Effect of Different Doses of Herbicides on Growth and Yield in Maize (*Zea mays* L.)

ABSTRACT

A field experiment was conducted at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during Kharif season of 2021, to evaluate effect of different doses of Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC on growth and yield of maize (*Zea mays* L.). The experiment was laid down in the Randomized block design with ten treatments which was replicated three times. At 45, 60 and 90 DAS among different herbicidal treatments maximum plant height was observed in Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.0 kg a.i. ha^{-1}. Among the herbicidal treatments, highest cob length (15.67 cm), grain rows per cob (13.26), grains per row (26.93) and grains per cob (370.83) was observed in the treatment T4 (Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.0 kg a.i. ha^{-1}) followed by treatment T3 (Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.875 kg a.i. ha^{-1}). Data from experiment revealed that significantly highest grain yield was recorded in weed free plot (35.65 q ha^{-1}). While among herbicidal treatments, application of Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 1.0 kg a.i. ha^{-1} (35.18) resulted in significantly higher grain yield followed by (T3) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 0.875 kg a.i. ha^{-1} (34.38 q ha^{-1}). Among all the treatments all the parameters of crop growth and yield was highest in the weed free treatment (T9).

Keywords: Doses; design; herbicidal.

1. INTRODUCTION

"Maize (*Zea mays* L.) is the multifunctional crop of the *Poaceae* family having wider adaptability in varied agro-ecologies" [1]. "There is no other alternative cereal, which has such an immense potentiality and thus rightly called 'Queen of Cereals'. Maize grains is a rich source of starch (70%), vitamins A & B (3%), proteins (10%), oil (4.8%), fibre (5.8%), sugar (3.0%) and ash (1.7%). It is a source of raw material for industry, where it is being extensively used for the preparation of corn starch, corn oil, dextrose, corn syrup, corn flakes, cosmetics, wax, alcohol and tanning material" [2]. "Apart from its significance as a food source for humans, maize is also a crucial feedstock for livestock and an essential raw material in industrial applications, such as biofuel and biodegradable plastics production" [3]. "However, in its processed form, it is also found as fuel (ethanol) and starch. In contrast, starch is involved in the enzymatic conversion to products such as sorbitol, dextrin, sorbic and lactic acid, and appears in household items such as beer, ice cream, syrup, shoe polish, and glue, fireworks, ink, batteries, mustard, cosmetics, aspirin and paint" [4]. "Weeds are a serious problem in corn, especially in irrigated and rain-fed areas, where there is adequate moisture throughout the crop's growing period. The main corn growing area is during the rainy season, during which time weeds are one of the main factors that limit productivity and reduce productivity significantly. Even if there is a slight weed infestation under ideal conditions, weeds still need to be controlled throughout the growing season. However, the most critical period for crop-weed competition is during the first six weeks after planting due to corn's initial slow growth rate and wider row spacing, combined with poor conditions. Favourable weather allows weeds to grow lushly, which can reduce yields by 28 to 100%" [5,6].

"Maize is infested by a wide range of weed flora viz. *Echinochloa colona, Cyperus rotundus, Commelina benghalensis* and *Trianthema portulacastrum* dominate during early stages of the crop growth whereas *Dactyloctenium aegyptium* toward the tasseling and maturity of the crop in Himalayan regions" [7]. "Atrazine has been widely used herbicide for controlling of the weeds in maize but does not provide effective control of many weeds particularly the *Cyperus rotundus* and *Echinochloa colona"* [8]. "There are good pre-emergence herbicidal options like Atrazine and Pendimethalin are available in maize but the availability of post-emergence herbicides in need of the maize cultivation in South and central Asia in view of escalating labor prices" [9] However, [10] reported that "the performance of atrazine was found better than pendimethalin in reducing the population of several weed species viz., *Commelina benghalensis* and *Trianthema portulacastrum* etc". "However*, Commelina benghalensis, Digera arvensis* and *Leptochloa chinensis* were not controlled by application of atrazine when it was used as post-emergence. In contrast to this, when Atrazine/Metribuzin was used as pre-emergence most of the broadleaf weeds were controlled. Mesotrione provides both pre- and post-emergence weed control. Mesotrione is an p-hydroxyphenylpyruvate dioxygenase (HPPD) enzyme inhibitor controls the major annual broad-leaved weeds with lesser effect against grassy weeds" [11,12]. "Mesotrione is also an alternative to control triazine resistant weeds like common lamb's quarters i.e., *Chenopodium album* L". [13].

