

## Effect of Sequential Application of Herbicides on Weed Persistence Index and on Nutrient Status in Sweet Corn Crop (*Zea mays var saccharata*)

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Received 10 February 2017; Accepted 13 March 2017; Published online 1 April 2017

**Abstract** A field experiment was conducted during 2015 to study the efficacy of sequential application of herbicides viz., atrazine, pendimethalin, halosulfuron methyl, topramezone and tembotrione in sweet corn. The lowest persistence of weeds was observed with atrazine *fb* tembotrione and phytotoxicity symptoms observed on sweet corn at 3-4 leaves stage when halosulfuron methyl applied as pre emergence @ 110 g a. i. per hectare. Application of atrazine *fb* tembotrione or topramezone were found to be at par with weed free condition with respect to fresh cob yield of sweet corn. Maximum uptake of N, P, K ( $\text{kg ha}^{-1}$ ) by sweet corn was observed with atrazine *fb* tembotrione whereas, the same treatment resulted in lower removal of N, P and K by weeds.

**Keywords** Herbicides, Pre-emergence, Post-emergence, Sweet corn, Weed management.

### Introduction

Maize is the world's third most important cereal crop after wheat and rice and is grown for grain and fodder. It is also known as queen of cereals and now referred as king of cereals due to its high productivity. During 2014-15, the world wide area of maize was 177 M ha with production and productivity of 989 Mt and  $5.5 \text{ t ha}^{-1}$  respectively. It accounts for about 64% of coarse grain and 27.1 % of total cereal production [1]. In India maize ranks 5<sup>th</sup> in area and 3<sup>rd</sup> in production. Maize has wide adaptability and compatibility under diverse soil and climatic conditions. It has a variety of uses. Heavy weed competition inflict huge losses ranging from 28 to 100% in maize [2]. There are very few herbicide options available for weed control in maize in India. Currently, herbicides used for control of weeds include pre-emergence application of atrazine, simazine, pendimethalin, alachlor and post-emergent application of 2, 4-D. Most of these herbicides provide only a narrow spectrum weed control in maize. Control of grasses and sedges remain a problem for the farmers, especially when the too high or too low soil moisture hinders the inter-cultural operation.

(The authors are thankful to the Assistant Director of Research, Regional Agricultural Research Station (RARS), Jagtial, Karimnagar, India for providing necessary facilities and encouragement during the course of investigation and Agricultural college Jagtial for providing financial support).

### Materials and Methods

The field experiment was carried out during rainy sea-

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son, 2015 at Agricultural College, Jagtial. The experimental site is in Northern Telangana agro climatic zone of Telangana State, India and experiences semiarid climate. The soil was sandy loam having pH 7.8 and organic carbon 0.18% with EC of 0.19 d Sm<sup>-1</sup>. The fertility status of the soil was low, medium and high in available nitrogen, phosphorus and potassium, respectively. A total of 433.2 mm of rainfall was received in 25 rainy days during the crop growth period, as against normal rainfall of 713.2 mm with 37 rainy days during the corresponding period. The crop was largely raised on irrigation.

The experiment was laid out in randomized block design with ten herbicidal treatments viz. atrazine @ 1.0 kg a.i. ha<sup>-1</sup> as pre-emergence (PE) followed by (*fb*) halosulfuron-methyl @ 110 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>1</sub>), pendimethalin @ 0.75 kg a.i. ha<sup>-1</sup> as PE *fb* halosulfuron-methyl @ 110 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>2</sub>), atrazine @ 1.0 kg a.i. ha<sup>-1</sup> as PE *fb* topramezone @ 25.2 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>3</sub>), pendimethalin @ 0.75 kg a.i. ha<sup>-1</sup> as PE *fb* topramezone @ 25.2 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>4</sub>), atrazine @ 1.0 kg a.i. ha<sup>-1</sup> as PE *fb* atrazine @ 500 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>5</sub>), pendimethalin @ 0.75 kg a.i. ha<sup>-1</sup> as PE *fb* atrazine @ 500 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>6</sub>), atrazine @ 1.0 kg a.i. ha<sup>-1</sup> as PE *fb* tembotrione @ 105 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>7</sub>), pendimethalin @ 0.75 kg a.i. ha<sup>-1</sup> as PE *fb* tembotrione @ 105 g a.i. ha<sup>-1</sup> at 25 DAS (T<sub>8</sub>), weedy check (T<sub>9</sub>) and weed free check (T<sub>10</sub>). The treatments were replicated thrice. The common fertilizer schedule adopted for all the treatments was 200:60:60 kg of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O ha<sup>-1</sup> in the form of urea, di-ammonium phosphate and muriate of potash, respectively. All other recommended package of practices was followed for raising the crop.

