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Effect of herbicides in combination and sequential use on crop growth and production potential in hybrid maize

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Abstract

An experiment was carried out at Agronomy Main Research Station, OUAT, and Bhubaneswar during *kharif*, 2016. The experiment was laid out in randomized block design with ten treatments and three replications. Amongst broad leaved weeds, *Ludwigia parviflora* was the dominant while in grasses, *Digitaria sanguinalis* was most prevalent and only one sedge weed *Cyprus rotundus* occurred. The herbicides in combination and sequential application comprised of atrazine @ 1.0 kg/ha as pre-emergence (PE) at 1 days after sowing (DAS), atrazine @750 g/ha+ pendimethalin @750 g/ha as PE at 1 DAS, atrazine @750 g/ha + 2,4-D amine salt @ 400 g/ha as post emergence (PoE) at 25 DAS, halosulfuron @ 60 g/ha as PoE at 25 DAS, tembotrione @120 g/ha as PoE at 25 DAS, atrazine @1.0 kg/ha as PE at 1 DAS followed by halosulfuron @60 g/ha at 25 DAS, pendimethalin @1.0 kg/ha as PE at 1 DAS followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha as PoE at 25 DAS and atrazine @1.0 kg/ha as PE at 1 DAS followed by tembotrione @120 g/ha at 25 DAS were tested with hand weeding at 20 and 40 (DAS) and un-weeded control. Weed management treatments exerted the significant effect in increasing the grain yield over un-weeded control (Table 24). Pre-emergence application of atrazine @ 750 g/ha + pendimethalin @ 750 g/ha at 1 DAS recorded the highest grain yield (7.00t/ha).

Keywords: Effect, herbicide combination, sequential use, weed management, yield of maize.

1. Introduction

Maize (*Zea mays* L.) is one of the most versatile emerging crop having wider adaptability under varied agro climatic conditions. The crop has immense potentiality with special characteristics that include its carbon pathway (C4), wider adaptability, higher multiplication ratio, high versatile use and the highest genetic yield potential among the cereals therefore, called as "Queen of Cereals". In India, maize is the third most important food crops after rice and wheat. In India, it is cultivated over an area of 8.69 m ha with production of 21.80 m tonnes and productivity is 2509 kg ha⁻¹ in 2015-16 (AICRP on maize 2016). The rainy season maize suffers from severe weed competition and depending upon the intensity, nature, stages and duration of weed infestation that cause yield losses varying from 28-100 % (Birendra *et al.*, 2013). Use of pre and post emergence herbicides at temporal variation may help in avoiding the problem of weeds throughout the growth stages.

2. Materials and methods

The experimental was conducted in the Agronomic Main Research Farm of Orissa University of Agriculture and Technology, Bhubaneswar. The soil of the experimental field was sandy loam in texture, acidic in reaction (pH 4.68) and available nitrogen (233.0 kg/ha), phosphorus (23.2 kg/ha) and potassium (153.1kg/ha). The experiment was laid out in randomized block design with ten treatments and three replications. The mean maximum temperature was 32.2°C during month of July. Both extreme (maximum and minimum) temperature during cropping season were 32.2.0°C (July) and 22.6°C (October). The maize variety Hishell hybrid was used for experimentation with 60cm x 20 cm and net plot size was 3.8m x 3.0m. The recommended dose of fertilizer for maize crop was 120:60:40.

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Treatment Details

T1	Control (weedy check)
T2	Hand weeding at 20 and 40 DAS
T3	Atrazine @ 1.0 kg/ha as pre-emergence at 1 DAS
T4	Atrazine @ 750 g/ha+ pendimethalin @ 750 g/ha as pre-emergence at 1 DAS
T5	Atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha as post emergence at 25 DAS
T6	Halosulfuron @ 60 g/ha at 25 DAS as post emergence
T7	Atrazine @ 1.0 kg/ha as pre-emergence at 1 DAS followed by halosulfuron @60 g/ha as post emergence at 25 DAS
T8	Tembotrione @120 g/ha at 25 DAS as post emergence
T9	Pendimethalin @1000 g/ha (PE) at 1 DAS followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha as post emergence at 25 DAS
T10	Atrazine @1.0 kg ha as pre-emergence at 1 DAS followed by tembotrione @120 g/ha as post emergence at 25 DAS

