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Weed Dynamics and Productivity of Hybrid Maize (*Zea mays*) as Affected by Integrated Weed Management Practices

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A B S T R A C T

A field experiment was conducted during *Rabi* season of 2015-2016 at Agricultural College and Research Institute, Killikulam to find out the most effective weed control measure study weed dynamics, productivity and economics of hybrid maize as affected by integrated weed management. None of the pre-emergence herbicides alone provided desired control of weeds. However, inclusion of one hand weeding at 30 DAS with pre-emergence herbicides markedly improved weed control efficiency (WCE), yield attributes, grain and stover yield. Alachlor @ 1.5 kg a.i./ ha + HW at 30 DAS proved most effective in controlling weeds (WCE 90.33%) followed by two hand weedings at 15 and 30 DAS(WCE 84.08%) and they reduce the weed density and weed biomass significantly, which in turn increased yield compared with unweeded control. Significantly highest grain yield were recorded underalachlor @ 1.5 kg a.i./ ha + HW at 30 DAS (7115 kg ha^{-1}) followed by two hand weedings at 15 and 30 DAS (6855 kg ha^{-1}) and mechanical weeding with power weeder twice on 15 and 30 DAS(6714 kg ha^{-1}). The highest net returns and highest benefit: cost ratio were obtained under alachlor @ 1.5 kg a.i./ ha + HW at 30 DAS followed by two hand weedings at 15 and 30 DAS.

Introduction

Maize (*Zea mays* L.) is an important cereal crop of India. The grains of maize are used in a variety of ways by the human beings. Recently, with the release of improved cultivars and hybrids, the grain yield has been increased but still the maize crop faces many problems. Farmers usually give prime importance to few cultural practices and neglect other factors like seed rate and weed control. Maize crop gets infested with variety of weeds and subjected to heavy weed competition, which often inflicts huge losses ranging from 28 to 100 % (Patel *et al.*, 2006). Weed management strategies attempt to limit the deleterious effects of weeds growing with crop plants. These effects could be quite variable, but the most common is competition for available resources. The quantities of growth factors used by weeds are thus unavailable to the crop. The extent of nutrient loss varies from 30-40 % of the applied nutrients (Mundra *et al.*, 2002). Hence,

suitable weed control strategies in maize can be the sequential use of pre-emergence and post-emergence herbicides or a pre-emergence herbicide application followed by two hand weedings or intercultural operation with power weeder so that the crop is protected well against the weeds during the critical period of crop weed competition. Atrazine, alachlor and pendimethalin are widely used for control of weeds in maize. But their continuous use for long time may lead development of herbicide resistance in weeds (Pandey *et al.,* 2000). Hence, there is a need to develop integrated weed management strategies for effective weed control and to realize higher maize productivity.

Materials and Methods

The field experiment was conducted during*Rabi* season of 2015-2016 at Department of farm management, Agricultural College farm, Agricultural College and Research Institute, Killikulam. The experimental field is geographically located in the southern part of Tamil Nadu at 8°46' North latitude and 77° 42' East longitude at an altitude of 40 meters above mean sea level. The experimental site was sandy clay loam, 0.34% organic carbon, neutral in reaction (pH 7.28), low in available N (198 kg ha^{-1}), low in available P (10.1 kg ha^{-1}) and medium in available K (139 kg ha^{-1}).

The experiment was laid out in a randomized block design with three replications. The gross plot size was 5 x 3.6 m and net plot size was 4.5 x 3.1 m. A set of nine twelve treatments comprising T_1 - Alachlor @ 1.5 kg a.i ha^{-1}, T_2 - Alachlor @ 1.5 kg a.i ha^{-1} + one hand weeding on 30 DAS, T_3 - Alachlor @ 1.5 kg a.i ha^{-1} + one mechanical weeding with power weeder on 30 DAS, T_4 - Atrazine @ 0.25 kg a.i ha^{-1}, T_5 - Atrazine @ 0.25 kg a.i ha^{-1} + one hand weeding on 30 DAS, T_6 - Atrazine @ 0.25 kg a.i ha^{-1} + one mechanical weeding with power weeder on 30 DAS ; T_7 - Pendimethalin @ 0.75 kg a.i ha^{-1}, T_8 - Pendimethalin @ 0.75 kg a.i ha^{-1} + one hand weeding on 30 DAS, T_9 - Pendimethalin @ 0.75 kg a.i ha^{-1} + one mechanical weeding with power weeder on 30 DAS, T_{10} - Hand weeding twice on 15 and 30 DAS, T_{11}-Mechanical weeding with power weeder twice on 15 and 30 DAS, T_{12} - Unweeded control. Maize hybrid COH (M) 6 sown with a spacing of 60 x 25 cm. Crop was fertilized with 250:75:75 Kg NPK ha^{-1} through urea, single super phosphate and muriate of potash respectively.

