

Effect of New Generation Mesotrione Herbicide on Growth and Yield of Maize (*Zea mays* L.)

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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 *Alternanthera sessilis*, *Borreria articularis*, *Euphorbia geniculata*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Echinochloa colonum*, *Eleusine indica* and *Cyperus rotundus*. Post-emergent application of mesotrione 48 per cent SC @ 120 ml a.i. ha⁻¹ recorded higher kernel yield, stover yield of maize and lower weed index value (6273 kg ha⁻¹, 7583.7 kg ha⁻¹ and 4.07%, respectively) and it was on par with mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ (6075 kg ha⁻¹, 7430 kg ha⁻¹ and 7.08%, respectively). Weedy check recorded a kernel yield (3090.7 kg ha⁻¹), lower stover yield (4096.3 kg ha⁻¹) of maize and higher weed index value (52.72%) compared to other treatments.

Keywords : Mesotrione, Weed flora, Growth, Yield and Weed index

MAIZE (*Zea mays* L.) is the world's third most important cereal grain after wheat and rice. It is grown primarily for grain and secondarily for fodder. 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 (Anonmous., 2021a). The predominant maize growing states that contributes more than 80 per cent 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 (Anonmous., 2021b). 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 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 per cent 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.

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, the present investigation was undertaken.

MATERIAL 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 12° 51' N Latitude and 77° 35' 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 per cent 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. T₁-Mesotrione 48 per cent SC @ 72 ml a.i. ha⁻¹, T₂-Mesotrione 48 per cent SC @ 96 ml a.i. ha⁻¹, T₃-Mesotrione 48 per cent SC @ 120 ml a.i. ha⁻¹, T₄-Mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹, T₅-Mesotrione 48 per cent SC @ 288 ml a.i. ha⁻¹, T₆-2,4-D Amine Salt 58 per cent SL @ 500 g

a.i. ha⁻¹, T₇-Weed free Check and T₈-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 P₂O₅ and 40 kg K₂O 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. Weed index (WI) was calculated as per standard formulae as:

$$WI (\%) = \frac{\text{Yield of weed free plot} - \text{Yield of treated plot}}{\text{Yield of weed free plot}} \times 100$$

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 *Alternanthera sessilis*, *Amaranths viridis*, *Borreria articularis* and *Euphorbia geniculata*. Application of mesotrione 48 per cent 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 mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ (15.80 m⁻² and 18.83 g m⁻²) and mesotrione 48 per cent 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. Whereas, weedy check recorded the higher weed density and dry weight due to the non-interruption for growth of weeds. Similar results were reported by Ahmed and Susheela (2012) at Hyderabad, Geetha Kumari (2014) at Hebbal, Bengaluru, Veeresh (2015) and Poojitha *et al.* (2021)

Effect on Maize Growth

Early post emergence (EPoE) application of mesotrione 48 per cent SC @ 120 ml a.i. ha⁻¹ herbicide significantly recorded higher values of growth attributes and at par with mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ and mesotrione 48 per cent SC @ 288 ml a.i. ha⁻¹. Whereas, weed free plot was significantly superior to all other treatments with respect of growth attributes like plant height, leaf area and dry matter production.

Plant Height

The data pertaining to plant height (cm) at different growth stages of maize as influenced by different doses of mesotrione herbicide are presented in Table 1.

At 30 days after sowing (DAS), application of mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ was recorded higher plant height (44.3 cm) and it was on par with all other treatments except weed free check (38.6 cm).

Among herbicide treatments, significantly higher plant height at 60, 90 DAS and at harvest (154, 180.7 and 183.8 cm, respectively) was recorded in mesotrione 48 per cent SC @ 120 ml a.i. ha⁻¹ and it was on par with mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ (145.3, 178, and 181.1 cm, respectively) and

TABLE 1
Category wise weed density and weed dry weight at 45 DAS of maize as influence by different doses of mesotrione herbicide

Treatments	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)
S.Em±	0.27	0.15	0.18	0.22	0.21	0.22	0.20	0.18
C. D. at 5%	0.81	0.44	0.56	0.66	0.64	0.66	0.61	0.56

Data within parentheses are original values; + - square root (x+1) transformation, BLW- Broad leaved weeds

