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RESEARCH PAPER

Weed management in maize with new generation herbicides under vertisols of Rajasthan

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Abstract: A field experiment was conducted at Research Farm of Agricultural Research Station, Ummedganj, Kota (Agriculture University, Kota), Rajasthan, India during *Kharif* 2017 and 2018, with the objective to find out effective post-emergence new generation herbicides for controlling weeds as season long and increasing the productivity of maize under vertisols of Rajasthan. The treatments comprised of T_1: Weedy check, T_2: Hand weeding twice (20 & 40 DAS), T_3: Atrazine 50% WP @ 0.5 kg a.i./ha (PE), T_4: Bentazone 48% SL @ 1.2 kg a.i./ha (15-20 DAS), T_5: Tembotrione 42% SC @ 120.75 g a.i./ha (15-20 DAS), T_6: Tembotrione 42% SC @ 150.95 g a.i./ha (15-20 DAS), T_7: Topramezone 33.6% SC @ 25.2 g a.i./ha (15-20 DAS), T_8: Topramezone 33.6% SC @ 31.5 g a.i./ha (15-20 DAS), T_9: Tembotrione 42% SC @ 120.75 g a.i./ha +Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS) and T_{10}: Topramezone 33.6% SC @ 25.2 g a.i./ha + Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS). Results showed that the application of Topramezone 31.5 g a.i./ha at 15-20 DAS recorded significantly minimum weed density, weed dry weight and maximum weed control efficiency at 30 & 60 DAS being at par with Tembotrione 150.95 g a.i./ha followed by Topramezone 25.2 g a.i./ha and Tembotrione 120.75 g a.i./ha, which were at par with hand weeding twice at 20 & 40 DAS over rest of the treatments. Maximum yield attributes viz., no. of cobs/ plant, no. of grains/cob, 100-grain weight and grain yield was recorded with the Topramezone 31.5 g /ha at 15-20 DAS and being on par with Tembotrione 150.95 g a.i./ha, Topramezone 25.2 g a.i./ha, Tembotrione 120.75 g a.i./ha and hand weeding twice at 20 & 40 DAS over rest of the weed management practices. Post emergence application of Topramezone 31.5 g a.i./ha at 15-20 DAS also fetched significantly higher net returns (Rs. 66503/ha) and B:C ratio to the tune of 207.39 & 158.33 per cent, respectively over weedy check and being on par with Tembotrione 150.95 g a.i./ha, Topramezone 25.2 g a.i./ha, Tembotrione 120.75 g a.i./ha, Tembotrione 120.75 g a.i./ha + Atrazine 0.5 kg a.i./ha, Topramezone 25.2 g a.i./ha + Atrazine 0.5 kg a.i./ha and hand weeding twice at 20 & 40 DAS.

Keywords: Economics · Maize · New generation herbicide · Weed control efficiency · Weed management

Introduction

Maize (*Zea mays* L.) is one of the important cereal crop of the world, known as “Queen of cereals” due to its great importance in human and animal diet. It is very efficient utilizer of solar energy and has immense potential for higher yield. It is known for its wider adaptability and multipurpose uses as food, fodder and industrial products (Murdia *et al*., 2016). It is also an important source of vitamins and minerals like Ca, P, S and small amounts of Na. Its flour is considered to be a good diet for heart patients due to its low gluten (protein) content (Rasool and Khan, 2016). The productivity of maize in India is relatively very low compared to developed countries of world mainly due to lack of timely weed control. The major yield reducing factors for maize cultivation in India are weeds (Gharde *et al*., 2018) and about 100 weed

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species in 66 genera and 24 plant families are known to be problematic for maize in the country. Most of the presently available herbicides provide only a narrow spectrum weed control (Patel *et al.*, 2006). Weed control practices in maize resulted in 65 to 90% higher yield than unweeded (Barla *et al.*, 2016). Topramezone and Tembotrione are the new selective, post-emergence herbicides introduced for use in maize that inhibit hydroxy-phenyl pyruvate dioxygenase (4-HPPD) enzyme and the biosynthesis of plastoquinone (Swetha *et al.*, 2015). There is need for some alternate post-emergence herbicide like Tembotrione which can provide broad spectrum weed control in *kharif* maize without affecting the growth and yield of crop (Williams *et al.*, 2011; Yadav *et al.*, 2017). Thus, weed management with new generation broad spectrum herbicides are needed. Therefore, this study was conducted to evaluate the weed control efficiency of new generation herbicides in *kharif* maize under vertisols of Rajasthan.

