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Effect of new post emergence herbicides on weeds of fodder maize (*Zea mays* L.)

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Abstract
The present study was conducted at Research Farm, AICRP on Forage Crops, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh) during *Kharif* season 2016-2017. With a view to find out the effect of new post emergence herbicides on weeds and seed yield of fodder maize (*Zea mays* L.). An experiment based on randomized block design with three replications. Eight treatments consisted with pre emergence application of atrazine 1000 g/ha, post emergence application of 2, 4-D 500 g/ha, tembotrione 120 g/ha and topramezone 35 g/ha alone, combined application of tembotrione 120 g/ha + atrazine 250 g/ha, topramezone 35 g/ha + atrazine 250 g/ha, hand weeding twice at 20 and 40 DAS and weedy check. Sowing of maize cv. African Tall was done on 1st July, 2016 by using the seed rate 40 kg/ha as per treatments in the rows 60 cm apart. Intensity of weeds and dry matter accumulation by weeds were made species wise and finally weed control efficiency and weed index were determined. The predominating weeds were *Cyperus rotundus* and *Commelina communis* among monocot, *Eclipta alba* and *Phyllanthus niruri and Alternanthera spp.* among dicot weeds, beside handsome total of several number of minor weeds in maize fields. These weeds severely invaded during crop-weed competition period and other growth stages as well. Post emergence application of topramezone 35 g/ha, tembotrione 120 g/ha and combined application of topramezone 35 g/ha + atrazine 250 g/ha, tembotrione 120 g/ha + atrazine 250 g/ha significantly reduced the infestation of all associated weeds over weedy check and was found most effective in paralyzing the weed growth to that of 2, 4-D 500 g/ha and atrazine 1000g/ha alone.

Keywords: topramezone, tembotrione, atrazine, 2, 4-D

Introduction
Maize (*Zea mays* L.) is a dual purpose crop cultivated by farmers for human consumption, poultry feed, cornflakes, popcorn and other industrial purposes in India. In India it is grown in 9.2 million hectares area with production of 24.17 million tones and average yield of 2560 kg/ha (Agricultural Statistics 2015). The world maize production is estimated about 96.80 crore tones in 2015-16 by International Grain Council report of September. India contributes merely about 2.5% in world maize production. In Madhya Pradesh maize is cultivated in 1132 thousand hectare area with production of 2062.3 thousand tones. The average yield of maize in the state is 1790 kg/ha (Agricultural Statistics 2015). Its cultivation is confined to the Chhindwara, Jhabua, Dhar, Ratlam and Rajgarh districts of Madhya Pradesh. Its plants grow very quickly and give palatable and nutritious fodder for livestock in large quantity. The worldwide production of maize was more than 960 MT in 2013-14.

Weed management is a severe issue in forage crop production and weeds play a large piece in maize production. Worldwide yield losses in maize due to weeds are estimated to be around 37%. Weeds reduce crop yield by competing for light, water, nutrients and carbon dioxide, interfere with harvesting and increase the cost involved in crop production. The predominant weed flora were *Echinochloa crusgalli* L. and *Cynodon dactylon* L. among monocots; *Cyperus rotundus* L. among sedges; and *Amaranthus viridis* L., *Digera arvensis* L., *Portulaca oleracea* L., *Alternanthera sessilis* L. and *Trianthema* spp. among dicots The infestation of these weeds is increasing day by day in the maize growing belt of the state especially where the farmers are using atrazine year after year. Topramezone and tembotrione is a selective, post emergence herbicide that has been recently introduced for use in maize. Topramezone and tembotrione applied in maize with its supplementary soil activity controls early and late germinating annual dicotyledoneous species. Manual weeding, doubtlessly cumbersome and time consuming and scarcity of labour make it more horrible.

As such the necessity of use of herbicide is inevitable. Among herbicides pre-emergence or early post-emergence application of atrazine followed by intercultivation has been reported to be quite effective in *kharif* maize. However it has been noticed that farmers sometimes fails to apply atrazine as pre-emergence spray due to excessive soil moisture as a result of unusual rains. Under such conditions application of post-emergence herbicide may be a good option. Most of the currently available herbicides *viz.*, atrazine, pendimethalin and alachlor provide only narrow spectrum of weed control in maize (Patel *et al.*, 2006) and continuous use of single herbicide leads to evolution of herbicide resistant weed species and shift in weed flora (Thakur and Sharma, 1996).

