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Effect on growth parameters of maize (*Zea mays* L.) by weed management through post-emergence herbicides

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Abstract

A field experiment entitled “Studies on effect of post-emergence herbicides for weed management in maize” was carried out during *kharif*, 2022 at Main Agriculture Research Station, University of Agricultural Sciences, Raichur, Karnataka, India. The experiment was laid out in Randomized Complete Block Design with three replications and eleven treatments. The results of the experiment revealed that weed free check had recorded significantly higher growth parameters *viz.*, plant height number of leaves per plant, leaf area, leaf area index and total dry matter production in maize. Among the herbicide treatments, application of mesotrione 48% SC @ 144 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS had resulted in higher growth parameters which was statistically on par with mesotrione 48% SC @ 120 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS, tembotrione 34.4% SC @ 125 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS and farmers’ practice wherein hand weeding was carried out at 20 DAS followed by IC at 40 DAS. Hence, mesotrione 48% SC @ 120 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS could be used as an effective weed management practice in maize.

Keywords: Maize, mesotrione, intercultivation (IC), days after sowing (das)

Introduction

Maize, the Indian and American word for corn means literally which "sustains life". It is the third most important cereal in India in terms of both area and production after rice and wheat, providing nutrients for humans, animals and serving as a basic raw material for the production of starch, oil, protein, alcoholic beverages, food sweeteners and more recently, fuel. In developed countries more than 60 per cent of the production is used in compounded feeds for poultry, pigs and ruminant animals (Anon., 1992) [1]. Verma *et al.* (2009) [7] reported that manual weeding followed by earthing up prevented weed competition (86%) and increased weed control efficiency which resulted in higher values of growth parameters *viz.*, plant height (40%), culm girth (36%), leaf area index (76%), dry weight of plants (42%) and crop growth rate (38%) than weedy check which recorded lower values of growth attributes in winter maize.

Eventhough the crop has very high production potential, weed menace will be a major constraint in its production as the crop is heavily fertilized, wide spaced and has slow initial growth. Since, hand weeding is tedious, time consuming, expensive and impractical during bad weather, there is a need to look for alternative methods of weed management to hand weeding like post-emergence herbicides application for broad spectrum weed control. Hence, this experiment was conducted with an objective to assess the effect of post-emergence herbicides on growth of maize.

Material and methods

A field experiment was laid out in Randomized Complete Block Design with eleven treatments and three replications during *kharif*, 2022 at Main Agricultural Research Station, UAS, Raichur. The maize hybrid (NK-6240) seeds were sown on 12th July, 2022 when there was sufficient moisture in *vertisols* of the experimental site. The crop was fertilized with recommended dose of fertilizers (150:75:37.5 kg NPK ha⁻¹, respectively).

Plant height was recorded from base of the plant to the base of the full opened leaf and number of leaves were counted manually in five randomly tagged plants of each treatment and then averaged. Total dry matter production was worked out by

uprooting plants from destructive sampling area, sun drying, weighing and averaged. Leaf area and leaf area index (LAI) were worked by using the following formulas given by Sticker *et al.* (1961)^[6] and Watson (1952)^[8], respectively.

$$\text{Leaf area (dm}^2 \text{ plant}^{-1}) = \text{Avg. length} \times \text{Avg. breadth} \times \text{No. of leaves plant}^{-1} \times 0.75$$

$$\text{LAI} = \frac{\text{Leaf area plant}^{-1} \text{ (dm}^2\text{)}}{\text{Land area occupied by the plant (dm}^2\text{)}}$$

Results and Discussion

Growth parameters (plant height, number of leaves, leaf area, leaf area index and total dry matter production) were recorded at 30, 60, 90 DAS and at harvest.

Plant height (cm)

At 30 DAS, significantly taller plant height was recorded in weed free check treatment (49.29 cm), while weedy check

treatment had recorded shorter plant height (32.75 cm). Among the herbicide treatments, all the herbicide treatments were statistically on par with farmers' practice (44.25 cm) except application of mesotrione 48% SC @ 96 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds (37.21 cm) and mesotrione 48% SC @ 96 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (36.98 cm) (Table 1).

