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Assessment of Different Weed Management Strategies on Varied Weed Flora and Yield of Maize (*Zea mays* L.)

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ABSTRACT

A field experiment was carried out at a farmer's field in Chidambaram, Tamil Nadu, between March and June 2021 to assess the different weed management strategies on varied weed flora and yield of maize. The field experiment was designed with three replications and nine treatments, viz., atrazine, topramezone, tembotrione, halo sulfuron methyl and hand weeding. The results of the experiment revealed that hand weeding twice at 15 and 30 DAS showed lowest weed population, biomass production, weed control index, highest grain, stover yield and harvest index which is statistically comparable with Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS and Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS. Hand weeding twice at 15 and 30 DAS had reduced the weed density, weed biomass and enhanced the weed control index, maximize the grain yield (6.73 t ha^{-1}) on par with Atrazine + Topramezone (6.63 t ha^{-1}) and Atrazine + Tembotrione (6.55 t ha^{-1}). As a result, it can be implied that sequential application of pre-emergence Atrazine followed by post emergence topramezone and tembotrione, proved better weed control over other treatments. Although hand weeding was superior to other treatments at 15 and 30 DAS, it was more expensive than herbicide application.

Keywords Hand weeding, Herbicides, Weed biomass, Growth parameters, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the world's most significant cereal crops, regarded as the "Queen of cereals" due to its importance in human and animal diets, effective use of solar energy, and immense potential for increased output. It is grown worldwide at 203.89 M ha^{-1}, yielding 1210.45 MMT with a productivity of 5.94 t ha^{-1}. It is grown in India's wide range area of 9.90 M ha^{-1}, with a yield of 32.50 MMT and a productivity of 3.28 t ha^{-1} respectively (USDA 2021-22). Maize is also an excellent feed for pigs, poultry, and other animals. It contains around 11.2 % protein, 8 % oil 70 % carbohydrate 2-3 % crude fiber 10.4 % albumins and 1.4 % ash (Raut *et al*. 2017). Weed infestation in maize crops is severe in India due to various factors contributing to weed development. Maize crops are often cultivated with wider spacing

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and delayed early crop growth results in more crop loss. Weeds are India's most significant yield-limiting variables in maize production (Gharde *et al*. 2018). In the country around 100 weed species in 66 genera and 24 plant groups are recognized as troublesome for maize. The critical period for crop weed competition in maize is between 15 to 45 days after sowing (DAS) and the uninterrupted growth of weeds especially during critical weed free period causes a reduction in grain yield of maize to the tune of 68.11 % (Mishra *et al*. 2020). Control of grasses broad-leaved weeds (BLWs) and sedges remains a main problem for the farmers especially when too high or too low soil moisture which hinders the intercultural operations along with the scarcity of labor during critical stages of weeding. Topramezone and tembotrione are two novel selective post-emergence herbicides for maize that block the hydroxy-phenyl pyruvate dioxygenase (4-HPPD) enzyme and plastoquinone production (Swetha *et al*. 2015). There is a need for an alternative post-emergence herbicide, such as topramezone or tembotrione, that can offer broad spectrum weed control in *kharif* maize without harming crop growth or production (Yadav *et al*. 2017). Keeping these facts in mind, the current investigation was carried out to assess the different weed management strategies on varied weed flora and yield of maize.

MATERIALS AND METHODS

The present study was conducted at farmer's field Chidambaram, Tamil Nadu during March-June 2021 to assess the different weed management strategies on varied weed flora and yield of maize. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments viz., T_1 – Un - weeded control, T_2 – Two hand weeding's on 15 and 30 DAS , T_3 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS, T_4 – Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_5 – Tembotrione (PoE) @ 125 g a.i ha^{-1} on 18 DAS, T_6 – Halo sulfuron ethyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS, T_7 - Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_8 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS, T_9 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Halo sulfuron methyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS. Maize hybrid (Ankur Adithya) seeds were sown on 10th March 2021 with 60 x 20 cm with 250:75:75 NPK kg ha^{-1}. The herbicides have been applied as per the treatment schedule with manually operated knapsack sprayer with flood fan nozzle. The amount of water utilized after calibrating the sprayer was 500 L ha^{-1} for P.E and PoE. The observations of weed density and weed biomass were taken from 30 DAS up to 45 DAS and yield parameters were taken from five randomly selected places using 1 m^2 quadrant from the net plot area. The weed density, weed biomass, weed control index, grain and stover yield were recorded for each treatment. Square root transformation was done for weed density by the using formula ($\sqrt{x+0.5}$). Harvest index (HI) was calculated using following formulae given by (Donald 1962).

$$HI(\%) = \frac{\text{Economic yield (t ha}^{-1})}{\text{Biological yield (t ha}^{-1})} \times 100$$

Biological yield = (Kernel yield + Stover yield)

All the data observations recorded in the experiments were statistically analyzed by AGRES Software.

