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EFFECT OF DIFFERENT HERBICIDES ON WEED CONTROL INDEX, GROWTH AND GRAIN YIELD OF HYBRID MAIZE

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Abstract

Field experiment was conducted at the Annamalai University, Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai Nagar to evaluate the new herbicides on growth and grain yield of hybrid maize during (Feb - June) 2015. The experiment was laid out in randomized block design with three replications and nine treatments. The treatment details are *viz.,* Weedy check (T_1), Lumax 440 ZC W/V @ 2.5 lit ha^{-1} on 3 DAS (T_2), Lumax 440 ZC W/V @ 3 lit ha^{-1} on 3 DAS (T_3), Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS (T_4), S - Metolachlor 96% EC @ 1lit ha^{-1} on 3 DAS (T_5), Mesotrione 48% SC @ 208 ml ha^{-1} on 3 DAS (T_6), Atrazine 50 WP @ 2 Kg ha^{-1} on 3 DAS (T_7), Paraquat dichloride 24% SL @ 2 lit ha^{-1} on 10 DAS (T_8) and twice hand weeding at 20 and 40 DAS (T_9). All the treatments were found to be significantly influenced the weed biometrics, growth attributes, yield attributes, grain and stover yields of maize. The result of the study clearly showed that pre-emergence application of Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS (T_4) significantly registered lesser weed biomass, maximum weed control Index (WCI), higher growth attributes *viz.,* plant height, LAI, DMP and yield attributes *viz.*, cob length, cob diameter and number of grains cob^{-1}, grain and stover yields of maize. However, it was on par with twice hand weeding at 20 and 40 DAS (T_9). Weedy check (T_1) recorded the higher weed biomass resulting in lesser values of growth and yield attributes and grain yield. From the results of the field study, it can be concluded that application of ready mix pre emergence herbicide Lumax 440 ZC W/V (S-Metolachlor 27.1% + Mesotrione 2.71% + Atrazine 10.2%W/W) @ 3.5 lit ha^{-1} on 3 DAS to hybrid maize was found to be an agronomically sound, economically viable practice and efficient weed management method for augmenting higher grain yield of hybrid maize.

Key words: Weed management, herbicides, hand weeding, weed control index, grain yield and maize

Introduction

Maize (*Zea mays* L.) is an important and versatile cereal grown over diverse environment and geographical ranges for human food, feed and fodder for livestock and maize serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc. (Arvadiya *et al.*, 2012). Worldwide maize is grown over an area of 168 million hectares with a production of 945.8 million tonnes and with the productivity of 5.7 t ha^{-1}. In India, maize occupies an area of 9.43 million hectares with a production of 24.35 million tonnes and the productivity of 2.54 t ha^{-1}. In Tamil Nadu, it is cultivated in an area of 0.22 million hectares with production of 0.81 million tonnes and a productivity of 3.7 t ha^{-1}. The low yield of maize under Indian conditions may be attributed by number of factors, among them weeds rank as prime enemy. Presence of weeds reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and there by reduces sink capacity of crop resulting in poor grain yield. Thus, the extent of reduction in grain yield of maize has been reported to be in the range of 28 to 100 per cent per cent depending on type of weed species in standing crop (Patel *et al.,* 2006). To minimize the weed losses, several weed control methods are available such as mechanical, cultural, chemical and biological methods. In Tamil Nadu, traditional hand weeding is the most efficient and widely adopted practice of weed control. But it is back breaking, labour intensive, time consuming and costly due to high wage rates which narrowed down

the profits of the cultivation. Keeping in view of these limitations, the use of herbicides is the best way which gives a quick and cost-effective solution of the numerous weed problems in maize field and hence has gained an important position over conventional methods (Chikoye *et al.,* 2004). The usage of pre-emergence herbicides has been advocated as the best option because of their ability to control weeds at initial growth stages of crop and also provide a weed competition free environment to ensure better crop establishment (Sunitha *et al*., 2010) in maize. However, the continuous use of single herbicide or herbicides having the same mode of action may lead to resistance problem in weeds. Hence it is necessary to test combination of the existing and new herbicide inlcluding atrazine, simazine, cyanazine, pendimethalin, acetochlor and metolachlor to control mixed weed flora in maize. On the other hand, herbicides offer economic and efficient weed control if applied at proper dose and stage. Keeping these in view, field experiment was conducted at the Annamalai University, Experimental Farm, Annamalainagar, to evaluate the effect of new premixed herbicide Lumax on hybrid maize.