Table 1: Plant height (cm) of maize at different growth stages as influenced by different weed management practices

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁ : Mesotrione 48% SC @ 96 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds	37.21	155.41	172.67	172.99
T ₂ : Mesotrione 48% SC @ 120 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds	40.97	165.64	182.89	183.11
T ₃ : Mesotrione 48% SC @ 144 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds	43.00	167.24	185.02	185.84
T ₄ : Mesotrione 48% SC @ 96 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	36.98	181.97	200.16	201.23
T ₅ : Mesotrione 48% SC @ 120 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	41.38	191.39	210.51	211.78
T ₆ : Mesotrione 48% SC @ 144 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	42.39	197.15	217.84	218.69
T ₇ : Tembotrione 34.4% SC @ 125 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	43.54	194.56	213.56	214.06
T ₈ : 2,4-D amine salt 58% SL @ 500 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	39.69	177.04	195.31	195.97
T ₉ : Farmers' practice (HW at 20 DAS <i>fb</i> IC at 40 DAS)	44.25	200.04	220.01	220.51
T ₁₀ : Weed free check	49.29	210.83	231.37	231.75
T ₁₁ : Weedy check	32.75	145.13	161.71	162.73
S.Em. ±	1.59	3.05	3.42	3.36
L.S.D. at 5%	4.68	8.99	10.09	9.92

Note: *a.i.* = Active ingredient, DAS = Days after sowing, *fb* = followed by, HW = Hand weeding IC = Intercultivation, SC = Suspension concentrates, SL = Soluble liquids

Significantly taller plant height at 60, 90 DAS and at harvest was observed in weed free check (210.83, 231.37 and 231.75 cm, respectively), whereas shorter plant height was noticed in weedy check (145.13, 161.71 and 162.73 cm, respectively). The next best treatment was farmers' practice wherein significantly taller plant height (200.04, 220.01 and 220.51 cm, respectively) was recorded at 60, 90 DAS and at harvest, respectively. However, it was statistically on par with the herbicide treatments like mesotrione 48% SC @ 144 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (197.15, 217.84 and 218.69 cm, respectively), tembotrione 34.4% SC @ 125 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (194.56, 213.56 and 214.06 cm, respectively) and mesotrione 48% SC @ 120 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (191.39, 210.51 and 211.78 cm, respectively).

Significantly taller plant height was observed in the herbicide treatments like mesotrione and tembotrione which might be due to the effect of chemicals on the weeds that reduced the weed density and dry weight to supply maize plants with optimum nutrients, moisture, space and sunlight for the potential crop growth by increased internode length through hastened cell multiplication and cell elongation due to improved ability of the crop to withstand strongly during critical period of crop-weed competition. These results are in conformity with the data

recorded by Arunkumar (2018)^[2] and Dey (2020)^[3]. Similarly, Harisha *et al.* (2023)^[4] reported that significantly higher plant height at 60, 90 DAS and at harvest was recorded with the application of mesotrione 48% SC @ 120 ml *a.i.* ha⁻¹.

Number of leaves plant⁻¹

At 30 DAS, no significant differences were observed in the number of leaves plant⁻¹, while at 60, 90 DAS and at harvest, number of leaves plant⁻¹ had shown significant differences among the various treatments involved in this study (Fig. 1). The maximum number of leaves plant⁻¹ at 60, 90 DAS and at harvest were found in weed free check (14.27, 15.40 and 14.60, respectively), whereas the minimum number of leaves plant⁻¹ were noticed in weedy check (10.27, 12.60 and 11.60, respectively). The next best treatment in the number of leaves plant⁻¹ at 60, 90 DAS and at harvest was farmers' practice (13.60, 14.87 and 14.20, respectively) which was statistically on par with application of mesotrione 48% SC @ 144 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (13.47, 14.80 and 14.13, respectively), tembotrione 34.4% SC @ 125 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (13.40, 14.73 and 14.00, respectively) and mesotrione 48% SC @ 120 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (13.13, 14.67 and 13.93, respectively), among the herbicide treatments.

