Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(6): 1600-1603
Received: 12-09-2020
Accepted: 20-10-2020

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Impact of different tank mix post- emergence herbicides with atrazine on weed control and productivity of maize (*Zea mays L.*)

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Abstract
A field experiment was conducted on clay loam soil during *kharif*, 2017 at Instructional Agronomy Farm, Rajasthan College of Agriculture, Udaipur to find out the best chemical weed management practices in maize. Thirteen treatments were tested in randomized block design with three replications. The results of the experiment revealed that the lowest total weed density was observed with tank mix application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} PoE at harvest. All the weed control treatments were also found significantly superior in reducing dry matter of monocot, dicot and total weeds compared to weedy check at harvest. The minimum total weed dry matter at this stages (2.91 g m^{-2}) were observed under atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} PoE at 15 DAS and it was closely followed by atrazine 0.5 kg ha^{-1} + topramezone 0.025 kg ha^{-1} PoE at 15 DAS (3.36 g m^{-2}). An application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} PoE at 15 DAS resulted in maximum weed control efficiency of 98.47 per cent, at harvest. All the weed control treatments increased the plant height, dry matter accumulation and plant population of maize over weedy check. The application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} as PoE at 15 DAS recorded the tallest plants (188.6 cm) with greatest dry matter accumulation per plant (87.67 g) at harvest.The post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS treatment resulted in maximum seed yield (5240 kg ha^{-1}) which was statistically at par with post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 20 DAS (4963 kg ha^{-1}).Alike seed yield, the maximum stover yield (7028 kg ha^{-1}) and biological yield (12269 kg ha^{-1}) were also recorded maximum under application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} PoE at 15 DAS treatment which were superior over rest of the treatments.

Keywords: maize, grain yield, post-emergence herbicides, weed control efficiency, harvest index, atrazine, sover yield, biological yield

Introduction
Maize (*Zea mays* L.) is the third most important cereal in the world; it is one of the most versatile crops having wider adaptability under varied agro-climatic conditions. It is also known as "Queen of Cereals". Maize in India, contribute nearly 9% in the national food basket and more than `100 billion to the agricultural GDP at current price, cultivated on 9.25 m ha area with production of 23.67 m t at a productivity of 2.53 t/ha. In Rajasthan, this crop occupied 0.90 m ha area with production of 1.60 m t and productivity of 1.70 t ha^{-1} (Agricultural Statistics at a Glance, 2016) [1]. Bieng rainy season crop, it has high yielding crop but weed infestation is one of the major constraints in cultivation of maize. 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) [4]. During this period, weeding is essentially required physical and mechanical means are expensive and many times timely operations are not possible due to continuous rains in monsoon season (Chopra and Angiras, 2008) [2].

Materials and Methods
The experiment was carried out at research farm of Raasthan college of Agriculture,Udaipur (24°35' N latitude and 73°42' E longitude.an altitude of 582.5 meter above mean sea level).The soil of experimental had low in nitrogen, medium in phosphorus, high in potassium and slightly alkaline and calcarious in nature. The soil of the experimental field was clay loam in texture.The experiment was laid out in randomized block design with 13 treatment combination tested were as follows weedy check, atrazine 0.5 kg ha-1at 10 DAS, atrazine 0.5 kg ha-1at 15 DAS, atrazine 0.5 kg ha-1at 20 DAS, atrazine 0.5 kg ha-1+ halosulfuron 0.09 kg ha-1at 10 DAS, atrazine 0.5 kg ha-1+ halosulfuron 0.09 kg ha-1at 15 DAS, atrazine 0.5 kg ha-1+ halosulfuron 0.09 kg ha-1at 20 DAS, atrazine 0.5 kg ha-1+ tembotrione 0.125 kg ha-1at 10 DAS, atrazine 0.5 kg ha-1+ tembotrione 0.125 kg ha-1at 15 DAS, atrazine 0.5 kg ha-

1+ tembotrione 0.125 kg ha-1at 20 DAS, atrazine 0.5 kg ha-1+ topramezone 0.118 kg ha-1at 10 DAS, atrazine 0.5 kg ha-1+ topramezone 0.118 kg ha-1at 15 DAS and atrazine 0.5 kg ha-1+ topramezone 0.118 kg ha-1at 20 DAS. The result were analyzed taking consideration of wed parameters such as as weed density, weed dry matter, weed control effienciecy and plant parameter such as plant population, plant dry matter, plant height, harvest index and grain yield, stover yield and biological yield.