#### Weed persistence index

Weed persistence index was computed by using the formula suggested by Mishra and Mishra [3]

$$WPI = \frac{[(\text{weed density in weedy check} \times (\text{weed dry weight in treated plot}))]}{[(\text{weed density in treated plot}) \times (\text{weed dry weight in weedy check})]}$$

#### Phytotoxic symptoms on sweet corn

Crop injury was recorded in sweet corn after spray-

**Table 1.** Phytotoxicity scoring chart.

Rating	Percent crop injury	Visual description
1	0	No reduction or no injury
2	1.0-3.5	Very slight discoloration
3	3.5-7.0	More sever but not lasting
4	7.0-12.5	Moderate and more lasting
5	12.5-20.0	Medium and lasting
6	20.0-30.0	Heavy
7	30.0-50.0	Very heavy
8	50.0-90.0	Nearly destroyed
9	100	Completely destroyed

ing of herbicides as per European Weed Research Council recommendation [4]. Different scoring was given based on the extent of damage observed in each plot and as per the suggested recommendations (Table 1).

#### Results and Discussion

##### Weed persistence index (%)

By the end of the sweet corn crop the data on weed persistence index (WPI) presented in Figure 1 revealed that significantly lower WPI was recorded in atrazine *fb* tembotrione (T<sub>7</sub>) followed by atrazine *fb* topramezone (T<sub>3</sub>). Highest WPI was recorded in weedy check. These observations collaborate with [5].

##### Phytotoxicity symptoms

Phytotoxicity symptoms on sweet corn was found in halosulfuron-methyl applied after atrazine or pendimethalin as PE on sweet corn plants at 3 to 4 leaf stage which were germinated after gap filling done at 15 DAS, with scorching symptoms (Table 1). However, the percent of crop injury was less (2.1) which indicates visual description of very slight discoloration of leaves [4]. Whereas. in other herbicide treatments no phytotoxic symptoms on sweet corn were observed.

##### Nutrient uptake by sweet corn

It is essential to determine the amount of nutrient uptake by the crop and weeds since it indicates the extent to which crop enriches or exhausts the soil source to formulate suitable nutrient management

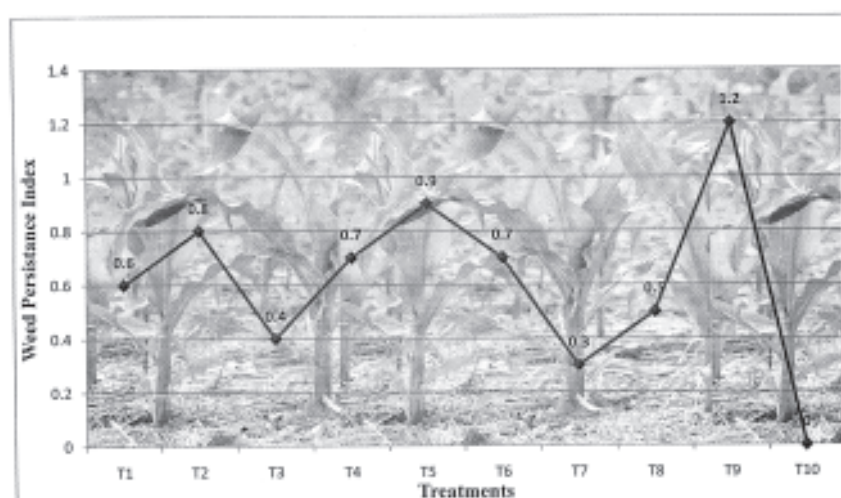


Fig. 1. Influence of sequential application of herbicides on weed persistence index (%) in sweet corn.

practices. Effective weed control by different methods provide a conducive environment for increased uptake of nutrients by crop with proportionate decrease in the removal of nutrients by weeds.

#### Nitrogen uptake

At 25 DAS (Table 2), pendimethalin *fb* halosulfuron methyl (51.2) recorded higher N uptake and it was at par with all treatments. Lower N uptake was with

weedy check treatment. At 50 DAS, atrazine *fb* tembotrione (62.0) recorded significantly higher N uptake when compared to weedy check and it was statistically at par with all treatments including weed free condition [6]. Similarly, at harvest also atrazine *fb* tembotrione (96.0) registered superior N uptake compared to weedy check and it was at par with weed free, atrazine *fb* topamezone (91.8) and pendimethalin *fb* tembotrione (90.3) and superior to the rest of the treatments.

Table 2. Influence of sequential application of herbicides on nutrient uptake by sweet corn crop. DAS : Days after sowing.