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at 'Student's Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The experimental field had an even topography and good drainage facility. Geographically, experimental site falls under the sub-tropical and semi- arid tract of North India of Indo- Gangetic plains and lies on the right bank of holy river Ganga. It is located on 260 28'36" N latitude, 800 18' 26" E longitude and at an altitude of 126 meters above mean sea level. The experimental plot was homogenous in fertility with assured irrigation and other required facilities.

2.2 Edaphic Condition

Soil samples were collected from different locations of the field before sowing and analysed some physio-chemical characteristics in the Laboratory, C.S. Azad University of Agriculture and Technology, Kanpur. The soil of the experimental field was clayey in texture and slightly alkaline in pH (7.6). The electrical conductivity (EC) of the soil was 0.32 (d S m^{-1}) estimated by Digital EC Meter. Organic carbon in the soil was 0.42% which was estimated by rapid titration method given by Walkley and Black, 1934. The available Nitrogen in soil was 208.40 kg ha^{-1}, which was estimated by the Alkaline permanganate method given by Subbiah and Asija, 1956. The available Phosphorus was 22.0 kg ha^{-1} estimated by Olsen's method given by Jackson, 1967. The available K was 196.50 kg ha^{-1} which was estimated by the Flame photometer method given by Jackson, 1967.

2.3 Experimental Design and Treatment Details

The experiment was designed as Randomized block design (RBD) with 10 Treatments replicated thrice. The treatment was allocated randomly in each block. The treatment details is given in Table 1.

2.4 Seed Sowing and Spacing

The field was ploughed with a tractor drawn cultivator and after with the rotavator to obtain a fine tilth. The seed was sown at the spacing of 45 cm between rows and 15 cm between plant. The Maize Variety *Azad Uttam* was sown and the applied seed rate was 25 kg ha^{-1}. Thinning and gap filling was after 20 days after sowing wherever it was required for maintaining optimum plant population.

Table 1. Treatment Details

T1	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.375 kg a.i. ha^{-1}
T2	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.75 kg a.i. ha^{-1}
T3	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.875 kg a.i. ha^{-1}
T4	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.0 kg a.i. ha^{-1}
T5	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.125 kg a.i. ha^{-1}
T6	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.750 kg a.i. ha^{-1}
T7	Atrazine 50% WP @ 1.0 kg a.i. ha^{-1}
T8	Hand weeding at 15 and 30 DAS
T9	Weed Free

T10 Control (Weedy check)

(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) is ready mix or premix herbicide bearing trade name Calaris Xtra manufactured by Syngenta.

3. RESULTS AND DISCUSSION

3.1 Effect of Treatments on Plant Height (cm)

Weed Free plot showed significantly higher plant height over most of the herbicidal treatments followed by two hand weeding. At 45,60 and 90 DAS among different herbicidal treatments maximum plant height was observed in treatment T4 (Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.0 kg a.i. ha^{-1} and minimum plant height was observed in Weedy check over all the crop growth period expect 30 DAS. Among all the treatments, the treatment T9 (weed free) recorded the highest plant height in every phase of crop growth.

3.2 Length of Cob

The data presented in Table 3 showed that length of cob differed significantly due to different herbicidal treatments. Perusal of data reveals that, significantly highest length of cob was recorded in the weed free plot (16.93 cm). However, among herbicide application treatments maximum cob length was observed in (T4) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 1.0 kg a.i. ha^{-1} (15.67 cm) followed by (T3) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 0.875 kg a.i. ha^{-1} (15.43 cm). Among all the treatments weedy check recorded the minimum cob length (12.26 cm).

Table 2. Plant Height (cm)

Treatments		30 DAS	45 DAS	60 DAS	90 DAS
T1	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.375 kg a.i. ha^{-1}	36.43	82.25	147.68	159.63
T2	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.75 kg a.i. ha^{-1}	36.50	88.34	157.10	170.68
T3	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.875 kg a.i. ha^{-1}	36.10	93.82	163.45	176.50
T4	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.0 kg a.i. ha^{-1}	36.33	95.45	165.78	178.25
T5	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.125 kg a.i. ha^{-1}	36.59	86.90	154.67	168.33
T6	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.750 kg a.i. ha^{-1}	36.26	85.10	151.28	163.56
T7	Atrazine 50% WP @ 1.0 kg a.i. ha^{-1}	36.45	85.45	150.90	162.69
T8	Hand Weeding @15 and 30 DAS	41.8	89.52	158.89	172.76
T9	Weed Free	42.56	98.87	170.53	181.40
T10	Control	36.67	64.45	142.45	151.87
S.E(m) ±		0.55	1.51	2.2	2.36
C.D at 5 %		1.64	4.48	6.54	7.0