Materials and Methods

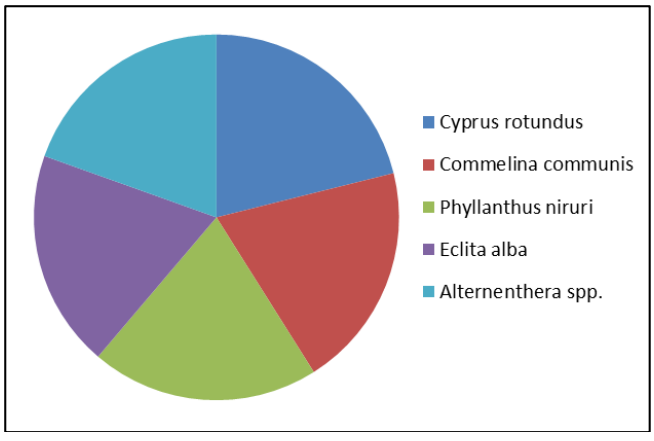
A field experiment titled "Effect of new post emergence herbicides on weeds and seed yield of fodder maize (*Zea mays* L.)" was conducted during the *kharif* 2016. Field experiment was conducted at Research Farm, AICRP on Forage Crops, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh) during *Kharif* season, (July 2016 to October 2016). The topography of the experimental field area was fairly uniform. All facilities including irrigation water were adequately available on the research farm to carry out the field experiment. Experimental technique total eight treatments were laid out on well prepared seed bed in a randomized block design with three replications. T_1 Tembotrione 120g/ha 20 DAS, T_2 Topramezone 35g/ha 20 DAS, T_3 Tembotrione + Atrazine 120g+ 250g/ha 20 DAS, T_4 Topramezone + Atrazine 35g+ 250g/ha 20 DAS, T_5 Atrazine 1000g/ha Pre-emergence, T_6 2,4-D 500g/ha 20 DAS, T_7 Hand weeding 20 and 40 DAS, T8 Control

Results

The experimental field was infested with several monocots, dicots and other minor weeds in weedy check plot at 30 DAS as well as 60 DAS, respectively. Among the monocots *Cyprus rotundus* (17.93 %) and *Commelina communis (*16.39 %) were the most dominant weeds at 30 DAS and 60 DAS respectively, whereas in dicots weeds, *Phyllanthus niruri* (17.14 %), *Eclipta alba* (16.32 %) and *Alternanthera spp.* (16.61 %) were the most dominant weeds. Beside these the other weeds which have been not identified were present (15.58 %) at 30 DAS and 60 DAS, respectively.

Table 1: Species wise mean intensity and relative density of weeds in weedy check plot at 30 DAS and 60 DAS stages, respectively

S. No.	Weeds	Density/m²		Mean	Relative density (%)
		30 DAS	60 DAS		
A	**Monocots**				
1.	*Cyprus rotundus*	36.33	45.33	40.83	17.93
2.	*Commelina communis*	34.00	40.66	37.33	16.39
	Sub – total			78.16	34.32
B	**Dicots**				
1.	*Phyllanthus niruri*	34.83	43.25	39.04	17.14
2.	*Eclipta alba*	34.33	40.00	37.16	16.32
3.	*Alternanthera spp.*	35.66	40.00	37.83	16.61
	Sub total			114.03	50.07
C	Others	32.66	38.33	35.49	15.58
	Total			227.68	100



Relative density (%) of weeds in weedy check at 30 and 60 DAS

Intensity of weeds

The intensity of total weeds including pre-dominant weeds viz., *Alternanthera spp., Cyperus rotundus, Commelina communis, Phyllanthus niruri* and *Eclipta alba* and other minor weeds are influenced by various weed control treatments at 30 DAS and 60 DAS of crop are presented in Table 2. The comparison among treatment means have been made statistically on the basis at on transformed values.

Alternanthera spp.

The density of *Alternanthera spp.* was influenced by different weed control treatments at 30 DAS and 60 DAS stages. It is evident from the data that weed control treatments caused significantly reduction on the density of *Alternanthera spp.* at both stages. The density was maximum (35.66 and 40/m²) under weedy check plots at 30 and 60 DAS. The highest reduction on weed density was recorded under herbicide topramezone 35g/ha + atrazine 250h/ha (3.76 and 10/m2) at 30 DAS and 60 DAS followed by tembotrione 120g/ha + atrazine 250g/ha (6.06 and 9.43/m2) at 30 DAS and 60 DAS. The reduction on weed density was also recorded under twice hand weeding (7.76 and 11/m²) at 30 and 60 DAS stages. The herbicide topramezone 35g/ha has also significant role in weed density (8.16 and 15.16/m²) reduction of *Alternanthera spp*. followed by tembotrione 120g/ha (11.16 and 15.33/m²). Application of 2, 4-D 500g/ha proved effective for control of *Alternanthera spp.* (22.5 and 26.76/m²) which was at par to atrazine 1000g/ha (20.1 and 26.03/m²).

