Original Research Article

Effect of different Post- emergence Herbicides tank mix with Atrazine on Nutrient uptake and Chlorophyll content in Maize (*Zea mays L.*)

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. The experiment comprising 13 treatment combinations *i.e.* weedy check, atrazine 0.5 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} PoE at 15 DAS, atrazine 0.5 Kg ha^{-1} PoE at 20 DAS, atrazine 0.5 Kg ha^{-1} + halosulfuron 0.09 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} + halosulfuron 0.09 Kg ha^{-1} PoE at 15 DAS, atrazine 0.5 Kg ha^{-1} + halosulfuron 0.09 Kg ha^{-1} PoE at 20 DAS, atrazine 0.5 Kg ha^{-1} + tembotrione 0.125 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} + tembotrione 0.125 Kg ha^{-1} PoE at 15 DAS, atrazine 0.5 Kg ha^{-1} + tembotrione 0.125 Kg ha^{-1} PoE at 20 DAS, atrazine 0.5 Kg ha^{-1} + topramezone 0.025 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} + topramezone 0.025 Kg ha^{-1} PoE at 15 DAS, and atrazine 0.5 Kg ha^{-1} + topramezone 0.025 Kg ha^{-1} PoE at 20 DAS.These 13 treatment were replicated thrice in randomized block design with the objectives to find out the effect of herbicides and their tank mix application on nutrition in plant as well as weed and chlorophyll content of maize and their economics. The minimum NPK uptake by weeds at harvest also was found under the treatment of atrazine 0.5 Kg ha^{-1}+ tembotrione 0.125 Kg ha^{-1} PoE at 15 days after sowing. All the weed control treatments increased the chlorophyll content of maize over weedy check. 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}).

The maximum uptake of total nitrogen (144.49 Kg ha^{-1}) and phosphorus (34.99 Kg ha^{-1}) by the crop was observed under application of atrazine 0.5 Kg ha^{-1} + tembotrione 0.125 Kg ha^{-1} PoE at 15 DAS, while maximum uptake of potassium (130.42 Kg ha^{-1}) recorded in atrazine 0.5

Kg ha^{-1} + topramezone 0.025 Kg ha^{-1} PoE at 20 DAS which were significantly higher over all other herbicidal treatments.

Keywords: maize, atrazine, Post emergence, chlorophyll, nutrient.

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^{-1}. In Rajasthan, this crop occupied 0.90 m ha area with production of 1.60 m t and productivity of 1.70 t h^{-1} (Agricultural Statistics at a Glance, 2016). Being 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%.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) (Dass *et al*., 2012).

MATERIALS AND METHODS

The experiment was carried out at research farm of Rajasthan college of Agriculture,Udaipur, during *kharif*, 2017 (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 (249.2 Kg ha^{-1}), medium in phosphorus(21.6 Kg ha^{-1}) , high in potassium(378.7 Kg ha^{-1}) and slightly alkaline (P^H 8.1) 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 which were replicated thrice tested were as follows weedy check, atrazine 0.5 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} PoE at 15 DAS, atrazine 0.5 Kg ha^{-1} PoE at 20 DAS, atrazine 0.5 Kg ha^{-1} + halosulfuron 0.09 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} + halosulfuron 0.09 Kg ha^{-1} PoE at 15 DAS, atrazine 0.5 Kg ha^{-1} + halosulfuron 0.09 Kg ha^{-1} PoE at 20 DAS, atrazine 0.5 Kg ha^{-1} + tembotrione 0.125 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} + tembotrione 0.125 Kg ha^{-1} PoE at 15 DAS, atrazine 0.5 Kg ha^{-1} + tembotrione 0.125 Kg ha^{-1} PoE at 20 DAS,

atrazine 0.5 Kg ha^{-1} + topramezone 0.025 Kg ha^{-1} PoE at 10 DAS, atrazine 0.5 Kg ha^{-1} + topramezone 0.025 Kg ha^{-1} PoE at 15 DAS, and atrazine 0.5 Kg ha^{-1} + topramezone 0.025 Kg ha^{-1} PoE at 20 DAS. The result were analyzed taking consideration of weed parameters such as weed dry matter at harvest nutrient content and uptake by weed and plant parameter such as nutrient (Nitrogen, Phosphorus and Potassium) content and uptake plant and grain yield.