Materials and methods

A field experiment was conducted on weed management in maize with new generation herbicides during *Kharif* 2017 and 2018 at Agricultural Research Station, Ummedganj, Kota, Rajasthan with the objective to find out effective post emergence new generation herbicide for controlling weeds as season long and increasing the productivity of maize. The region falls under the Agro Climatic Zone V of Rajasthan *i.e.* Humid South-Eastern Plain zone.

The mean weekly meteorological observations recorded during the crop period are presented in Figure 1. The mean daily maximum and minimum temperature during the growing season fluctuated between 30.0 to 43.2°C and 15.3 to 29.0°C, respectively in the year 2017. The corresponding values for the year 2018 were between 28.3 to 43.4°C and 18.9 to 29.1°C, respectively. The total rainfall received was 487 and 524 mm and total rainy days were 25 and 29 days respectively, during the growing season of the year 2017 and 2018.

The soil of the experimental field was clay loam with slightly alkaline pH (7.65), having medium available nitrogen (395.0 kg/ha), available phosphorus (22.5 kg/ha) and high available potassium (360.0 kg/ha) content. The experiment was laid out in randomized block design with three replications. The experimental site was mainly infested with grassy and broad leaf weeds *viz.*, *Echinochloa colona, Cyperus rotundus, Cynodon Dectylon, Commelina benghalensis, Trianthema monogyana* and *Digera arvensis etc.* It was observed that maize crop was majorly infested with grassy weeds followed by broad leaf weeds during growing season. The treatments comprised of T_1: Weedy check, T_2: Hand weeding twice (20 & 40 DAS), T_3: Atrazine 50% WP @ 0.5 kg a.i./ha (PE), T_4: Bentazone 48% SL @ 1.2 kg a.i./ha (15-20 DAS), T_5: Tembotrione 42% SC @ 120.75 g a.i./ha (15-20 DAS), T_6: Tembotrione 42% SC @ 150.95

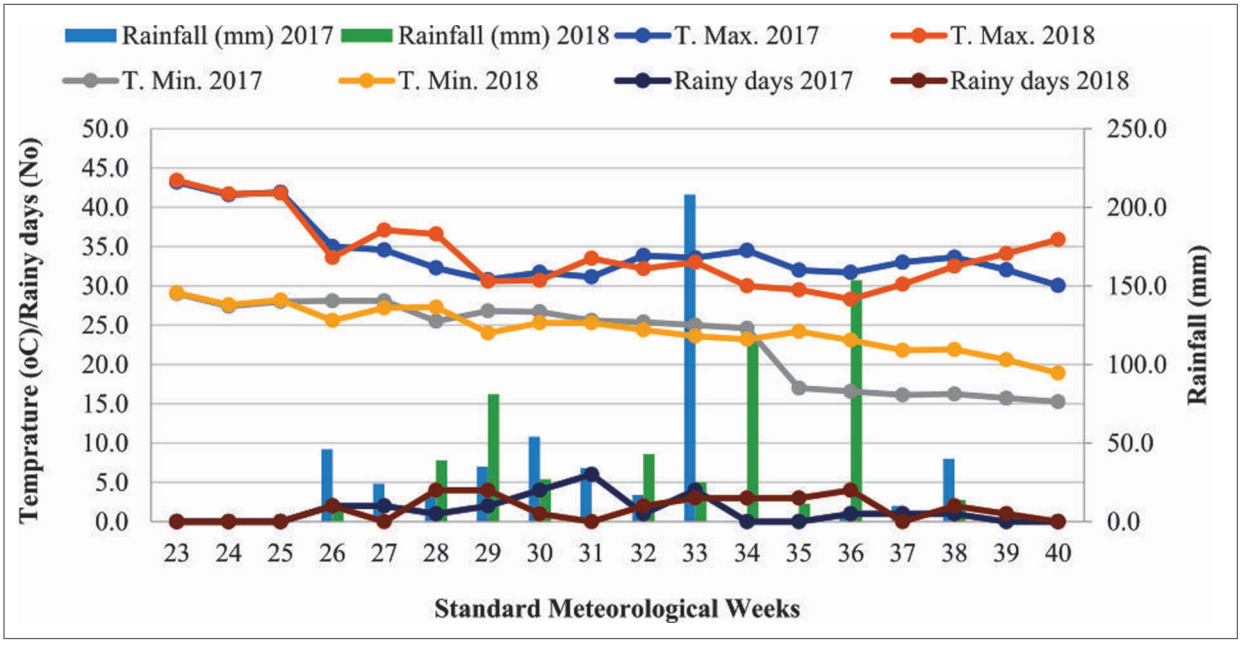

Figure 1. Weekly meteorological observatory data during experimental years (2017 & 2018)

