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PERIODICAL EFFICACY OF ATRAZINE 50% WP AGAINST MAJOR WEED SPECIES IN *SURU* SUGARCANE CROP

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Abstract: An experiment on efficacy of atrazine 50% WP was designed in Randomized Block Design with three replications and eight treatments at Regional Sugarcane &Jaggery Research Station, Kolhapur. The maximum weed control efficiency was observed in atrazine 50% WP formulation of 2000, 4000 g a.i per hectare, diuron (80% WP) @ 3200 g a.i. per ha and hand weeding treatments. Weeds species of *Xantheium strumarium* and *Cleome viscose* recorded highest weed control efficiency. The plant population was not influenced statistically due to different herbicide treatments. Hand weeding treatment recorded highest yield attributes as compared with other weed management treatments but characters of millable cane and girth of cane was non-significantly affected by various treatments. The significantly highest cane yield (132.59 t ha^{-1}) was recorded by hand weeding treatment. No any treatment showed phytotoxic effect viz;.leaf injury, necrosis, vein clearing, hyponasty and epinasty on sugarcane.

Index terms :**Efficacy, Atrazine, Weeds & Sugarcane**

I. INTRODUCTION

India is the second largest producer of sugar after Brazil. Overfive million farmers are involved in the cultivation of sugarcane in tropical and subtropical region. At present, according to ISMA (Indian sugar Mills Association), there is 8 per cent increase in area under sugarcane to nearly 52.28 lakh hectares (lh) as compared to 48.41 lh in the previous sugar season of 2019-20. (Annonymous [1], 2020). According to the Ministry of Agriculture and Farmers' Welfare's First Advance Estimates for 2019-20, 4.9 million hectares of area is under sugarcane cultivation, with an average yield of 77.6 tonnes per hectare and total production of 377.8 million tonnes, 5.6 percent lower than the last year (Annonymous[2], 2020). The fluctuation in sugarcane yield is due to adverse weather conditions issue that has plagued sugarcane production systems in the country for many years. Therefore, understanding of productivity movements over the recent past and in the longer run would help understand potential issues and identify appropriate actions to improve crop yields and reduce variability. Yield instability is a major problem in sugarcane with large interannual variations. The reasons for low yield of sugarcane includes improper land preparation, conventional planting methods, less than recommended seed rate, heavy weed infestation, shortage of irrigation water, imbalanced fertilizer application, less support price, lack of coordination between growers and mill owners, natural calamities, delayed harvesting, pests and disease incidence, poor management of ratoon crop and salinity. Among the various factors limiting cane production, weed infestation is one of the significant biotic constraints in sugarcane production (Malik and Gurmani, 2005). Weeds pose most serious because of liberal use of farmyard manure, chemical fertilizers and frequent irrigations that help the weeds to grow vigorously. It has been well established that losses from weeds accounts for 45 per cent more than when compared to insect, pest and diseases about 30 and 20 per cent, respectively (Rao, 1993) . Weed flora of sugarcane. The type and number of weed species vary from country to country due to varied climatic, edaphic, and biotic factors. Different types of weed population have reported losses up to

40% of cane yield. Johnson grass and tall perennial grasses decreased cane yield by 36% and sugar yield by 31% compared to weed-free sugarcane fields (El-Shafai*et al*., 2010). The typical weed flora observed in sugarcane crop was *Cyperus rotundus, Cynadon dactylon, Sporobolus sp., Digitaria sanguinalis, Trianthema portulacastrum, Amaranthus viridis, Gyanandropsis pentaphylla, Cleome viscosa, Euphorbia hirta and Tridax procumbens. Cyperus rotundus among sedges and Trianthema portulocastrum and Cleome viscosa among dicots* were predominant and these species occupied about 70% of the total weed density (Chitkaladevi *et al*., 2010). At Coimbatore, the major weed flora of the sugarcane field included *Trianthema portulacastrum, Portulaca quadrifida, Corchorus olitorius, Datura fastuosa, Digera arvensis Cyperus rotundus, Cynodondactylon, Dactyloctenium aegyptium, Chloris barbata and Setaria verticillata* (Kalaiyarasi, 2012).