Table 2: Effect of different weed control treatments on weed density (/m2) at 30 and 60 DAS stages

Treatments		Alternanthera spp.		Cyperus Rotundus		Commelina communis		Phyllanthus niruri		Eclipta Alba		Other weeds		Total	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T1	Tembotrione 120g/ha	3.84 (11.16)	4.41 (15.33)	2.80 (5.33)	3.60 (9.66)	2.5 (4)	3.86 (8.33)	3.26 (7.66)	4.81 (18.66)	3.14 (7)	3.91 (11.66)	3.93 (11.83)	4.89 (19.3)	7.35 (47)	9.63 (83.46)
T2	Topramezone 35g/ha	3.35 (8.16)	4.39 (15.16)	2.58 (4.33)	3.5 (9)	2.32 (3.33)	3.38 (8.33)	3.56 (9.41)	4.66 (17.33)	3.01 (6.33)	3.41 (11.66)	3.58 (9.5)	4.10 (13)	6.90 (41.08)	9.13 (74.5)
T3	Tembotrione + Atrazine 120g+ 250g/ha	2.96 (6.06)	3.57 (9.43)	2.32 (3.33)	3.5 (9)	2.73 (5)	3.81 (11)	2.43 (3.75)	3.54 (9.25)	2.32 (3.33)	3.44 (8.66)	2.45 (3.83)	3.79 (10.83)	5.52 (25.3)	8.12 (58.18)
T4	Topramezone + Atrazine 35g+ 250g/ha	2.43 (3.76)	3.66 (10)	1.78 (1.66)	2.73 (5)	2.32 (3.33)	3.32 (8)	1.98 (2.2)	3.39 (8.4)	2.13 (2.66)	3.32 (8)	3.04 (6.5)	3.55 (9.33)	4.98 (20.1)	7.48 (48.73)
T5	Atrazine 1000g/ha	4.9.98 (20.1)	5.60 (26.03)	4.74 (18)	5.22 (22.33)	4.83 (18.83)	5.41 (24.16)	4.93 (19.66)	5.47 (24.75)	4.85 (19)	5.43 (24.33)	4.93 (19.66)	5.79 (28)	7.93 (55.26)	9.96 (89.61)
T6	2,4-D 500g/ha	5.24 (22.5)	5.67 (26.76)	4.58 (16.66)	5 (20.33)	4.78 (18.33)	5.22 (22.33)	4.79 (18.46)	5.5 (25)	5.15 (21.66)	5.69 (27)	5.24 (22.5)	5.56 (25.66)	7.5 (49.13)	9.22 (76.16)
T7	Hand weeding	3.28 (7.76)	3.81 (11)	1.5 (1)	2.94 (6)	1.07 (0.33)	2.80 (5.33)	1.41 (0.83)	1.07 (0.33)	1.31 (0.66)	2.65 (4.66)	1.33 (0.7)	0.81 (0.1)	3.86 (11.3)	5.73 (27.43)
T8	Control	6.47 (35.66)	6.82 (40)	6.52 (36.33)	7.23 (45.33)	6.83 (34)	6.87 (40.66)	6.40 (34.83)	7.07 (43.25)	6.35 (34.33)	6.82 (40)	6.21 (32.66)	6.69 (38.33)	12.65 (147.8)	14.19 (187.58)
SEm±		0.55	0.58	0.40	0.65	0.79	0.68	0.29	1.12	0.44	0.65	0.40	1.69	1.732	2.88
CD at 5%		1.66	1.76	1.22	1.98	2.39	2.0	0.89	3.40	1.34	1.98	1.22	5.11	5.24	8.73

Cyperus rotundus

The data recorded on the density of *Cyperus rotundus* is presented in Table 2. Observation recorded after the application of herbicide shows that all treatment have equal number of weeds. The density of *Cyperus rotundus* was influenced by different weed control treatments at 30 DAS and 60 DAS stages. It is evident from the data that weed control treatments caused significantly reduction on the density of *Cyperus rotundus* at both stages. The density was maximum (36.33 and 45.33/m²) under weedy check plots at 30 and 60 DAS. The highest reduction on weed density was under twice hand weeding (1.00 and 6.00/m²) at 30 and 60 DAS. The herbicide tembotrione 120g/ha has also significant role in weed density ((5.33and (9.66/m²) reduction followed by topramezone 35g/ha (4.33 and (9.00/m²). Combined application of tembotrione 120g + atrazine 250g/ha and topramezone + atrazine 35g+ 250g/ha proved very effective for control of *Cyperus rotundus* (3.33, 9.0 and 1.66, 5.00/m²) followed by pre emergence application of atrazine 1000g/ha (18.00, 22.3/m²) which were at par to post emergence application of 2, 4-D 500g/ha (16.6 and 20.33/m²).