TABLE 2

Plant height (cm) of maize at different growth stages as influenced by different doses of mesotrione herbicide

Treatments	30 DAS	60 DAS	90 DAS	At harvest
T ₁ : Mesotrione 48% SC @ 72 ml a.i. ha ⁻¹ as EPoE	40.7	135.3	155.3	159.4
T ₂ : Mesotrione 48% SC @ 96 ml a.i. ha ⁻¹ as EPoE	41.5	136.0	160.7	163.1
T ₃ : Mesotrione 48% SC @ 120 ml a.i. ha ⁻¹ as EPoE	43.2	154.0	180.7	183.8
T ₄ : Mesotrione 48% SC @ 144 ml a.i. ha ⁻¹ as EPoE	44.3	145.3	178.0	181.1
T ₅ : Mesotrione 48% SC @ 288 ml a.i. ha ⁻¹ as EPoE	43.5	145.7	177.3	182.0
T ₆ : 2,4-D Amine Salt 58% SL @ 500 g a.i. ha ⁻¹ as EPoE	41.3	121.3	143.0	146.1
T ₇ : Weed free check	46.1	165.3	195.3	210.4
T ₈ : Weedy check	38.6	112.3	125.3	130.1
S.Em±	1.72	5.40	7.21	7.35
C. D. @ 5%	5.22	16.37	21.87	22.29

EPoE- Early post emergence application, SE-Soluble concentrate

mesotrione 48 per cent SC @ 288 ml a.i. ha⁻¹ (145.7, 177.3, and 182 cm, respectively). Whereas, lower plant height was recorded in weedy check (112.3, 125.3 and 130.1 cm, respectively).

Leaf Area

The data relating to the leaf area (cm² plant⁻¹) as influenced by different doses of mesotrione herbicide are presented in Table 2. Significantly higher leaf area plant⁻¹ was recorded in weed free check at all the stages of crop growth.

Among herbicide treatments, significantly higher leaf area at 30, 60 and 90 DAS was recorded in

mesotrione 48 per cent SC @ 120 ml a.i. ha⁻¹ (1905, 1322 and 5444 cm², respectively) and it was on par with mesotrione 48 per cent SC @ 288 ml a.i. ha⁻¹ (1874, 5120 and 5176 cm², respectively) and mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ (1857, 5060, and 5249 cm², respectively). Whereas, lower leaf area was recorded in weedy check (1232, 3958, and 3780 cm², respectively).

Dry Matter Production

The data relating to dry matter production (g plant⁻¹) as influenced by different doses of mesotrione herbicide are presented in Table 3.

TABLE 3

Leaf area (cm² plant⁻¹) of maize at different growth stages as influenced by different doses of mesotrione herbicide

Treatments	30 DAS	60 DAS	90 DAS
T ₁ : Mesotrione 48% SC @ 72 ml a.i. ha ⁻¹ as EPoE	1481	4173	4296
T ₂ : Mesotrione 48% SC @ 96 ml a.i. ha ⁻¹ as EPoE	1604	4310	4432
T ₃ : Mesotrione 48% SC @ 120 ml a.i. ha ⁻¹ as EPoE	1905	5322	5444
T ₄ : Mesotrione 48% SC @ 144 ml a.i. ha ⁻¹ as EPoE	1857	5060	5249
T ₅ : Mesotrione 48% SC @ 288 ml a.i. ha ⁻¹ as EPoE	1874	5120	5176
T ₆ : 2,4-D Amine Salt 58% SL @ 500 g a.i. ha ⁻¹ as EPoE	1583	4032	4154
T ₇ : Weed free check	2109	5857	6013
T ₈ : Weedy check	1232	3958	3780
S.Em±	77.0	196.3	195.6
C. D. @ 5%	233.8	595.5	593.5

TABLE 4
Total dry matter production (g plant⁻¹) of maize at different growth stages as influenced by different doses of mesotrione herbicide