RESULTS AND DISCUSSION

Weed flora of the experiment site

The major weeds appeared in the experimental field at all the stages of observation were *Trianthema protulocastrum, Cleome viscosa, Amaranthus viridis* and *Convolvulus arvensis* among broad leaf weeds and in grasses viz., *Dactyloapticum aegyptium, Digitaria sanguinallis* and *Cyanodon dactylon* among sedges *Cyperus rotundus*.

Effect of weed management strategies on weed population

Among the broad leaf weed *Trianthema protulocastrum* is the predominant weed in the experimental plot and it was effectively controlled by two-handed weeding's at 15 and 30 DAS and closely followed by sequential application of atrazine (P.E.) at 1 kg a.i. ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS and Atrazine (P.E) @ 1 kg a.i. ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i. ha^{-1} to 18 DAS and other weeds, namely *Cleome viscosa*, *Amaranthus*

Table 1. Effect of weed management practices on individual weed population @ 45 DAS.

	Broad leaved weeds				Grasses			Sedges
	T. P	C.V	A.V	C.A	D.Ae	D.S	C.D	C.R
T_1	9.83 (96.14)	7.63 (57.77)	6.34 (39.72)	5.02 (24.71)	8.79 (76.71)	5.90 (34.26)	5.10 (25.56)	4.71 (21.65)
T_2	3.17 (9.55)	2.74 (7.02)	2.46 (5.55)	2.04 (3.67)	2.74 (7.00)	2.17 (4.19)	1.86 (2.97)	1.37 (1.39)
T_3	7.07 (49.51)	6.14 (37.21)	5.20 (26.52)	4.21 (17.25)	6.14 (37.22)	4.67 (21.34)	4.33 (18.24)	3.17 (9.54)
T_4	5.16 (26.13)	4.49 (19.67)	3.91 (14.76)	3.19 (9.69)	4.49 (19.64)	3.45 (11.40)	3.07 (8.94)	2.47 (5.59)
T_5	5.29 (27.49)	4.62 (20.87)	4.01 (15.61)	3.28 (10.27)	4.62 (20.87)	3.57 (12.21)	3.10 (9.14)	2.53 (5.91)
T_6	6.21 (38.11)	5.41 (28.74)	4.59 (20.54)	3.75 (13.55)	5.41 (28.73)	4.10 (16.32)	3.75 (13.58)	2.12 (4.01)
T_7	3.26 (10.16)	2.81 (7.41)	2.55 (6.00)	2.11 (3.97)	2.81 (7.40)	2.24 (4.54)	1.92 (3.17)	1.74 (2.53)
T_8	3.37 (10.85)	2.92 (8.03)	2.43 (5.41)	2.19 (4.31)	2.92 (8.01)	2.36 (5.07)	1.99 (3.48)	1.78 (2.68)
T_9	4.25 (17.55)	3.69 (13.14)	3.26 (10.12)	2.70 (6.77)	3.69 (13.09)	2.91 (7.94)	2.54 (5.94)	1.42 (1.51)
SEd	0.38	0.31	0.23	0.19	0.32	0.22	0.18	0.14
CD	0.81	0.66	0.49	0.39	0.67	0.48	0.39	0.30

Note – figures in the table are transformed values (√x+0.5).

T.P -*Trianthema protulocastrum,* C.V - *Cleome viscosa*, A.V - *Amaranthus viridis*, C. A- *Convolvulus arvensis,* D.Ae - *Dactyloapticum aegyptium*, D.S - *Digitaria sanguinallis,* C.D - *Cyanodon dactylon,* C.R - *Cyperus rotundus*.

(T_1 – Un - weeded control, T_2 – Two hand weeding's on 15 and 30 DAS , T_3 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS,T_4 – Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_5 – Tembotrione (PoE) @ 125 g a.i ha^{-1} on 18 DAS, T_6 – Halo sulfuron ethyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS, T_7 - Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_8 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS, T_9 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Halo sulfuron methyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS).

viridis and *Convolvulus arvensis, Dactyloapticum aegyptium, Digeria arvensis, Cyanodon dactylon*, and *Cyperus rotundus* also showed reduced weed density (Table 1). This is because pre-emergence application of atrazine will help to reduce weed germination during the initial stages of crop growth, and the usage of topramezone and tembotrione as post-emergence herbicides will significantly suppress weed density that emerges later as well as herbicidal application alone and in combination which was effective in timely reducing total weed population (Mahto *et al*. Lavanya *et al*. and Jyoti Jaybhaye *et al*. 2020). Considering topramezone is an effective post-emergence HPPD-blocking herbicide capable of inhibiting photo-system II in both narrow- and broad-leaved weeds, the weed population was decreased (Tiwari *et al*. 2018).

