Environment and Ecology 41 (4B) : 2633—2636, October—December 2023
Article DOI: https://doi.org/10.60151/envec/PPYA8264
ISSN 0970-0420

Mesotrione: A New Herbicide for Productivity and Profitability of Maize (*Zea mays* L.)

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Received 29 May 2023, Accepted 17 August 2023, Published on 29 November 2023

ABSTRACT

The field experiment was conducted at Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru during summer 2021 to evaluate the effect of new generation mesotrione herbicide on growth and yield of maize (*Zea mays* L.). The experiment consists of application of different doses of mesotrione herbicide as early post emergent (EPoE) and weed free check and unweeded control were replicated thrice in RCBD. Major weeds observed were *Alternanthra sessilis, Borreria articularis, Euphorbia geniculata, Cynodon dactylon, Dactyloctenium aegyptium, Echinochloa colonum, Eleusine indica* and *Cyperus rotundus*. Post-emergent application of mesotrione 48% SC @ 120 ml ai. ha^{-1} recoded higher kernel yield, stover yield of maize and BC ratio (6273 kg ha^{-1}, 7583.7 kg ha^{-1} and 2.94 respectively) and it was on par with mesotrione 48% SC @ 144 ml a.i. ha^{-1} (6075 kg ha^{-1}, 7430 kg ha^{-1} and 2.79 respectively). Weedy check recorded a kernel yield (3090.7 kg ha^{-1}), lower stover yield (4096.3 kg ha^{-1}) of maize and lower BC ratio (1.03) compared to other treatments.

Keywords Mesotrione, Weed flora, Yield, Economics.

INTRODUCTION

Maize (*Zea mays* L.) is the world's third most important cereal grain after wheat and rice. Globally, maize is cultivated on an area of 193.7 m ha with production of 1147.7 m t and a productivity of 5750 kg ha^{-1}. In India, it is cultivated on an area of 9.89 m ha with a production of 31.65 m t and the productivity of 3199 kg ha^{-1} (Anon 2021a). The predominant maize growing states that contributes more than 80% of the total maize production are Andhra Pradesh (20.9%), Karnataka (16.5%), Rajasthan (9.9%), Maharashtra (9.1%), Bihar (8.9%), Uttar Pradesh (6.1%), Madhya Pradesh (5.7%) and Himachal Pradesh (4.4%). In Karnataka, it is cultivated on an area of 1.3 m ha with a production of 3.96 m t and an average productivity of 3305 kg ha^{-1} (Anon 2021b). Recently with the releaze of improved cultivars and hybrids, the grain yield has been increased but still the maize crop faces many problems.

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Weeds are one of the most important factor affecting maize production. Because of higher quantity of fertilizer application, wider spacing and initial slow growth, maize is more susceptible for weed competition, being maximum during initial 2 to 6 weeks after sowing. This suggests the importance of maintaining the fields weed free during this critical period of weed competition. The extent of reduction in grain yield of maize has been reported to be in the range of 33 to 50% depending on the intensity and persistence of weed density in standing crop (Sharma *et al.* 2000). Atrazine has been found to be the most effective pre emergence herbicide and is widely used in maize, but its usage does not control late emerged weeds and there are reports of persistence of atrazine in soil resulting in residual effects. To manage complex and dynamic weed flora in maize during later stages of crop growth, the new generation herbicides needs to be evaluated.

At presently, efficacy of mesotrione herbicide has not been tested for wide spectrum weed control in maize under Eastern Dry Zone of Karnataka. Therefore, to study the efficacy of new generation mesotrione herbicide on maize productivity and profitability the present investigation was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during Summer 2021 at the field unit of Agronomy, Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru. The experimental site is situated in the Eastern Dry Zone (Zone V) of Karnataka which is situated between 12º 51' N Latitude and 77º35' E Longitude at an altitude of 930 m above Mean Sea Level (MSL). The soil of the experimental site was sandy loam in its texture. The moisture content at field capacity was 18.63% with a bulk density of 1.43 g cc^{-1}. The soil of the site is slightly acidic in reaction (pH 5.8) with medium electrical conductivity (0.32 dS m^{-1}) and organic carbon content (0.50%). It has low available nitrogen (253.60 kg ha^{-1}), medium phosphorus (32.24 kg ha^{-1}) and potassium (283.2 kg ha^{-1}), respectively. The experiment included eight treatments laid out in Randomized Complete Block Design with three replications. Treatments involved of early post emergence application of different doses of mesotrione herbicide. T_1-Mesotrione 48% SC @ 72 ml a.i. ha^{-1}, T_2-Mesotrione 48% SC @ 96 ml a.i. ha^{-1}, T_3-Mesotrione 48% SC @ 120 ml a.i. ha^{-1}, T_4-Mesotrione 48% SC @ 144 ml a.i. ha^{-1}, T_5-Mesotrione 48% SC @ 288 ml a.i. ha^{-1}, T_6-2,4-D Amine Salt 58% SL @ 500 g a.i. ha^{-1}, T_7 -Weed free check and T_8-Weedy check. Treatment imposition was done at two to three leaf stage of weeds. The maize hybrid MAH 14-5 seeds were sown in lines at the rate of 15 kg ha^{-1} at a depth of 4-5 cm, maintaining 60 cm row and 30 cm plant spacing. The crop was fertilized with 100 kg N, 75 kg P_2O_5 and 40 kg K_2O ha^{-1} through urea, single super phosphate and muiate of potash, respectively. The crop was sown during 19th January 2021 and harvested at 13th May 2021 and labor input for all the operations. The predominant market prices of the maize after harvest was attained from the Zonal Agricultural Research Station, GKVK Bengaluru was used for the calculation of gross returns. Gross returns, net returns and benefit cost ratio were worked out by using the following formulae and expressed in rupees per hectare.