Treatments	Nitrogen uptake (kg ha <sup>-1</sup> )			Phosphorus uptake (kg ha <sup>-1</sup> )			Potassium uptake (kg ha <sup>-1</sup> )		
	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS
Atrazine <i>fb</i> halosulfuron+methyl at 25 DAS	49.1	57.9	83.0	6.4	18.8	23.2	32.1	45.3	60.2
Pendimethalin <i>fb</i> halosulfuron methyl at 25 DAS	51.2	58.1	84.7	5.7	17.3	21.3	35.0	41.8	69.1
Atrazine <i>fb</i> topamezone at 25 DAS	49.2	61.0	91.8	6.1	18.4	26.5	35.8	43.0	72.3
Pendimethalin <i>fb</i> topamezone at 25 DAS	46.6	60.8	83.7	5.6	19.6	24.7	33.8	39.3	74.0
Atrazine <i>fb</i> atrazine at 25 DAS	48.5	60.2	79.3	6.4	20.0	24.3	34.2	38.8	69.9
Pendimethalin <i>fb</i> atrazine at 25 DAS	49.5	57.7	76.0	5.8	18.2	25.5	33.4	43.1	55.8
Atrazine <i>fb</i> tembotrione at 25 DAS	48.4	62.0	96.0	5.7	22.3	26.1	34.5	58.2	79.7
Pendimethalin <i>fb</i> tembotrione at 25 DAS	47.2	61.1	90.3	6.0	19.0	24.0	37.7	50.0	71.0
Weedy check	37.3	44.7	60.0	5.5	14.3	16.5	33.8	35.2	48.8
Weed free check	55.1	65.5	105.9	6.9	22.2	26.0	38.2	60.6	82.5
CD ( $p=0.05$ )	2.8	8.0	3.1	0.6	3.5	5.5	5.7	10.5	14.6
SEm $\pm$	3.7	10.4	9.1	NS	4.6	7.2	NS	13.7	19.0

**Table 3.** Influence of sequential application of herbicides on nutrient removal by weeds and fresh cob yield of sweet corn crop. DAS : Days after sowing.

Treatments	Nitrogen removal (kg ha <sup>-1</sup> )			Phosphorus removal (kg ha <sup>-1</sup> )			Potassium removal (kg ha <sup>-1</sup> )			Fresh cob yield (kg ha <sup>-1</sup> )
	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS	
Atrazine <i>fb</i> halosulfuron-methyl at 25 DAS	0.9	5.2	9.3	1.9	2.3	4.7	5.7	6.6	8.1	22946
Pendimethalin <i>fb</i> halosulfuron-methyl at 25 DAS	2.7	3.6	7.5	0.6	3.0	3.6	3.7	4.0	5.9	24074
Atrazine <i>fb</i> topramezone at 25 DAS	1.5	5.6	7.8	0.8	2.1	3.5	4.4	5.0	4.3	29240
Pendimethalin <i>fb</i> topramezone at 25 DAS	2.0	3.7	8.3	1.0	1.6	2.4	3.9	5.5	6.2	27685
Atrazine <i>fb</i> atrazine at 25 DAS	3.8	6.0	11.3	3.0	4.3	6.6	6.6	7.8	8.6	26315
Pendimethalin <i>fb</i> atrazine at 25 DAS	4.6	6.4	12.1	4.3	6.4	6.6	5.3	5.9	6.8	20999
Atrazine <i>fb</i> tembitrione at 25 DAS	2.1	3.5	5.5	0.3	2.7	3.4	2.1	3.1	4.1	29499
Pendimethalin <i>fb</i> tembitrione at 25 DAS	0.8	5.0	6.8	0.4	2.5	3.5	2.2	3.0	3.8	26592
Weedy check	17.3	25.2	39.5	9.0	15.5	19.6	19.9	24.5	28.9	12963
Weed free check	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34055
CD ( <i>p</i> =0.05)	0.8	1.0	1.5	0.5	0.9	1.1	1.2	1.1	1.8	1761.52
SEm ±	1.1	1.3	2.0	0.7	1.2	1.4	1.6	1.5	2.3	5233.93

### Phosphorus uptake

At 25 DAS, P uptake by the sweet corn was non significant, however, atrazine *fb* halosulfuron methyl (6.4) and atrazine *fb* atrazine (6.4) both treatments recorded higher P uptake [7]. Weedy check recorded lowest P uptake. At 50 DAS, atrazine *fb* tembitrione (22.3) recorded significantly higher P uptake when compared to weedy check and it was at par atrazine *fb* atrazine (20.0), pendimethalin *fb* topramezone (19.6) and pendimethalin *fb* tembitrione (19.0) which were superior to weedy check. Lower uptake was with weedy check and it was at par with pendimethalin *fb* halosulfuron methyl (17.3), pendimethalin *fb* atrazine (18.2), atrazine *fb* topramezone (18.4) and atrazine *fb* halosulfuron methyl (18.8). At 75 DAS, P uptake was significantly higher in atrazine *fb* topramezone (26.5) compared to weedy check and was at par with all other treatments including weed free treatment.