Weeds compete for light, space, nutrients and moisture and thus reduce the crop yields (Rao and Prashar, 1987). The magnitude of losses depends upon the intensity, type of weed flora and stage of crop growth. The yield reduction has been estimated to range from 26–75 per cent (Chauhan and Das, 1990; Srivastava, 2003 and Srivastava *et al,* 2005). Weeds removed 5.8, 7.8 and 3.0 times more N, P and K, respectively from 35 days old unweeded sugarcane crop (Chaudhari *et al*, 1971). Removing weeds at any time during growing season may not be beneficial. Stage of weed removal is as important. The competition of weeds during germination and early shoot formation stage did not reduce the yield markedly. The damage caused by weed competition during tillering phase of the crop remained quite enormous and showed its significant effect till the end. After the onset of monsoon the damage by weeds was negligible (Verma, 2000; Chauhan and Srivastava, 2002). Few studies indicates that atrazine is effective in controlling many weeds when applies as pre-emergence. The weeds that were efficiently controlled, even at low rates of application. The management of these weed flora is therefore, required and in present situation considering the net return, chemicals are preferred to control weeds in order to augment the productivity. Chemical weed control probably offers the most economic, efficient and effective method due to non availability of sufficient and timely labour for manual weeding. In this context, the experiment was designed to evaluate the efficacy of Atrazine 50% WP and its phytotoxic effect.

II. RESEARCH METHODOLOGY

The experiment was conducted at Regional Sugarcane & Jaggery Research Station; Kolhapur affiliated to Mahatma Phule Krishi Vidyapeeth, Rahuri. This experiment was performed in medium deep soil having 7.01 pH, 0.20 dSm^{-1} EC, 0.79% organic carbon, 192.0 Kg ha^{-1} N, 22.0 Kg ha^{-1} P and 310.0 Kg ha^{-1} K. The crop was grown with recommended package of practices for sugarcane. Two eye bud setts of Sugarcane were planted on 22/01/2017 in *Suru* season by wet method of sugarcane planting. The whole experiment was laid out in Randomized Block Design with three replications and eight treatments as below.

T_1 : 50% WP Atrazine @500 ga.i./ha
T_2 : 50% WP Atrazine @ 1000 ga.i./ha
T_3 : 50% WP Atrazine @ 2000 ga.i./ha
T_4 : 50% WP Atrazine @ 4000 ga.i./ha
T_5 : 80% WPDiuron @ 3200 ga.i./ha
T_6 : 2,4-D @ 3500g a.i./ha
T_7 : Hand weeding
T_8 : Control

The test of herbicide Atrazine 50% WP at given formulation dosages were sprayed as pre emergence within 3rd day after planting of sugarcane sets by knapsack sprayer fitted with flood jet nozzle. Species wise weed from 1 m x 1 m quadrate in marked area at 15, 30, 45 and 60 days after planting (DAP) were sundried and transferred to hot air oven at 60°C. Biomass of the weeds of each sample was recorded in g/m^2. Observations on growth attributes like germination per cent at 30 DAP, tillering ratio at 150 DAP were recorded. The yield attributes viz; number. of millable canes per hectare, millable cane height, girth of cane, number of inetrnodes, single cane weight and yield of sugarcane at harvest were recorded scientifically by taking samples in treated and untreated plots. The crop was harvested at maturity was recorded in kg/ plot and converted to tonn/ha. The Weed control efficiency (WCE) is expressed as the percentage of control of weeds over un-weeded control. It denotes the efficiency of the applied herbicide for comparison purpose and worked out with the following formula given by Mani *et al.*, 1973

$$\text{Weed Control Efficiency } (\%) = \frac{X - Y}{X} X\ 100 \qquad (1)$$

Where, X= Weed dry weight in control (untreated or un-weeded) plot,
Y= Weed dry weight of treated plot

The Phytotoxicity was assessed on basis of yellowing, necrosis, wilting, vein clearing, hyponasty, leaf injury and epinasty of sugarcane plants were recorded at 15, 30, 45 and 60 days after application (DAS). The visual assessment was undertaken to measure the phytotoxic effect on sugarcane plane. These visual assessments were measured in phytotoxicity rating scale (PRS) *i.e.* 0-10 scale (Rao and Rao, 1986).