Treatments	30 DAS	60 DAS	90 DAS	At harvest
T ₁ : Mesotrione 48% SC @ 72 ml a.i. ha ⁻¹ as EPoE	7.3	44.9	149.0	202.9
T ₂ : Mesotrione 48% SC @ 96 ml a.i. ha ⁻¹ as EPoE	7.6	49.8	153.0	222.3
T ₃ : Mesotrione 48% SC @ 120 ml a.i. ha ⁻¹ as EPoE	8.5	54.5	193.0	258.9
T ₄ : Mesotrione 48% SC @ 144 ml a.i. ha ⁻¹ as EPoE	8.3	53.3	173.9	232.8
T ₅ : Mesotrione 48% SC @ 288 ml a.i. ha ⁻¹ as EPoE	8.1	51.6	172.1	234.7
T ₆ : 2,4-D Amine Salt 58% SL @ 500 g a.i. ha ⁻¹ as EPoE	7.4	45.9	151.5	208.4
T ₇ : Weed free check	8.8	57.7	197.3	272.5
T ₈ : Weedy check	7.1	38.9	129.4	112.0
S.Em±	0.46	2.80	8.77	11.42
C. D. @ 5%	1.39	8.49	26.61	34.65

Among herbicide treatments application of mesotrione 48% SC @ 120 ml a.i. ha⁻¹ recorded higher dry matter production at 30, 60, 90 DAS and at harvest (8.5, 54.5, 193 and 258.9 g plant⁻¹, respectively) and it was on par with mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ (8.3, 53.3, 173.9 and 232.8 g plant⁻¹, respectively) and mesotrione 48 per cent SC @ 288 ml a.i. ha⁻¹ (8.1, 51.6, 172.1 and 234.7 g plant⁻¹, respectively). Whereas, lower leaf area was recorded in weedy check (7.1, 38.9, 129.4 and 112 g plant⁻¹, respectively)

Among the herbicide treatments, significantly higher plant height, leaf area, and total dry matter production per plant at all stages of plant growth was recorded

with the application of mesotrione 48 per cent SC @ 120 ml a.i. ha⁻¹ due to broad spectrum weed control during critical period of crop weed competition through which leads to better growth and development of plant parts and ultimately produced higher plant height, leaf area and total dry matter production plant⁻¹. These results are in confirmity with the findings of Chhokar *et al.* (2019), Veeresh *et al.* (2014) and Poojitha *et al.* (2021).

Maize Crop Yield

The data pertaining to yield attributes of maize as influenced by different doses of mesotrione herbicide are presented in Table 4.

TABLE 5
Kernel weight per cob, kernel yield, stover yield, harvest index and weed index in 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)	Weed index(%)
T ₁ : Mesotrione 48% SC @ 72 ml a.i. ha ⁻¹ as EPoE	104.7	5286	6529	19.14
T ₂ : Mesotrione 48% SC @ 96 ml a.i. ha ⁻¹ as EPoE	108.3	5502	6746	15.83
T ₃ : Mesotrione 48% SC @ 120 ml a.i. ha ⁻¹ as EPoE	131.7	6273	7583	4.07
T ₄ : Mesotrione 48% SC @ 144 ml a.i. ha ⁻¹ as EPoE	126.0	6075	7430	7.08
T ₅ : Mesotrione 48% SC @ 288 ml a.i. ha ⁻¹ as EPoE	122.7	5737	7016	12.25
T ₆ : 2,4-D Amine Salt 58% SL @ 500 g a.i. ha ⁻¹ as EPoE	89.3	4730	6278	27.65
T ₇ : Weed free check	142.3	6538	7695	0
T ₈ : Weedy check	66.0	3090	4096	52.72
S.Em±	5.0	99.3	146.6	-
C. D. @ 5%	15.1	301.2	444.6	-

Weed free plot was significantly superior to all other treatments with respect of yield attributes. Among herbicide treatments, application of mesotrione 48 per cent 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 per cent 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). Lower weed index was noticed in the treatment with mesotrione 48% SC @ 120 ml a.i. ha⁻¹ (4.07%) followed by mesotrione 48 per cent SC @ 144 ml a.i. ha⁻¹ (7.08%) and higher weed index value was recorded in weedy check (52.72%). This is due to broad spectrum control of weeds effectively during the critical period of crop weed competition, which otherwise quite notorious for imposing competition for light, space and nutrients with the crop. 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).

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