Material and methods

Field Experiment was conducted at the Experimental farm, Annamalai University, Annamalainagar during (Febraury–June) 2015 to study the efficacy of new herbicides on weed management in hybrid maize. The experimental farm is geographically located at 11°24' North latitude and 79°44' East longitude with an altitude of 5.79 m above mean sea level. The weather at Annamalai nagar is moderately warm with hot summer months. During the cropping period received a rainfall of 162.9 mm with distribution over 10 rainy days. The soil of the experimental field is clay loam in texture. The fertility status of the soil was found to be low in available nitrogen (216 kg ha^{-1}), medium in available phosphorus (19 kg ha^{-1}) and high in available potassium (315 kg ha^{-1}). The maize hybrid Pioneer 30B07 was chosen for the study. The experiment was laid out in randomized block design with three replications and nine treatments. The treatment details are *viz.,* Weedy check (Control)-(T_1), Lumax 440 ZC W/V @ 2.5 lit ha^{-1} on 3 DAS-(T_2), Lumax 440 ZC W/V @ 3 lit ha^{-1} on 3 DAS-(T_3), Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS - (T_4), S-metolachlor 96% EC @ 1 lit ha^{-1} on 3 DAS - (T_5), Mesotrione 48% SC @ 208 ml ha^{-1} on 3 DAS-(T_6), Atrazine 50 WP @ 2 Kg ha^{-1} on 3 DAS-(T_7), Paraquat dichloride 24% SL @ 2 lit ha^{-1} on 15 DAS - (T_8) and Hand weeding twice at 20 and 40 DAS-(T_9). The recommended seed rate of 15 kg ha^{-1} was used for the trail. The seeds were sown by dibbling with a spacing of 60×20 cm. The fertilizers were applied to the experimental field as per the recommended manurial schedule of 135:62.5:50 kgs of N, P_2O_5 and K_2O ha^{-1}. The entire dose of phosphorus, potassium and half dose of nitrogen was applied as basal. The remaining half dose of nitrogen was top dressed in two equal splits at 25 and 45 days after sowing. As per the treatment schedule required quantity of pre and post emergence herbicides were sprayed with knapsack sprayer fitted with flood jet nozzle using 600 litres of water ha^{-1}. Pre emergence herbicides *viz*., Lumax 440 ZC W/V (S-Metolachlor 27.1% + Mesotrione 2.71%+Atrazine 10.2%W/W), S - Metolachlor 96% EC, Mesotrione 48% SC, Atrazine 50 WP were sprayed on 3 DAS and post emergence herbicide *viz*., Paraquat dichloride 24% SL was sprayed on 15 DAS with adequate soil moisture. Hoeing and hand weeding was done as per treatment schedule. Need based plant protection measures were taken up based on the economic threshold level of pest and disease.

Biometric observations on weeds

Weed biomass

Weeds in sample quadrates were collected from each plot separately at 30 and 60 DAS and root clipped off, oven dried at 80°C ± 5°C till a constant weight obtained and expressed in g m^{-2}.

Weed control index

The weed control index for each plot was calculated by using the formula suggested by Mishra and Tosh (1979) and recorded as percentage.

$$WCT = \frac{a-b}{a} \times 100$$

Where,

WCI = Weed control index

a = Weed biomass in unweeded control plot

b = Weed biomass in treated plot

Biometric observations on maize

Five plants in each plot were selected at random in border rows and tagged. These plants were used for recording all biometric observation at different stages of crop growth. Harvesting was done in each plot separately from the net plot area leaving the border rows. Grains were separated, dried, cleaned and grain yield was recorded plot wise at 12 per cent moisture content. The grain and stover yields were computed to Kg ha^{-1}

The data on various characters studied during the course of investigation were statistically analyzed as suggested by Gomez and Gomez (1984). For significant

results, the critical difference was worked out at 5 per cent probability level and statistical conclusions were drawn.

