Study of Weed Management Options, Weed Dynamics And Crop Yield In Irrigated Hybrid Maize

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Abstract- *Field experiments were conducted at Maize Research Station, Vagarai, Tamilnadu during kharif season of years 2015, 2016 and 2017 to assess the performance of herbicide molecules on weed dynamics and grain yield of maize under irrigated field condition. The herbicide molecules of atrazine, pendimethalin, halosuluron and tembotrion were tried at different doses, combinations and time. The combinations were fixed as Atrazine @ 1500 g a.i./ha PE, Atrazine (750 g a.i./ha) + Pendimethalin (750 ml a.i./ha) PE, Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS as PoE, Halosulfuron 60 g a.i./ha at 25 DAS, Atrazine @ 1500 g a.i./ha PE fb Halosulfuron 60 g a.i./ha 25 DAS, Tembotrione 120 g a.i./ha PoE at 25 DAS, Pendimethalin (1000 ml a.i./ha) PE fb Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS, Atrazine @ 1500 kg a.i./ha PE fb Tembotrione 120 g a.i./ha) PoE at 25 DAS, Atrazine @ 250 g a.i./ha + One hand weeding at 30 – 35 DAS and Atrazine @ 250 g a.i./ha + 2,4 D @ 1000 g/ha at 20-25 DAS. These combinations and their effect were compared with weedy check and weed free check. These trials were laid out in the statistical model RBD and replicated thrice. The result of the experiment revealed that lesser number of broad leaved weeds were recorded under application of atrazine @ 1500 g a.i./ha PE fb tembotrione @ 120 g a.i./ha PoE at 25 DAS at 50 DAS and at harvest. Grass weed population was significantly lesser under atrazine @ 250 g/ha + One Hand weeding done at 30-35 DAS and application of atrazine @ 750 g a.i./ha + pendimethalin @ 750 ml a.i./ha as pre-emergence at harvest stage. Weed control efficiency was higher under pre-emergence application of pendimethalin @ 1000 ml a.i./ha fb atrazine @ 750 g a.i./ha + 2,4 D amine salt. Higher grain yield (9768 kg/ha) was recorded in atrazine (1500 g a.i./ha) as pre-emergence herbicide, which was followed by halosulfuron @ 60 g/ha at 25 DAS as PoE at 50 DAS, which was on par with weed free treatment and followed by application of pendimethalin @ 1000 ml a.i./ha as PE fb atrazine @ 750 g a.i./ha + 2,4 D amine (75%) at 25 DAS as PoE alsofollwed by application of atrazine @ 250 g a.i./ha + One hand weeding at 30-35 DAS and application of tembotrione @ 120 g a.i./ha as PoE at 25 DAS.*

Keywords- Maize, herbicide, weed management, weed population, weed dry matter, weed control efficiency, grain yield.

I. INTRODUCTION

Maize (*Zea mays* L.) is the second most important cereal crop in the world in terms of total food production. It is grown for fodder as well as for grain. The grains of maize are used in a variety of ways by the human beings. Recently, with the release of improved cultivars and hybrids, the grain yield has been increased but still the maize crop faces many problems. Weeds are one of the most important factors affecting maize production. They cause yield losses worldwide with an average of 12.8 % despite weed control and 29.2 % in the case of no weed control (Oerke and Steiner, 1996). Maize, being a rainy season and widely spaced crop, gets infested with variety of weeds and subjected to heavy weed competition, which often inflicts huge losses ranging from 28 to 100 per cent (Patel *et al*., 2006). Pre-emergence application of atrazine @ 0.5 kg a.i./ha + hand weeding and inter culturing at 30 DAS or pendimethalin @ 0.9 kg a.i./ha as pre-emergence + hand weeding and inter culturing at 30 DAS would be the better option under south Saurashtra Agro-climatic conditions (Mathukia *et al*., 2014). They have also reported that sequential application of atrazine 0.75 kg a.i./ha *fb* 2,4-D @ 1.0 kg/ha is on par with weed free treatment. The improvement in yield components was due to improved growth attributes such as higher total dry matter production and leaf area index. Thus, the improvement in growth and yield components was as a consequence of lower crop-weed competition, which shifted the balance in favour of crop in the utilization of nutrients, moisture, light and space (Shantveerayya and Agasimani, 2012).