Table 1: Phytotoxicity Rating Scale (PRS)

Score	Phytotoxicity (%)	Effect of rating
0	0-00	No injury
1	1 – 10	Very poor control Slight stunting, injury or discolouration
2	11 – 20	Poor control Some stand loss, stunting or discolouration
3	21 – 30	Poor to deficient control Injury more pronounced but not persistent Moderate
4	31 – 40	Deficient control Moderate injury, recovery possible
5	41 – 50	Deficient to moderate control Injury more persistent, recovery doubtful
6	51 – 60	Moderate control Near severe injury no recovery possible Severe
7	61 – 70	Satisfactory control Severe injury stand loss
8	71 – 80	Good control Almost destroyed a few plants surviving
9	81 – 90	Good to excellent control Very few plants alive
10	91 – 100	Complete destruction

III. RESULTS AND DISCUSSIONS:

Efficacy :Dry weight of weeds : It was revealed from Table 2 to 5 that hand weeding treatment recorded lowest dry weight of weeds at 60 days after application where 5.14 g dry weight was observed. Among the other weed management treatments, application of pre emergence herbicide atrazine 50% WP @ 4000 g a. i. per hectare recorded lowest weed dry weight at 45 & 60 days after application. Initially, herbicidal treatment of atrazine @ 2000 g a.i. per hectare recorded lowest dry weight of weeds followed by hand weeding treatment showed lowest yield. But at 45 & 60 days after application, atrazine @ 4000 g a.i. per hectare recorded lowest dry weight of weeds may be due to the higher concentration or formulation of chemical. Regarding the weed species, *Cleome viscose* recorded lowest dry weight at 45 and 60 days after application of herbicides. The lower weed dry weight in weed control treatments may be ascribed to the less number of weeds, rapid depletion of carbohydrate reserves of weeds through rapid respiration (Dakshina das, 1962) and may be due to reduced photosynthetic activity (Hilli and Santkemann, 1969).

Weed control efficiency: The data in respect of weed control are presented in Table 2 to 5. Maximum weed control efficiency was observed in atrazine 50% WP formulation of 2000, 4000 g a.i per hectare, diuron (80% WP) @ 3200 g a.i. per ha and hand weeding treatments. Weeds species of *Xantheium strumarium* and *Cleome viscose* recorded highest weed control efficiency. Besides this, *Cyprus rotundus*, *Cena* and *Ipomea sp.* type of weeds observed under experimental conditions. Similar results were obtained by Shivalingappa *et al*. (2014).

Yield attributes: The hand weeding treatment recorded highest yield attributes as compared with other weed management treatments but characters of millable cane and girth of cane was non-significantly affected by various treatments (Table 6). The significantly highest cane yield (132.59 t ha^{-1}) was recorded by hand weeding treatment followed by T_5 (121.21 t ha^{-1}) and T_3 (115.86 t ha^{-1}). Soumen Bera and Ratikanta.Ghosh (2013) reported the maximum cane yield was recorded from atrazine 50% WP @ 4.0kg ha^{-1} (58.01 t ha^{-1}) which was statistically at par with atrazine 50% WP @ 4.0 kg ha^{-1} (55.10 t ha^{-1}) while the minimum was from the control (31.87 t ha^{-1}).

Phytotoxicity: The data on phytotoxicity effect viz;. leaf injury, necrosis, vein clearing, hyponasty and epinasty except wilting are presented in Table 7. No phytotoxic symptoms such as epinasty/hyponasty, leaf yellowing, necrosis, stunting growth, wilting etc were found. This is in conformity with the earlier findings of Kathiresan and Avudathai (2004).