3. Result and discussion

The data presented in Table-1 revealed that the Effect of weed management treatments on plant height (cm) at 90 DAS, number of leaves, leaf area index (LAI) and crop growth ratio (CGR) in 60 Days after sowing. Maximum plant height and number of leaves was recorded in atrazine @ 750 g/ha + pendimethalin @ 750 g/ha at 1 DAS as pre-emergence (178.7 cm) which was at par with all other treatments at 90 DAS except weedy check. In 60 DAS, the maximum LAI was recorded in atrazine @750 g/ha + pendimethalin @ 750 g/ha as pre-emergence at 1 DAS (1.17) which was statistically at par with atrazine @ 1.0 kg/ha at 1 DAS (PE) followed by tembotrione @ 120 g/ha at 25 DAS (POE), atrazine @ 1.0 kg/ha at 1 DAS as pre-emergence (PE), hand weeding at 20 and 40 DAS, pendimethalin @ 1.0 kg/ha at 1 DAS (PE) followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha at 25 DAS (POE), atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha at 25 DAS (POE). Between 45-60 DAS (14.83g/m²/day), the highest CGR was recorded with combination of atrazine @ 750 g/ha + pendimethalin @750 g/ha as pre-emergence at 1 DAS which was at par with all other treatments except weedy check.

Table 1: Effect of weed management treatment on Plant height, number of leaves, leaf area index (LAI) and crop growth ratio (CGR)

Treatment	Plant Height 90 DAS	Number Of leaves 60 DAS	LAI 60 DAS	CGR 45-60 DAS
Weedy check	149.30	10.33	2.67	9.21
Hand weeding at 20 and 40 days after sowing (DAS)	179.10	12.63	3.86	13.98
Atrazine @ 1.0 kg/ha as pre-emergence (PE) at 1 DAS	177.30	12.33	3.37	13.08
Atrazine @750 g/ha + pendimethalin @750 g/ha (PE) at 1 DAS	180.00	12.93	4.13	14.83
Atrazine @750 g/ha + 2,4-D Amine salt @ 400 g/ha as post emergence (PoE) at 25 DAS	176.30	12.40	4.03	13.76
Halosulfuron @ 60 g/ha (PoE) at 25 DAS	177.30	12.17	3.07	12.72
Atrazine @1.0 kg/ha at 1 DAS (PE) followed by halosulfuron @60 g/ha (PoE) at 25 DAS	179.30	12.57	3.75	13.76
Tembotrione @ 120 g/ha (PoE) at 25 DAS	175.70	12.53	3.10	12.80
Pendimethalin @1.0 kg/ha at 1 DAS (PE) followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha (PoE) at 25 DAS	175.30	12.60	3.83	13.24
Atrazine @1.0 kg ha at 1 DAS (PE) followed by tembotrione @120 g/ha(PoE) at 25 DAS	177.30	12.60	4.07	14.47
SE(m)±	2.10	0.44	0.23	0.96
CD (P = 0.05)	6.22	1.32	0.67	2.85

3.1 At harvest studies

3.1.1 No. of rows/cob

An introspection of data presented in Table-2 revealed that number of rows/cob was significantly different by application of weed control treatments. It was increased with atrazine @ 750 g/ha + pendimethalin @750 g/ha at 1 DAS as pre-emergence (PE) (14.53) followed by atrazine @1.0 kg/ha at 1 DAS (PE) with sequential application of tembotrione @120 g/ha at 25 DAS (POE) which remained at par with all treatments. The least number of rows/cob was observed in weedy check (10.67).

3.1.2 Cob girth (cm)

The data on cob girth (cm) presented in Table 2 indicated that atrazine @ 750 g/ha + pendimethalin @ 750 g/ha at 1 DAS as pre-emergence (PE) significantly recorded the higher value (13.37cm) followed by atrazine @ 1.0 kg/ha at 1 DAS (PE) with sequential application of tembotrione @ 120 g/ha (POE) at 25 DAS (POE) and atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha at 25 DAS (POE). The lowest cob girth was obtained in weedy check.