Weed control efficiency was calculated at 30 DAS using the following formula (Mani *et al*., 1968) [6].

The harvest index of both crops were calculated by dividing the economic yield (grain yield) by biological yield and expressed as percentage (Donald and Hamblin, 1976) [5].

Result and Discussion

Weed flora

Maize was heavily infested with mixed flora of monocot and dicot weeds mainly consisted of *Echinochloa colona*, *Dinebra retroflexa Commelina benghalensis* and *Amaranthus viridis, Trianathema portulacastrum Digeria arvensis*, respectively (Table 1).

Table 1: Effect of herbicides on weed density in Maize at harvest

Treatment	Weed density* (m^{-2})					
	Echinochloa colona	*Dinebra retroflexa*	*Digera arvensis*	*Commelina benghalensis*	*Trienthemma portulacastrum*	*Amerenthus Viridis*
Weedy check	9.73 (94.16)	4.60 (20.70)	5.03 (24.78)	4.94 (24.01)	3.17 (9.56)	2.94 (8.14)
Atrazine at 10 DAS	3.11 (9.19)	3.48 (11.59)	2.12 (3.99)	3.24 (10.04)	0.71 (0.00)	2.27 (4.67)
Atrazine at 15 DAS	3.17 (9.55)	4.19 (17.09)	2.13 (4.06)	3.58 (12.36)	0.71 (0.00)	2.45 (5.51)
Atrazine at 20 DAS	3.59 (12.48)	4.27 (17.70)	3.12 (9.21)	3.85 (14.29)	2.05 (3.73)	2.56 (6.08)
Atrazine + Halosulfuron at 10 DAS	2.70 (6.80)	3.38 (10.94)	2.04 (3.67)	3.00 (8.50)	0.71 (0.00)	2.09 (3.89)
Atrazine + Halosulfuron at 15 DAS	2.78 (7.23)	3.99 (15.45)	2.06 (3.73)	3.24 (10.04)	0.71 (0.00)	2.23 (4.47)
Atrazine + Halosulfuron at 20 DAS	3.70 (13.19)	4.19 (17.06)	2.46 (5.57)	3.53 (11.97)	1.73 (2.48)	2.41 (5.32)
Atrazine + Tembotrione at 10 DAS	1.67 (2.31)	1.57 (1.95)	0.96 (0.42)	1.66 (2.27)	0.71 (0.00)	0.95 (0.44)
Atrazine + Tembotrione at 15 DAS	1.36 (1.35)	1.08 (0.67)	0.71 (0.00)	1.03 (0.56)	0.71 (0.00)	0.84 (0.20)
Atrazine + Tembotrione at 20 DAS	1.47 (1.66)	1.51 (1.80)	0.71 (0.00)	1.24 (1.04)	0.71 (0.00)	0.97 (0.44)
Atrazine + Topramezone at 10 DAS	1.66 (2.27)	1.53 (1.85)	0.71 (0.00)	1.45 (1.61)	0.71 (0.00)	1.54 (1.89)
Atrazine + Topramezone at 15 DAS	1.37 (1.39)	1.09 (0.70)	0.71 (0.00)	1.10 (0.71)	0.71 (0.00)	0.96 (0.42)
Atrazine + Topramezone at 20 DAS	1.67 (2.30)	1.60 (2.06)	0.95 (0.41)	1.62 (2.12)	0.71 (0.00)	1.55 (1.91)
SEm ±	0.13	0.06	0.03	0.07	0.03	0.06
CD (P=0.05)	0.37	0.19	0.10	0.21	0.08	0.18

*$\sqrt{x + 0.5}$ Transformed values and Data in parenthesis are original values

Effect on weed

In weedy check plot, complex weed flora comprising monocot and dicot were present. The density and dry matter proportion of monocot to dicot weeds in weedy check plots at harvest was 1:0.30 and 1:0.31 respectively.