Effect of weed management strategies on weed biomass and weed control index (WCI)

The (Table 2) clearly indicates that different weed management approaches substantially affected the weed biomass. Among them hand weeding twice at 15 and 30 DAS recorded lowest weed biomass (8.85 and 28.21 g m-2) on 30 and 45 DAS and it is on par with Atrazine (P.E) @ 1 kg a.i. ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS and Atrazine (P.E) @ 1 kg a.i. ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS (11.45 and 33.69 gm^{-2}). The unweed control recorded the higher weed biomass (195.21 and 285.21 g m^{-2}). This might be due to the result of a major weed invasion. Chemical and cultural weed control strategies considerably reduced weed dry weight compared to the control. Sequential

Table 2. Effect of weed management practices on total weed bio mass and weed control index.

	Weed bio mass (g m²)		Weed control index	
	30 DAS	45 DAS	30 DAS	45 DAS
T_1	13.99 (195.21)	16.90 (285.21)	-	-
T_2	3.06 (8.85)	5.36 (28.21)	95.47	90.11
T_3	8.76 (76.21)	12.76 (162.32)	60.96	43.09
T_4	5.95 (34.85)	9.31 (86.25)	82.15	69.76
T_5	6.19 (37.85)	9.58 (91.21)	80.61	68.02
T_6	7.40 (54.21)	11.03 (121.25)	72.23	57.49
T_7	3.25 (10.05)	5.62 (31.06)	94.85	89.11
T_8	3.46 (11.45)	5.85 (33.69)	94.13	88.19
T_9	4.58 (20.51)	7.51 (55.92)	89.49	80.39
SEd	0.40	0.52	-	-
CD	0.84	1.11	-	-

Note – figures in the table are transformed values (√x+0.5).

(T_1 – Un - weeded control, T_2 – Two hand weeding's on 15 and 30 DAS , T_3 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS, T_4 – Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_5 – Tembotrione (PoE) @ 125 g a.i ha^{-1} on 18 DAS, T_6 – Halo sulfuron ethyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS, T_7 - Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_8 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS, T_9 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Halo sulfuron methyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS).

application, resulted in a significant reduction in total weed dry weight. The application of topramezone and tembotrione with atrazine may have resulted in enhanced foliar absorption of herbicides by the target weed, resulting in weed control.

Highest weed control index (WCI) at 30 and 45 DAS was higher in hand weeding twice at 15 and 30 DAS i.e., 95.47 and 90.11 on 30 and 45 DAS and it is close with application of Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS (94.85 and 89.11) and Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS (94.13 and 88.71). This might be due to fact that lower weed density in the treatment plots which resulted in lower weed biomass and higher weed control at 30 and 45 DAS.

Yield and harvest index

Different weed management strategies resulted in a significant increase in maize grain and stover yield above unweeded control. The highest grain yield and stover yield were recorded in hand weeding twice at 15 and 30 DAS which was comparable with Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS. The higher grain yield was achieved due to the herbicide mixture's excellent broad-spectrum weed control throughout the critical crop growth period which resulted in a minimal dry weight of weeds. Higher grain yield achieved due to effective broad spectrum weed control provided by the applied herbicide mixture at critical crop growth period registered minimum dry weight of weeds lead to direct increase in uptake of nutrient and thereby proper growth and development of crop which resulted in higher plant height and leaf area which help to more light penetration as a result increased the photosynthetic activity which have positive response on higher cob girth, cob length, number of grains/cob and seed index ultimately resulted into increased grain yield. These findings are correlated with (Patel *et al*. 2019). The lowest grain yield and stover yield were recorded in unweeded control (2.88 and 5.82 t ha^{-1}) (Table 3). It might be because high weed density causes increased loss of nutrients and moisture resulting in intense weed competition between plants and weeds. These results are in accordance with (Arun Kumar *et al*. 2020).

The harvest index of maize did not differ significantly across weed control methods. A significantly lower weed infestation through various treatments may have helped crop plants acquire more dry matter through increased nitrogen absorption. So, it might have allowed a higher supply of photosynthates to develop sink in crop plants that could generate more yields. Highest harvest index was found in hand weeding twice at 30 and 45 DAS and followed by sequential application of Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS (Table 3). These results were corroborated with findings of

Table 3. Effect of weed management practices on yield.

