazine 0.5 kg/ha on 3 DAS followed by one hand weeding on 45 DAS.

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