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Comparative assessment of herbicidal treatments on weed management and yield in *rabi* maize: A field study

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Abstract

Maize (*Zea mays* L.) crop is severely affected by wide range of narrow and broad leaved weeds. Wider row spacing particularly in winter season and other factors of weed infestation like stages, intensity, nature and duration leads to reduction in yield up to the extent of 30-95 percent (Pandey *et al.* 2001 and Singh *et al.* 2009) ^[1, 2]. Under prevailing situation of weed infestation in *rabi* maize, farmers need alternate production system using chemical and cultural weed management practices that are more efficient, less labour consuming and offer quick response enabling farmers to produce more yield at lowest cost. Keeping this in view, an On Farm Trial (OFT) was conducted to study the effect of weed management practices on yield and economics of *rabi* maize on farmers field of Purnea district at three locations of Kasba and Jalalgarh block with 10 replications during *rabi* season of 2019-20 and 2020-21. The trial was laid out in randomized block design and treatments comprised of management options: Farmer's practice-Atrazine 50% WP @ 1.25 kg a.i./ha PE (T₁), Tembotrione 34.4% SC @ 120 g a.i./ha + Atrazine 500 g/ha (tank mix) PoE at 25 DAS (T₂), Topramezone 33.6% sc @ 25 g a.i./ha + Atrazine 500 g/ha (tank mix) as PoE at 25 DAS (T₃) and un-weeded check (T₄) treatments. The test variety was P 3355, at each location, highly preferred by the farmers of this region. The result revealed that significantly lower weed density (29.20 /m²), lower weed dry weight (10.12 g /m²) with higher weed control efficiency (89.64) were recorded at 45 DAS when Tembotrione 34.4% SC @ 120 g a.i./ha + Atrazine 500 g/ha (tank mix) applied at 25 days after sowing. Due to effective weed management the same treatment (T₁) recorded highest grain yield (104.50 q/ ha) when compared with farmer's practice and Topramezone 33.6% SC @ 25 g a.i./ha + Atrazine 500 g/ha (tank mix) applied at 25 DAS. The net return (Rs. 141075/ ha) and benefit: cost ratio (3.65) was also recorded significantly higher under treatment receiving Tembotrione 34.4% SC @ 120 g a.i./ha + Atrazine 500 g/ha (tank mix) at 25 days after sowing (T₂) when compared with other treatments.

This investigation suggests farmer to adopt tank mix application of Tembotrione + Atrazine for efficient weed management and achieving higher productivity and profitability in *rabi* maize.

Keywords: Herbicidal treatments, weed management, yield, *rabi* maize

Introduction

Maize is the world's widely grown upland cereal and staple food crop in many parts of developing countries. It ranks third in the cereal's world production after rice and wheat in area, but in productivity it surpasses all cereals. Winter maize is the most versatile, highest yielding cereals due to the climatic condition it experiences during its growth period. In koshi region of Bihar, significant shifts from rice-wheat cropping system to more profitable rice-maize system have either occurred or are emerging. The area under maize is gradually increasing in Bihar and high yield is particularly realized from koshi region due to congenial weather and soil conditions experienced for growth and development. Simultaneously, weed emerges vigorously and poses severe crop-weed competition during critical growth period. Generally, in widely spaced winter crop like maize, the initial growth rate of crop is very slow and the inter-row spaces remains completely unutilized for long period. Such situation is most congenial for the emergence and growth of weeds. The fast growth of weeds poses competition maize plants for space, light, nutrients and moisture etc. it is reported that the losses caused by weeds exceed from any category of agricultural pests (Sharma and Behra, 2009) ^[3]. Thus, to achieve the maximum benefits from applied inputs and high yields from maize crop, management of weeds is inevitable. The yield losses in maize due to weeds are estimated to be around 37 percent

worldwide (Oerke and Dehne, 2004) [4]. Under such a situation, use of herbicides is an obvious choice because manual weeding is always difficult, labour intensive and costlier. Hence, keeping in mind the above facts, the present investigation was undertaken.