### Potassium uptake

The data pertaining to potassium (K) uptake at 25 DAS (Table 2), K uptake was non significant however, among the treatments pendimethalin *fb* tembitrione (37.7) recorded higher K. At 50 DAS, K uptake was significantly higher in atrazine *fb* tembitrione (58.2) compared to weedy check and at par with weed free treatment, pendimethalin *fb*

tembitrione (50.0) and atrazine *fb* halosulfuron methyl (45.3). At harvest also, all the treatments recorded significantly higher K uptake when compared to weedy check except two treatments i.e., pendimethalin *fb* atrazine (55.8) and atrazine *fb* halosulfuron methyl (60.2) and these were at par with weedy check which recorded lowest K uptake [8]. The increase in uptake of nutrients by sweet corn in herbicide treated plots compared to weedy plots might be due to less competition for nutrients and moisture by weeds which are subsized due to sequential application of herbicides.

### Nutrient removal by weeds

Weeds that grow with crop plants deplete considerable amount of costly fertilizer nutrients in addition to available soil moisture.

### Nitrogen removal

At 25 DAS (Table 3) pendimethalin *fb* tembitrione (0.8) recorded lower N uptake and was at par with atrazine *fb* halosulfuron methyl (0.9) and atrazine *fb* topramezone (1.5). At 50 DAS, atrazine *fb* tembitrione (3.5) recorded significantly lower uptake of N by weeds [3] and at par with pendimethalin *fb* halosulfuron methyl (3.6) and pendimethalin *fb* topramezone (3.7) and superior to rest of the treat-

ments [9]. At harvest (75 DAS) also, lower N uptake was observed in atrazine *fb* tembotrione (5.5) which was significantly lower than all the treatments except pendimethalin *fb* halosulfuron methyl (7.5) and pendimethalin *fb* tembotrione (6.8).

#### Phosphorus removal

Table 3 atrazine *fb* tembotrione (0.3) recorded lower P uptake at 25 DAS however, it was at par with pendimethalin *fb* tembotrione (0.4), pendimethalin *fb* halosulfuron methyl (0.6) and atrazine *fb* topramezone (0.8). At 50 DAS, pendimethalin *fb* topramezone (1.6) recorded lower P uptake and was at par with atrazine *fb* topramezone (2.1), atrazine *fb* halosulfuron methyl (2.3) pendimethalin *fb* tembotrione (2.5) and atrazine *fb* tembotrione (2.3) and superior to rest of the treatments [11]. At harvest also, pendimethalin *fb* topramezone (2.4) recorded significantly lower P uptake and at par with atrazine *fb* tembotrione (3.4), atrazine *fb* topramezone (3.5), pendimethalin *fb* tembotrione (3.5) and pendimethalin *fb* halosulfuron methyl (3, 6).

#### Potassium removal

At 25 DAS (Table 3), lowest potassium was removed by weeds in atrazine *fb* tembotrione (2.1) compared to weedy check (19.9) but statistically at par with pendimethalin *fb* tembotrione (2.2). At 50 DAS and harvest pendimethalin *fb* tembotrione recorded significantly lower K removal over weedy check and was statistically at par with atrazine *fb* tembotrione and pendimethalin *fb* halosulfuron methyl. Sequential application of herbicides checked the nutrient drain by weeds very effectively [10].

#### Fresh cob yield (kg ha<sup>-1</sup>)

The fresh cob yield of sweet corn was significantly superior in all the herbicidal treatments compared to weedy check (Table 2). However, among them, highest cob yield was recorded in atrazine *fb* tembotrione (T<sub>7</sub>) which was significantly superior to atrazine *fb* halosulfuron-methyl (T<sub>1</sub>), pendimethalin *fb* halosulfuron-methyl (T<sub>2</sub>) and pendimethalin *fb* atrazine (T<sub>6</sub>) but at par with the rest of the treatments

[11]. Efficient control of weeds in time due to the combination of pre- and post-emergence herbicides might have resulted in better growth parameters due to increased photosynthetic rate and dry matter accumulation.

#### Conclusion

Lower weed persistence index were recorded in atrazine *fb* tembotrione sequence. It was followed by pendimethalin *fb* tembotrione and atrazine *fb* topramezone. Maximum uptake of N, P, K (kg ha<sup>-1</sup>) by sweet corn was observed with atrazine *fb* tembotrione at different intervals of observation, whereas, the lowest was recorded with weedy check. The reverse trend was observed in nutrients (N, P and K) removal by weeds. Application of tembotrione following atrazine (T<sub>7</sub>) registered significantly higher fresh cob.

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