RESEARCH ARTICLE

PERFORMANCE OF NEW HERBICIDE MOLECULES FOR WEED MANAGEMENT IN MAIZE

Omprakash Sahu and A.K. Sinha*

RMD College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya Ambikapur, Surguja- 497001 (Chhattisgargh)
Email: amitksinha11@gmail.com

Received-09.08.2020, Revised-28.08.2020

Abstract: A field experiment on "performance of new herbicide molecules for weed management in maize" was conducted on the RMD College of Agriculture & Research Station, Ambikapur, during the *kharif* season of 2019-20. Soil of the experimental field was sandy loam in texture. Nine treatments herbicidal combination of weed management practices were study in randomized block design and 3 times replicated under rainy season. weed control treatments atrazine 1000 g ha^{-1} (P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS was preformed mostly higher than all the other herbicidal treatments for growth, yield attributes viz., cob length, cob girth, number of kernel rows cob^{-1}, number of kernels row^{-1}, 100 kernel weight and kernel yield (5954.00 kg ha^{-1}) and also found lower weed density, lower weed dry weight and effective for complex weed flora. which was found statistically at par with atrazine 1000 g ha^{-1} (P.E.) fb tembotrione 120 g ha^{-1} at 25 DAS and atrazine 750 g ha^{-1}(P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS. At 60 DAS, lower weed index and higher weed control efficiency recorded with atrazine 1000 g ha^{-1} (P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS. Although weed free check is most effective treatment as compare to herbicidal combinations.Highest net returns and B:C ratio was recorded in atrazine 1000 g ha^{-1} (P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS (₹ 66082.62 ha^{-1} and 1.49) followed by higher net return under atrazine 1000 g ha^{-1} fb tembotrione 120 g ha^{-1} at 25 DAS (₹ 62573.43 ha^{-1}), atrazine 750 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS (₹ 62506.87 ha^{-1}) and higher B:C ratio atrazine 750 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS (1.42) and atrazine 1000 g ha^{-1} fb tembotrione 120 g ha^{-1} at 25 DAS (1.39).

Keywords: Maize, Weed management, Herbicide Combinations

INTRODUCTION

Maize (*Zea mays* L.) is the most widely distributed crop in the world and cultivated in the tropics, sub-tropics and temperate regionsranks next to wheat and rice.Being a C_4 plant, it is capable to utilize solar radiation more efficiently even at higher radiation intensity and it is also **of cereals**which occupies pride place in Indianagriculture and contributing around 24% of total cereal production (Singh *et al.* 2011).

Maize or corn serves as basic row material foragriculture based industryand over 85% of its production in India is used as various processed products like oil, starch, alcoholic beverages, food sweetener, cosmetics, films, gums,corn syrup, popcorn, corn flakes, roasted ears, biscuits, instant upma, instant kesari bhat, ready to eat maize puffs and chapaties etc.Maize provides food to the human beings and feed to the cattle.Maize grains are a good source of carbohydrates (60% starch), lipids (5%) and protein content (7-8%).In India, maize is grown over an area of 8.69 million ha with an average production of around 28.75 MT and productivity is 2689 kg ha^{-1}(Rakshit and Karjagi, 2018).The most important maize growing states are Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, Rajasthan, Bihar, Uttar Pradesh, Gujarat and Madhya Pradesh, which account for more than 80% of the total maize area of the country and also account for similar share in production. Both area and production of maize have been steadily increasing. In Chhattisgarh, it occupies an area of 228.00 thousand hectares productivity of 2570 kg ha^{-1} (Ministry of Agriculture and farmers welfare, Government of India, 2018).The competition of weeds with crop for nutrients, water, light and space isresponsible for poor yield of maize (Kumar *et al*. 2015)

Weeds are responsible for reduction in yield depending on complex flora and severity of infestation under various fields. The most critical period for crop-weed competition is first six weeks after planting of crop which may reduce yield by 28-100% (Dass *et al.* 2012). A wider row spacing and sowing of the crop with the onset of monsoon provides a favorable environment for weed growth. Apart from offering competition for light, space and moisture, it also helps the weeds to absorb more nutrients and it varies from 30-40% of the applied nutrients (Mundra *et al*. 2002).A higher level of infestation combined with many weed species poses a serious problem in *kharif* maize which includes almost all types of weeds viz., grassy, broad leaved and sedgesweeds. The choice of weed management measures largely depends on its effectiveness and economics and there is an immense need to find out the best chemical for effective weed management in maize. Use of pre- and post-emergence application ofherbicides would make herbicidal weed control more acceptable to farmers. Atrazine is recommended since long as pre-emergence herbicide, is not effective against grasses and

*Corresponding Author

sedges.Control of grasses and sedges remain a problem for the farmers, especially when the too high or too low soil moisture hinders the intercultural operation and scarcity of labour during critical stages of weeding. Hence, present study has beenconducted to evaluate the efficacy of new herbicide molecules in different treatment combinations as well as sequential applications along with very famous herbicide "Atrazine".