Gross return = Grain yield × market rate of grain
Net returns = Gross returns – total cost of cultivation

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

RESULTS AND DISCUSSION

Effect on weed flora

The dominated weed flora observed in the experimental plots were *Cyperus rotundus*, the grasses were *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Digitaria marginata, Echinochloa colonum, Eleusine indica* and the broad leaf weeds were *Alternanthra sessilis, Amaranths viridis, Borreria articularis* and *Euphorbia geniculata*. Similar results were reported by Ahmed and Susheela (2012), Geetha (2014) at Hebbal, Bengaluru, Veeresh *et al.* (2014) and Poojitha *et al.* (2021).

Application of mesotrione 48% SC @ 288 ml a.i. ha^{-1} recorded lower total weed density and weed dry weight (10.73 m^{-2} and 14.53 g m^{-2}) and at par with

Table 1. Category wise weed density and weed dry weight at 45 DAS of maize as influence by different doses of mesotrione herbicide. Data within parentheses are original values; + - square root (x+1) transformation, BLW- Broad leaved weeds.

Treat-ments	Weed density at 45 DAS (number m^{-2})				Weed dry weight at 45 DAS (g m^{-2})			
	Sedges^{+}	Grasses^{+}	BLW^{+}	Total^{+}	Sedges^{+}	Grasses^{+}	BLW^{+}	Total^{+}
T_1	2.20 (4.0)	3.95 (14.6)	4.13 (16.33)	5.97 (35.00)	2.58 (5.83)	4.40 (18.40)	4.46 (19.00)	6.63 (43.23)
T_2	1.99 (3.0)	3.85 (14.0)	3.79 (13.33)	5.59 (30.33)	2.12 (3.53)	4.15 (16.40)	4.26 (17.13)	6.16 (37.07)
T_3	1.72 (2.0)	3.14 (9.0)	3.25 (9.53)	4.63 (20.53)	1.95 (2.83)	3.18 (9.23)	3.20 (9.37)	4.74 (21.43)
T_4	1.82 (2.3)	2.63 (6.0)	2.91 (7.47)	4.09 (15.80)	1.93 (2.73)	3.04 (8.23)	2.97 (7.87)	4.45 (18.83)
T_5	1.49 (1.3)	2.38 (4.7)	2.37 (4.67)	3.42 (10.73)	1.69 (2.10)	2.60 (5.87)	2.75 (6.57)	3.93 (14.53)
T_6	3.13 (9.0)	5.4 (26.6)	2.87 (7.27)	6.63 (42.93)	3.28 (9.80)	4.71 (21.53)	3.39 (10.50)	6.54 (41.83)
T_7	1.00 (0.0)	1.00 (0.0)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
T_8	3.39 (11.0)	5.79 (32.6)	5.96 (34.67)	8.90 (78.33)	3.77 (13.53)	6.74 (44.67)	6.57 (42.33)	10.07 (100.53)
SEm±	**0.27**	**0.15**	**0.18**	**0.22**	**0.21**	**0.22**	**0.20**	**0.18**
CD at 5%	**0.81**	**0.44**	**0.56**	**0.66**	**0.64**	**0.66**	**0.61**	**0.56**

mesotrione 48% SC @ 144 ml a.i. ha^{-1} (15.80 m^{-2} and 18.83 g m^{-2}) and mesotrione 48% SC @ 120 ml a.i. ha^{-1} (20.53 m^{-2} and 21.43 g m^{-2}). Whereas, weedy check recorded highest total weed density and dry weight (78.33 m^{-2} and 100.53 g m^{-2}) at 45 days of the crop stage (Table 1). The application of mesotrione inhibits the enzyme 4-hydroxyphenylpyruvate dioxygenase (HPPD) activity. In plants, HPPD is necessary for the biosynthesis of tocopherols and plastoquinone, which is essential to carotenoid production. Inhibition of the pathway ultimately leads to bleaching of leaves as chlorophyll is degraded, followed by plant death as a result of achieving higher weed control efficiency similar results found with Chhokar *et al*. (2019).

