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Efficacy of Pre and Post Emergence Herbicides on Sequential Basis for Weed Control in Maize (*Zea mays* L.)

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ABSTRACT

A field experiment was conducted at Agricultural College Farm, Bapatla on sandy clay loam soils during the *kharif* 2014 to study the effect of pre-emergence (Atrazine @ 1.0 kg a.i ha^{-1} and pendimethalin @ 1.0 kg a.i ha^{-1}) and post-emergence (Topramezone @ 25 g a.i ha^{-1}) herbicides on growth and yield of maize. Hand weeding at 20 and 40 DAS recorded the lowest density and dry weight of weeds and the highest weed control efficiency which resulted in enhanced level of plant growth, yield attributes and grain yield. Atrazine @ 1.0 kg a.i ha^{-1} fb topramezone @ 25 g a.i ha^{-1} at 20 DAS and pendimethalin @ 1.0 kg a.i ha^{-1} fb topramezone @ 25 g a.i ha^{-1} at 20 DAS were on a par with each other with hand weeding treatment at 20 and at 40 DAS for weed control efficiency as well as in plant growth and yield.

Key words : Economics, Maize, Pre and post-emergence herbicides, Yield.

Maize, a cereal grain produced worldwide, assume importance to subsistence farmers and commercial farmers while occupying a prominent position in global agriculture. In India, it is grown in an area of 9.43 million hectares with an annual production of 24.35 million tonnes. (Ministry of Agriculture, Government of India, 2013-14) and ranks third after rice and wheat in terms of production besides contributing nearly 9% to the national food basket.

Maize, which is mostly grown as rainfed crop during *kharif* faces a formidable weed problem, which compete severely for growth resources. The yield loss owing to weeds may extend from 33 to 50 per cent (Sharma *et al.*, 2000). Maximum yield loss of maize due to weed competition is estimated to occur during the first 3-6 weeks, i.e., before the canopy has developed thick enough to smother the weeds (Shad *et al.,* 1993). Wider row spacing and slow crop growth during the initial 3-4 weeks (Nagalakshmi *et al.,* 2006) makes maize highly sensitive to weed competition upto 6 weeks growth period. Hence, to realize optimum yields in maize thorough weed management is a must during the initial 6 weeks of crop growth which is considered critical for crop weed competition. The yield losses reported in maize due to uncontrolled weed growth ranged from 30 to 100% (Rout and Satpathy, 1996). Rainy season corresponds to heavy and continuous rains besides scarcity of labour, renders difficult to control the weeds by conventional, cultural and mechanical methods. Thus, chemical weed control assumes significance in the cultivation of maize. Herbicides not only curb the weeds timely and effectively but also offer greater scope for minimizing the cost of weed control irrespective of the situation. Use of pre and post-emergence application of herbicides would make herbicidal weed control more acceptable to farmers which will not change the existing agronomic practices but will allow for complete control of weeds. Pre-emergence application of herbicides will control the weeds upto 25 days and thereafter post-emergence application is given so that further growth of weeds can also be controlled. An investigation was carried out to the sequential application of pre-emergence and post-emergence herbicides in maize during *kharif* 2014.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* 2014 at Agricultural College Farm, Bapatla on sandy clay loam soil with pH 7.4, medium in organic carbon (0.52%), low in available N (258 kg ha^{-1}), high in available P (53.9 kg ha^{-1}) and