	Kernel yield (t ha^{-1})	Stover yield (t ha^{-1})	HI (%)
T_1	2.88	5.82	33.15
T_2	6.73	10.92	38.13
T_3	4.01	6.78	37.17
T_4	5.36	8.85	37.72
T_5	5.21	8.66	37.59
T_6	4.61	7.73	37.36
T_7	6.63	10.77	38.09
T_8	6.55	10.66	38.04
T_9	5.95	9.72	37.96
SEd	0.26	0.40	1.47
CD	0.55	0.84	N. S

(T_1 – Un - weeded control, T_2 – Two hand weeding's on 15 and 30 DAS , T_3 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS, T_4 – Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_5 – Tembotrione (PoE) @ 125 g a.i ha^{-1} on 18 DAS, T_6 – Halo sulfuron ethyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS, T_7 - Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS, T_8 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS, T_9 – Atrazine (P.E) @ 1 kg a.i ha^{-1} on 3 DAS + Halo sulfuron methyl (PoE) @ 67.5 g a.i ha^{-1} on 18 DAS).

with (Reddy *et al*. 2019).

CONCLUSION

In terms of weed density, weed dry weight, weed control index, grain yield and harvest index atrazine 50 % WP as @ 1 kg a.i ha^{-1} (P.E) at 0-3 DAS *fb* (PoE) application of herbicide Topramezone (PoE) @ 36.5 g a.i ha^{-1} on 18 DAS and Tembotrione (PoE) @ 120 g a.i ha^{-1} on 18 DAS was found to be the most effective weed management approach for controlling diverse weed flora. As a result, i conclude that sequential application of pre- and post-emergence herbicides is the most effective strategy of weed management in maize.

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REFERENCES

Anonymous (2021-22) World Agricultural Production, United States Department of Agriculture (USDA).

Arun Kumar, Negalur RB, Halepyati AS, Yadahalli GS, Nagaraj MN (2020) Influence of sequential application of pre and post - emergence herbicides in maize (*Zea mays* L.). *J Pharmacog Phytochem* 9(4): 1364-1367.

Donald CM (1962) In search of yield. *J Australian Inst Agric Sci* 28: 171-178.

Gharde Y, Singh PK, Dubey RP, Gupta PK (2018) Assessment of yield and economic losses in agriculture due to weeds in India. *Crop Prot* 107: 12–18.

Joyti Jaybhaye, Kakade SU, Deshmukh JP, Thakare SS, Solanke MS (2020) Effect of Pre and Post Emergence Herbicides on Weeds, Productivity and Profitability of Maize (*Zea mays* L.). *Int J Curr Microbiol Appl Sci* 9(5): 2797-2805.

Lavanya Y, Srinivasan K, Chinnamuthu C, Arthanari PM, Shanmugasundaram S, Chandrasekhar C (2021) Effect of weed control methods on growth and yield of maize in western zone of Tamil Nadu. *Int J Chem Studies* 9(1) 122–125.

Mahto R, Kumar C, Singh RK (2020) Weed management in maize (*Zea mays* L.) through 4-hydroxyphenylpyruvate dioxygenase inhibitor herbicide with or without a methylated seed oil adjuvant. *Pestic Res J* 32(1): 179–185.

Mishra GC, Gayathree Mishra, Nayak BS, Behara MP, Lenka SK (2020) Influence of weed management practices on weed control efficiency, growth and productivity of hybrid maize. *Int J Chem Studies* 8(3): 2085–2089.

Patel PK, Patel BD, Patel VJ, Chaudhary DD, Dankhara M (2019) Influence of sequential and tank mix application of herbicides against complex weed flora and phytotoxicity in *kharif* maize. *Int J Chem Studied* 7(3): 4808–4812.

Raut VG, Khawale VS, Moharkar R, Bhadoriya R, Meshram D (2017) Effect of different herbicides on weeds and grain yield of maize. *J Soils Crop* 27(1): 248–252.

Reddy KVK, Narayana PL, Madhavi M (2018) Effect of new generation herbicide molecules on growth and yield parameters of *rabi* maize (*Zea mays* L.). *J Pharmacog Phytochem* 8(3): 1206–1209.

Swetha K, Madhavi M, Pratibha G, Ramprakash T (2015) Weed management with new generation herbicides in maize. *Ind J Weed Sci* 47: 432-433.

Tiwari DK, Paradkar VK, Dubey Rajiv, Dwivedi RK (2018) Bio-efficacy of post-emergence herbicide topramezone against weed control of maize (*Zea mays* L.). *Int J Agric Sci* 10: 5079-5081.

Yadav TK, Choudhary RS, Jat G, Singh D, Sharma N (2017) Effect of weed management practices on yield attributes, yield and economics of maize (*Zea mays* L.). *Chem Sci Rev Lett* 6(23): 1452–1456.