Result and discussions

Weed biomass (g m^{-2}) and weed control index (WCI)

Among the weed control measures, pre emergence application Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS (T_4) excelled others by recording the lowest weed biomass of 10.37 and 15.38 g m^{-2} at 30 and 60 DAS, respectively. The same treatment also registered higher weed control index of 86.72 per cent. This can be attributed to the better performance of premixed herbicides in reducing the weed infestation throughout the cropping period due its wide spectrum activity and its combination effect, as opined by Grzegorz *et al*. (2011) and Sonawane *et al.* (2014). It was followed by on par with twice hand weeding (T_9) by recording the weed biomass of 12.25 and 17.99 g m^{-2} at 30 and 60 DAS, respectively and weed control index of 84.47 per cent. Weedy check plot (T_1) registered significantly higher weed biomass of 72.71 and 115.81 gm^{-2} at 30 and 60 DAS, respectively, which may be due to sever weed infestation during entire cropping period under this treatment. The weed control index of 28.95 was found to be least in (T_6) Mesotrione 48% SC @ 208 ml ha^{-1} on 3 DAS.

Table 1: Effect of Lumax herbicide on weed biomass (g m^{-2}), WCI and growth characters of maize.

Treatments	Weed biomass (30 DAS)	Weed biomass (60 DAS)	WCI (%)	Plant height (cm)	LAI	Crop DMP (Kg ha^{-1})
T_1	72.71	115.81	-	97.56	3.03	4206
T_2	28.18	39.71	8.14 (65.71)	179.65	6.25	11029
T_3	17.93	26.34	8.82 (77.26)	197.04	6.98	12089
T_4	10.37	15.38	9.34 (86.72)	218.25	8.05	13696
T_5	40.81	68.66	6.42 (40.72)	134.54	4.10	7458
T_6	47.78	82.29	5.43 (28.95)	113.86	3.56	5806
T_7	30.91	45.04	7.85 (61.11)	169.74	5.71	9875
T_8	35.31	56.81	7.17 (50.94)	150.13	4.88	8532
T_9	12.25	17.99	9.22 (84.47)	213.12	7.64	13014
SEd	1.79	3.41	0.21	7.92	0.23	403
CD(p=0.05)	3.62	6.84	0.46	16.80	0.50	855

(Figure in parentheses indicate the original values)

Treatment details: Control - (T_1), **Lumax*** 440 ZC W/V @ 2.5 lit ha^{-1} on 3 DAS - (T_2), Lumax 440 ZC W/V @ 3 lit ha^{-1} on 3 DAS-(T_3), Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS-(T_4), S-metolachlor 96% EC @ 1 lit ha^{-1} on 3 DAS-(T_5), Mesotrione 48% SC @ 208 ml ha^{-1} on 3 DAS-(T_6), Atrazine 50 WP @ 2 Kg ha^{-1} on 3 DAS-(T_7), Paraquat dichloride 24% SL @ 2 lit ha^{-1} on 15 DAS - (T_8) and Hand weeding twice at 20 and 40 DAS-(T_9). **Lumax***-(S-Metolachlor 27.1% + Mesotrione 2.71% + Atrazine 10.2%W/W).

Growth attributes

Among the various treatments, application of Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS (T_4) had significantly registered the highest plant height of 218.25 cm, LAI of 8.05 and DMP of 13696 kg ha^{-1} (Table 1). This might be due to better weed control throughout the growth stages of maize and better availability of all resources *viz.,* light, moisture, space and nutrients to maize (Bibi, 2010). Besides, effective utilization of available nutrients which ultimately resulted in increased growth attributes of maize as reported by Gul and Khanday (2015). However it was on par with twice hand weeding (T_9), which is recorded the plant height of 213.12 cm, LAI of 7.64 and DMP of 13014 kg ha^{-1}. The control (T_1) registered the least plant height of 97.56 cm, LAI of 3.03 and DMP of 4206 kg ha^{-1}. This might be attributed to severe weed competition from the beginning of the crop which interfered with nutrient uptake, light and space for rooting resulted in poor growth characters of crop, this is turn in least values of growth attributes under weedy check. This observation was in accordance with the report of Khan *et al*. (2012).