All herbicide treatments gave minimum weed density and dry matter at different growth stages compared to weedy check.Post-emergence application of atrazine 0.5 kg ha^{-1}+ tembotrione 0.125 kg ha^{-1} PoE at 15 DAS recorded the lowest total weed density at harvest which was at par with atrazine 0.5 kg ha^{-1} + topramezone 0.025 kg ha-1 PoE at 15 DAS (Table 3). The per cent reduction in total weed density was 86.57 and 85.75, respectively due to these treatment over weedy check.

Post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} PoE at 15 DAS recorded the lowest total weed dry matter at harvest and provided 98.47 per cent reduction in total weed dry matter, over weed dry matter produced in weedy check (Table 3). The results corroborate the findings of Nadiger *et al.* (2013) [7], swetha *et al.* (2015) [11] and Rana *et al.* (2017) [12]. Maximum weed control efficiency of total weeds was observed with application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} PoE at 15 DAS 98.47 per cent, at harvest followed by application of atrazine 0.5 kg ha^{-1} + topramezone 0.025 kg ha^{-1} PoE at 20 DAS (98.23 per cent,at harvest) (Table 3). Result so obtained are in close conformity with finding of swetha *et al.* (2015) [11] and Triveni *et al*. (2017) [13].

Table 2: Effect of herbicides on weed dry matter in Maize at harvest

Treatment	Weed dry matter (g m^{-2})					
	Echinochloa colona	*Dinebra retroflexa*	*Digera arvensis*	*Commelina benghalensis*	*Trienthemma portulacastrum*	*Amerenthus Viridis*
Weedy check	98.77	21.61	26.06	25.24	10.02	8.53
Atrazine at 10 DAS	9.64	12.22	4.17	10.50	0.00	4.90
Atrazine at 15 DAS	10.02	17.93	4.24	12.93	0.00	5.78
Atrazine at 20 DAS	13.09	18.57	9.61	14.92	3.91	6.38
Atrazine + Halosulfuron at 10 DAS	7.13	11.43	3.87	8.96	0.00	4.09
Atrazine + Halosulfuron at 15 DAS	7.59	16.29	3.92	10.53	0.00	4.69
Atrazine + Halosulfuron at 20 DAS	13.83	17.90	5.84	12.56	2.60	5.58
Atrazine + Tembotrione at 10 DAS	2.42	2.05	0.44	2.37	0.00	0.47
Atrazine + Tembotrione at 15 DAS	1.42	0.70	0.00	0.59	0.00	0.21
Atrazine + Tembotrione at 20 DAS	1.74	1.89	0.00	1.09	0.00	0.46
Atrazine + Topramezone at 10 DAS	2.39	1.93	0.00	1.69	0.00	1.98
Atrazine + Topramezone at 15 DAS	1.45	0.73	0.00	0.74	0.00	0.44
Atrazine + Topramezone at 20 DAS	2.41	2.14	0.43	2.24	0.00	2.00
SEm ±	0.78	0.56	0.31	0.61	0.12	0.28
CD (P=0.05)	2.29	1.64	0.90	1.77	0.35	0.82

Table 3: Effect of treatments on weed density*(m^{-2}), weed dry matter (g m^{-2}) and weed control efficiency (%) at harvest