MATERIALS AND METHODS

The field experiment was carried out during *Kharif* season of 2019-20 at the Research farm, RMD College of Agriculture & Research Station, Ambikapursituated at $23^0$18' N latitude and $83^0$15' Elongitude and at altitude of 611 meter above mean sea level which represents the northern hills agro-climatic zone of Chhattisgarh. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.7), medium in organic carbon (0.56), available nitrogen (234 kg ha^{-1}), available phosphorus (8.4 kg ha^{-1}) and available potassium (268 kg ha^{-1}). The experiment was carried out in randomized block design (RBD) with 3 replications. The treatments contained of nine weed management practices. The treatment comprised of weedy check, weed free check, atrazine 1000.0 g *a.i.* ha^{-1} as pre-emergence + 1 hand weeding at 25 DAS, atrazine 750 g ha^{-1}as PE + Topramezone 25.2 gha^{-1} at 25 DAS, atrazine 750 g ha^{-1}as PE fbtembotrione 120 g ha^{-1} PoE at 25 DAS,atrazine 1000 g ha^{-1}as PE + Topramezone 25.2 gha^{-1} at 25 DAS,atrazine 1000 g ha^{-1}as PE fbtembotrione 120 g ha^{-1} PoE at 25 DAS, Topramezone 25.2 gha^{-1}+atrazine 750 g ha^{-1}at 15 DAS and tembotrione 120 g ha^{-1} + atrazine 750 g ha^{-1}at 15 DAS,. Sowingwas done manually in 2^{nd} week of July 'Super 502' maize hybrid variety was used. The crop was fertilized with recommended dose of fertilizer (150:80:60 kg ha^{-1} N: P_2O_5: K_2O) were applied equally in all treatments through iffco (12:32:16), urea and MOP.One fourth nitrogen, full dose of P_2O_5 and K_2O were applied as basal at the time of sowing. Remaining nitrogen was top dressed in three equal splits at Knee high stage (30 DAS), tasseling stage (50 DAS) and seed setting (65 DAS) equally in all treatments. Maize hybrid was sown at spacing of 75 cm with plant to plant spacing 20 cm to maintain the plant population of 66,333 plants ha^{-1}using 20 kg seeds ha^{-1}. All the herbicides and their combinations were applied as per treatment using knapsack sprayer fitted with flat fan nozzle using in 500liters water ha^{-1}. Pre-emergence application of herbicides and HW at 15 DASto control the first weed flushes whereas 2^{nd} and 3^{rd} flushes were controlled by HW at 40 DASand post-emergence application of herbicides. Data on weed population were recorded at 30, 60 days after sowing and at harvest. The observations of weed density and their dry matter were taken randomly from 0.25 m^2quadrate from net plot area from each treatment. Same were harvested and then oven dried at 48 hours 70^0C. To calculate the cost of weed control, the cost of each treatment was determined and then compared with each other according to the prevailing market prices of grains. Data on weed density and dry weight was subjected to square root transformation before analysis.

RESULTS AND DISCUSSION

Weed density and dry weight

Different weed management practices had significant effect on total weed density and dry weight. Density of total weeds and dry weight of weeds were reduced substantially (table 1) byherbicidal combination of T_6 i.e., atrazine 1000 g ha^{-1} (P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS fallowed byT_7 i.e. atrazine 1000 g ha^{-1} (P.E.) fb tembotrione 120 g ha^{-1} at 25 DAScompare to other all treatments but significantly inferior to weed free check and atrazine 1000 g ha^{-1} (P.E.) fb hand weeding at 25 DAS.

Amongst herbicidal treatment sequential method application of atrazine 1000 g ha^{-1} (P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS and atrazine 1000 g ha^{-1} (P.E.) fb tembotrione 120 g ha^{-1}at 25 DAS was found most effective herbicidal treatment reducing weeds of 1st as well as 2nd flush also. The plots treated with atrazine 1000 g ha^{-1} (P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS and atrazine 1000 g ha^{-1} (P.E.) fb tembotrione 120 g ha^{-1}at 25 DAS recorded few grasses and broad leaf weeds as compared to other herbicidal treatment.Similar results were reported by Swetha *et al.* (2015) and Biswas *et al.* 2018.