Commelina communis

It is evident from the data that weed control treatments caused significantly reduction on the density of *Commelina communis* at both stages over weedy check (Table 2). The density was maximum (34.00 and 40.66/m²) under weedy check plots at 30 and 60 DAS, respectively. The highest reduction on weed density was observed under twice hand weeding (0.33 and 5.33/m²) at 30 and 60 DAS over weedy check. The post emergence application of topramezone 35g/ha has also significant role in weed density (3.33 and 8.33/m²) reduction followed by topramezone 35g + atrazine 250g/ha (3.33, 8.00g/m²), which were at par to tembotrione 120g/ha (4.00, 8.33g/m²) and tembotrione 120g + atrazine 250g/ha (5.00, 11.00g/m²) and superior over 2,4-D 500g/ha (18.33, 22.33g/m²) and atrazine 1000g/ha (18.83, 24.16g/m²) at 30 and 60 DAS.

Phyllanthus niruri

The density of *Phyllanthus niruri* was influenced by different weed control treatments at 30 DAS and 60 DAS stages are given in Table 2. It is evident from the data that weed control treatments caused significantly reduction on the density of *Phyllanthus niruri* at both stages. The density was maximum (34.83and 43.25/m²) under weedy check plots at 30 DAS and 60 DAS. The highest reduction on weed density over twice hand weeding (0.83and 0.33/m²) at 30 DAS and 60 DAS. The herbicide topramezone 35g + atrazine 250g/ha has also significant role in weed density ((8.40/m²) reduction followed by tembotrione 120g + atrazine 250g/ha (9.25/m²) at 60 DAS. The post emergence application of topramezone 35g/ha has also significant role in weed density (17.33/m²) reduction followed by tembotrione 120g/ha (18.66/m²) at 60 DAS. The pre emergence application of atrazine 1000g/ha (24.75/m²) which was at par to post emergence application of 2,4-D 500g/ha (25.00/m²) at 60 DAS.

Eclipta alba

The data on the density of this weed at 30 and 60 DAS stages under different weed control treatments is presented in Table 2. It is obvious from the data that weed control treatments caused significantly reduction on the density of *Eclipta alba* at both stages. The density was maximum (34.33and 40.00/m²) under weedy check plots at 30 DAS and 60 DAS. The highest reduction on weed density over twice hand weeding (0.66 and 4.66/m²) at 30 DAS and 60 DAS. The herbicide topramezone 35g + atrazine 250g/ha has also significant role in weed density (2.66 and 8.00/m²) reduction followed by tembotrione 120g + atrazine 250g/ha (3.33 and 8.66/m²) at 30 and 60 DAS. The post emergence application of herbicide topramezone 35g/ha (6.33, 11.66/m²) which was at par to tembotrione 120g/ha (7.00, 11.66/m²). The herbicide atrazine 1000g/ha (19.00, 24.33 /m²) which was differed significantly from 2,4-D 500g/ha (21.66, 27.00/m²) at 30 and 60 DAS.

Other weeds

The data recorded on the density of other weeds is presented in Table2.Observation recorded after the application of herbicide showed that all treatment has equal number of weeds. But the density of other weeds was influenced by different weed control treatments at 30 DAS and 60 DAS stages. It is evident from the data that weed control treatments caused significantly reduction on the density of other weeds. The density were maximum ((32.66 and 38.33/m²) under weedy check plots at 30 DAS and 60 DAS. The highest reduction on weed density was recorded under twice hand weeding (0.70 and 0.10/m²) at 30 and 60 DAS. The herbicide topramezone 35g + atrazine 250g/ha has also significant role

in weed density (9.33/m²) reduction followed by tembotrione 120g + atrazine 250g/ha (10.83/m²) which were at par to topramezone 35g/ha (13.00/m²) at 60 DAS. The herbicide 2,4-D 500g/ha has also significant role in weed density (25.66/m²) reduction followed by atrazine 1000g/ha (28.00/m²) which were significantly differ from post emergence application of tembotrione 120g/ha (19.30/m²) at 60 DAS.

Dry weight of weeds

Dry matter (DM) of total including pre-dominant weeds viz., *Digiteria sanguinalis*, *Cyperus rotundus*, *Commelina communis*, *Phyllanthus niruri* and *Eclipta alba* and other minor weeds as influenced by various weed management treatments at 30 DAS and 60 DAS stages of crop are presented in Table 3. The comparison of the treatments have been made on the basis of transformed values.