g a.i./ha (15-20 DAS), T_7: Topramezone 33.6% SC @ 25.2 g a.i./ha (15-20 DAS), T_8: Topramezone 33.6% SC @ 31.5 g a.i./ha (15-20 DAS), T_9: Tembotrione 42% SC @ 120.75 g a.i./ha +Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS) and T_{10}: Topramezone 33.6% SC @ 25.2 g a.i./ha + Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS). The crop was grown and managed with the recommended package of practices for the zone. All the herbicides were applied uniformly in the experimental plots with the help of knapsack sprayer. The maize variety "Hybrid Kaveri Seeds (218+)" was sown at a spacing of 60×25 cm^2 between rows and plants. All the recommended agronomic and plant protection measures were adopted to raise the crop. Observation recorded on weed density (Nos/m^2), weed dry weight (g/m^2) at 30 & 60 DAS, these were subjected to square root transformation to normalize their distribution, yield attributes (number of cobs $plant^{-1}$, number of grains cob^{-1}, 100-grain weight (g) and grain yield (kg/ha). The efficiency of weed management treatments was assessed by weed control efficiency (%) calculated as:

$$WCE\ (\%) = \frac{WD_C - WD_t}{WD_C} \times 100$$

Where, WCE is weed control efficiency, WD_C is the weed dry matter in control plot and WD_t is the weed dry matter in the respective treatment.

The economics was calculated on the basis of prevailing market prices of input and produce.

Results and discussion

The data on pooled basis depicted in Table 1, revealed that the significantly minimum weed density and weed dry weight was observed with the application of Topramezone 31.5 g a.i./ha at 15-20 DAS, however it was at par with Tembotrione 150.95 g a.i./ha over rest of the treatments. The next best treatment was Topramezone 25.2 g a.i./ha being on par with Tembotrione 120.75 g a.i./ha, which were at par with hand weeding twice at 20 & 40 DAS. Maximum weed density was found in weedy check which was significantly higher over rest of the treatments. These findings were in close conformity with the Stephenson *et al.* (2015), Rana *et al.* (2017), Sundari *et al.* (2019) and Kantwa *et al.* (2020).

The data in Table 1 also revealed that the maximum per cent weed control efficiency (92.87 and 86.01) was recorded under the treatment of Topramezone 31.5 g a.i./ha, being at par with Tembotrione 150.95 g a.i./ha (90.67 and 83.88) followed by Topramezone 25.2 g a.i./ha (90.38 and 79.05) and Tembotrione 120.75 g a.i./ha (87.92 and 77.40) which were at par with hand weeding twice at 20 & 40 DAS (88.11 and 82.40) at 30 & 60 DAS, respectively over rest of the treatments. This might be due to post-emergence application of Topramezone and

Table 1. Effect of different herbicides on weed density, weed dry weight and weed control efficiency (WCE) in maize (Pooled mean of 2 years)

Treatments	Weed density (Nos/m^2)		Weed dry weight (g/m^2)		WCE (%)	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Weedy check	13.80 (190.00)*	15.43 (237.83)	6.52 (43.01)	8.06 (64.74)	0.00	0.00
Hand weeding twice (20 & 40 DAS)	3.97 (15.50)	5.82 (33.67)	2.24 (4.86)	3.40 (11.36)	88.11	82.40
Atrazine 50% WP @ 0.5 kg ai/ha (PE)	7.81 (60.33)	11.35 (128.17)	4.07 (16.28)	6.28 (39.04)	59.89	38.36
Bentazone 48% SL @ 1.2 kg ai/ha (15-20 DAS)	9.31 (85.83)	12.84 (163.67)	5.00 (24.60)	7.07 (49.35)	37.83	22.12
Tembotrione 42 % SC @ 120.75 g ai/ha (15-20 DAS)	3.74 (13.67)	6.75 (45.00)	2.24 (4.82)	3.82 (14.26)	87.92	77.40
Tembotrione 42 % SC @ 150.95 g ai/ha (15-20 DAS)	3.26 (10.33)	5.73 (32.50)	1.95 (3.63)	3.24 (10.21)	90.67	83.88
Topramezone 33.6 % SC @ 25.2 g ai/ha (15-20 DAS)	3.39 (11.17)	6.16 (37.33)	2.01 (3.88)	3.69 (13.28)	90.38	79.05
Topramezone 33.6 % SC @ 31.5 g ai/ha (15-20 DAS)	2.91 (8.17)	5.08 (25.50)	1.73 (2.83)	3.02 (8.93)	92.87	86.01
Tembotrione 42 % SC @ 120.75 g ai/ha +Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS)	3.96 (15.33)	6.50 (41.67)	2.22 (4.72)	3.74 (13.62)	88.13	78.21
Topramezone 33.6 % SC @ 25.2 g ai/ha + Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS)	3.23 (10.17)	5.98 (35.33)	1.92 (3.50)	3.61 (12.69)	91.10	79.70
SEm±	0.13	0.19	0.09	0.10	1.49	1.65
CD (P=0.05)	0.38	0.55	0.26	0.30	4.27	4.74