Weed control efficiency

The data regarding weed control efficiency calculated at 60 DAS (table 1) differed significantly due to various weed management practices. Higher weed control efficiency was recorded underT_6 i.e., atrazine 1000 g ha^{-1} (P.E.) fb topramezone 25.2 g ha^{-1} at 25 DAS (82.70 %) followed byT_7 i.e., atrazine 1000 g ha^{-1} (P.E.) fb tembotrione 120 g ha^{-1}at 25 DAS (81.40 %).These treatments were statistically superior over other herbicidal treatmentsbut weed free check had maximum weed control efficiency (100 %) whereas minimum was observed under weedy check (0.00 %).The results are in accordance with the findings of Swetha *et al*. (2015)and tiwari *et al*. 2018.

Table 1. Weed density, dry weight and weed control efficiency as influenced by different weed management practices in maize.

Treatments		Weed density				Dry weight of total weeds (g/m^2)	Weed control efficiency (%)
		Grassy	Broad-leaf	Sedge	Total		
T1	Weedy check	10.31 (105.83)	8.73 (76.33)	5.27 (27.33)	14.91 (222.25)	12.94 (167.5)	0
T2	Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	100
T3	Atrazine 1000 gha^{-1} (P.E.) fb Hand weeding at 25 DAS	3.82 (14.17)	4.53 (20.33)	2.36 (5.08)	6.61 (43.58)	5.65 (31.87)	81.0
T4	Atrazine 750 gha^{-1} (P.E.) fb Topramezone 25.2 gha^{-1} at 25 DAS	4.09 (16.25)	5.09 (25.51)	2.34 (5.00)	7.11 (50.03)	6.23 (38.38)	77.1
T5	Atrazine 750 gha^{-1} (P.E.) fb Tembotrione 120 gha^{-1} at 25 DAS	5.20 (26.50)	4.32 (18.28)	3.00 (8.58)	7.52 (56.18)	6.44 (41.15)	75.4
T6	Atrazine 1000 gha^{-1} (P.E.) fb Topramezone 25.2 gha^{-1} at 25 DAS	3.56 (12.17)	4.42 (19.27)	2.04 (3.67)	6.21 (38.26)	5.41 (28.99)	82.7
T7	Atrazine 1000 gha^{-1} (P.E.) fb Tembotrione 120 gha^{-1} at 25 DAS	4.62 (20.83)	3.68 (13.13)	2.81 (7.42)	6.65 (43.76)	5.62 (31.21)	81.4
T8	Topramezone 25.2 gha^{-1} + Atrazine 750 gha^{-1} at 15DAS	4.66 (21.25)	5.63 (31.33)	2.75 (7.08)	8.01 (63.65)	6.98 (48.37)	71.1
T9	Tembotrione 120 gha^{-1} + Atrazine 750 gha^{-1} at 15 DAS	5.43 (29)	5.07 (25.42)	3.07 (8.92)	8.18 (66.44)	7.09 (50.03)	70.1
Sem±		0.09	0.18	0.12	0.15	0.18	
CD (P=0.05)		0.27	0.53	0.36	0.45	0.54	

Note: Data in parenthesis (original value) was subjected to $\sqrt{X + 0.5}$ transformations.

Yield attributes and yield

Data regarding growth attributes of maize viz., cob length (cm), cob girth (cm),number of kernel rows cob^{-1}, number of kernels row^{-1} and 100 kernel weightas influenced by different weed management practices were recorded after harvest (Table 2). Herbicidal combination of T_6 i.e., atrazine 1000 g ha^{-1} fb topramezone 25.2 g ha^{-1}at 25 DAS had higher value of yield attributing characters which was on par withT_7 i.e., atrazine 1000 g ha^{-1} fb tembotrione 120 g ha^{-1}at 25 DAS along withT_3 i.e., atrazine 1000 g ha^{-1} fb hand weeding at 25 DAS. Further analysis of data also showed that weed free check (T_2) had maximumyield attributing characters.Weedy check had significantly lower value yield attributing characters as compared to other weed management practices.