Thinning was done at 15 DAS to maintain plant to plant distance of 25 cm. Thinning was done at 10 DAS to maintain plant to plant distance of 25 cm. All the herbicides dissolved in water (500 L ha^{-1}) were sprayed as pre-emergence on the next day of sowing.

Results and Discussion

Weed flora

The predominant weed species observed in the experimental field were *Cyperus rotundus* among sedges, *Cynodon dactylon* among grasses and *Digeraarvensis*, *Trianthema portulacastrum*, *Cleome viscosa* and *Phyllanthus niruri* among broad-leaved weeds. Among all the three weed groups, the most predominant weed species observed was *Cyperus rotundus*.

Plant height, leaf area index and dry matter production

Highest plant height, leaf area index and dry matter production was noticed with alachlor @ 1.5 kg a.i ha^{-1} with one hand weeding on 30 DAS (T_2) which was however, on par with hand weeding twice on 15 and 30 DAS (T_{10}) (Table 1). This might be due to lesser weed infestation as evident from lower weed dry matter.

Table.1 Growth and yieldof hybrid maize as influenced by different weed management practices

Treatments	Plant height (cm) at harvest	LAI (60 DAS)	Dry matter production (kg ha^{-1}) at harvest	Crop Growth Rate (kg ha^{-1} day^{-1}) (30-60 DAS)	Grain yield (kg ha^{-1})
T_1 - Alachlor @ 1.5 kg a.i ha^{-1} (PE)	221.0	4.03	15970	212.7	6431
T_2 - Alachlor @ 1.5 kg a.i ha^{-1}+ one hand weeding on 30 DAS	244.6	4.46	17660	235.2	7115
T_3 - Alachlor @ 1.5 kg a.i ha^{-1}+ one mechanical weeding with power weeder on 30 DAS	226.7	4.13	16350	217.7	6584
T_4 - Atrazine @ 0.25 kg a.i ha^{-1} (PE)	205.1	3.74	14780	196.7	5959
T_5 - Atrazine @ 0.25 kg a.i ha^{-1}+ one hand weeding on 30 DAS	228.4	3.90	15430	207.7	6218
T_6 - Atrazine @ 0.25 kg a.i ha^{-1}+ one mechanical weeding with power weeder on 30 DAS	208.2	3.80	15040	200.3	6053
T_7 - Pendimethalin @ 0.75 kg a.i ha^{-1} (PE)	208.6	3.50	13870	184.0	5581
T_8 - Pendimethalin @ 0.75 kg a.i ha^{-1}+ one hand weeding on 30 DAS	199.5	3.63	14380	191.2	5793
T_9 - Pendimethalin @ 0.75 kg a.i ha^{-1}+ one mechanical weeding with power weeder on 30 DAS	196.4	3.58	14170	189.2	5711
T_{10} - Hand weeding twice on 15 and 30 DAS	235.7	4.30	17020	226.2	6855
T_{11} - Mechanical weeding with power weeder twice on 15 and 30 DAS **T_{12}- Un weeded control**	231.0 170.7	4.21 3.12	16660 12340	221.7 164	6714 4967
SEd	**5.5**	**0.39**	**402**	**5.4**	**162**
CD (p=0.05)	**11.5**	**0.81**	**832**	**11.1**	**335**

Table.2 Weed dynamics and weed control efficiency of hybrid maize as influenced by different weed management practices