Table 1. Weed dynamics as influenced by different weed control treatments in

Treatments	*Weed density (No. m^{-2})				*Weed drymatter (g m^{-2})				**Weed control efficiency (%)			
	30 DAS	60 DAS	90 DAS	Maturity	30 DAS	60 DAS	90 DAS	Maturity	30 DAS	60 DAS	90 DAS	Maturity
T1 - Weedy check	13.2 (173.7)	14.3 (205.4)	12.4 (153.7)	10.7 (115.0)	13.8 (189.8)	18.4 (337.8)	15.7 (247.2)	14.1 (197.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
T2 - Hand weeding at 20 & 40 DAS	3.9 (15.3)	5.2 (27.3)	6.2 (38.6)	5.5 (29.7)	3.7 (13.5)	5.0 (24.9)	7.7 (59.6)	7.5 (56.5)	74.5 (92.9)	73.6 (92.7)	60.3 (75.2)	57.7 (71.4)
T3 - Pendimethalin @ 1.0 kg a.i ha^{-1} (PE)	7.6 (57.3)	8.9 (78.2)	8.4 (70.3)	7.6 (57.4)	7.9 (62.8)	9.9 (97.7)	10.7 (114.9)	9.8 (95.2)	54.8 (66.8)	57.5 (71.1)	46.3 (52.3)	45.6 (51.3)
T4 - Atrazine @ 1.0 kg a.i ha^{-1} (PE)	7.2 (52.4)	8.6 (74.4)	8.1 (64.8)	7.3 (52.1)	7.6 (56.9)	9.7 (93.6)	10.4 (107.7)	9.3 (87.6)	56.8 (70.0)	58.2 (72.1)	47.9 (54.9)	47.7 (54.7)
T5 - Topramezone @ 25 g a.i ha^{-1} at 20 DAS (POE)	7.1 (50.2)	7.5 (56.5)	7.1 (50.3)	6.7 (44.3)	6.4 (41.2)	7.8 (60.7)	8.0 (64.6)	7.9 (61.0)	62.0 (77.8)	64.9 (81.8)	59.2 (73.8)	56.2 (69.0)
T6 - Topramezone @ 25 g a.i ha^{-1} at 40 DAS (POE)	12.7 (162.3)	9.0 (81.3)	8.1 (64.6)	6.8 (46.6)	13.2 (172.9)	9.1 (83.4)	8.5 (72.2)	7.7 (59.4)	15.0 (8.3)	60.1 (75.0)	56.8 (69.8)	56.8 (70.0)
T7 - Topramezone @ 25 g a.i ha^{-1} at 20 & 40 DAS (POE)	6.6 (43.7)	6.8 (46.6)	6.7 (44.0)	5.8 (33.5)	6.3 (39.2)	7.5 (56.3)	7.8 (60.9)	7.6 (59.8)	62.8 (78.8)	66.0 (83.4)	60.2 (75.2)	56.7 (69.9)
T8 - Pendimethalin @ 1.0 kg a.i ha^{-1} fb topramezone@ 25 g a.i ha^{-1} at 20 DAS (POE)	5.7 (32.8)	6.6 (44.0)	7.0 (48.7)	6.2 (37.8)	5.9 (35.3)	7.4 (55.2)	10.1 (102.9)	8.9 (78.5)	64.5 (80.9)	66.3 (83.8)	49.0 (56.8)	50.9 (59.9)
T9 - Atrazine @ 1.0 kg a.i ha^{-1} fb topramezone@ 25 g a.i ha^{-1} at 20 DAS (POE)	5.5 (30.5)	6.1 (37.0)	6.4 (40.3)	5.7 (32.0)	5.4 (29.2)	7.2 (51.2)	9.8 (95.3)	8.5 (71.7)	66.9 (84.6)	67.1 (84.7)	51.5 (61.2)	52.8 (63.3)
SEm±	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.5	2.4	2.4	2.8	2.6
CD (p=0.05)	1.3	1.4	1.4	1.1	1.2	1.4	1.5	1.5	7.1	7.1	8.4	7.9
CV (%)	9.8	9.9	10.7	9.4	9.2	9.0	9.1	9.7	8.1	7.2	10.1	9.7

* Square root transformed values **Arc sin transformed values
The figures in parentheses are original values

available K (539.8 kg ha^{-1}). The experiment was laid out in Randomized Block Design with nine weed control treatments replicated thrice. The maize hybrid 'LAXMI 2277' was sown by hand dibbling and the crop was grown by adopting the recommended package of practices. Weed control in experimental plots was done as per the treatments proposed for evaluation. Calibrated quantity of herbicides were applied as aqueous spray (500 L ha^{-1}) with knapsack sprayer fitted with flat fan nozzle. Pre-emergence application of herbicide was done within 24 hours of sowing maize and post-emergence application of topramezone @ 25 g a.i ha^{-1} at 20 DAS. Data on weeds was recorded at four places per plot at 30, 60, 90 DAS and at maturity using a quadrant of 0.25 m^2. Data pertaining to weed density and dry weight was subjected to square root transformation $\sqrt{x + 0.5}$ and weed control efficiency was subjected to arc sin transformation for statistical analysis. Observations on crop such as plant growth and yield parameters were recorded at 30, 60, 90 DAS and at maturity as per standard procedure. Cost of cultivation in each treatment was worked out to obtain total cost of cultivation. Based on the prevailing market price of the produce and cost of cultivation, the net returns and B: C ratio was computed.

RESULTS AND DISCUSSION

Weed flora

The predominant weed species observed in the experimental field were *Cyperus rotundus* among sedges, *Trianthema portulacastrum,*

Table 2. Yield attributing characters, yield and economics of maize as influenced by different weed control treatments

