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Short Note

Effect of time and method of post-emergence application of atrazine on nutrients depletion by weeds in maize

M.C. Rana, Shivani Chand, S.S. Rana and Narender Sankhyan*
Department of Agronomy, Forages and Grassland Management
*Department of Soil Science
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur -176 062, India.
Corresponding author: mc_rana2003@yahoo.com

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Abstract

Fifteen weed control treatments comprising of atrazine 1.5 & 2.0 kg/ha spray and broadcast with sand on 7, 14 and 21 DAS; atrazine 1.5 kg/ha pre-emergence; farmer's practice and weedy check were evaluated for nutrients depletion by weeds in maize during *kharif* 2013 at Palampur. The soil of the test site was silty clay loam in texture, acidic in reaction, medium in organic carbon, low in N and K and medium in P. *Echinochloa colona, Commelina benghalensis, Ageratum conyzoides, Cyperus* sp., *Digitaria sanguinalis and Panicum dichotomiflorum* were the important weeds. Atrazine 2 kg/ha spray at 7 DAS and pre-emergence application of atrazine reduced N, P and K uptake by weeds over weedy check and also gave lowest weed dry weight. Grain yield of maize was also higher when atrazine 2 kg/ha was applied at 7 DAS by spraying and was at par with pre-emergence application of atrazine. Significantly lower N, P and K uptake by weeds was obtained with atrazine 2 kg/ha spray at 7 DAS.

Key words: Atrazine, dose, time, method, weeds, maize.

Weeds take away considerable amount of native and applied plant nutrients from the soil depriving there by crop plants from that much amount of nutrients (Rana *et al.* 1997). Therefore, management of weeds is an important factor for achieving higher productivity. 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. Nutrient losses due to season long weed infestation amounts to 73.8 kg N, 18.7 kg P and 84.3 kg/ha (Rana *et al.* 1997). The choice of weed control measure largely depends on its effectiveness and economics. Due to increased cost and non availability of manual labour for hand weeding, herbicidal technology is a preferred practice. Atrazine is a broad-spectrum selective herbicide recommended for the control of weeds in maize. Atrazine as pre or early post-emergence is widely used for broadleaf and grassy weed control in maize. Its application as pre-emergence is well established. In certain areas, farmers are facing difficulty in spraying herbicides because of labour shortage and scarcity of water particularly during the critical stages of crop growth. The application of some herbicides along with sand as broadcast was found effective in some of the crops (Sharma *et al.* 2000). Moreover, the acceptability of herbicide by the growers as pre-emergence is very poor and generally the post-emergence applied herbicides are preferred. Therefore, the post-emergence application of atrazine by different methods *viz.,* spray or mixed with sand was felt essential. The effect of post-emergence application of atrazine application on weed count and economics has been presented (Chand *et al.* 2016). Here the efficacy of post-emergence atrazine in reducing the crop weed competition for nutrients in maize is presented.

The field experiment was conducted at Palampur (32^0.6' N latitude, 76^0.3' E longitudes and 1290.8 meters altitude) during *kharif* 2013. The soil of the test site was silty clay loam in texture, medium in organic carbon, low in N and K, medium in P and acidic in reaction. Fifteen weed control treatments constituting of atrazine 1.5 and 2.0 kg/ha spray and as broadcast with sand on 7, 14 and 21 DAS; atrazine 1.5 kg/ha as pre-emergence; farmer's practice and weedy check (Table 1)

were tested in randomized block design with 3 replications. The seeds of 'Kanchan Hybrid 717' were sown on June 17, 2013 in lines at plant-to-plant distance of 20 cm and row-to-row distance of 60 cm. N, P_2O_5 and K_2O at 120, 60 and 40 kg/ha were applied through urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively. One- third nitrogen and whole P_2O_5 and K_2O were applied at the time of sowing. The required fertilizer quantity was mixed thoroughly and then placed in open furrows. Remaining nitrogen was applied in two splits each at knee high and tasseling stage. Atrazine 1.5 and 2 kg as per the treatment was applied using 750 litres of water per hectare with the help of manually operated power sprayer and with sand at 150 kg/ha. Hand weeding and earthing up was done on 30th DAS in farmer's practice with the help of local tools called 'khunti' and 'kudal'. The maize crop was harvested on October 5, 2013.

Weed samples were collected by throwing 25 cm x 25 cm quadrat between two border rows of each plot at random. The samples were oven dried at 70°C till constant dry weight. Weeds, grain and straw samples of maize at harvest were collected, dried in oven at 70 ºC for 3-4 days, then ground and stored in paper bags for further analysis. The oven dried sample of weeds, maize grain and straw were analyzed for N, P and K content using the method as outlined below:

Parameter	Method	Reference
Total N	Modified Kjeldahl's Method	Jackson (1973)
Total P	Vanadomolybdate phosphoric acid yellow colour method	Jackson (1973)
Total K	Diacid digestion method	Black (1965)

Uptake of N, P and K by weeds and maize grain and straw was obtained by multiplying their nutrient content with corresponding dry matter. Total uptake by crop was obtained by adding the uptake by grain and straw.