Grain yield is a function of the cumulative behavior among various yield determining components namely the number of cobs per plants, cob length, number grains per cob and 1000 grain weight which showed variations by prevailing growing conditions and various crop management practices. Significantly higher grain yield (78.28 % grains increased over check) (8,071 kg/ha) with manual hoeing which was statistically at par with Pendimethalin @ 1050 g a.i./ha (75.37 %) and Pendimethalin + Prometryn @ 1225 g a.i./ha (69.86 %) was recorded by Tahir *et al*. (2009). Therefore, weed control is an important management practice for maize production that should be carried out to ensure optimum grain yield. With these ideas, the present study was taken up to find

out the suitable weed management practice in maize under irrigated condition.

II. METHODOLOGY

Field experiments were conducted at Maize Research Station, Vagarai during *kharif* 2015, 2016 and 2017 to develop weed management options with new herbicide molecules in irrigated maize. The experiment was laid out in RBD replicated thrice with the following 12 treatments. T_1 - Control (Weedy check), T_2 - Weed free, T_3 - Atrazine @ 1500 g a.i./ha PE, T_4 - Atrazine (750 g a.i./ha) + Pendimethalin (750 ml a.i./ha) PE, T_5 - Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS as PoE, T_6 - Halosulfuron 60 g a.i./ha at 25 DAS, T_7 - Atrazine @ 1500 g a.i./ha PE *fb* Halosulfuron 60 g a.i./ha 25 DAS, T_8 - Tembotrione 120 g a.i./ha PoE at 25 DAS, T_9 - Pendimethalin (1000 ml a.i./ha) PE *fb* Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS, T_{10} - Atrazine @ 1500 kg a.i./ha PE *fb* Tembotrione 120 g a.i./ha) PoE at 25 DAS, T_{11} - Atrazine @ 250 g a.i./ha + One hand weeding at 30-35 DAS and T_{12} - Atrazine @ 250 g a.i./ha + 2,4 D @ 1000 g/ha at 20-25 DAS.

Observations on weed parameter, growth, yield parameters and yield were taken and analysed. The pooled data of the year 2015, 2016 and 2017 were statistically analyzed and the result of the effect of weed management practices on weed density, weed dry matter, weed control efficiency and grain and stover yield were calculated.

III. RESULT AND DISCUSSION

Weed population: The predominant weeds observed in the experimental field were *Trianthema portulacastrum* (Pig weed), *Amaranthus viridis* (Slender amaranth), *Ageratum conyzoides* (Goat weed), *Ageratum haustoni* (Floss flower), *Cleome viscosa* (Tick weed) and *Digera arvesis* (False amaranth) (Broad leaved weeds, BLW), *Chloris barbata* (Marvel grass), *Dactyloctenium aegyptium* (Crow foot grass) and *Panicum repens* (Creeping panic) (Grasses). The sedge species was *Cyperus rotundus* (Purple nut sedge).

There existed significant difference in the population of broad leaved weeds and grasses at 50 DAS and at harvest. Since the weed free treatment (T_2) was absolutely of weed free condition, there were no weeds throughout the crop duration. Among the other weed management practices tested, a significant higher broad leaved weed population (84.8 no/m^2) was noticed in control (T_1-weedy check) at 50 DAS followed by halosulfuron @ 60 g a.i./ha as post emergence on 25 DAS (T_6 – 68.9 no/m^2). Significantly lesser broad leaved population (22.6 no/m^2) on 50 DAS was recorded under T_{10} (application atrazine @ 1500 g a.i./ha as pre emergence followed by Tembotrione 120 g a.i./ha at 25 DAS as post emergence).

At harvest, weed population was significantly higher under control (T_1-weedy check) followed by the application of halosulfuron @ 60 g a.i./ha as PoE on 25 DAS (36 no/m^2 in both). The weed population was significantly lesser under atrazine @ 1500 g a.i./ha as pre emergence followed by tembotrione 120 g a.i./ha at 25 DAS (T_{10}) (6.2 no/m^2) followed by T_5 (atrazine @ 750 g a.i./ha + 2,4 D Amine (75 %) at 25 DAS as PoE) and T_9 (Pendimethalin @ 1000 ml a.i./ha as PE followed by atrazine (750 ml a.i./ha) + 2,4 - D amine (75%) at 25 DAS as PoE (8.4 no/m^2 in each). Lower weed density due to manual hoeing and herbicide application under the above treatments over weedy check might be due to the mortality of weeds in these treatments while higher weed density was found in weedy check due to unchecked weed growth as no weed control practices were applied. This result corroborates the findings of Tahir *et al*. (2009) and Ali *et al*. (2011) who reported similar findings.