Treatments	Weed density (No. m^{-2})	Weed dry matter (kg ha^{-1})	*Weed control efficiency (%)
T_1 - Alachlor @ 1.5 kg a.i ha^{-1} (PE)	42.61 (6.57)	475.1	80.48
T_2 - Alachlor @ 1.5 kg a.i ha^{-1}+ one hand weeding on 30 DAS	31.46 (5.65)	186.0	90.33
T_3 - Alachlor @ 1.5 kg a.i ha^{-1}+ one mechanical weeding with power weeder on 30 DAS	27.24 (5.27)	447.3	82.79
T_4 - Atrazine @ 0.25 kg a.i ha^{-1} (PE)	46.58 (6.86)	681.4	69.65
T_5 - Atrazine @ 0.25 kg a.i ha^{-1}+ one hand weeding on 30 DAS	24.41 (4.99)	583.6	73.71
T_6 - Atrazine @ 0.25 kg a.i ha^{-1}+ one mechanical weeding with power weeder on 30 DAS	28.97 (5.43)	647.2	71.69
T_7 - Pendimethalin @ 0.75 kg a.i ha^{-1} (PE)	49.64 (7.08)	862.4	64.89
T_8 - Pendimethalin @ 0.75 kg a.i ha^{-1}+ one hand weeding on 30 DAS	24.78 (5.03)	780.3	66.34
T_9 - Pendimethalin @ 0.75 kg a.i ha^{-1}+ one mechanical weeding with power weeder on 30 DAS	28.54 (5.39)	836.6	63.55
T_{10} - Hand weeding twice on 15 and 30 DAS	20.87 (4.62)	394.6	84.08
T_{11} - Mechanical weeding with power weeder twice on 15 and 30 DAS	44.36 (6.70)	418.2	83.59
T_{12}- Un weeded control	134.35 (11.61)	1756.2	-
SEd	**0.34**	**1.05**	**-**
CD (p=0.05)	**0.70**	**2.19**	**-**

*Data not statistically analysed

The LAI (leaf area index) and CGR (crop growth rate) increased upto 90 DAS and declined there after marginally due to senescence. Alachlor @ 1.5 kg a.i ha^{-1} with one hand weeding on 30 DAS (T_2) created weed free environment, reduce weed density and biomass, which would have favoured the crop to grow well, producing more photosynthetic area, which ultimately lead to higher LAI and CGR. Better stature of crop, as reflected by taller plants, higher LAI and CGR would have enhanced the photosynthesis, which in turn resulted in higher dry matter production (Table 1).

Grain yield

The highest grain yield was recorded with alachlor @ 1.5 kg a.i ha^{-1} as pre-emergence with one hand weeding on 30 DAS (Table 1), which was in parity with hand weeding twice on 15 and 30 DAS. This was due to lesser crop weed competition for growth resources throughout the crop growth period and availability of congenial environment for better expression of growth and yield potential. Similar findings were reported by Pandey *et al.,* (2001), Sunitha *et al.,* (2011) and Sandhya Rani and Karuna Sagar (2013). Heavy weed infestation in control (T_{12}) had deprived the crop for all the growth resources and resulted in poor performance of corn (Table 1).

Weed density, dry matter and weed control efficiency

Weed population and dry weight were significantly reduced due to all weed-control treatments compared with the weedy check. Among the various weed management practices, the lowest weed population and dry weight were recorded under alachlor @ 1.5 kg a.i ha^{-1} with one hand weeding on 30 DAS (T_2) (Table 2). This indicated that sequential application of herbicides has reduced the weed density compared to the application of pre-emergence herbicides alone. Hand weeding twice on 15 and 30 DAS (T_{10}) is at a par with T_2 treatment (Table 2). Lower weed dry matter was noticed at all the stages of crop growth. Removal of weeds that germinated along with crop during the first hand weeding and removal of weeds that germinated afterwards during the second hand weeding and smothering of weeds by crop thereafter could be attributed to this. Invariably unweeded control (T_{12}) registered highest total weed population and dry weight with maximum grass, sedge and broad leaved weed populations (Table 2). The current results are in conformity with the findings of Pandey *et al.,* (2000), Maliya and Singh (2007).

Weed-control efficiency (WCE) of different treatments varied from 63.55-90.33%. Among all the treatments, alachlor @ 1.5 kg a.i ha^{-1} with one hand weeding on 30 DAS (T_2) was the most effective in controlling the weeds (WCE 90.33%), followed by hand weeding twice on 15 and 30 DAS(T_{10})(WCE 84.08%) (Table 2). This could be attributed to the weed free condition achieved during the critical period of crop growth with two hand weeding. Weed control efficiency recorded with pre-emergence application of atrazine with one hand weeding was high at all the stages of crop growth. This could be due to the fact that the initial weed population was effectively controlled by persistence activity of pre-emergence application of atrazine. The results are in line with the findings of Malviya *et al.,* (2012), Mundra *et al.,* (2002), Selvakumar and Sundari (2006) and Kamble *et al.,* (2005).

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