Treatments	Cob length (cm)	Grains			Grain weight cob^{-1} (g)	100 grain weight (g)	Yield (kg ha^{-1})		*Weed index (%)
		rows cob^{-1}	row^{-1}	cob^{-1}			Grain	Stover	
T1 - Weedy check	12.6	12.1	22.2	270.6	69.0	20.9	2917	4477	45.8 (51.4)
T2 - Hand weeding at 20 & 40 DAS	18.4	14.7	30.0	456.4	128.3	26.9	5974	7837	0.0 (0.0)
T3 - Pendimethalin @ 1.0 kg a.i ha^{-1} (PE)	16.9	13.4	25.0	334.8	85.1	23.5	3791	5285	37.2 (36.5)
T4 - Atrazine @ 1.0 kg a.i ha^{-1} (PE)	16.7	13.6	25.2	342.0	89.5	23.8	3822	5418	36.9 (36.0)
T5 - Topramezone @ 25 g a.i ha^{-1} at 20 DAS (POE)	16.2	13.1	24.0	311.3	88.6	22.9	4048	5656	34.6 (32.2)
T6 - Topramezone @ 25 g a.i ha^{-1} at 40 DAS (POE)	14.3	12.6	22.0	290.4	75.2	22.0	3482	5249	40.0 (41.6)
T7 - Topramezone @ 25 g a.i ha^{-1} at 20 & 40 DAS (POE)	16.9	13.9	25.1	349.9	93.7	25.2	4623	6564	28.4 (22.6)
T8 - Pendimethalin @ 1.0 kg a.i ha^{-1} fb topramezone @ 25 g a.i ha^{-1} at 20 DAS (POE)	17.1	14.2	28.8	422.0	99.6	26.1	5282	7291	18.1 (11.4)
T9 - Atrazine @ 1.0 kg a.i ha^{-1} fb topramezone@ 25 g a.i ha^{-1} at 20 DAS (POE)	17.8	14.4	30.3	436.4	109.2	26.7	5627	7652	13.9 (5.8) 1.9 5.8 11.9
SEm±	0.5	0.4	0.9	11.4	3.3	0.8	213	332	
CD (p=0.05)	1.5	1.2	2.7	34.2	10.0	2.3	640	994	
CV (%)	5.4	4.9	5.9	5.5	6.2	5.5	8.4	9.3	

*The data are arc sin transformed values. The figures in parentheses are original values

Cleome viscosa, Euphorbia hirta and *Phyllanthus niruri* among dicots and *Cynodon dactylon, Panicum repens* and *Dactyloctenium aegyptium* among grasses.

Effect on weeds

Among the weed control methods, hand weeding at 20 and 40 DAS (T_2) resulted in the lowest weed density, drymatter and the highest weed control efficiency throughout the crop growth period. This might be due to fact that the first hand weeding at 20 DAS eliminated all the early emerged weeds while the second hand weeding at 40 DAS removed the later germinated weeds keeping the weed density below the critical level of competition. The results are in conformity with the findings of Tripathi *et al.* (2005), Walia *et al.* (2007).

Even though treatments involving only pre-emergence herbicides application and pre-emergence herbicide application fb topramezone at 20 DAS recorded significantly superior result in respect of weed density, drymatter and weed control efficiency when compared to weedy check, better results were obtained when pre-emergence

herbicides treatments were followed by topramezone at 20 DAS. Among the sequential treatments atrazine @ 1.0 kg a.i ha^{-1} PE fb topramezone spray @ 25 g a.i ha^{-1} at 20 DAS (T_9) and pendimethalin @ 1.0 kg a.i ha^{-1} PE fb topramezone spray @ 25 g a.i ha^{-1} at 20 DAS (T_8) recorded better weed control results and were at par with hand weeding at 20 and 40 DAS. The better performance of this treatment might be due to the effective control of weeds achieved by atrazine upto 20 DAS and topramezone thereafter. The present findings are in conformity with the findings of Sreenivas and Satyanarayana (1994) and Sinha *et al*. (2003) and Aleem *et al.* (2012).

Yield attributes and yield

Hand weeding at 20 and 40 DAS (T_2) recorded the highest cob length, grain rows cob^{-1}, grains row^{-1}, total grains cob^{-1}, grain weight cob^{-1}, test weight (g/100 grains), grain yield and stover yield. Atrazine @ 1.0 kg a.i ha^{-1} PE fb topramezone spray @ 25 g a.i ha^{-1} at 20 DAS (T_9) and pendimethalin @ 1.0 kg a.i ha^{-1} PE fb topramezone spray @ 25 g a.i ha^{-1} at 20 DAS (T_8) were on a par with hand weeding (T_2) for the yield and yield attributes. The lowest yield and yield attributes were recorded with weedy check (T_1).

Higher grain yield in hand weeding at 20 and 40 DAS (5974 kg ha^{-1}), atrazine @ 1.0 kg a.i ha^{-1} PE fb topramezone spray @ 25 g a.i ha^{-1} at 20 DAS (5627 kg ha^{-1}) and pendimethalin @ 1.0 kg a.i ha^{-1} PE fb topramezone spray @ 25 g a.i ha^{-1} at 20 DAS (5282 kg ha^{-1}) might be due to greater availability of nutrients under lower weed competition, which might have promoted higher production and better translocation of photosynthates from source to sink. Severe weed competition reduced crop growth and drymatter accumulation in weedy check which resulted in the lowest cob yield. Similar results were also reported by Pandey *et al.* (2001), Srividya *et al*. (2011) and Aleem *et al.* (2012).

Pre-emergence herbicides alone could not improve the yield as they failed to reduce the weed germination and growth during the later part of the critical period of crop weed competition. The lowest green cob yield (2917 kg ha^{-1}) was recorded with the weedy check (T_1) clearly reflecting the competition by unchecked weed growth to the crop. Similar results were also reported by Aleem *et al.* (2012).

Topramezone would be complement to current weed management program in grain maize. Alternatively it can be used in sequential application to pre-emergence soil applied treatments (Porter *et al.,* 2005).

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