Regarding the population of grass weeds on 50 DAS, a significant higher grass weed population (9.6 no/m^2) was recorded in T_5 (atrazine @ 750 g a.i./ha + 2,4,D amine (75%) at 25 DAS as PoE followed by T_{10} (8.3 no/m^2), T_3 (8.0 No/m^2) and T_6 (7.0 no/m^2) and T_1 (5.2 no/m^2) respectively, which was supported by the reports of Meena Shekhar *et al*. (2014). Ravisankar *et al*. (2013) has also opined that post emergence herbicide application recorded lesser total weed density in maize. The weed population at harvest also significantly differed between the treatments. A significantly higher weed population (13.3 no/m^2) was recorded in T_1 (Weedy check). The grass weed population at harvest in T_{12} (13.1 no/m^2), T_8 (9.3 no/m^2), T_5 (9.1 no/m^2), T_6 (9.1 no/m^2) and T_{11} (8.7 no/m^2) was on par with control T_1. Significantly lesser number of weeds was recorded in T_2 (0.0), followed by T_4 (2.4 no/m^2) and T_9 (2.7 no/m^2). Shankar *et.al.* (2015) reported lower density and dry weight of weeds per square metre with atrazine (50%) @ 1.25 kg a.i./ha or pendimethalin (50%) @ 2.5 lit a.i./ha as compared to other chemical weed management treatments and this lend support to the present findings. Thus, the improvement in growth and yield components was as a consequence of lower crop-weed competition, which shifted the balance in favour of crop in the utilization of nutrients, moisture, light and space. These results are in conformity with the findings of Saini and Angiras (1998), Sreenivas and Satyanarayana (1994) and Kamble *et al*. (2015).

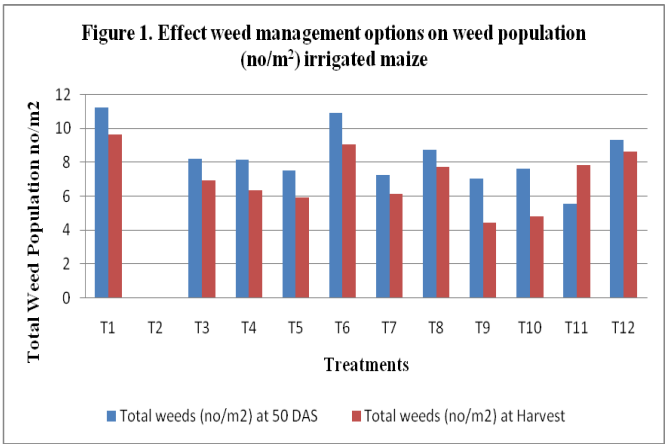


Table 1. Effect weed management options on weed population (no/m^2) irrigated maize