*$\sqrt{x}$+0.05 Transformed values and data in parenthesis are original values

Tembotrione controlled majority of weeds. The results are in close agreement with the findings of Swetha *et al*. (2015), Damalas *et al.* (2018) and Kantwa *et al*. (2020).

A perusal of data presented in Table 2 reveals that all weed management practices significantly affected the yield attributes and grain yield of maize over weedy check. Maximum yield attributes *viz.*, no. of cobs/plant, no. of grains/cob, 100-grain weight and grain yield was recorded with the Topramezone 31.5 g a.i./ha at 15-20 DAS and being on par with Tembotrione 150.95 g ai/ha, Topramezone 25.2 g a.i./ha, Tembotrione 120.75 g a.i./ha and twice hand weeding twice at 20 & 40 DAS over rest of the weed management practices. The better expression of yield attributes in herbicide treated plots might be due to minimum crop-weed competition during critical phases of crop growth chemically exerts an important regulation function on complex processes of yield formation, due to better availability of growth inputs *viz*., water, space and nutrients. These findings are close conformity with the Teame *et al*. (2017), Patel *et al*. (2018) and Kantwa *et al*. (2020).

Results further shown in Table 3 reported that post-emergence application of Topramezone 31.5 g a.i./ha at 15-20 DAS fetched significantly higher net returns (Rs. 66503/ha) and B:C ratio (2.48) to the tune of 207.39 and 158.33 per cent, respectively over weedy check and while

Table 2. Effect of different herbicides on yield attributes and yield of maize (Pooled mean of 2 years)

Treatments	No. of cobs /plant	No. of grains /cob	100-grain weight (g)	Grain yield (kg/ha)
Weedy check	0.93	254.83	30.88	2830
Hand weeding twice (20 & 40 DAS)	1.15	434.50	32.79	5736
Atrazine 50% WP @ 0.5 kg ai/ha (PE)	1.00	352.33	31.96	4645
Bentazone 48% SL @ 1.2 kg ai/ha (15-20 DAS)	1.00	342.67	31.93	4494
Tembotrione 42 % SC @ 120.75 g ai/ha (15-20 DAS)	1.12	429.67	32.85	5701
Tembotrione 42 % SC @ 150.95 g ai/ha (15-20 DAS)	1.15	452.67	32.75	5884
Topramezone 33.6 % SC @ 25.2 g ai/ha (15-20 DAS)	1.13	438.00	32.89	5764
Topramezone 33.6 % SC @ 31.5 g ai/ha (15-20 DAS)	1.17	463.00	32.94	5990
Tembotrione 42 % SC @ 120.75 g ai/ha +Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS)	1.08	398.83	32.37	5382
Topramezone 33.6 % SC @ 25.2 g ai/ha + Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS)	1.09	406.67	32.47	5417
SEm±	0.02	11.59	0.13	170
CD (P=0.05)	0.05	33.22	0.37	487

Table 3. Effect of different herbicides on economics of maize (Pooled mean of 2 years)

Treatments	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C Ratio
Weedy check	22562	21636	0.96
Hand weeding twice (20 & 40 DAS)	30602	58752	1.92
Atrazine 50% WP @ 0.5 kg ai/ha (PE)	22962	49298	2.15
Bentazone 48% SL @ 1.2 kg ai/ha (15-20 DAS)	24122	45743	1.90
Tembotrione 42 % SC @ 120.75 g ai/ha (15-20 DAS)	26422	62383	2.36
Tembotrione 42 % SC @ 150.95 g ai/ha (15-20 DAS)	27387	64166	2.34
Topramezone 33.6 % SC @ 25.2 g ai/ha (15-20 DAS)	25712	64090	2.49
Topramezone 33.6 % SC @ 31.5 g ai/ha (15-20 DAS)	26762	66503	2.48
Tembotrione 42 % SC @ 120.75 g ai/ha +Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS)	27072	64422	2.38
Topramezone 33.6 % SC @ 25.2 g ai/ha + Atrazine 50 WP @ 0.5 kg a.i./ha (15-20 DAS)	26362	65721	2.49
SEm±	-	2759	0.11
CD (P=0.05)	-	7912	0.30