Digiteria sanguinalis

The dry weight of *Digiteria sanguinalis* differed significantly at 30 and 60 DAS due to weed control treatments (Table 3). The data revealed that the dry weight of *Digiteria sanguinalis* was maximum (64.41and 85.16g/m²) under weedy check plots at both stages where weeds not controlled. Where its dry weight was reduced identically when control measures were adopted in different plots. The maximum reduction found in hand weeding twice at 30

Table 3: Effect of different treatments on dry weight of weeds (g/m2) at 30 DAS and 60 DAS stages

Treatments		*Digitaria sanguinalis*		*Cyperus Rotundus*		*Commelina communis*		*Phyllanthus niruri*		*Eclipta alba*		Other weeds		Total	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T1	Tembotrione 120g/ha	4.30 (14.5)	5.05 (20.75)	4.04 (12.58)	4.89 (19.33)	4.18 (13.58)	4.94 (19.75)	4.41 (15.33)	5.01 (20.41)	4.14 (13.25)	5.02 (20.5)	2.5 (4)	2.21 (4.9)	9.05 (73.25)	10.77 (105.65)
T2	Topramezone 35g/ha	4.19 (13.66)	4.90 (19.41)	3.82 (11.08)	4.72 (17.88)	4.02 (12.41)	4.75 (22.08)	4.25 (14.08)	5.04 (20.66)	4.38 (15.08)	5.03 (20.58)	2.37 (3.5)	2.52(4.1)	8.85 (69.83)	10.73 (104.68)
T3	Tembotrione + Atrazine 120g+ 250g/ha	3.23 (7.5)	4.24 (14)	3.44 (8.66)	4.03 (12.5)	3.25 (7.6)	4.2 (13.75)	3.20 (7.33)	3.81 (11)	3.14 (7)	4.10 (13)	2.03 (2.35)	2.39 (3.6)	6.86 (40.51)	8.73 (67.85)
T4	Topramezone + Atrazine 120g+ 250g/ha	3.41 (8.5)	3.93 (11.83)	3.14 (7)	3.95 (11.91)	3.42 (8.58)	4.12 (13.16)	3.22 (7.41)	3.80 (10.91)	3.29 (7.8)	4.25 (14.08)	2.09 (2.53)	2.42 (3.7)	6.96 (41.86)	8.60 (65.68)
T5	Atrazine 1000g/ha	5.79 (28.08)	6.20 (32.58)	6.09 (31.25)	6.48 (35.83)	6.04 (30.75)	6.35 (34.33)	5.98 (30.08)	6.28 (33.41)	6.02 (30.5)	6.17 (32.25)	3.71 (10.36)	4.41 (15.3)	13.18 (161.02)	14.05 (183.7)
T6	2,4-D 500g/ha	6.28 (33.41)	6.69 (38.33)	7.01 (42.41)	7.876 (54.41)	6.98 (42.08)	7.37 (47.33)	7.73 (52.41)	8.02 (56.66)	7.04 (42.83)	7.25 ?(45.58)	3.6 (10.23)	3.57 (9.47)	15.44 (223.37)	16.36 (251.78)
T7	Hand weeding	1.14 (0.42)	3.66 (10.04)	1.11 (0.38)	3.75 (10.58)	1.12 (0.39)	3.81 (11)	1.04 (0.3)	3.74 (10.5)	1.04 (0.3)	4.07 (12.75)	1.50 (1.01)	2.26 (3.13)	2.17 (2.81)	58.00
T8	Control	8.52 (64.41)	9.72 (85.16)	8.28 (60.66)	9.94 (89.25)	8.28 (60.58)	9.97 (89.83)	8.4 (62.83)	9.92 (88.91)	8.25 (60.16)	9.92 (88.91)	3.98 (12.16)	4.33 (14.7)	18.41 (320.8)	456.76
	SEm±	0.34	0.62	0.60	0.57	0.47	0.59	0.40	0.49	0.57	1.22	0.32	0.38	1.29	1.80
	CD at 5%	1.04	1.88	1.82	1.73	1.43	1.78	1.21	1.49	1.74	3.69	0.97	1.17	3.93	5.44

DAS and 60 DAS (0.42and 10.0g/m²). The herbicide topramezone 35g/ha has also significant role in dry weight (19.41g/m²) reduction followed by tembotrione 120g/ha (20.75g/m²) which were differ significantly from herbicide topramezone 35g + atrazine 250g/ha, tembotrione 120g + atrazine 250g/ha, atrazine 1000g/ha and 2,4-D 500g/ha (11.83, 14.00, 32.58 and 38.33g/m²) at 60 DAS.

Cyperus rotundus

The dry weight of *Cyperus rotundus* differed significantly at 30 and 60 DAS due to weed control treatments (Table 3). The dry weight of *Cyperus rotundus* was maximum (60.66 and 89.25/m²) under weedy check plots at 30 DAS and 60 DAS stages, respectively, where weeds were not controlled where as its dry weight was reduced identically when control measures were used in different plots. The highest reduction on weed dry weight was observed in hand weeding twice (0.38 and 10.58/m²) at 30 DAS and 60 DAS, which was at par to combined application of topramezone 35g + atrazine 250g/ha and tembotrione 120g + atrazine 250g/ha (11.91, 12.50g/m²), which were superior to topramezone 35g/ha, tembotrione 120g/ha, atrazine 1000g/ha and 2,4-D 500g/ha (17.88, 19.33,35.83 and 54.41 g/m²).