Treatment	Weed population at 50 DAS (No/m^2)				Weed population at harvest (No/m^2)			
	Broad leaved weeds	Grass weeds	Sedges	Total Weeds	Broad leaved weeds	Grass weeds	Sedges	Total Weeds
T_1 - Control (Weedy check)	8.92 (84.8)	2.25 (5.2)	0.0 (0.0)	11.2	5.98 (36.0)	3.65 (13.3)	0.0 (0.0)	9.6
T_2 - Weed free	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0
T_3 - Atrazine @ 1500 g a.i./ha PE	5.84 (34.1)	2.76 (8.0)	0.19 (0.1)	8.2	5.12 (26.2)	1.76 (3.1)	0.0 (0.0)	6.9
T_4 - Atrazine (750 g a.i./ha) + Pendimethalin (750 ml a.i./ha) PE	4.84 (23.6)	1.53 (2.4)	1.74 (6.7)	8.1	4.39 (19.3)	1.48 (2.4)	0.47 (0.7)	6.3
T_5 - Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS as PoE	4.57 (22.7)	2.96 (9.6)	0.0 (0.0)	7.5	2.90 (8.4)	3.0 (9.1)	0.0 (0.0)	5.9
T_6 - Halosulfuron 60 g a.i./ha at 25 DAS	8.27 (68.9)	2.58 (7.0)	0.0 (0.0)	10.9	5.99 (36.0)	2.97 (9.1)	0.0 (0.0)	9.0
T_7 - Atrazine @ 1500 kg a.i./ha PE *fb* Halosulfuron 60 g a.i./ha 25 DAS	5.34 (29.0)	1.87 (3.6)	0.0 (0.0)	7.2	3.55 (13.1)	2.53 (6.4)	0.0 (0.0)	6.1
T_8 - Tembotrione 120 g a.i./ha PoE at 25 DAS	6.58 (43.3)	2.10 (4.6)	0.0 (0.0)	8.7	4.73 (24.1)	3.01 (9.3)	0.0 (0.0)	7.7
T_9 - Pendimethalin (1000 ml a.i./ha) PE *fb* Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS	5.17 (26.8)	1.53 (2.7)	0.27 (0.2)	7.0	2.79 (8.4)	1.56 (2.7)	0.0 (0.0)	4.4
T_{10} - Atrazine @ 1500 kg a.i./ha PE *fb* Tembotrione 120 g a.i./ha) PoE at 25 DAS	4.67 (22.6)	2.88 (8.3)	0.0 (0.0)	7.6	2.26 (6.2)	2.52 (6.6)	0.0 (0.0)	4.8
T_{11} – Atrazine @ 250 g a.i./ha + One hand weeding at 30-35 DAS	5.02 (25.2)	0.47 (0.7)	0.0 (0.0)	5.5	4.18 (17.9)	2.82 (8.7)	0.84 (2.1)	7.8
T_{12} – Atrazine @ 250 g a.i./ha + 2,4 D @ 1000 g/ha at 20-25 DAS.	7.18 (52.2)	2.08 (4.9)	0.0 (0.0)	9.3	5.03 (26.2)	3.59 (13.1)	0.0 (0.0)	8.6
SEd	0.85	0.54	0.57	--	0.67	0.46	0.40	--
CD (P=0.05)	1.77	1.13	NS	--	1.38	0.95	NS	--

(Figures in parenthesis are original values)

Weed dry matter: In general, the density and dry weight of weeds were significantly reduced with the application of herbicides compared to weedy check. The dry matter of broad leaved weeds was higher under control (T_1) (204.6 g/m^2 and 178.4 no/m^2 at 50 DAS and at harvest, respectively). On 50 DAS, next to weedy check treatment (T_1), the treatment T_6 (halosulfuran @ 60 g a.i./ha at 25 DAS), T_8 (Tembotrione @ 120 g a.i./ha at 25 DAS) and T_4 (atrazine @ 750 g a.i./ha + pendimethalin @ 750 ml a.i./ha as PE) had higher weed dry weight, respectively and were on par with each other. Apart from the weed free treatment (T_2), lesser weed dry weight (61.1 g/m^2) was recorded in T_{11} (atrazine 0.25 kg a.i./ha + one hand weeding at 30-35 DAS). At the time of harvest, the dry weight of broad leaved weeds was significantly higher (178.4 g/m^2) in T_1 (weedy check) and it was on par with T_3 (atrazine @ 1500 g a.i./ha PE) and T_6 (halosulfuran @ 60 g a.i./ha at 25 DAS) (147.7 and 145.4 g/m^2 respectively). Apart from weed free treatment (T_2), significantly lesser weed dry weight was recorded in T_5 (atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS as PoE) and T_{10} (Atrazine @ 1500 g a.i./ha PE *fb* Tembotrione 120 g a.i./ha) PoE at 25 DAS) (45.6 and 45.7 g/m^2, respectively).