Materials and Methods

An On Farm Trial (OFT) was aimed to evaluate the effectiveness of different herbicidal treatments on weed density, dry weight, and subsequent impacts on yield of *rabi* maize and economic parameters at farmers field of Purnea district at three locations of Kasba and Jalalgarh block with 10 replications during *rabi* season of 2019-20 and 2020-21. The experimental sites were prepared by following standard agronomical practices, including ploughing, levelling, and fertilizers application based on soil test recommendations. Weed management was implemented according to the specified treatments. On an average at all location soil was sandy loam in texture, neutral in reaction (pH varies between 6.7 to 7.4) having medium phosphorus and organic carbon status, low in available nitrogen and potassium. The trial was laid out in randomized block design and treatments comprised of management options: Farmers practice-Atrazine 50% WP @ 1.25 kg a.i./ha PE (T₁), Tembotrione 34.4% SC @ 120 g a.i./ha + Atrazine 500 g/ha (tank mix) PoE at 25 DAS (T₂), Topramezone 33.6% sc @ 25 g a.i./ha + Atrazine 500 g/ha (tank mix) as PoE at 25 DAS (T₃) and weedy check (T₄) treatments. The test variety was P 3355, at each location, highly preferred by the farmers of this region. The data on weed density and weed dry weight were recorded at periodical interval of 25 and 45 days after sowing of the crop while, weed control efficiency was calculated once at 45 days after sowing. Weed control efficiency was calculated by using the standard procedure:

$$\text{WCE (\%)} = \frac{\text{Weed count in un-weeded plots} - \text{Weed count in treated plots}}{\text{Weed count in un-weeded plots}}$$

The grain and stover yields of maize crop were obtained during crop cutting experiments at site and recorded in kg and converted into q/ha. Gross return, net return and benefit: cost ratio were worked out on the basis of prevailing market prices of inputs and produce during both the year of investigation. The data obtained after two years were statistically analysed using the F-test (Gomez and Gomez, 1984) [5]. Test of significance of the treatment differences were done on the basis of t-test. The significant difference between treatment means were compared

with critical differences at 5% levels of probability. These detailed methodology outlines the experimental setup, herbicidal treatments, data collection, and statistical analysis procedures employed in the study.

Results and Discussion

The weed flora under field conditions when counted in un-weeded check plots at 25 days after sowing of crop recorded the dominating broad-leaved weeds as *Chenopodium album* L., *Cannabis Sativa* L., *Fumaria parviflora* L., *Melilotus indica* L. and *Anagallis arvensis* L. etc. and, among the grasses *Cynodon dactylon* L. and *Polypogon monspeliensis* L. while, *Cyprus rotandus* L. were found predominantly.

The mean data presented in table 1 represents the impact of different weed management practices on weed density, dry weight of weeds, and weed control efficiency (WCE) at 25 and 45 days after sowing (DAS). Results at 25 DAS showed that T₁ (Atrazine 50% WP at 1.25 kg a.i./ha pre-emergence) had significantly lowest weed density (52/m²) compared to other treatments. Pasha *et. al.* (2012) [6] also reported the similar results with pre-emergence application of Atrazine on sandy clay loam soil. However, T₂ (Tembotrione 34.4% SC @ 120 g a.i./ha + Atrazine 500 g/ha) and T₃ (Topramezone 33.6% SC @ 25 g a.i./ha + Atrazine 500 g/ha) exhibited higher weed densities probably due to their post emergence application at 25 DAS and by that time no suppressive effect was visualised. The effect of both these treatments (T₂ and T₃) were found to be effective in reducing the weed density significantly at 45 DAS (29.20 and 38.40 /m², respectively) when compared with T₁ and un-weeded check (T₄). Consequently, T₂ exhibited significantly lowest dry weight of weeds (10.12 g/m²) which was found at par with T₃ (13.24 g/m²) at 45 DAS, indicating both these herbicidal treatments were effective in weed control over farmer's practice (T₁). The reduction of weed infestation with application of herbicides and their combination can be attributed to their phytotoxic effects on weeds which led to inhibition of seed germination, photosynthesis and other physiological activities in weeds (Mahadi, 2014) [7]. Weed control efficiency (WCE) at 45 DAS reflects the effectiveness of each treatment. The treatment combination with Tembotrione + Atrazine tank mix (T₂) exhibited the highest weed control efficiency upto the extent of 89.64 percent, followed by Topramezone + Atrazine tank mix (T₃) 86.44 percent which was at par to each other, but both these treatments were found significantly superior over the farmer's practice (T₁) which demonstrated considerable WCE, 51.18 percent and un-weeded check.