3.1.3 Number of grains/row

The data presented in the Table 23 showed that the number of grains/row was maximum in pendimethalin @ 1.0 kg/ha at 1 DAS (PE) followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha (POE) at 25 DAS (29.47) followed by atrazine @ 750 g/ha + pendimethalin @ 750 g/ha as pre-emergence at 1 DAS (28.97) which were at par with all treatments except halosulfuron methyl @ 60 g/ha (PoE) at 25 DAS and weedy check.

3.1.4 1000 grain weight (g)

The test weight of hybrid maize was significantly influenced by different weed management treatments (Table 25). Significantly increase in test weight was recorded in atrazine @750 g/ha+ pendimethalin @750 g/ha as pre-emergence at 1 DAS (288.77 g) closely followed by pendimethalin@1.0 kg/ha (PE)at 1 DAS with sequential application of by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha (POE) at 25 DAS (275.23g).Those treatments did not differ significantly from other treatments except halosulfuron @ 60 g/ha at 25 DAS (POE) and weedy check. The 1000 grain weight in un-weeded treatment was the lowest (227.90 g).

Table 2: Effect of weed management treatment on yield attribute characters.

Treatment	No. of rows/cob	Cob girth (cm)	No. of Grains/row	1000 grain weight (g)
Weedy check	10.67	11.17	25.53	227.90
Hand weeding at 20 and 40 days after sowing (DAS)	13.33	12.71	26.97	261.97
Atrazine @ 1.0 kg/ha as pre-emergence (PE) at 1 DAS	13.13	11.87	27.37	264.00
Atrazine @ 750 g/ha + pendimethalin @ 750 g/ha as pre-emergence at 1 DAS	14.53	13.37	28.97	288.77
Atrazine @ 750 g/ha + 2,4-D Amine salt @ 400 g/ha as post emergence (PoE) at 25 DAS	13.40	13.03	27.40	263.67
Halosulfuron @ 60 g/ha(PoE) at 25 DAS	12.93	12.34	25.13	250.00
Atrazine @ 1.0 kg/ha at 1 DAS (PE) followed by halosulfuron @ 60 g/ha (PoE) at 25 DAS	13.20	12.79	27.10	264.73
Tembotrione @ 120 g/ha (PoE) at 25 DAS	13.00	12.05	26.60	257.00
Pendimethalin @1.0 kg/ha at 1 DAS (PE) followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha (PoE) at 25 DAS	13.27	12.82	29.47	275.23
Atrazine @ 1.0 kg/ha at 1 DAS (PE) followed by tembotrione @ 120 g/ha (PoE) at 25 DAS	13.47	13.19	27.53	274.97
SE(m)±	0.42	0.42	0.85	7.87
CD (P = 0.05)	1.24	1.25	2.51	23.38

Table 3: Grain yield, Stover yield, and harvest index as influenced by weed control treatments.

Treatment	Grain yield(t/ha)	Stover yield(t/ha)	Harvest index (%)
Weedy check	4.49	5.79	43.79
Hand weeding at 20 and 40 days after sowing (DAS)	6.47	7.27	46.97
Atrazine @ 1.0 kg/ha as pre-emergence (PE) at 1 DAS	5.85	6.96	45.38
Atrazine @ 750 g/ha + pendimethalin @ 750 g/ha as pre-emergence at 1 DAS	7.00	7.57	48.03
Atrazine @ 750 g/ha + 2,4-D Amine salt @ 400 g/ha as post emergence (PoE) at 25 DAS	6.57	7.40	47.00
Halosulfuron @ 60 g/ha(PoE) at 25 DAS	4.77	6.80	41.19
Atrazine @ 1.0 kg/ha at 1 DAS (PE) followed by halosulfuron @ 60 g/ha (PoE) at 25 DAS	6.10	7.03	46.42
Tembotrione @ 120 g/ha (PoE) at 25 DAS	5.03	6.77	42.60
Pendimethalin @1.0 kg/ha at 1 DAS (PE) followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha (PoE) at 25 DAS	6.26	7.41	45.76
Atrazine @ 1.0 kg/ha at 1 DAS (PE) followed by tembotrione @ 120 g/ha (PoE) at 25 DAS	6.74	7.53	47.20
SE(m)±	0.35	0.26	1.34
CD (P = 0.05)	1.05	0.77	3.99