Table 2. Kernel weight per cob, kernel yield and stover yield of maize as influenced by different doses of mesotrione herbicide.

Treatments	Kernel weight per cob (g)	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1 : Mesotrione 48% SC @ 72 ml a.i. ha^{-1} as EPoE	104.7	5286	6529
T_2 : Mesotrione 48% SC @ 96 ml a.i. ha^{-1} as EPoE	108.3	5502	6746
T_3 : Mesotrione 48% SC @ 120 ml a.i. ha^{-1} as EPoE	131.7	6273	7583
T_4 : Mesotrione 48% SC @ 144 ml a.i. ha^{-1} as EPoE	126.0	6075	7430
T_5 : Mesotrione 48% SC @ 288 ml a.i. ha^{-1} as EPoE	122.7	5737	7016
T_6 : 2,4-D Amine Salt 58% SL @ 500 g a.i. ha^{-1} as EPoE	89.3	4730	6278
T_7 : Weed free check	142.3	6538	7695
T_8 : Weedy check	66.0	3090	4096
SEm±	**5.0**	**99.3**	**146.6**
CD @ 5%	**15.1**	**301.2**	**444.6**

Maize yield

The data pertaining to yield attributes of maize as influenced by different doses of mesotrione herbicide are presented in Table 2.

Among herbicide treatments, application of

Table 3. Economics of different weed management practices in maize.

Treatments	Gross returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net re-turns (Rs ha^{-1})	B:C
T_1 : Mesotrione 48% SC @ 72 ml a.i. ha^{-1} as EPoE	97803	28958	68845	2.38
T_2 : Mesotrione 48% SC @ 96 ml a.i. ha^{-1} as EPoE	101799	29200	72599	2.49
T_3 : Mesotrione 48% SC @ 120 ml a.i. ha^{-1} as EPoE	116051	29442	86609	2.94
T_4 : Mesotrione 48% SC @ 144 ml a.i. ha^{-1} as EPoE	112394	29685	82709	2.79
T_5 : Mesotrione 48% SC @ 288 ml a.i. ha^{-1} as EPoE	106135	31140	74995	2.41
T_6 : 2,4-D Amine Salt 58% SL @ 500 g a.i. ha^{-1} as EPoE	87511	28490	59021	2.07
T_7 : Weed free check	120959	35730	85229	2.39
T_8 : Weedy check	57177	28230	28947	1.03

mesotrione 48% SC @ 120 ml a.i. ha^{-1} recorded significantly higher kernel weight per cob, kernel yield and stover yield (131.7 g, 6273 kg ha^{-1} and 7583.7 kg ha^{-1}) and it was on par with mesotrione 48% SC @ 144 ml a.i. ha^{-1} (126 g, 6075 kg ha^{-1} and 7430 kg ha^{-1}). However, lower values were recorded in weedy check (66 g, 3090.7 kg ha^{-1} and 4096.3 kg ha^{-1}). This is due to broad spectrum control of weeds effectively during the critical period of crop weed competition and it has provided a congenial environment for better expression of growth and yield attributes. The cumulative effect of all these yield components resulted in increased seed yield. These results document with the findings of Zhang *et al.* (2013) and Swetha *et al.* (2015), Kumar *et al.* (2017) and Lavanya *et al.* (2021).

Economics

Among all treatment combinations, post-emergence application of mesotrione 48% SC @ 120 ml a.i. ha^{-1} recorded higher net returns (Rs 1,16,051 ha^{-1}) and B:C ratio (2.94) and its followed by mesotrione 48% SC @ 144 ml a.i. ha^{-1} (Rs 1,12,394 ha^{-1}) and B:C ratio (2.79) compared to other treatments. While, weedy check noticed lower net returns and the lowest B: C ratio (Rs 57177 ha^{-1} and 1.03) (Table 3). Even though highest gross returns were recorded in weed free check followed higher labor wages increased the cost of cultivation and lowered the B:C ratio. Whereas in herbicide treatments, T_3 and T_4 lower cost of cultivation due to lower dose of herbicide requirement decreased the cost of cultivation which further increased the B:C ratio. Similar results were reported by Sonali *et al.* (2018), Rani *et al.* (2011) and Dharam *et al.* (2018) (Table 3).

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