Commelina communis

The dry weight of *Commelina communis* differed significantly at 30 and 60 DAS due to weed control treatments (Table 3).The data revealed that the dry weight of *Commelina communis* was maximum (60.58, 89.83g/m²) under weedy check plots at both stages where weeds not controlled. Where its dry weight was reduced identically when control measures were adopted in different plots. The maximum reduction found in hand weeding twice at 30 DAS and 60 DAS (0.39 and 11.00 g/m²). The combined application of herbicide topramezone 35g + atrazine 250g/ha has also significant role in dry weight (7.60, 13.16g/m²) reduction followed by tembotrione 120g + atrazine 250g/ha (8.58, 13.75g/m2) at 30 and 60 DAS, which was differed significantly from pre emergence application of atrazine 1000g/ha (30.75, 34.33g/m²) and post emergence application of 2,4-D 500g/ha (42.08, 47.33)g/m²) at 30 and 60 DAS. The herbicide topramezone 35g/ha proved very effective for reduction on dry weight (12.41g/m²) followed by tembotrione 120g/ha (13.58g/m²) at 60 DAS.

Phyllanthus niruri

The dry weight of *Phyllanthus niruri* differed significantly at 30 and 60 DAS due to weed control treatments (Table 3). The data revealed that the dry weight of *Phyllanthus niruri* was maximum (62.83and 88.91)g/m²) under weedy check plots at both stages where weeds not controlled. Where its dry weight was reduced identically when control measures were adopted in different plots. The maximum reduction found in hand weeding twice at 30 DAS and 60 DAS (0.3 and 10.50g/m²). The herbicide topramezone 35g + atrazine 250g/ha has also significant role in dry weight (7.33, 10.91g/m²) reduction

followed by tembotrione 120g + atrazine 250g/ha (7.34, 11.00g/m²) at 30 and 60 DAS. The post emergence application of topramezone 35g proved effective for reduction on dry weight (14.08, 20.66g/m²) followed by tembotrione 120g (15.33, 20.41g/m²) than atrazine 1000g/ha (30.08, 33.41g/m²) and 2,4-D 500g/ha (52.41, 56.66g/m²) at 30 and 60 DAS.

Eclipta alba

The dry weight of *Eclipta alba* differed significantly at 30 and 60 DAS due to weed control treatments (Table 3). The data revealed that the dry weight of *Eclipta alba* was maximum (60.16 and 88.91 g/m²) under weedy check plots at both stages where weeds not controlled. Where its dry weight was reduced identically when control measures were adopted in different plots. The maximum reduction found in hand weeding twice at 30 DAS and 60 DAS (0.30 and 12.75 g/m²). The herbicide topramezone 35g + atrazine 250g/ha has also significant role in dry weight (13.00 g/m²) reduction followed by tembotrione 120g + atrazine 250g/ha (14.08 g/m²) at 60 DAS. The post emergence application of topramezone 35g proved effective for reduction on dry weight (20.58 g/ m²) which was at par to tembotrione 120g (20.50 g/m²). The herbicide atrazine has also effective for reduction on dry weight (30.50, 32.25g/m²) which was differed from 2,4-D 500g/ha (42.83, 45.58g/m²) at 30 and 60 DAS.

Other weeds

The dry weight of other weeds differed significantly at 30 and 60 DAS due to weed control treatments (Table 3). The data revealed that the dry weight of other weeds was maximum (12.1and 14.70) g/m²) under weedy check plots at both stages where weeds not controlled. Where its dry weight was reduced identically when control measures were adopted in different plots. The maximum reduction found in hand weeding twice at 30 DAS and 60 DAS (1.01and 3.13g/m²). The herbicide topramezone 35g + atrazine 250g/ha has also significant role in dry weight (2.35, 3.60g/m²) reduction which was at par to tembotrione 120g + atrazine 250g/ha (2.53, 3.70g/m²), which were differed from the post emergence application of topramezone 35g/ha (3.50,4.10g/m²) at 30 and 60 DAS. The herbicide 2,4-D 500g/ha has significant role in dry weight (10.23g/m²) reduction followed by atrazine 1000g/ha (10.36g/m²) at 30 DAS.