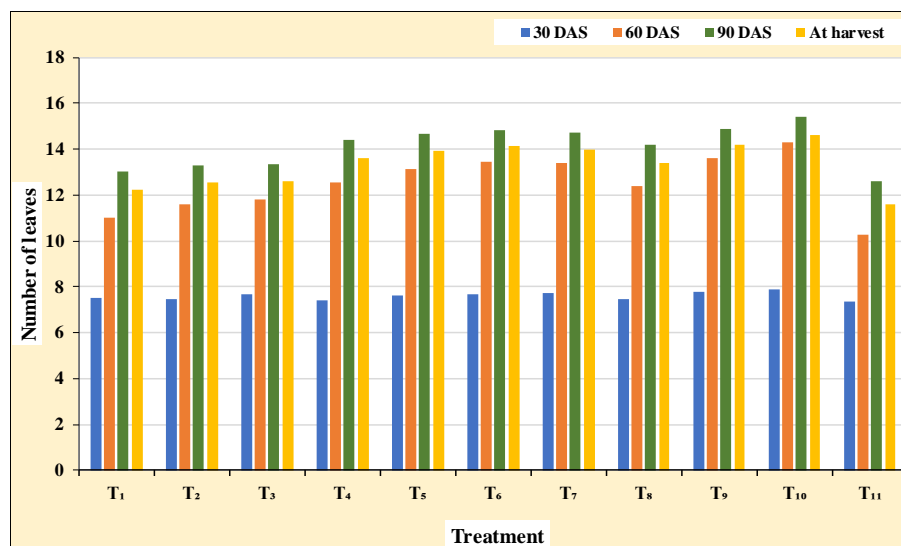


Fig 1: Number of leaves per plant at different growth stages of maize as influenced by different weed management practices

Significantly higher number of leaves plant⁻¹ in mesotrione herbicide treatments might be attributed to auxin synthesis, meristematic activity and higher plant height at various stages of the crop growth which was in turn dependent on the length of internodes and their elongation due to the cells rapidity in mitosis. Longer the internodes, higher the plant height, more the number of leaves. These findings are in collaboration with the results of Arunkumar (2018) [2] and Dey (2020) [3] who also reported that the maximum number of leaves were found in the treatment involving the application of mesotrione + atrazine @ 200 + 1000 g a.i. ha⁻¹ at 90, 120 DAS and at harvest.

Leaf area (dm² plant⁻¹)

At 30 DAS, significantly maximum leaf area was observed in weed free check (40.83 dm² plant⁻¹), whereas weedy check was noticed with the lower leaf area of 30.76 dm² plant⁻¹. Among the herbicide applications, all the treatments were found to be statistically on par with farmers' practice (37.60 dm² plant⁻¹) except mesotrione 48% SC @ 96 g a.i. ha⁻¹ at 3-4 leaf stage of weeds (34.02 dm² plant⁻¹) and weeds fb IC at 45 DAS (33.55 dm² plant⁻¹) (Table 2).

Significantly higher leaf area at 60, 90 DAS and at harvest in maize was recorded from weed free check treatment (87.31, 93.54 and 90.21 dm² plant⁻¹, respectively), whilst lower leaf area was observed in weedy check treatment (55.92, 58.21 and 57.17 dm² plant⁻¹, respectively). The next best treatment in the leaf area of maize at 60, 90 DAS and at harvest was farmers' practice (82.32, 88.45 and 84.89 dm² plant⁻¹, respectively) which was statistically on par with the herbicide treatments like application of mesotrione 48% SC @ 144 g a.i. ha⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS (81.25, 87.44 and 83.93 dm² plant⁻¹, respectively), tembotrione 34.4% SC @ 125 g a.i. ha⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS (80.29, 85.27 and 82.46 dm² plant⁻¹, respectively) and mesotrione 48% SC @ 120 g a.i. ha⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS (79.01, 84.06 and 81.08 dm² plant⁻¹, respectively).

Herbicides application like mesotrione and tembotrione resulted in better weed control efficiency thereby boosting the crop to stimulate chlorophyll formation for improving the efficiency of photosynthesis by trapping sufficient amount of sunlight, moisture consumption, improved

Table 2: Leaf area (dm² plant⁻¹) of maize at different growth stages as influenced by different weed management practices

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁ : Mesotrione 48% SC @ 96 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds	34.02	60.71	63.50	61.57
T ₂ : Mesotrione 48% SC @ 120 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds	35.52	65.42	68.53	66.43
T ₃ : Mesotrione 48% SC @ 144 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds	36.70	67.72	70.21	68.65
T ₄ : Mesotrione 48% SC @ 96 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS	33.55	75.33	79.12	76.74
T ₅ : Mesotrione 48% SC @ 120 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS	35.82	79.01	84.06	81.08
T ₆ : Mesotrione 48% SC @ 144 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS	36.08	81.25	87.44	83.93
T ₇ : Tembotrione 34.4% SC @ 125 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS	36.96	80.29	85.27	82.46
T ₈ : 2,4-D amine salt 58% SL @ 500 g a.i. ha ⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS	35.29	72.05	75.19	73.02
T ₉ : Farmers' practice (HW at 20 DAS fb IC at 40 DAS)	37.60	82.32	88.45	84.89
T ₁₀ : Weed free check	40.83	87.31	93.54	90.21
T ₁₁ : Weedy check	30.76	55.92	58.21	57.17
S.Em. ±	0.82	1.17	1.64	1.43
L.S.D. at 5%	2.41	3.46	4.84	4.22