Figure 2. (a) Weedy Check, (b) Tembotrione 42% SC 120.75 g a.i./ha, (c)Topramezone 33.6% SC 25.2 g a.i./ha

being at par with Tembotrione 150.95 g a.i./ha, Topramezone 25.2 g a.i./ha, Tembotrione 120.75 g a.i./ha, Tembotrione 120.75 g a.i./ha + Atrazine 0.5 kg a.i./ha, Topramezone 25.2 g a.i./ha + Atrazine 0.5 kg a.i./ha and hand weeding twice at 20 & 40 DAS. This might be due to the higher grain yield of maize under these treatments. The results are in close conformity with the findings of Kantwa *et al*. (2020).

Conclusion

Post-emergence application of new generation herbicides *viz.*, Topramezone 25.2 g a.i./ha or Tembotrione 120.75 g a.i./ha at 15-20 DAS found effective for controlling season long weeds, higher yield and returns in *kharif* maize under vertisols of south-eastern Rajasthan.

References

Barla, S., Upasani, R. R., Puran, A. N. & Thakur, R. (2016). Weed management in maize. *Indian Journal of Weed Science,* **48**(1): 67–69.

Damalas, C. A., Gitsopoulos, T. K., Koutroubas, S. D., Alexoudis, C. & Georgoulas, I. (2018). Weed control and selectivity in maize (*Zea mays* L.) with Tembotrione mixtures. *International Journal of Pest Management,* **64**(1): 11–18.

Gharde, Y., Singh, P. K., Dubey, R. P. & Gupta P. K. (2018). Assessment of yield and economic losses in agriculture due to weeds in India. *Crop Protection,* **107**: 12–18.

Kantwa, S., Jadon, C. K., Tetarwal, J. P., Ram, B., Kantwa, S. R. & Yadav, R. K. (2020). Effect of weed management practices on weed dynamics, yield attributes and yield of maize. *International Journal of Bio-resource and Stress Management.* **11**(5): 488-493.

Murdia, L. K., Wadhwani, R., Wadhawan, N., Bajpai, P. & Shekhawat, S. (2016). Maize utilization in India: an overview. *American Journal of Food and Nutrition,* **4**(6): 169–176.

Patel, B. D., Chaudhari, D. D., Patel, V. J., Patel, H. K. & Mishra, A. (2018). Weed dynamics and production potential of *kharif* maize *(Zea mays* L.) as influenced by new generation herbicides. *Crop Research,* **53**(5&6): 209–214.

Patel, V. J., Upadhyay, P. N., Patel, B. & Patel, B. D. (2006). Evaluation of herbicide mixtures for weed control in maize (*Zea mays* L.) under middle Gujarat conditions. *The Journal of Agricultural Science*, **2**(1): 81–86.

Rana, S. S., Badiyala, D., Sharma, N., Kumar, R. & Pathania, P. (2017). Impact of Tembotrione on weed growth, yield and economics of maize (*Zea mays* L.) under mid hill conditions of Himachal Pradesh. *Pesticide Research Journal*, **29**(1): 27–34.

Rasool, S. & Khan, M. H. (2016). Growth and yield of maize (*Zea mays* L.) as influenced by integrated weed management under temperate conditions of North Western Himalayas. *American Journal of Experimental Agriculture,* **14**(1): 1–9.

Sundari, A., Kalaisudarson, S., Srinivasaperumal, A. P. & Gowtham, S. S. R. (2019). Response of irrigated maize to new herbicides. *Plant Archives,* **19**(2): 2465–2468.

Swetha, K., Madhavi, M., Pratibha, G. & Ramprakash, T. (2015). Weed management with new generations herbicides in maize. *Indian Journal of Weed Science*, **47**(4): 432-433.

Teame, G., Tsegay, A. & Abrha, B. (2017). Effect of organic mulching on soil moisture, yield and yield contributing components of sesame (*Sesamum indicum* L.) *International Journal of Agronomy*. https://doi. org/10.1155/2017/4767509.

Williams, M. M., Boydston, R. A., Peachey, R. E. & Robinson, D. (2011). Significance of Atrazine as a tank-mix partner with Tembotrione. *Weed Technology,* **25**(3): 299–302.

Yadav, T. K., Choudhary, R. S., Jat, G., Singh, D. & Sharma, N. (2017). Effect of weed management practices on yield attributes, yield and economics of maize (*Zea mays* L.). *Chemical Science Review and Letters*, **6**(23): 1452-1456.