Echinochloa colona and *Commelina benghalensis* were the major weeds constituting 22.6 and 20.7% of total weed population, respectively. *Ageratum conizoides, Cyperus sp., Digitaria sanguinalis* and *Panicum dichotomiflorum* constituted 16.0, 14.1, 14.5 and 12.2% of total weed population, respectively.

Weed dry weight

Data on total dry weight (90 DAS) have been presented in Table 1. Weed control treatments significantly decreased total weed dry weight as compared to weedy check. Atrazine 1.5 kg/ha (pre- emergence) remaining at par with atrazine 2 kg/ha applied on 7 DAS (spray) and atrazine 2 kg/ha applied on 14 DAS (spray) resulted in significantly lower total weed dry weight over other treatments. The lower weed dry weight in the above treatments was mainly due to better weed control efficiency with atrazine application (Rana *et al.* 1998; Kumar *et al.* 2012). Application of herbicide with sand gave poor control of weeds, therefore, had lower weed control efficiency. Among the weed control treatments, atrazine 1.5 kg/ha (pre-emergence) resulted in the maximum weed control efficiency. The other better treatment in order was atrazine 2 kg/ha at 7 DAS (spray). The higher weed control efficiency with these treatments could be attributed to lower dry weight in these treatments (Kolage *et al.* 2004; Kumar *et al.* 2012).

Yield

All the weed control treatments except Farmer's practice were significantly superior to weedy check in increasing the grain yield of maize. Atrazine 2 kg/ha applied on 7 DAS (spray) remaining at par with atrazine 1.5 kg/ha applied on 7, 14 & 21 DAS (spray), atrazine 2 kg/ha applied on 14 & 21 DAS (spray) and atrazine 1.5 kg/ha as pre- emergence gave significant higher grain yield over rest of the treatments. It was mainly due to minimum crop-weed competition throughout the crop growth period. Weeds in weedy check reduced the grain yield of maize by 57.5 %. The above results were corroborated with the findings of Kumar *et al.* (2012), Kolage *et al.* (2004) and Rana *et al.* (1998). All weed control treatments were significantly superior to weedy check in increasing the stover yield of maize. Atrazine 2 kg/ha applied on 7 DAS (spray) being at par with atrazine 1.5 kg/ha applied on 7 & 14 DAS (spray) and atrazine 1.5 kg/ha applied as pre- emergence resulted in significantly higher stover yield over all treatments. The harvest index of maize was not significantly affected due to weed control treatments.

NPK uptake

Owing to significant reduction in dry weight, weed control treatments significantly reduced N, P and K uptake by weeds as compared to weedy check (Table 2). Significantly lower N uptake was recorded in atrazine 2 kg/ha applied on 7 DAS (spray) which was at par with atrazine 1.5 kg/ha (pre-

emergence), atrazine 2 kg/ha applied on 14 DAS (spray) and atrazine 2 kg/ha applied on 21 DAS (spray) as the weeds were effectively controlled. P uptake was lower in atrazine 2 kg/ha sprayed on 7 DAS and was at par with atrazine 1.5 kg/ha (pre-emergence), atrazine 1.5 kg/ha sprayed on 7 & 14 DAS, atrazine 2 kg/ha broadcasted with sand on 7 & 14 DAS and atrazine 2 kg/ha sprayed on 14 DAS. K uptake by weeds was lower in atrazine 2 kg/ha sprayed on 7 DAS which was at par with atrazine 1.5 kg/ha (pre-emergence), atrazine 1.5 kg/ha sprayed on 7 DAS, atrazine 1.5 kg/ha broadcasted with sand on 7 DAS and atrazine 2 kg/ha broadcasted with sand on 7 & 14 DAS.

Table 1. Effect of treatments on on dry weight (g/m^2) of weeds at their maximum dry weight stage i.e. 90 DAS and yield and harvest index of maize

Treatment	Dose (kg/ha)	TOA (DAS)	Total weed dry weight	WCE (%)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index
Atrazine	1.5	7 (spray)	11.0 (120.0)	81.2	4398	8333	0.35
Atrazine	1.5	7 (Bc)	13.3 (177.0)	72.2	3472	6481	0.35
Atrazine	2	7 (spray)	10.3 (105.0)	83.5	4630	8843	0.34
Atrazine	2	7 (Bc)	13.1 (171.0)	73.2	3588	7037	0.34
Atrazine	1.5	14 (spray)	11.8 (138.0)	78.4	4167	8252	0.34
Atrazine	1.5	14 (Bc)	13.8 (190.0)	70.2	3588	7037	0.34
Atrazine	2	14 (spray)	10.5 (110.0)	82.7	3935	7697	0.34
Atrazine	2	14 (Bc)	13.6 (184.0)	71.1	3241	6481	0.33
Atrazine	1.5	21 (spray)	12.8 (162.0)	74.6	3819	7396	0.34
Atrazine	1.5	21 (Bc)	14.1 (199.0)	68.8	3472	6782	0.34
Atrazine	2	21 (spray)	12.0 (142.0)	77.7	3935	7697	0.34
Atrazine	2	21 (Bc)	14.2 (201.0)	68.5	3472	6817	0.34
Atrazine	1.5	PE	10.1 (101.5)	481	4514	8796	0.34
Farmer's practice	-	30	18.9 (358.0)	43.9	2778	5417	0.34
Weedy check	-	-	25.3 (637.67)	0.0	1968	3738	0.35
CD (P=0.05)	-	-	0.50		924	717	NS