Table 1: Effect of weed management Practices on weed dynamics of *Rabi* maize (Pooled data of two years)

Treatments	Weed density (No./m ²)		Weed dry weight (g/m ²)		WCE% at 45 DAS
	25 DAS	45 DAS	25 DAS	45 DAS	
T ₁ –farmers Practice: Atrazine 50% WP @ 1.25 kg a.i/ ha pre-em	52.00	143.00	12.15	47.70	51.18
T ₂ -Tembotrione 34.4% SC @ 120 g a.i./ha + Atrazine 500 g/ha (tank mix) at 25 DAS	155.50	29.20	34.06	10.12	89.64
T ₃ -Topramezone 33.6% sc @ 25 g a.i./ha + Atrazine 500 g/ha (tank mix) at 25 DAS	152.80	38.40	32.16	13.24	86.44
T ₄ Un-weeded check	158.30	298.00	34.15	97.70	-
SEm +	3.30	6.80	2.10	3.10	-
CD (P = 0.05)	7.10	14.60	4.90	8.20	-

Table 2: Effect of weed management Practices on yield and economics of *Rabi* maize (Pooled data of two years)

Treatments	Yield (q/ha)	Cost of cultivation (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	BCR
T ₁ – farmers Practice: Atrazine 50% WP @ 1.25 kg a.i/ ha pre-em	90.40	37160	122040	84860	3.28
T ₂ -Tembotrione 34.4% SC @ 120 g a.i/ha + Atrazine 500 g/ha (tank mix) at 25 DAS	104.50	38670	141075	102405	3.65
T ₃ -Topramezone 33.6% sc @ 25 g a.i/ha + Atrazine 500 g/ha (tank mix) at 25 DAS	95.50	38840	128925	90085	3.32
T ₄ .Un-weeded check	70.80	34680	95580	60900	2.75
SEm +	3.30	870	3680	2360	0.14
CD (P = 0.05)	8.80	1740	9870	7140	0.31

The table 2 presents the economic impact of different weed management practices on maize cultivation, encompassing yield, cost of cultivation, gross income, net income, and the benefit-cost ratio (BCR). All the weed management practices significantly out weighed an out numbered the un-weeded check with respect to yield and economics. The highest maize grain yield (104.50 q/ha) was recorded with application of Tembotrione + Atrazine tank mix (T₂) closely followed by Topramizone + Atrazine tank mix (T₃). at 25 DAS. All weed management receiving plots produced significantly higher maize yield over un-weeded check mainly due to superiority in yield attributes of crop as a result of reduced crop-weed competition due to management practices adopted in the field which lead to increased suitable environment, availability of nutrients and water to the crops (Sinha *et. al.* 1999) [8].

Significantly maximum net realization (Rs. 102405/ha) and benefit: cost ratio (3.65) was recorded with application of T₁, Tembotrione 120 g ai. /ha + Atrazine 0.5 kg/ha (tank mix) at 25 DAS. Application of Topramezone 25 g ai. /ha + Atrazine 0.5 kg/ha (tank mix) at 25 DAS was next to them with regard to net monetary return (Rs. 90085/ha) and benefit: cost ratio (3.32). Sidhu *et. al.* (2014) [9] reported that tank mix application of Atrazine with other suitable herbicides can effectively and economically control weeds in maize with increased net income and benefit: cost ratio. This suggests that effective weed management influenced efficient use of resources, maximised maize yield and economics along with BCR. All the treatment associated with weed management measures were more remunerative than un-weeded check with regard to crop economics and yield.

In summary, the results suggest that the tank mix of Tembotrione and Atrazine (T₂) is the most effective treatment in controlling weed density and biomass, showcasing the potential for improved weed management strategies in maize cultivation.

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