Weed biomass

Total dry matter of all weeds significantly differed due to the effect of different weed control treatments at both growth stages of crop Table 8. The weed biomass was maximum (320.80and 456.76g/m²) in weedy plots where weeds were not controlled at all, which was reduce appreciably in plots receiving weed control treatments at 30 and 60 DAS. The maximum reduction found in hand weeding twice at 30 DAS and 60 DAS ((2.81 and 58.00g/m²). The herbicide topramezone 35g + atrazine 250g/ha has also significant role in dry weight (64.41g/m²) reduction which superior to herbicide atrazine 1000g/ha (183.70g/m²), 2,4-D 500g/ha (251.78g/m²) and at par to tembotrione 120g + atrazine 250g/ha (69.03 g/m²) at 60 DAS. The post emergence application of topramezone 35g found very effective for reduction on weed density (104.68g/m²) followed by tembotrione 120g (105.65g/m²) at 60 DAS.

4. Weed control efficiency

Weed control efficiency (WCE) of various treatments was determined on the basis of relative weed biomass recorded under weedy check and other treatments at 60 DAS and data are presented in Table 4.

The WCE was maximum with 2 hand weedings at 60 DAS stage of crops. At 60 DAS, the WCE was 87.30 % with 2 hand weedings, which was significantly superior over all the herbicidal treatments. Among the herbicide treatments higher weed control efficiency (85.89%) was noted in plots receiving post emergence application of topramezone 120g + atrazine 250g/ha (T4) at 60 DAS stage followed by T3, T1, T2, T5, T6, and T8.

Table 4: Effect of different treatments on weed control efficiency (%)

Tr. No.	Treatments	Weed control efficiency (%) 60 DAS
T1	Tembotrione 120g/ha	77.86
T2	Topramezone 35g/ha	77.08
T3	Tembotrione + Atrazine 120g+ 250g/ha	84.88
T4	Topramezone + Atrazine 120g+ 250g/ha	85.89
T5	Atrazine 1000g/ha	59.78
T6	2,4-D 500g/ha	44.87
T7	Hand weeding	87.30
T8	Control	0.00

Discussion

Dominant weed flora

The dominant weeds associated with crop in the experimental field were mainly comprised of *Alternanthera* spp., *Cyperus rotundus*, *Commelina communis*, *Eclipta alba* and *Phyllanthus niruri* while other minor weeds were also present. Almost similar weed flora associated with maize was reported by Kamble *et al* (2005) [6], Arvadiya *et al* (2012) [2]. Species wise weed data recorded in weedy check plots at 30 DAS and 60 stages of maize, indicated that, there was pre-dominance of dicot weeds (50.07%) as compared to monocot weeds (34.32%) while other species (15.58 %) in the experimental field cropped with maize. Among the weeds *Cyperus rotundus* (17.93%) and *Commelina communis* (16.39%) were the most dominant monocot weed at 30 DAS and 60 DAS stages respectively, whereas dicot weeds like *Phyllanthus niruri* (17.14%), *Eclipta alba* (16.32%) and *Alternanthera spp.* (16.61%) were present in lesser number in maize ecosystem.

Density and dry weight of weeds

Density and dry weight of all the six weeds namely *Digitaria sanguinalis*, *Cyperus rotundus*, *Eclipta alba*, *Phyllanthus niruri*, *Alternanthera spp.* and *Commelina communis* with other minor weeds recorded at 30 DAS and 60 DAS stages under different weed control treatments varied significantly It is evident from the data that the density including dry weight of all the six weeds including other minor weeds was maximum under weedy check plot at both the stages due to uninterrupted growth of weeds as no weed control measures were adopted in weedy check plots. However, identical reduction in density and dry weight of weeds were observed when weeds were controlled by chemical method and mechanical method of weed control.

The application of atrazine 1000g/ha, 2,4-D 500g/ha caused marginal reduction in density and dry weight of monocot and dicot weeds including other minor weeds but reduction was more pronounced all the above herbicide applied as post

emergence application of tembotrione 120g/ha, topramezone 35g/ha. The application of topramezone 35g/ha + atrazine 250g/ha and tembotrione 120g/ha + atrazine 250g/ha as post emergence controlled both monocot and dicot weeds effectively when these herbicides applied in combination.

Hand weeding done at 20 and 40 DAS reduced the density including dry weight of weeds to maximum extent over herbicidal treatments due to elimination of short of weeds. Similar view was also endorsed by Mandal *et al* (2004) [8].

Weed control efficiency

The weed control efficiency significantly varied due to different weed control treatments at 60 DAS stage of crop (Table 3). The weed control efficiency (WCE) had significant inverse relationship with dry matter production by weeds. The weed control efficiency was maximum with hand weeding twice (87.30%) at 60 DAS stage, because associated weeds produced minimum dry matter with this treatment. The dry matter accumulation by weeds correspondingly reduced in T6, T5, and T2, therefore the weed control efficiency correspondingly increased with these treatments. Post emergence application topramezone 35g/ha, tembotrione 120g/ha and combined application of topramezone 35g/ha + atrazine250g/ha, tembotrine 120g/ha + atrazine 250g/ha had minimum dry matter production by weeds. Consequently, these treatments had greater value of weed control efficiency than herbicide use alone.