Note: a.i. = Active ingredient, DAS = Days after sowing, fb = followed by, HW = Hand weeding IC = Intercultivation, SC = Suspension concentrates, SL = Soluble liquids

uptake of nutrients by the crop and to increase number of leaves in each maize plant. The decrease in leaf area at harvest was because of drying and withering of leaves. Such similar results were also reported by Arunkumar (2018) [2] and Dey (2020) [3].

Harisha *et al.* (2023) [4] also observed significantly higher leaf area at 30, 60, 90 DAS and at harvest due to application of mesotrione 48% SC @ 120 ml a.i. ha⁻¹ as compared to other treatments.

Leaf area index (LAI)

Significantly higher leaf area index was observed in weed free check (3.40) at 30 DAS and the lower leaf area index of 2.56 had been noticed from weedy check. Among the herbicide applications, all the treatments were statistically on par with

farmers' practice (3.13) except the treatments like mesotrione 48% SC @ 96 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds (2.84) and mesotrione 48% SC @ 96 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (2.80) (Fig. 2).

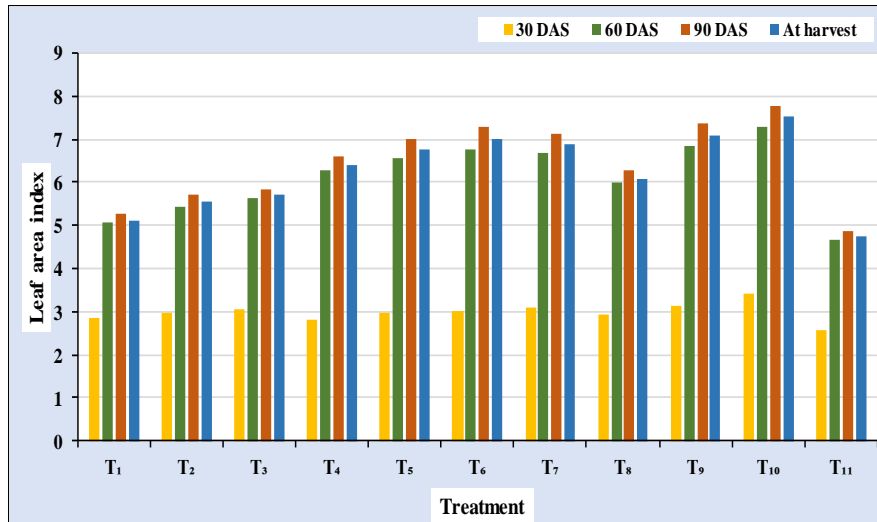


Fig 2: Leaf area index at different growth stages of maize as influenced by different weed management practices

At 60, 90 DAS and at harvest, significantly higher leaf area index was recorded in weed free check (7.28, 7.79 and 7.52, respectively), whereas lower leaf area index was observed in weedy check (4.66, 4.85 and 4.76, respectively). The next best treatment was farmers' practice with the leaf area index of 6.86, 7.37 and 7.07 at 60, 90 DAS and at harvest, respectively which was statistically on par with mesotrione 48% SC @ 144 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (6.77, 7.29 and 6.99, respectively), tembotrione 34.4% SC @ 125 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (6.69, 7.11 and 6.87, respectively) and mesotrione 48% SC @ 120 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (6.58, 7.00 and 6.76, respectively).

Significantly higher leaf area index was observed in mesotrione and tembotrione herbicide treatments which might be due to higher number of leaves along with leaf area. The presence of higher number of leaves resulted in higher the leaf area which

ultimately resulted in higher leaf area index. These results are corroborative with the findings of Arunkumar (2018)^[2]. Sairam *et al.* (2023)^[5] also observed significantly higher leaf area index at 30 and 60 DAS due to the application of mesotrione 40% SC @ 350 g *a.i.* ha⁻¹ in maize.