The dry matter of weeds obtained at harvest was ground and analyzed for N, P, K and S contents as detailed for plant analysis. Nutrient N, P, K and S uptake by weeds at harvest were computed by following formula and expressed in terms of Kg ha^{-1}.

$$\text{Nutrient uptake by weeds (Kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in weeds (\%) x Weed dry matter (Kg ha}^{-1}\text{)}}{100}$$

Fresh leaf sample were collected at 30 and 60 DAS from crop, and immediately were taken to lab, washed with distil water and dried with blotting paper. A sample of 100 mg was taken from each experimental unit in mortar and pestle. The sample was ground well with 80 per cent acetone and filtered into a 25 ml volumetric flask the volume was raised and absorbance was recorded. The Chlorophyll content was estimated as per standard procedure (Arnon, 1949).

$$\text{Chlorophyll content (mg g}^{-1}\text{ f. w.)} = \left(\frac{20.2(A645) + 8.02(A663)}{a \times 1000 \times W}\right) X\, V$$

Where,

a = length of light path in cell (1 cm)

V = volume of extract in ml

W = fresh weight of leaf sample in g

For estimation of nitrogen, phosphorus and potassium contents, representative plant samples were collected at harvest, oven dried and ground to fine powder and nutrient contents in grain and straw were estimated as per the method given in Table 1.0.

Table 1.0: Methods for determination of nutrient content

Nutrient	Method of analysis	Reference
Nitrogen	Nesseler's reagent colorimetric method	Lindner (1944)
Phosphorus	Ammonium vanadomolybdo phosphoric acid yellow colour method	Richards (1968)
Potassium	Flame photometer method	Jackson (1973)

The uptake of nutrient by grain and stover at harvest were calculated by using following formula:

$$\text{Nutrient uptake by Grain/stover (Kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in grain/stover (\%) X Grain/stover yield (Kg ha}^{-1}\text{)}}{100}$$

Total nutrient uptake by the crop was computed by summing up the uptake by both grain and stover.

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 and Digeria arvensis* respectively.

Effect on weed

Nutrient content and uptake by weed at harvest

The data explicit that there was no significant effect of weed management practices on N, P, and K content in weed.

Nutrient uptake by weeds was maximum in weedy check plots where uncontrolled weed growth throughout the crop season resulted in a loss of 33.05 kg N, 6.57 kg P and 24.68 kg K_2O ha^{-1} (Table 2.0). Herbicidal weed control treatments brought about significant reduction in NPK uptake by weeds. Reduction in weed dry matter through tank mix application of atrazine 0.5 Kg

ha-$^{-1}$ + tembotrione 0.125 Kg ha^{-1} PoE at 15 DAS was accompanied by corresponding reduction in per hectare removal of N, P and K. The nutrient uptake by weeds is a direct function of its dry matter and nutrient content. The nutrient depletion by weeds in the present study also substantiates this fact.

The minimum nutrient uptake was recorded by weed controlling through atrazine 0.5 Kg ha-$^{-1}$ + tembotrione 0.125 Kg ha^{-1} PoE at 15 DAS (0.49 kg N ha^{-1}, 0.10 kg P_2O_5 ha^{-1} and 0.39 kg K_2O ha^{-1}). This weed control treatment was found statistically superior over the rest of treatments. The correlation study also indicates a positive significant correlation between weed biomass and NPK uptake by weeds.

Effect on crop

All the weed control measures tended to improve the nitrogen, phosphorus and potassium by grain and stover significantly compared to weedy check (Table 4.0). Nutrient uptake by crop is primarily a function of yield and nutrient content. The highest NPK uptake was recorded with atrazine 0.5 Kg ha^{-1}+ tembotrione 0.125 Kg ha^{-1} PoE at 15 DAS (Table 5.0) which might be due to decreased crop weed competition had concurrently increased in nutrient availability, better crop growth and higher crop biomass production coupled with more nutrient content.Similar results were also reported by Patel *et al.* (2006) and Choudhary *et al*. (2013)

In general, the aforesaid improvements seems to be on account of their direct impact through least crop-weed competition while, indirect effect might be on account of least competition for plant growth inputs *viz*., light, space, water and nutrient etc. Better weed control also resulted in increased chlorophyll content of leaves which can be attributed to greater nutrient availability of nutrients specially nitrogen which has a significant role to play in chlorophyll synthesis. Leaf chlorophyll content is often highly correlated with leaf N status, photosynthetic capacity, and RuBP carboxylase activity.