Data transformed to square root transformation ($\sqrt{x+1}$) Values given in parenthesis are the means of original values, TOA: Time of application, Bc: Broadcast with sand, PE: Pre-emergence, DAS: Days after sowing

Table 2. Effect of treatments on NPK uptake (kg/ha) by total weeds and maize at harvest

Treatment	Dose (kg/ha)	TOA (DAS)	Nutrient uptake by weeds (kg/ha)			Nutrient uptake by Maize (kg/ha) (grain+stover)		
			N	P	K	N	P	K
Atrazine	1.5	7 (spray)	26.6	2.6	6.7	120.0	18.9	83.6
			(0.274)	(0.027)	(0.069)	(0.126)	(0.020)	(0.088)
Atrazine	1.5	7 (Bc)	32.4	3.5	8.0	70.8	14.9	80.6
			(0.248)	(0.027)	(0.062)	(0.085)	(0.018)	(0.096)
Atrazine	2	7 (spray)	10.7	2.1	6.4	167.4	15.3	79.7
			(0.157)	(0.031)	(0.093)	(0.155)	(0.014)	(0.074)
Atrazine	2	7 (Bc)	28.9	3.0	7.6	110.4	11.9	82.4
			(0.239)	(0.025)	(0.063)	(0.110)	(0.012)	(0.082)
Atrazine	1.5	14 (spray)	25.8	2.9	9.9	114.5	20.0	97.0
			(0.233)	(0.026)	(0.090)	(0.104)	(0.018)	(0.088)
Atrazine	1.5	14 (Bc)	38.7	3.0	12.5	110.8	13.1	89.5
			(0.250)	(0.019)	(0.081)	(0.120)	(0.014)	(0.097)
Atrazine	2	14 (spray)	13.8	2.9	6.6	128.3	18.5	72.7
			(0.140)	(0.030)	(0.067)	(0.114)	(0.017)	(0.065)
Atrazine	2	14 (Bc)	37.1	3.9	10.9	105.3	18.0	84.4
			(0.273)	(0.028)	(0.080)	(0.114)	(0.020)	(0.092)
Atrazine	1.5	21 (spray)	30.8	3.9	11.2	133.9	19.9	80.5
			(0.217)	(0.028)	(0.078)	(0.133)	(0.020)	(0.080)
Atrazine	1.5	21 (Bc)	32.1	4.7	12.3	104.1	17.9	83.3
			(0.198)	(0.029)	(0.076)	(0.110)	(0.019)	(0.088)
Atrazine	2	21 (spray)	22.1	3.2	10.3	126.5	19.1	85.4
			(0.196)	(0.028)	(0.091)	(0.114)	(0.017)	(0.077)
Atrazine	2	21 (Bc)	40.8	5.3	13.1	99.0	18.0	71.6
			(0.246)	(0.032)	(0.079)	(0.107)	(0.020)	(0.078)
Atrazine	1.5	PE	13.9	2.3	6.4	140.4	19.3	89.0
			(0.174)	(0.029)	(0.080)	(0.130)	(0.018)	(0.082)
Farmer's	-	30	70.1	6.1	15.9	58.3	18.6	78.0
practice			(0.289)	(0.025)	(0.066)	(0.082)	(0.026)	(0.110)
Weedy check	-	-	77.7	9.4	21.0	57.3	15.4	82.0
			(0.211)	(0.026)	(0.057)	(0.103)	(0.028)	(0.148)
CD (P=0.05)	-	-	14.8	1.0	3.1	-	-	-

TOA: Time of application, Bc: Broadcast with sand, PE: Pre-emergence, DAS: Days after sowing, nutrient content is given in parenthesis

All the weed control treatments increased the N, P and K uptake by maize over weedy check (Table 2). Nutrient uptake is the function of dry matter and nutrient content. Higher dry matter accumulation by maize with application of atrazine as spray may be attributed to higher root spread and penetration in soil due to weed free environment. Also, lower N, P and K removal by weeds allowed maize to grow vigorously and accumulate more biomass, which consequently led to higher uptake of these nutrients. These results are in conformity with Rana *et al.* (1997), Chalka and Nepalia (2005) and Balyan and Kumpawat (2008).

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