IV. CONCLUSION: Among weedicide, application of 80% WP Diuron @ 3200 g and 50% WP atrazine @ 2000g a.i.per ha are suitable for control of weeds in *suru* sugarcane.

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Efficacy : Species wise dry weight of weeds

Table 2 :Species wise dry weight of weeds (per m^2) and weed control efficiency (%) in *suru* sugarcane as influenced by various treatments at 15 days after application.

Sr.No.	Weed species	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Mean	Species wise WCE (%)
1	*Trianthama monogyna*	-	-	-	-	-	-	-	-	-	-
2	*Diegra arvensis*	-	-	-	-	-	-	-	-	-	-
3	*Echinocholae leusine*	0.16	0.17	-	-	-	-	0.18	0.30	0.62	40.00
4	*Xantheium strumarium*	-	-	-	-	-	-	-	0.23	0.56	100.00
5	*Brachiaria spp*	-	-	-	-	-	0.33	2.67	1.33	0.54	-100.75
6	*Digitaria spp*	-	-	-	-	-	-	-	-	-	-
7	*Amaranthus viridis*	-	0.33	-	-	-	-	-	-	0.04	NA
8	*Cleome viscose*	0.13	0.11	-	-	-	0.14	0.18	0.25	0.33	28.00
9	*Polygonum sp*	-	-	-	-	-	-	-	-	-	-
10	*Portulaca oleraceae*	0.04	0.02	-	-	0.02	0.01	0.01	0.17	0.46	94.12
11	*Boerhavia diffusa*	-	-	-	-	-	-	-	-	-	-
12	*Euphorbia sp*	-	-	-	-	-	-	-	-	-	-
13	*Tribulus terestis*	-	-	-	-	-	0.03	-	-	0.004	NA
14	*Cyprus rotundus*	0.19	0.22	0.1	0.58	0.11	-	0.13	1.23	0.45	89.43
15	*Senna spp*	0.1	0.07	0.03	0.12	0.12	-	0.21	0.23	0.60	8.70
16	*Ipomea sp.*	0.06	0.02	-	-	0.05	-	0.11	0.07	0.24	-57.14
17	*Penicum repens*	-	0.03	0.01	0.07	0.09	0.11	0.05	0.08	0.32	37.50
	Mean	**0.040**	**0.039**	**0.008**	**0.045**	**0.023**	**0.076**	**0.522**	**0.386**		
	Treatment wise WCE (%)	**89.63**	**89.94**	**97.87**	**88.26**	**94.05**	**80.34**	**-35.21**	**0.00**		

Table 3: Species wise dry weight of weeds (per m^2) and weed control efficiency (%) in *suru* sugarcane as influenced by various treatments at 30 days after application

Sr.No.	Weed species	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Mean	Species wise WCE (%)
1	*Trianthama monogyna*	-	-	-	-	-	-	-	-	-	-
2	*Diegra arvensis*	-	-	-	-	-	-	-	-	-	-
3	*Echinocholae leusine*	0.38	6.00	0.62	1.67	0.14	1.00	0.09	0.67	1.72	70.28
4	*Xantheium strumarium*	-	-	-	-	-	-	-	-	-	-
5	*Brachiaria spp*	-	-	-	-	-	-	-	-	-	-
6	*Digitaria spp*	-	-	-	-	-	-	-	-	-	-
7	*Amaranthus viridis*	-	-	-	-	-	-	-	-	-	-
8	*Cleome viscose*	1.43	1.00	-	-	0.31	0.57	0.83	0.66	0.78	32.03
9	*Polygonum sp*	-	-	-	-	-	-	-	-	-	-
10	*Portulaca oleraceae*	2.40	1.00	1.34	0.33	0.59	0.33	0.46	1.33	1.85	67.76
11	*Boerhavia diffusa*	-	-	-	-	-	-	-	-	-	-
12	*Euphorbia sp*	-	-	-	-	-	-	-	-	-	-
13	*Tribulus terestis*	-	-	-	-	-	-	-	-	-	-
14	*Cyprus rotundus*	1.57	5.00	1.31	0.67	0.16	2.67	0.94	1.00	2.12	65.99
15	*Senna spp*	0.98	2.33	0.57	2.00	0.46	5.67	1.50	2.33	2.34	68.52
16	*Ipomea sp.*	3.31	2.00	1.94	2.00	1.40	2.67	1.42	4.33	3.29	71.35
17	*Penicum repens*	0.95	1.33	0.32	1.00	0.19	2.33	0.37	2.00	2.42	76.10
	Mean	**0.65**	**1.10**	**0.40**	**0.45**	**0.17**	**0.86**	**0.28**	**0.73**		
	Treatment wise WCE (%)	**55.90**	**72.95**	**88.25**	**80.87**	**80.07**	**68.51**	**55.73**	**0.00**		