The data presented in Table 3.0 showed that herbicide had no significant effect on chlorophyll content (mg g^{-1} fresh weight) in maize plant at 30 DAS however, resulted highest chlorophyll content (1.15 mg g^{-1} fresh weight) under treatment PoE at 15 DAS.

At 60 DAS, the results showed that herbicide alone and mixture had no significant effect on chlorophyll content (mg g^{-1} fresh weigh t) on maize plant.

Conclusion

It could be concluded that under the conditions of the current experiment that the tank mix application of atrazine 0.5 kg ha^{-1} + tembotrione 0.125 kg ha^{-1} at 15 DAS has positive effects on chlorophyll , nutrient content and uptake by maize along with corresponding reduction in per hectare removal of N, P and K by weed and highest grain yield (5240 kg ha^{-1}),net return (₹ 71009 ha^{-1}) and BC ratio (2.57). However, the findings are based on one year experimentation that need to be validated through further research to formulate recommendation.

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Table 2.0: Effect of herbicides on nutrient content and uptake by weed

Treatment	Nutrient content (%) in weed			Nutrient uptake by (Kg ha^{-1}) weed		
	N	P	K	N	P	K
Weedy check	1.74	0.35	1.30	33.05	6.57	24.68
Atrazine at 10 DAS	1.74	0.34	1.35	7.21	1.42	5.57
Atrazine at 15 DAS	1.75	0.36	1.31	8.93	1.84	6.69
Atrazine at 20 DAS	1.72	0.32	1.27	11.41	2.14	8.46
Atrazine + Halosulfuron at 10 DAS	1.74	0.36	1.30	6.18	1.26	4.62
Atrazine + Halosulfuron at 15 DAS	1.75	0.34	1.34	7.53	1.48	5.75
Atrazine + Halosulfuron at 20 DAS	1.70	0.30	1.27	9.90	1.75	7.41
Atrazine + Tembotrione at 10 DAS	1.73	0.33	1.29	1.34	0.26	1.00
Atrazine + Tembotrione at 15 DAS	1.70	0.34	1.33	0.49	0.10	0.39
Atrazine + Tembotrione at 20 DAS	1.74	0.34	1.31	0.90	0.18	0.68
Atrazine + Topramezone at 10 DAS	1.77	0.33	1.32	1.41	0.26	1.05
Atrazine + Topramezone at 15 DAS	1.80	0.32	1.34	0.60	0.11	0.45
Atrazine + Topramezone at 20 DAS	1.68	0.32	1.25	1.55	0.30	1.15
SEm $\pm$	0.025	0.012	0.030	0.251	0.106	0.190
CD (P=0.05)	**NS**	**NS**	**NS**	**0.734**	**0.309**	**0.554**

Table 3.0: Effect of herbicide on yield (Kg ha^{-1}) and chlorophyll content in maize

Treatments	Yield (Kg ha^{-1})			Chlorophyll content (mg g^{-1}fresh wt.)	
	Grain yield	Stover yield	Biological yield	At 30 DAS	At 60 DAS
Weedy check	2367	4009	6376	1.10	1.63
Atrazine at 10 DAS	3821	5624	9444	1.12	1.73
Atrazine at 15 DAS	3290	5272	8563	1.12	1.66
Atrazine at 20 DAS	3579	4886	8465	1.11	1.65
Atrazine + Halosulfuron at 10 DAS	3225	4717	7942	1.12	1.65
Atrazine + Halosulfuron at 15 DAS	3194	5071	8265	1.11	1.58
Atrazine + Halosulfuron at 20 DAS	3587	5382	8969	1.10	1.65
Atrazine + Tembotrione at 10 DAS	4829	7018	11847	1.13	1.65
Atrazine + Tembotrione at 15 DAS	5240	7028	12269	1.15	1.71
Atrazine + Tembotrione at 20 DAS	4963	6885	11847	1.14	1.67
Atrazine + Topramezone at 10 DAS	4892	6773	11664	1.13	1.68
Atrazine + Topramezone at 15 DAS	4638	6947	11584	1.13	1.68
Atrazine + Topramezone at 20 DAS	4598	6886	11483	1.13	1.67
SEm ±	232	250	344	0.009	0.037
CD (P=0.05)	679	729	1004	**NS**	**NS**