Kernel and stover yield of maize were significantly influenced by different weed management practices (Table 2). Herbicidal combinations of atrazine 1000 g ha^{-1} fb topramezone 25.2 g ha^{-1}at 25 DASi.e., T_6 recorded higher kernel as well as stover yield which was on par toT_7 i.e., atrazine 1000 g ha^{-1} fb tembotrione 120 g ha^{-1}at 25 DAS,T_4 i.e.,atrazine 750 g ha^{-1} fb topramezone 25.2 g ha^{-1}at 25 DAS, T_5 i.e. atrazine 750 g ha^{-1} (P.E.) fb tembotrione 120 g ha^{-1} at 25 DAS along with T_3 i.e., atrazine 1000 g ha^{-1} fb hand weeding at 25 DASbut significantly superior over other herbicide treatments. Further analysis of data also showed that weed free check (T_2)recordedmaximum kernel and stover yield. Significantly minimum kernel and stover yield were recorded under weedy check (T_1).

The highest kernel yield obtained under weed-free condition was mainly due to minimum crop-weed competition throughout the crop growth period, thus enabling the crop for maximum utilization of nutrients, moisture, light, and space, which favoured growth and yield components. These results were in close conformity with those of deewan *et al.* (2018), kaur *et al.* (2016).

Economics

The data regarding economics (Net returns and B:C ratio) as influenced by different weed management practices. significantly maximum net return and benefit cost ratiowere recorded under T_6 i.e., Atrazine 1000 g ha^{-1} fb topramezone 25.2 g ha^{-1}at 25 DAS which was on par to T_7 i.e., atrazine 1000 g ha^{-1} fb tembotrione 120 g ha^{-1}at 25 DAS (₹ 62573.43 ha^{-1}), T_4 i.e., atrazine 750 g ha^{-1} fb topramezone 25.2 g ha^{-1}at 25 DAS (₹ 62506.87 ha^{-1}) and other herbicidal treatments. However, the minimum net returns and benefit cost ratio recorded under weedy check (T_1).All the herbicidal treatments provided more net return than that of weedy check. Out of herbicides,atrazine 1000 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS gave the highest net return of ₹ 66082.62 ha^{-1} which was on par with atrazine 1000 g ha^{-1} fb tembotrione 120 g ha^{-1} at 25 DAS (₹ 62573.43 ha^{-1}), atrazine 750 g ha^{-1} fb topramezone 25.2 g ha^{-1}

at 25 DAS (₹ 62506.87 ha^{-1}) and weed free check (₹ 60078.53 ha^{-1}).Significantly minimum net returns and benefit cost ratio were recorded under weedy check (18640.26 Rs ha^{-1} and 0.49 respectively).The results are supported with the findings of sabiry and babu 2019 and Swetha *et al.* (2015).

CONCLUSION

Herbicidal combination atrazine 1000 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS significantly recorded lower density of weed, dry weight, weed index, higher weed control efficiency and increased growth and yield of maize over rest of the other herbicidal treatments except weed free check. Atrazine 1000 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS was most effective herbicidal combination against complex weed flora. Atrazine 1000 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS was found maximum net returns and B:C ratio (₹66082.62 ha^{-1} and 1.49 respectively).followed by higher net return under atrazine 1000 g ha^{-1} (P.E.) fb tembotrione 120 g ha^{-1} at 25 DAS (₹ 62573.43 ha^{-1}), atrazine 750 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS (₹ 62506.87 ha^{-1}) and higher B:C ratio atrazine 750 g ha^{-1} fb topramezone 25.2 g ha^{-1} at 25 DAS (1.42) and atrazine 1000 g ha^{-1} fb tembotrione 120 g ha^{-1} at 25 DAS (1.39).

Table 2. Yield attributes, yield and economics of maize as influenced by different weed management practices.