Table 4 :Species wise dry weight of weeds (per m^2) and weed control efficiency (%) in *suru* sugarcane as influenced by various treatments at 45 days after application.

Sr.No.	Weed species	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Mean	Species wise WCE(%)
1	*Trianthama monogyna*	-	-	-	-	-	-	-	-	-	-
2	*Diegra arvensis*	-	-	-	-	-	-	-	-	-	-
3	*Echinocholae leusine*	13.51	8.00	17.58	4.67	11.33	2.00	-	1.33	8.10	70.93
4	*Xantheium strumarium*	-	-	-	-	-	-	-	-	-	-
5	*Brachiaria spp*	-	-	-	-	-	-	-	-	-	-
6	*Digitaria spp*	-	-	-	-	-	-	-	-	-	-
7	*Amaranthus viridis*	-	-	-	-	-	-	-	-	-	-
8	*Cleome viscose*	4.07	2.33	2.67	1.00	1.06	1.00	-	1.33	2.41	75.04
9	*Polygonum sp*	-	-	-	-	-	-	-	-	-	-
10	*Portulaca oleraceae*	7.66	3.33	7.02	1.67	4.64	1.67	4.04	3.00	5.89	69.92
11	*Boerhavia diffusa*	-	-	-	-	-	-	-	-	-	-
12	*Euphorbia sp*	-	-	-	-	-	-	-	-	-	-
13	*Tribulus terestis*	-	-	-	-	-	-	-	-	-	-
14	*Cyprus rotundus*	2.47	8.67	2.94	3.00	1.07	5.00	1.74	1.67	3.42	54.34
15	*Senna spp*	3.87	7.00	4.30	3.33	1.77	7.33	3.43	5.67	4.88	52.35
16	*Ipomea sp.*	8.02	5.33	6.96	4.33	5.12	4.00	5.36	6.67	6.31	62.10
17	*Penicum repens*	3.88	3.33	2.42	2.67	4.08	4.00	1.79	3.33	4.79	66.98
	Mean	**2.56**	**2.24**	**2.58**	**1.22**	**1.71**	**1.47**	**1.32**	**1.35**		
	Treatment wiseWCE (%)	**55.53**	**55.10**	**70.25**	**77.02**	**70.55**	**53.10**	**89.72**	**0.00**		

Table 5 :Species wise dry weight of weeds (per m^2) and weed control efficiency (%) in *suru* sugarcane as influenced by various treatments at 60 days after application