The grass weed dry weight was significantly higher (20.3g/m^2) in T_1 (weedy check) and was on par with T_5 (atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS as PoE) at 50 DAS, whereas, lesser grass weed dry weight (0.7 g/m^2) was recorded in T_{11} (Atrazine @ 250 g a.i./ha + one hand weeding at 30-35 DAS) followed by T_8 (Tembotrione (120 ml a.i./ha) at 25 DAS as PoE). There was also a significant difference in weed dry weight of grass weeds at harvest stage. Weedy check (T_1) had significantly higher grass weed dry weight (45.6 g/m^2), which was onpar with T_{12} (Atrazine @ 0.25 kg a.i./ha + 2,4 D @ 1000 g a.i./ha at 20-25 DAS). Significantly lesser weed dry weight was registered in T_4 and followed by T_3 (7.9 and 9.2 g/m^2 respectively). Ravisankar *et. al.* (2013) reported that atrazine effectively controlled majority of broad leaved and grassy weeds at earlier stages of maize growth. Application of atrazine at 0.5 kg/ha as pre-emergence followed by inter cultivation at 35 DAS in maize significantly reduced the total weed density and weed dry weight.

Weed control Efficiency: Higher weed control efficiency (100 %) was calculated in T_2 (Weed free treatment). Apart from T_2 treatment, higher weed control efficiency (65.1 %) was associated with T_{11} (atrazine @ 250 g a.i./ha + one hand weeding at 30-35 DAS) followed by T_9 (60.2 %) (pendimethalin (1000 ml a.i./ha) as pre-emergence *fb* atrazine (750 g a.i. /ha) + 2,4 D amine (75%) at 50 DASand T_{10} (atrazine (1500 g a.i./ha) pre-emergence *fb* tembotrione (120 ml a.i./ha) (59.8 %). At the time of harvest the weed control efficiency was higher in T_9 (pendimethalin (1000 ml a.i./ha) as pre-emergence *fb* atrazine (750 g a.i. /ha) + 2,4 D amine (75%) followed by T_{10} (atrazine @ 1500 g a.i./ha PE *fb* tembotrione 120 g a.i./ha) PoE at 25 DAS) (except T_2-weed free). Next to weedy check (T_1), application of halosulfuron @ 60 g a.i./ha (T_6) had the lesser weed control efficiency (3.4 % and 6.6 % on 50 DAS and at harvest respectively).

The weed control efficiency was higher in absolute weed free plots as well as where one hand weeding done after the application of atrazine @ 250 g a.i./ha (T_{11}) as pre emergence herbicide. Either the higher dose of herbicide (atrazine @ 1500 g a.i./ha as PE) or the post emergence herbicide (tembotrione 120 g a.i./ha or atrazine @ 750 g a..i./ha + 2,4 D amine at 25 DAS application might be the reason to higher weed control efficiency in maize. The research evidences of Shankar*et al.* (2015) have shown that higher weed control efficiency at harvest was found with application of atrazine (50%) @ 1.25 kg/ha + pendimethalin (50%) @ 2.5 lit/ha which was on par with rest of the chemical treatments except atrazine 50 EC @ 2.5 lit/ha, Metasulfuron methyl 20 EC @ 0.02 kg/ha, Pendimethalin 30 EC @ 5 lit/ha, one hand weeding and hand weeding twice, respectively and

this lend support to the present result. Kamble *et al.* (2015) reported that higher weed control efficiency at harvest was found with application of atrazine (50%) @ 1.25 kg + pendimethalin (50%) @ 2.5 lit/ha (7.33) and which was on par rest of the chemical treatments except atrazine 50 EC -2.5 lit/ha – Metasulfuron methyl 20 EC-0.02 kg/ha, pendimethalin 30 EC -5lit/ha- one hand weeding and hand weeding in twice respectively. Kolage *etal*. (2004) found that the maximum weed control efficiency was observed in weed free check followed by application of atrazine @1 kg/ha and PE application of Atrazine 0.5 kg/ha *fb* one hand weeding.

Table 2. Effect weed management options on weed dry weight (g/m^2) and weed control efficiency in irrigated maize