3.2 Grain yield

Weed management treatments exerted the significant effect in increasing the grain yield over un-weeded control (Table 3). Pre-emergence application of atrazine @ 750 g/ha + pendimethalin @ 750 g/ha at 1 DAS recorded the highest grain yield (7.00t/ha). It was at par with atrazine @1.0 kg/ha (PE) at 1 DAS followed by tembotrione @ 120 g/ha (POE) at 25 DAS (6.74 t/ha) and atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha at 25 DAS as post emergence (6.57 t/ha), hand weeding at 20 and 40 days after sowing (6.47 t/ha), pendimethalin @ 1.0 kg/ha (PE) at 1 DAS followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha (PoE) at 25 DAS (6.26 t/ha) and atrazine @ 1.0 kg/ha (PE) at 1 DAS followed by halosulfuron @ 60 g/ha (POE) at 25 DAS (6.10 t/ha). The grain yield obtained among the herbicidal treatments was the lowest in halosulfuron @ 60 g/ha as PoE. Weedy check treatment recorded the lowest grain yield of 4.49 t/ha.

3.3 Stover yield

Data pertaining to stover yield indicated that significant variation was observed due to weed control treatment (Table 3). The stover yield of maize was increased significantly with the atrazine @ 750 g/ha + pendimethalin @ 750 g/ha as pre-emergence at 1 DAS (7.57 t/ha) which was found at par with all other treatment except tembotrione @ 120 g/ha as post emergence application and weedy check treatment. Absence

of weed control in weedy check recorded the lowest stover yield (5.79t/ha).

3.4 Harvest Index

Data on harvest index presented in Table 3 indicated that the maximum harvest index was obtained in atrazine @ 750 g/ha + pendimethalin @ 750 g/ha as pre-emergence at 1 DAS (48.03%) which was at par with all other treatment except post emergence application of halosulfuron @ 60 g/ha at 25 DAS and tembotrione @ 120 g/ha at 25 DAS and weedy check treatment. The second highest harvest index (47.20%) was observed in atrazine @ 1.0 kg/ha at 1 DAS (PE) followed by tembotrione @120 g/ha (POE) at 25 DAS.

4. Conclusion

Crop growth characters such as plant height, number of leaves/plant, LAI and CGR were significantly affected by the weed control treatments. The weed management treatments remarkably influenced the yield attributes like number of cobs/plant, number of row/plant, number of grains/cob, cob girth and 1000 grain weight in hybrid maize. Pre-emergence application atrazine @ 750 g/ha + pendimethalin @ 750 g/ha in combination at 1 DAS, atrazine @ 1.0 kg ha at 1 DAS as pre-emergence followed by tembotrione @ 120 g/ha at 25 DAS (POE), atrazine @ 750 g/ha + 2,4-D Amine salt @ 400 g/ha at 25 DAS as post emergence (POE), pendimethalin @ 1.0 kg/ha at 1 DAS (PE) followed by atrazine @ 750 g/ha + 2,4-D amine salt @ 400 g/ha at 25 DAS (PoE) and twice

hand weeding treatments were on par and proved their superiority in increasing the yield components in maize.

The grain (7.0 t/ha) and stover yield (7.57 t/ha) of hybrid maize were enhanced with herbicide combination of atrazine @ 750 g/ha + pendimethalin @ 750 g/ha as pre emergence at 1 DAS. It was followed by atrazine @ 1.0 kg/ha as pre emergence at 1 DAS with sequential application of tembotrione @120 g/ha at 25 DAS being comparable with hand weeding at 20 and 40 DAS. Weedy check recorded the lowest grain yield of 4.49 t/ha.

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