Treatments	Weed density*(m^{-2})			weed dry matter (g m^{-2})			Weed control efficiency (%)		
	Monocot weeds	Dicot weeds	Total weeds	Monocot weeds	Dicot weeds	Total weeds	Monocot weeds	Dicot weeds	Total weeds
Weedy check	11.80 (138.86)	6.55 (42.48)	13.48 (181.34)	145.61	44.61	190.22	0.00	0.00	0.00
Atrazine at 10 DAS	5.60 (30.82)	3.03 (8.66)	6.32 (39.48)	32.36	9.07	41.43	77.76	79.67	78.20
Atrazine at 15 DAS	6.28 (39.00)	3.17 (9.57)	7.00 (48.57)	40.88	10.02	50.90	71.92	77.58	73.24
Atrazine at 20 DAS	6.70 (44.47)	4.42 (19.02)	8.00 (63.49)	46.58	19.90	66.48	67.98	55.33	65.03
Atrazine + Halosulfuron at 10 DAS	5.17 (26.24)	2.84 (7.56)	5.85 (33.80)	27.52	7.95	35.47	81.12	82.16	81.37
Atrazine + Halosulfuron at 15 DAS	5.76 (32.72)	2.95 (8.21)	6.44 (40.93)	34.41	8.61	43.02	76.36	80.65	77.36
Atrazine + Halosulfuron at 20 DAS	6.54 (42.22)	3.72 (13.36)	7.49 (55.58)	44.29	14.02	58.30	69.58	68.45	69.32
Atrazine + Tembotrione at 10 DAS	2.65 (6.53)	1.16 (0.87)	2.81 (7.40)	6.84	0.91	7.75	95.30	97.97	95.93
Atrazine + Tembotrione at 15 DAS	1.75 (2.58)	0.84 (0.20)	1.81 (2.78)	2.70	0.21	2.91	98.14	99.53	98.47
Atrazine + Tembotrione at 20 DAS	2.24 (4.50)	0.97 (0.44)	2.33 (4.94)	4.72	0.46	5.18	96.75	98.97	97.27
Atrazine + Topramezone at 10 DAS	2.50 (5.73)	1.54 (1.89)	2.85 (7.62)	6.01	1.98	7.99	95.87	95.56	95.80
Atrazine + Topramezone at 15 DAS	1.81 (2.79)	0.96 (0.42)	1.92 (3.21)	2.93	0.44	3.36	97.99	99.01	98.23
Atrazine + Topramezone at 20 DAS	2.64 (6.48)	1.68 (2.32)	3.05 (8.80)	6.80	2.43	9.23	95.33	94.54	95.14
SEm ±	0.09	0.06	0.09	0.93	0.49	1.15			
CD (P=0.05)	0.27	0.17	0.25	2.73	1.42	3.35			

*$\sqrt{x+0.5}$ Transformed values and Data in parenthesis are original values

Effect on crop

Plant population

It was clear from data in table 4 that combination of herbicide and herbicide alone have no significant influence on plant population at harvest. All weed control treatments were found statistical superiority in enhancing plant height of maize at harvest. The post-emergence application at 15 DAS of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} recorded the highest plant height at harvest which were significantly higher to rest of the treatments. The per cent increase in plant height due to this treatment was 42.1 per cent, over weedy check.

Dry matter accumulation by the crop was significantly increased with all the weed control treatments over dry matter accumulated by crop in weedy check. The maximum dry matter accumulation (87.67 g $plant^{-1}$) at harvest was recorded under post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} PoE at 15 DAS treatment with the corresponding per cent increase of 63.3 per cent compared to weedy check (Table 4). The result also have been reported by Singh *et. al.* (2012) [10], Rao *et al.* (2009) [9].

All weed control treatments significantly enhanced grain yield over weedy check. The maximum grain yield (5240 kg ha^{-1}) was recorded under post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS which found statistically at par with post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 20 DAS (4963 kg ha^{-1}). The per cent increse in seed yield due to post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS and post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 20 DAS was 121.37 and 109.67 respectively, over weedy check (Table 4).

The stover yield was significantly increased with all the weed control treatments. The highest strover yield obtained with post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS (7028 kg ha^{-1}) which was closed to post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 10 DAS (7018 kg ha^{-1}) with per cent increase of 75.30 and 75.05, respectively over weedy check (4009 kg ha^{-1}). The biological yield increased significantly by various weed control treatments. Amongst the herbicide treatments, post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS gave maximum biological yield (12269). The per cent increase in biological yield due to this treatments was 92.42, over weedy check while comparing different herbicide mixtures under test the post emergence application of combination of atrazine with tembotrione either at 10,15 or 20 DAS recorded better results than atrazine with topramazone or halosulfuron. The harvest index was not significantly affected by weed control treatments. Maximum harvest index of 42.60 per cent was recorded under the treatment post-emergence application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS, while it was minimum under weedy check (37.04 per cent). It is well established fact that least crop weed competition during critical phases of crop growth exerts an important regulation function on complex process of yield formation due to better availability of water, space and nutrient. The results corroborate the findings of Patel *et al.* (2006) [8], Rana *et al*. (2017) [12],Walia *et.al*.(2007) [14]. and Choudhary *et al.* (2013) [3]. It was concluded that the tank mix application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS proved effective in improving weed control and maize yield.