Table 4.0 : Effect of herbicides on nutrient content (N,P and K) in maize at harvest

Treatment	Nutrient content (%)in Grain			Nutrient content (%)in Stover		
	N	P	K	N	P	K
Weedy check	1.70	0.31	0.41	0.56	0.15	1.38
Atrazine at 10 DAS	1.71	0.34	0.42	0.74	0.15	1.41
Atrazine at 15 DAS	1.80	0.32	0.43	0.82	0.16	1.42
Atrazine at 20 DAS	1.90	0.41	0.44	0.84	0.17	1.41
Atrazine + Halosulfuron at 10 DAS	1.72	0.41	0.42	0.85	0.17	1.40
Atrazine + Halosulfuron at 15 DAS	1.73	0.44	0.44	0.85	0.16	1.48
Atrazine + Halosulfuron at 20 DAS	1.81	0.42	0.44	0.70	0.16	1.47
Atrazine + Tembotrione at 10 DAS	1.83	0.45	0.43	0.72	0.17	1.43
Atrazine + Tembotrione at 15 DAS	1.81	0.42	0.43	0.71	0.18	1.42
Atrazine + Tembotrione at 20 DAS	1.75	0.41	0.44	0.83	0.17	1.42
Atrazine + Topramezone at 10 DAS	1.80	0.41	0.43	0.82	0.17	1.43
Atrazine + Topramezone at 15 DAS	1.81	0.40	0.44	0.82	0.16	1.40
Atrazine + Topramezone at 20 DAS	1.81	0.40	0.43	0.83	0.16	1.60
SEm $\pm$	0.01	0.01	0.00	0.00	0.00	0.04
CD (P=0.05)	0.02	0.03	0.01	0.01	0.00	0.11

Table 5.0: Effect of herbicides on nutrient uptake (N,P and K) by plant (grain and stover) at harvest in maize

Treatment	Nutrient uptake by Grain (Kg ha^{-1})			Nutrient uptake by Stover (Kg ha^{-1})			Total nutrient uptake by Plant (Kg ha^{-1})		
	N	P	K	N	P	K	N	P	K
Weedy check	40.23	7.29	9.80	22.45	6.13	55.09	62.69	13.42	64.89
Atrazine at 10 DAS	65.20	12.92	16.04	41.34	8.53	79.34	106.54	21.45	95.38
Atrazine at 15 DAS	59.36	10.61	14.28	43.11	8.45	74.82	102.48	19.06	89.10
Atrazine at 20 DAS	67.94	14.74	15.77	41.11	8.26	68.80	109.05	23.00	84.56
Atrazine + Halosulfuron at 10 DAS	55.52	13.28	13.56	39.87	7.82	66.10	95.39	21.10	79.66
Atrazine + Halosulfuron at 15 DAS	55.25	14.16	14.08	42.92	8.35	75.25	98.17	22.51	89.34
Atrazine + Halosulfuron at 20 DAS	64.89	15.06	15.89	37.74	8.78	79.00	102.63	23.85	94.88
Atrazine + Tembotrione at 10 DAS	88.40	21.50	20.87	50.37	11.86	100.48	138.76	33.36	121.35
Atrazine + Tembotrione at 15 DAS	94.71	22.23	22.42	49.78	12.77	99.81	144.49	34.99	122.23
Atrazine + Tembotrione at 20 DAS	86.74	20.37	21.78	57.26	11.64	97.97	144.00	32.01	119.75
Atrazine + Topramezone at 10 DAS	87.93	19.96	20.81	55.73	11.42	97.33	143.65	31.38	118.14
Atrazine + Topramezone at 15 DAS	84.03	18.47	20.19	56.65	11.21	97.27	140.68	29.68	117.46
Atrazine + Topramezone at 20 DAS	83.30	18.40	19.91	57.14	11.34	110.51	140.44	29.74	130.42
SEm $\pm$	4.26	1.08	0.99	1.98	0.41	4.89	4.68	1.14	4.96
CD (P=0.05)	12.43	3.15	2.90	5.78	1.20	14.27	13.65	3.32	14.48