Sr.No.	Weed species	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Mean	Species wise WCE (%)
1	*Trianthama monogyna*	-	-	-	-	-	-	-	-	-	-
2	*Diegra arvensis*	-	-	-	-	-	-	-	-	-	-
3	*Echinocholae leusine*	19.88	9.33	28.06	5.67	15.62	3.33	9.90	2.00	11.72	68.55
4	*Xantheium strumarium*	-	-	-	-	-	-	-	-	-	-
5	*Brachiaria spp*	-	-	-	-	-	-	-	-	-	-
6	*Digitaria spp*	-	-	-	-	-	-	-	-	-	-
7	*Amaranthus viridis*	-	-	-	-	-	-	-	-	-	-
8	*Cleome viscose*	10.19	3.00	8.33	1.33	3.32	1.33	3.81	1.33	4.08	73.01
9	*Polygonum sp*	-	-	-	-	-	-	-	-	-	-
10	*Portulaca oleraceae*	18.47	4.33	14.66	3.00	9.50	3.33	11.39	4.33	8.63	57.29
11	*Boerhavia diffusa*	-	-	-	-	-	-	-	-	-	-
12	*Euphorbia sp*	-	-	-	-	-	-	-	-	-	-
13	*Tribulus terestis*	-	-	-	-	-	-	-	-	-	-
14	*Cyprus rotundus*	6.53	9.00	4.91	4.00	2.99	5.00	3.77	2.67	4.86	67.05
15	*Senna spp*	15.82	7.67	11.04	4.67	6.33	8.00	7.99	6.67	8.52	55.48
16	*Ipomea sp.*	46.84	6.00	33.79	4.67	24.01	6.33	33.60	7.00	20.28	56.75
17	*Penicum repens*	26.23	5.33	18.01	2.67	8.18	5.67	16.94	4.00	10.88	61.02
	Mean	**8.47**	**2.63**	**6.99**	**1.53**	**4.12**	**1.94**	**5.14**	**1.65**		
	Treatment wiseWCE (%)	**44.76**	**54.42**	**73.16**	**66.46**	**64.87**	**46.67**	**81.81**	**0.00**		

Table 6: Growth and yield attributing parameters of *suru* sugarcane as influenced by various treatments

Treatments	Germination (%) at 30 DAP	Tillering ratio at 150 DAP	At Harvest					Cane yield (t ha^{-1})
			No. of Millable Canes (ha $^{-1}$)	Millable cane height(cm)	Girth of cane(cm)	No. of Internodes cane^{-1}	Single cane weight(kg)	
T_1	56.93	2.22	80034	215.00	8.83	17.93	1.22	100.25
T_2	55.07	2.42	80249	217.00	8.83	18.93	1.27	102.93
T_3	53.47	2.54	83103	234.67	9.07	20.93	1.38	115.86
T_4	54.00	2.52	82087	229.00	8.83	20.73	1.32	109.61
T_5	54.27	2.56	85436	235.67	9.10	21.27	1.40	111.21
T_6	53.73	2.51	81067	225.33	8.83	19.47	1.30	106.36
T_7	55.73	2.69	91996	239.67	9.13	21.27	1.44	132.59
T_8	56.67	1.72	76437	205.33	8.47	18.93	0.98	78.27
SE(m) ±	**1.64**	**0.11**	**2781**	**8.11**	**0.17**	**0.62**	**0.06**	**3.37**
CD at 5 %	**NS**	**0.35**	**NS**	**NS**	**NS**	**1.90**	**0.17**	**10.33**

Table 7: Phytotoxic effect of herbicide treatments on *suru* sugarcane as influenced by various treatments at different days after application

Tr. No.	Treatments	Days after application			
		15	30	45	60
Leaf Injury/ Wilting/Vein clearing/ Necrosis/ Epinasty					
T_1	Atrazine 50% WP @ 500 g a.i./ha	0	0	0	0
T_2	Atrazine 50% WP @ 1000 g a.i./ha	0	0	0	0
T_3	Atrazine 50% WP @ 2000 g a.i./ha	0	0	0	0
T_4	Atrazine 50% WP @ 4000 g a.i./ha	0	0	0	0
T_5	Diuron 80%WP @ 3200 g a.i./ha	0	0	0	0
T_6	2,4-Dimethyl Amine Salt 58% S.L@ 3500 g a .i./ ha	0	0	0	0
T_7	Hand weeding	0	0	0	0
T_8	Control	0	0	0	0