Total dry matter production (g plant⁻¹)

At 30 DAS, significantly higher dry matter production was observed in weed free check (14.75 g plant⁻¹), whereas weedy check had recorded lower dry matter production of 10.52 g plant⁻¹. Among the herbicide applications, all the treatments were on par with farmers' practice (12.91 g plant⁻¹) except application of mesotrione 48% SC @ 96 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds (12.06 g plant⁻¹) and mesotrione 48% SC @ 96 g *a.i.* ha⁻¹ at 3-4 leaf stage of weeds *fb* IC at 45 DAS (11.89 g plant⁻¹) (Table 3).

Table 3: Total dry matter production (g plant⁻¹) in maize at different growth stages as influenced by different weed management practices

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁ : Mesotrione 48% SC @ 96 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds	12.06	78.75	236.94	245.45
T ₂ : Mesotrione 48% SC @ 120 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds	12.28	87.35	254.27	264.06
T ₃ : Mesotrione 48% SC @ 144 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds	12.70	90.41	259.34	269.51
T ₄ : Mesotrione 48% SC @ 96 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	11.89	112.21	290.65	298.86
T ₅ : Mesotrione 48% SC @ 120 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	12.43	119.55	308.56	318.35
T ₆ : Mesotrione 48% SC @ 144 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	12.53	121.37	316.93	325.84
T ₇ : Tembotrione 34.4% SC @ 125 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	12.74	120.22	312.24	320.92
T ₈ : 2,4-D amine salt 58% SL @ 500 g <i>a.i.</i> ha ⁻¹ at 3-4 leaf stage of weeds <i>fb</i> IC at 45 DAS	12.09	109.15	282.79	291.11
T ₉ : Farmers' practice (HW at 20 DAS <i>fb</i> IC at 40 DAS)	12.91	122.25	321.46	329.42
T ₁₀ : Weed free check	14.75	133.09	344.57	351.93
T ₁₁ : Weedy check	10.52	67.15	193.13	203.85
S.Em. ±	0.22	1.05	4.76	4.38
L.S.D. at 5%	0.64	3.11	14.04	12.93

Note: *a.i.* = Active ingredient, DAS = Days after sowing, *fb* = followed by, HW = Hand weeding IC = Intercultivation, SC = Suspension concentrates, SL = Soluble liquids

At 60, 90 DAS and at harvest, weed free check resulted in significantly higher dry matter production in maize (133.09, 344.57 and 351.93 g plant⁻¹, respectively), whilst lower dry

matter production was noticed from weedy check (67.15, 193.13 and 203.85 g plant⁻¹, respectively). The next best treatment was farmers' practice wherein higher total dry matter production

(122.25, 321.46 and 329.42 g plant⁻¹ at 60, 90 DAS and at harvest, respectively) had been observed and was statistically on par with the application of mesotrione 48% SC @ 144 g a.i. ha⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS (121.37, 316.93 and 325.84 g plant⁻¹, respectively), tembotrione 34.4% SC @ 125 g a.i. ha⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS (120.22, 312.24 and 320.92 g plant⁻¹, respectively) and mesotrione 48% SC @ 120 g a.i. ha⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS (119.55, 308.56 and 318.35 g plant⁻¹, respectively).

Significantly higher dry matter production was observed in mesotrione and tembotrione treated plots which might be attributed to the chemical's weed control efficiency at all stages that hastened the morphological and physiological growth of the crop by killing weeds so that all the available resources are potentially exploited for the economic growth of maize. Besides, significantly higher dry matter accumulation in leaves, stem and reproductive part by withstanding the competition for resources against weeds contributed for the total dry matter production by creating conducive environment for the crop's growth. Earlier, this kind of results were also confirmed by Dey (2020)^[3] and Sairam *et al.* (2023)^[5]. Similarly, Harisha *et al.* (2023)^[4] also observed significantly higher dry matter production in maize at 30, 60, 90 DAS and at harvest due to early post-emergence application of mesotrione 48% SC @ 144 ml a.i. ha⁻¹.

Significantly higher growth parameters in weed free check might be due to complete omission of weeds which helps in better nutrient availability, soil moisture, ground space, sunlight and carbon dioxide utilization by maize plants for better growth through improved auxin synthesis and photosynthetic rates.

Conclusion

It can be concluded from the experiment that application of mesotrione 48% SC @ 120 g a.i. ha⁻¹ at 3-4 leaf stage of weeds fb IC at 45 DAS can be recommended as an effective weed management strategy among the herbicide treatments in order to achieve better crop growth in maize.

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