Yield attributes

The treatment Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS (T_4) significantly recorded the highest cob length of 21.82 cm, cob diameter of 9.75 cm and grain number cob^{-1} of 385.08. The better suppressing of weeds at early stage favored the vigorous growth and establishment of crop, without any crop weed competition and with sustained nutrient availability leads to better uptake of NPK by the crop might have contributed to the increased yield attributes which had a favorable effect in getting increased yield components. These results are in agreement with the findings of Hawaldar and Agasimani (2012). This treatment followed by on par with twice hand weeding (T_9) with cob length of 21.31 cm, cob diameter of 9.52 cm and grain number cob^{-1} of 376.08. No significant difference was observed among the treatments in regard to hundred grain weight. The least values of cob length, cob diameter, number of grains cob^{-1}, 100 grain weight was observed in weedy

Table 2: Effect of Lumax herbicide on yield attributes and grain yield of maize

Treatments	Cob length (cm)	Cob Diameter (cm)	No.of grains cob^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1	11.47	5.41	192.78	24.37	2163	3244
T_2	19.19	8.43	326.10	27.65	5285	7927
T_3	20.29	8.92	350.76	28.24	5796	8694
T_4	21.82	9.75	385.08	28.93	6418	9627
T_5	15.81	6.93	268.42	26.25	3957	5935
T_6	13.87	6.04	245.88	25.42	3348	5022
T_7	18.63	8.25	314.58	27.43	4993	7489
T_8	17.43	7.57	291.02	26.81	4417	6625
T_9	21.31	9.52	376.08	28.74	6268	9402
SEd	0.39	0.15	8.99	1.62	142	247
CD(p=0.05)	0.82	0.32	19.05	NS	301	524

Treatment details: Control - (T_1), **Lumax*** 440 ZC W/V @ 2.5 lit ha^{-1} on 3 DAS-(T_2), Lumax 440 ZC W/V @ 3 lit ha^{-1} on 3 DAS-(T_3), Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS-(T_4), S-metolachlor 96% EC @ 1 lit ha^{-1} on 3 DAS-(T_5), Mesotrione 48% SC @ 208 ml ha^{-1} on 3 DAS-(T_6), Atrazine 50 WP @ 2 Kg ha^{-1} on 3 DAS-(T_7), Paraquat dichloride 24% SL @ 2 lit ha^{-1} on 15 DAS - (T_8) and Hand weeding twice at 20 and 40 DAS - (T_9). **Lumax*** - (S-Metolachlor 27.1%+Mesotrione 2.71%+trazine 10.2%W/W).

check plot.

Grain Yield

All the treatments significantly influenced the grain and stover yields**.** Among the treatments Lumax 440 ZC W/V @ 3.5 lit ha^{-1}on 3 DAS (T_4) significantly registered the highest grain yield of 6418 kg ha^{-1} and stover yield of 9627 kg ha^{-1}. Efficient weed control during the critical period of crop weed competition, higher LAI and sustained availability of nutrients for uptake of the crop contributed to higher post flowering photosynthesis and assimilate portioning to sink, might be reason for higher grain and stover yield. Similar results have been discussed by Kamble *et al.* (2015). However, this treatment on par with twice hand weeding (T_9), which was registered the grain yield of 6268 kg ha^{-1} and stover yield of 9402 kg ha^{-1}. This might be due to better removal of weeds at early stage favoured the growth and yield components, which is reflected registering higher grain and stover yield of maize with this treatment. The next in order of ranking were T_3 and T_4. Among the herbicide application, Mesotrione 48% SC @ 280 ml ha^{-1} on 3 DAS registered lower yield attributes and yield of maize. This might be due to inadequacy of herbicide required to control weeds during cropping period. Similar finds have been reported by Patel *et al*. (2006). The lowest grain yield of 2163 kg ha^{-1} and stover yield of 3244 kg ha^{-1} were recorded in weedy check. This could be attributed to greater removal of nutrients by weeds and severe crop weed competition resulted in poor source and sink development with lesser yield components and yield of crop. This was conformity with the findings of Riaz *et al.* (2007).

Conclusion

Based on the results of the study, it can be concluded that efficient and economic weed management in maize could be achieved by application of pre emergence herbicide Lumax 440 ZC W/V @ 3.5 lit ha^{-1} on 3 DAS. It effectively reduced the infestation of weeds and favored the growth attributes, yield attributes, yield of hybrid maize.

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