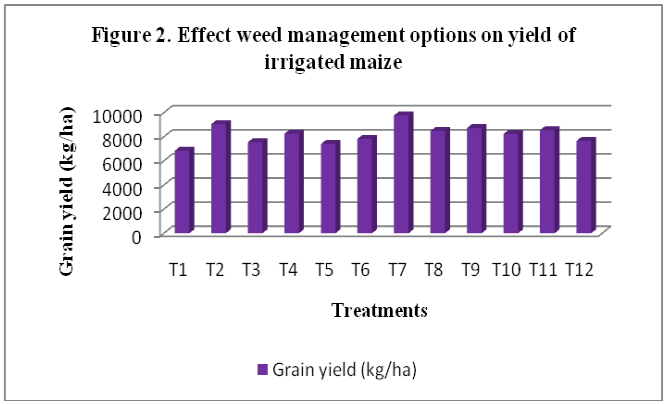
Treatment	Weed dry weight at 50 DAS (g/m^2)			Weed dry weight at harvest (g/m^2)			Weed control efficiency (%)	
	Broad leaved weeds	Grass weeds	Sedges	Broad leaved weeds	Grass weeds	Sedges	50 DAS	Harvest
T_1 - Control (Weedy check)	14.21 (204.6)	4.50 (20.3)	0.0 (0.0)	13.23 (178.4)	6.68 (45.6))	0.0 (0.0)	0	0
T_2 - Weed free	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	100	100
T_3 - Atrazine @ 1500 g a.i./ha PE	11.0 (121.9)	3.52 (12.7)	0.43 (0.6)	12.12 (147.7)	3.0 (9.2)	0.43 (0.6)	41.7	40.2
T_4 - Atrazine (750 g a.i./ha) + Pendimethalin (750 ml a.i./ha) PE	9.32 (88.2)	1.94 (4.3)	1.09 (2.2)	9.51 (90.5)	2.64 (7.9)	0.0 (0.0)	56.5	53.5
T_5 - Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS as PoE	9.41 (92.8)	4.31 (19.2)	0.0 (0.0)	6.45 (45.6)	5.00 (25.5)	0.0 (0.0)	58.4	63.9
T_6 - Halosulfuron 60 g a.i./ha at 25 DAS	12.04 (145.8)	3.64 (14.1)	0.0 (0.0)	12.06 (145.4)	4.55 (21.0)	0.0 (0.0)	3.4	6.6
T_7 - Atrazine @ 1500 g a.i./ha PE *fb* Halosulfuron 60 g a.i./ha 25 DAS	9.13 (83.5)	3.72 (14.0)	0.0 (0.0)	7.43 (57.9)	4.29 (18.4)	0.0 (0.0)	55.0	59.8
T_8 - Tembotrione 120 g a.i./ha PoE at 25 DAS	11.45 (134.4)	1.83 (4.2)	0.0 (0.0)	10.27 (108.1)	5.40 (29.9)	0.0 (0.0)	34.0	32.5
T_9 - Pendimethalin (1000 ml a.i./ha) PE *fb* Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS	9.51 (91.3)	2.64 (7.1)	0.19 (0.1)	8.34 (70.4)	3.57 (13.7)	0.0 (0.0)	60.2	77.2
T_{10} - Atrazine @ 1500 g a.i./ha PE *fb* Tembotrione 120 g a.i./ha) PoE at 25 DAS	9.83 (97.3)	3.41 (11.7)	0.0 (0.0)	6.33 (45.7)	3.65 (13.4)	0.0 (0.0)	59.8	74.7
T_{11} – Atrazine @ 250 g a.i./ha + One hand weeding at 30 – 35 DAS	7.77 (61.1)	0.47 (0.7)	0.0 (0.0)	7.66 (59.3)	5.21 (29.2)	1.02 (3.1)	65.1	42.1
T_{12} – Atrazine @ 250 g a.i./ha + 2,4 D @ 1000 g/ha at 20 – 25 DAS.	10.83 (113.2)	2.55 (7.3)	0.0 (0.0)	8.72 (78.9)	6.65 (45.1)	0.0 (0.0)	23.2	20.1
SEd	1.20	0.65	0.35	1.43	0.82	0.46	-	-
CD (P=0.05)	2.50	1.35	NS	2.96	1.70	NS	-	-

(Figures in parenthesis are original values)