Table 3. Effect of treatments on cob length, cob girth, grain rows per cob, grains per row and grains per cob

Treatments	Cob Length (cm)	Grain rows cob^{-1}	Grains row^{-1}	Grains cob^{-1}
T1	12.34	12.16	23.67	287.83
T2	13.10	12.96	24.93	323.09
T3	15.43	13.63	26.65	363.24
T4	15.67	13.77	26.93	370.83
T5	12.87	12.67	24.27	307.50
T6	12.36	12.35	23.74	293.19
T7	12.54	12.43	23.56	292.85
T8	14.32	13.56	25.87	350.80
T9	16.93	13.87	27.88	386.70
T10	12.26	12.07	22.87	276.04
S.E(m) ±	0.19	0.26	0.28	3.28
C.D at 5 %	0.56	0.76	0.83	9.73

3.3 Number of Grain Rows per Cob

The data presented in Table 3 showed that the number of grain rows per cob differed significantly due to different herbicidal treatments. Data in Table 3 reveals that, significantly higher no. of grain rows per cob was recorded in the weed free plot (13.87). However, among herbicidal treatments maximum no. of grain rows per cob (13.77) was observed in treatment (T4) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 1.0 kg a.i. ha^{-1} and lowest no. of rows per cob were observed in the treatment T1.

3.4 Number of Grains Per Row

The data presented in Table 3 showed that no. of grains per row differed significantly due to different herbicidal treatments. Perusal of data reveals that, significantly higher no. of grains per row was recorded in the (T9) weed free plot (27.88). However, among herbicide application maximum no. of grains per cob was observed in Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 1.0 kg a.i. ha^{-1} (26.93) followed by Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 0.875 kg a.i. ha^{-1} (26.65). Among all the treatments weedy check (T10) recorded the minimum no. (22.87) of grains per cob.

3.5 Number of Grains Per Cob

The data presented in Table 3 showed that number of grains per cob differed significantly due to different herbicidal treatments. Experimental data reveals that, significantly higher no. of grains per cob was recorded in the weed free plot (386.70). However, among herbicide application maximum no. of grains per cob was observed in (T4) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 1.0 kg a.i. ha^{-1} (370.83) followed by (T3) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 1.0 kg a.i. ha^{-1} (363.24). Among all the treatments weedy check (T10) recorded the minimum no. of grains per cob.

Table 4. Effect of treatments on grain yield and stover yield

Treatments		Grain Yield (Quintal/ha)	Stover yield (Quintal/ha)
T1	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.375 kg a.i. ha^{-1}	30.21	65.66
T2	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.75 kg a.i. ha^{-1}	33.12	68.52
T3	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 0.875 kg a.i. ha^{-1}	34.38	70.26
T4	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.0 kg a.i. ha^{-1}	35.18	71.86
T5	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.125 kg a.i. ha^{-1}	32.78	67.97
T6	(Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) @ 1.750 kg a.i. ha^{-1}	31.83	67.53
T7	Atrazine 50% WP @ 1.0 kg a.i. ha^{-1}	30.98	66.71
T8	Hand Weeding @15 and 30 DAS	34.17	69.98
T9	Weed Free	35.65	71.97
T10	Control	24.94	57.43
S.E(m) ±		0.48	0.61
C.D at 5 %		1.41	1.81

3.6 Grain Yield and Stover Yield

It is clear from the data (Table 4) that grain yield of maize differed significantly. Data from experiment revealed that significantly highest grain yield was recorded in weed free plot (35.65 q ha^{-1}) as reported by Sachan et. al., [3]. Among herbicidal treatments, application of Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 1.0 kg a.i. ha^{-1} (35.18) resulted in significantly higher grain yield followed by (T3) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 0.875 kg a.i. ha^{-1} (34.38 q ha^{-1}) and (T2) Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC @ 0.75 kg a.i. ha^{-1} (33.12 q ha^{-1}). The lowest grain yield was recorded in (T10) weedy check (24.94 q ha^{-1}). Maximum stover yield was observed in the treatment T9 which was at par with the treatment T4.

Swetha et al. [14] and Kumar et al. [15] also reported maximum grain yield with manual weeding.

4. CONCLUSION

Therefore, farmers of plains region of India should be suggested that they should apply ready mixture herbicide Mesotrione 2.27% w/w + Atrazine 22.7% w/w SC) at the rate of 1.0 kg a.i. ha^{-1}. The application of ready mixture herbicide (trade name- Calaris xtra), Mesotrione + Atrazine is efficient in controlling weeds in maize crop and can give higher yield based on environmental conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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