Conclusion

Several weeds severely infested maize in weedy check plot of experimental area. The predominant weeds were *Cyperus rotundus* (17.93%) and *Commelina communis* (16.39%) under monocot weeds and, *Phyllanthus niruri* (17.14%), *Eclipta alba* (16.32%) and *Alternanthera spp*. (16.61%) among dicot weeds and many others minor weeds having small intensity (15.58%) were also present in maize ecosystem at 30 DAS and 60 DAS stages, respectively. In weedy check treatments the total weed population was significantly higher than all the herbicidal treatments 2,4-D 500 g/ha, atrazine 1000 g/ha, tembotrione 120 g/ha, topramezone 35 g/ha, tembotrione 120 g/ha + atrazine 250 g/ha, topramezone 35 g/ha + atrazine 250 g/ha, and weed free treatments. The weed menace was minimum under hand weeding done at 20 and 40 DAS but it was marginal at 60 DAS due to emergence of weeds during later part of crops growth. Among the post emergence herbicides treatments, activity of tembotrione 120 g/ha, topramezone 35 g/ha, alone was not well marked against most of weeds but when all these herbicide applied in combined application of tembotrione 120 g/ha + atrazine 250 g/ha, topramezone 35 g/ha + atrazine 250 g/ha, controlled most of the associated weeds.

Weedy check had the highest weed biomass and it had reduced significantly when weeds were controlled either by use of herbicides or hand weeding (20 and 40 DAS). The lowest weed biomass was recorded under weed free treatment closely followed by T4 – topramezone 35 g/ha + atrazine 250 g/ha, T3 – tombotrione 120 g/ha + atrazine 250 g/ha, topramezone 35 g/ha and tembotrione 120 g/ha, found significant to reduced the weed biomass over pre emergence application of atrazine 1000 g/ha, 2,4-D 500 g/ha alone. The WCE was maximum with 2 hand weeding closely followed by T6 -alachlor 2.5 kg/ha + hand weeding at 30 DAS, T4 – topramezone 35 g/ha + atrazine 250 g/ha, T3 tembotrione 120 g/ha + atrazine 250 g/ha in combined application, tembotrione 120 g/ha, topramezone 35 g/ha but lowest WCE found with pre emergence application of atrazine 1000 g/ha and post emergence application of 2,4-D 500g/ha alone.

References

1. Abdullahi S, Ghosh G, Dawson J. Effect of Different Weed Control Methods on Growth and Yield of Maize (*Zea mays* L.) Under Rainfed Condition in Allahabad. *IOSR* Journal of Agriculture and Veterinary Science. 2016; 9(4):44-47.
2. Arvadiya LK, Raj VC, Patel TU, Arvadiya MK. Influences of plant population and weed management on weed flora and productivity of sweet corn (*Zea mays* L.). Indian Journal of Agronomy. 2012; 57(2):162-167.
3. Bially ME. Efficacy of atrazine with other herbicides used alone in sequences or as tank mix in maize. Annals Agril, Sci. Cairo. 1995; 40:709-721.
4. Chakor IS, Awasthi OP. Cultural-cum-chemical weed control in maize under rainfed conditions of Himachal Pradesh. Indian Journal of Weed Science. 1983; 15(1):65-68.
5. Gill GS, Kumar Vijay. Weed index, a new methods for reporting weed control trail. Journal of Agronomy. 1969; 14(2):96-98.
6. Kamble TC, Kakade SU, Nemade SU, Pawar RV, Apotikar VA. Integrated weed management in hybrid maize. Crop Research (Hisar), 2005; 29(3):396-400.
7. Khan, Waheed Ullah MA, Sadiq Muhammad, Rehman Habib-ur, Nawaz Anwar, Sher MA. Impact of integrated weed management on weeds and yield of maize. Pakistan Journal of Weed Science Research. 2008; 14(3, 4):141-151.
8. Mandal, Subhendu, Mandal, Subimal, Nath, Subhadeep. Effect of integrated weed management on yield components, yield and economics of baby corn (*Zea mays* L.). Annals of Agricultural Research. 2004; 25(2):242-244.
9. Prasad TVR, Dwarakanath N, Narasimha N, Krishnamurthy K. Integrated weed management in maize (*Zea mays* L.) effect on weeds, crop growth and yield. Mysore Journal of Agricultural Sciences. 1990; 24(1):39-44.
10. Swetha K, Madhavi M, Pratibha G, Ramprakash T. Weed management with new generation herbicides in maize. Indian Journal of Weed Science. 2015; 47(4):432-433.