Table 4: Effect of herbicides on plant population, plant height and plant dry matter accumulation in maize

Treatment	Plant population	Plant height (cm)	Plant dry matter	Grain yield (kg ha^{-1})	Stover Yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Weedy check	56581	132.8	53.67	2367	4009	6376	37.04
Atrazine at 10 DAS	59636	143.6	62.33	3821	5624	9444	40.51
Atrazine at 15 DAS	60508	146.3	58.33	3290	5272	8563	38.42
Atrazine at 20 DAS	60726	149.8	54.33	3579	4886	8465	42.13
Atrazine + Halosulfuron at 10 DAS	60290	158.0	50.67	3225	4717	7942	40.60
Atrazine + Halosulfuron at 15 DAS	58109	135.8	51.33	3194	5071	8265	38.69
Atrazine + Halosulfuron at 20 DAS	58327	142.6	49.67	3587	5382	8969	40.06
Atrazine + Tembotrione at 10 DAS	61550	182.8	70.67	4829	7018	11847	40.74
Atrazine + Tembotrione at 15 DAS	61550	188.6	87.67	5240	7028	12269	42.60
Atrazine + Tembotrione at 20 DAS	61356	174.4	80.67	4963	6885	11847	41.68
Atrazine + Topramezone at 10 DAS	60883	181.6	85.33	4892	6773	11664	42.14
Atrazine + Topramezone at 15 DAS	58423	186.8	79.33	4638	6947	11584	40.04
Atrazine + Topramezone at 20 DAS	57175	168.6	78.33	4598	6886	11483	40.07
SEm ±	1473	6.0	4.42	232	250	344	1.600
CD (P=0.05)	NS	17.5	12.91	679	729	1004	NS

References

1. Agricultural Statistics at a Glance. Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India 2016, pp. 103-105.
2. Chopra P, Angiras NN. Effect of tillage and weed management on productivity and nutrient uptake of maize (*Zea mays*). Indian Journal of Agronomy 2008;53:66-69.
3. Choudhary P, Nepalia V, Singh D. Effect of weed control and sulphur on productivity of quality protein maize (*Zea mays*), dynamicsof associated weeds and relative nutrient uptake. Indian Journal of Agronomy 2013;58:534-538.
4. Dass S, Kumar A, Jat SL, Parihar CM, Singh AK, Chikkappa GK, *et al*. Maize holds potential for diversification and livelihood security. Indian Journal of Agronomy 2012;57(3rd IAC Special Issue):32-37.
5. Donald CM, Hamblin J. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Advances in Agronomy 1976;28:361-405.
6. Mani VS, Gautam KC, Chakraberty TK. Losses in crop yield in India due to weed growth. PANS 1968;42:142-158.
7. Nadiger S, Babu R, Kumar ABN. Bioefficacy of pre emergence herbicides on weed management in maize. Karnataka Journal of Agricultural Science 2013;26:17-19.
8. Patel VJ, Upadhyay PN, Patel JB, Meisuriya MI. Effect of herbicide mixture on weeds in kharif maize (Zea mays L.) under middle Gujarat conditions. Indian Journal of Weed science 2006;38:54-57.
9. Rao AS, Ratnam M, Reddy TY. Weed management in zero –till down maize. Indian Journal of Weed Science 2009;41:46-49.
10. Singh VP, Guru SK, Kumar A, Akshita B, Tripathi N. Bioefficacy of tembotrione against mixed weed complex in maize. Indian Journal of Weed Science 2012;44:1-5.
11. Swetha K, Madhavi M, Pratibha G, Ramprakash T. Weed management with new generation herbicides in maize. Indian Journal of Weed Science 2015;47:432-433.
12. Rana SS, Badiyala D, Sharma N, Kumar R, Pathania P. Impact of tembotrione on weed growth, yield and economics of maize (*Zea mays* L.) under mid hill conditions of Himachal Pradesh. Pesticide Research Journal 2017;29:27-34.
13. Triveni U, Rani YS, Patro TSSK, Bharathalakshmi M. Effect of different pre- and post-emergence herbicides on weed control,productivity and economics of maize. Indian Journal of Weed Science 2017;49:231-235.
14. Walia US, Surjit Singh, Buta Singh. Integrated control of hardy weeds in Maize (*Zea mays* L.). Indian. Journal of Weed Science 2007;39:17-20.