Treatments		Yield attributes					Kernel yield (t ha^{-1})	Stover yield (t ha^{-1})	Economics	
		Cob length (cm)	Cob girth (cm)	No. of kernel rows cob^{-1}	No. of kernels row^{-1}	100 kernels weight (g)			Net returns (Rs.)	B:C ratio
T1	Weedy check	14.17	13.93	11.53	26.80	30.87	2998.00	5357.78	18640.26	0.49
T2	Weed free check	18.84	16.65	15.33	38.20	36.53	6151.33	11795.56	60078.53	1.12
T3	Atrazine 1000 gha^{-1} (P.E.) fb Hand weeding at 25 DAS	18.13	16.02	14.80	36.13	35.60	5615.33	10813.33	59477.69	1.33
T4	Atrazine 750 gha^{-1} (P.E.) fb Topramezone 25.2 gha^{-1} at 25 DAS	17.77	15.93	14.60	35.60	35.00	5591.78	10780.00	62506.87	1.42
T5	Atrazine 750 gha^{-1} (P.E.) fb Tembotrione 120 gha^{-1} at 25 DAS	17.70	15.88	14.40	34.07	34.90	5435.33	10568.89	56499.52	1.26
T6	Atrazine 1000 gha^{-1} (P.E.) fb Topramezone 25.2 gha^{-1} at 25 DAS	18.68	16.25	15.13	37.20	35.87	5954.00	11455.56	66082.62	1.49
T7	Atrazine 1000 gha^{-1} (P.E.) fb Tembotrione 120 gha^{-1} at 25 DAS	18.33	16.08	14.87	36.53	35.80	5800.44	11164.44	62573.43	1.39
T8	Topramezone 25.2 gha^{-1} + Atrazine 750 gha^{-1} at 15DAS	17.07	14.82	13.73	33.67	33.20	4952.89	9473.33	48850.42	1.12
T9	Tembotrione 120 gha^{-1} + Atrazine 750 gha^{-1} at 15 DAS	16.62	14.38	13.67	32.33	32.93	4591.33	8735.56	41563.41	0.94
Sem±		0.34	0.42	0.22	0.95	0.35	182.72	456.90	3437.66	0.08
CD (P=0.05)		1.03	1.25	0.67	2.84	1.04	547.81	1369.84	10306.57	0.23

REFERENCES

Biswas, S., Debnath, S., Saha, A. and Biswas, B. (2018). Weed Management in Maize System in New Alluvial Zone of West Bengal, India.*International Journal of Current Microbiology and Applied Sciences,*Volume 7 Number 04 pp.1344-1350.

Dass, S., Kumar, A., Jat, S. L., Parihar, C. M., Singh, A. K., Chikkappa, G. K. and Jat, M. L. (2012). Maize holds potential for diversification and livelihood security. *Indian Journal of Agronomy,*57 (3rd IAC Special Issue): 32-37.

Deewan, P., Mundra, S.L., Trivedi, J., Meena, R.H. and Verma, R. (2018). Nutrient uptake in maize under different weed and nutrient management options.*Indian Journal of Weed Science,*50(3): 278–281.

K, Swetha., M, Madhavi., G, Pratibha. and T, Ramprakash (2015). Weed management with new generation herbicides in maize. Asian-Pacific Weed Science Society Conference on “Weed Science for Sustainable Agriculture, Environment and Biodiversity”, Hyderabad, India.*Indian Journal of Weed Science,*47(4): 432–433.

Kaur, T., Kaur, S. and Bhullar, M.S. (2016). Management of complex weed flora in maize with post-emergence herbicides. *Indian Journal of Weed Science*,48(4): 390–393.

Kumar, A., Kumar, J., Puniya, R., Mahajan, A., Sharma, N. and Stanzen, L. (2015). Weed management in maize-based cropping system. *Indian Journal of Weed Science*,47: 254-266.

Ministry of agriculture & farmers welfare, government of India (2018). Crop coverage *Kharif*Chhattisgarh, pp-9.

Mundra, S.L., Vyas, A.K. and Maliwal, P.L. (2003). Effect of weed and nutrient management on weed growth and productivity of maize *(Zea mays* L.*). Indian J. Weed Sci.*, 35 (1/2): pp57-61.

Sabiry, Bahirgul. and Ramesh, Babu (2019). Influence of early emergent herbicide mixtures on weed control and grain yield of maize (*Zea mays* L.). *Acta scientific agriculture,*Volume 3 Issue 5, 26-28.

Singh, R., Sharma, A.R., Dhyani, S.K. and Dube, R.K. (2011). Tillage and mulching effects on performance of maize *(zea mays)-wheat (Triticum aestivum)* cropping system under varying land slopes.*Indian journal of agricultural sciences,*81(4). pp 330-335.

Sujay, Rakshit and Chikkappa, G.K. (2018). Perspective of maize scenario forward. *Maize Journal*, 7 (2), 49-55.

Tiwari, D. K., Paradkar, V.K., Dubey, Rajiv and Dwivedi, R.K. (2018). Bio-efficacy of post-emergence herbicide topramezone against weed control of maize (*Zea mays* L.). *International Journal of Agriculture Sciences,* Volume 10, Issue 2, pp.-5079-5081.