Yield and economics: Among the different weed management practices higher grain yield (9768 kg/ha) was registered in T_7 (atrazine (1500 g a.i./ha as pre-emergence) *fb* halosulfuron (60 g a.i./ha) at 25 DAS as PoE) at 50 DAS), which was on par with T_2 (weed free) (9052 kg/ha). This was mainly due to the lesser crop weed competition during the early and critical stages of the maize crop. Santveeraiyya and Agasimani (2012) reported that higher grain yield of maize of (7.72 t/ha) was obtained under weed free check. It was mainly due to minimum crop-weed competition throughout the crop growth period, thus enabling the crop for maximum utilization of nutrients, moisture, light and space which had influence the growth and yield components. The same was on par with T_9 - Pendimethalin (1000 ml a.i./ha) PE *fb* atrazine (750 g a.i./ha) + 2,4-D amine (75%) at 25 DAS), T_{11} - Atrazine @ 250 g a.i./ha + one hand weeding at 30-35 DAS and T_8 - Tembotrione 120 g a.i./ha PoE at 25 DAS (8479 kg/ha, 8775 kg/ha and 8549 kg/ha, respectively). The reports of Tahir *et al.* (2009) who found that manual hoeing and pendimethalin pre-emergence application can be more effective in controlling weeds as compared to all other treatments without compromising maize grain yield due to weeds lend support to the present result. Kamble *et al.* (2015) has also reported that pre-emergent application of atrazine @ 1 kg *a.i.*/ha recorded significantly higher grain yield (7079 kg/ha) over rest of the weed control treatments and was on par with weed free check. The higher yield with these practices was due to improvement in yield attributing characters like 100 seed weight and seed weight per cob.

Table 3. Effect weed management options on yield of irrigated maize

Treatment	Grain yield (kg/ha)	Stover yield (kg/ha)
T_1 - Control (Weedy check)	6846	8860
T_2 - Weed free	9052	9065
T_3 - Atrazine @ 1500 g a.i./ha PE	7545	8476
T_4 - Atrazine (750 g a.i./ha) + Pendimethalin (750 ml a.i./ha) PE	8254	9087
T_5 - Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS as PoE	7402	9078
T_6 - Halosulfuron 60 g a.i./ha at 25 DAS	7826	9457
T_7 - Atrazine @ 1500 g a.i./ha PE *fb* Halosulfuron 60 g a.i./ha 25 DAS	9768	7980
T_8 - Tembotrione 120 g a.i./ha PoE at 25 DAS	8479	9069
T_9 - Pendimethalin (1000 ml a.i./ha) PE *fb* Atrazine (750 g a.i./ha) + 2,4-D Amine (75%) at 25 DAS	8725	9603
T_{10} - Atrazine @ 1500 g a.i./ha PE *fb* Tembotrione 120 g a.i./ha) PoE at 25 DAS	8229	8859
T_{11} – Atrazine @ 250 g a.i./ha + One hand weeding at 30 – 35 DAS	8549	9198
T_{12} – Atrazine @ 250 g a.i./ha + 2,4 D @ 1000 g/ha at 20 – 25 DAS	7661	8580
SEd	658	622
CD (P=0.05)	1365	NS



IV. CONCLUSION

The results of the experiment revealed that higher grain yield was registered under application of atrazine @ 1500 g a.i./ha as pre-emergence) *fb* halosulfuron @ 60 g a.i./ha at 25 DAS as PoE at 50 DAS, which was on par with weed free condition. The weed population was lesser under atrazine @ 1500 kg a.i./ha as pre emergence followed by Tembotrione 120 g a.i./ha at 25 DAS. Weedy check had higher grass weed dry weight and on par with pre-emergence application of atrazine @ 250 g a.i./ha + 2,4 D @ 1000 g a.i./ha at 20–25 DAS. Lesser weed dry weight was registered in atrazine (750 g a.i./ha) + pendimethalin (750 ml a.i./ha) PE followed by atrazine @ 1500 g a.i./ha PE. The higher dose of herbicides (atrazine @ 1500 g a.i./ha as PE) as well as post emergence herbicide application (tembotrione 120 g a.i./ha or atrazine @ 750 g a..i./ha + 2,4 D amine at 25 DAS might be the influencing factor to higher weed control efficiency in maize.

V. ACKNOWLEDGEMENT

This study was conducted under All India Co-ordinated Research Project on Maize headed by the Indian Institute of Maize Research, Ludhiana. Trials were conducted at Maize Research Ststion, Vagarai, Tamil Nadu Agricultural University. I thank Dr.A.K.Singh, PI, AICRP Agronomy, Dr.S.L.Jat, Agronomist, IIMR, Ludhiana, Dr.K.Sethuraman, Professor and Head, MRS, Vagarai for the support of successful conduct of experiment.

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