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## Soil Microflora as Influenced by Pre and Post Emergence Herbicide in Sweet Corn Grown in Vertisols

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### ABSTRACT

#### Keywords

Bacteria, Fungi and Actinomycetes

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Field experiment was conducted at Department of Agronomy, College of Agriculture, Dhule during *Kharif* 2019 to study the effect of pre and post emergence herbicides on soil microflora in sweet corn. The per cent decrease in the bacterial, fungal and actinomycetes count was in the range of 8.26 to 9.22 % in the weed free treatment (two hand weeding), 18.57 to 24.94 % in the treatment of weedy check ( $T_1$ ) and 22.48 to 30.10 % in the treatments of pre and post emergence herbicides ( $T_3$  to  $T_{10}$ ) over the initial values of  $24.5 \times 10^7$  cfu  $g^{-1}$  soil,  $8.6 \times 10^4$  cfu  $g^{-1}$  soil and  $19 \times 10^6$  cfu  $g^{-1}$  soil, respectively. Application of tembotrione @  $120 \text{ g ha}^{-1}$  as post emergence herbicide ( $T_9$ ) showed less adverse effect on soil bacterial population at harvest than the other herbicides treatments. Application of 2,4 D ethyl ester @  $1000 \text{ g ha}^{-1}$  as post emergence herbicide ( $T_{10}$ ) showed less adverse effect on soil fungal population than the other herbicides treatments. Application of halosulfuron-methyl @  $90 \text{ g ha}^{-1}$  as post emergence herbicide ( $T_8$ ) showed less adverse effect on soil actinomycetes population than the other herbicides treatments under study.

### Introduction

In India, sweet corn is cultivated on very small area to meet the demands of many industries. The demand for eating roasted cobs in cities and towns is increasing day by day. Sweet corn is gaining popularity among the urban masses in terms of nutrition and health consciousness in India.

Heavy weed infestation is one of the major constraints that limit the productivity of sweet corn crop. Wider spacing and slow growing nature of the crop during the first 3-4 weeks

provide enough opportunity for weeds to invade and offer severe competition resulting in 30-100 % yield reduction (Dey *et al.*, 2017). Weeds emerge fast and grow rapidly competing with the crop for growth *viz.*, nutrients, moisture, sunlight and space during entire vegetative and early reproductive stages of sweet corn.

In the modern era of urbanization, labour component in agriculture is becoming scarce, not available at time and prohibitive cost. Chemical weed control is a better supplement to conventional methods and forms an

integral part of the modern crop production. Herbicides are toxic agrochemicals, which have been used to control the weeds in the agricultural farms and gardens. These herbicides are rampantly used to some extent, by farmers without considering the long or short term effects in soil medium. It is evident that most of these herbicides may cause the reduction of sensitive populations of certain groups of biota in soil medium.

Biological properties are critically important to the ecosystem functioning since they are involved in soil organic matter decomposition, nutrient cycling, and degradation of pesticides, such as herbicides (Araujo *et al.*, 2003). Therefore, studies assessing the effect of herbicides on soil biological properties are important for evaluating soil quality and health. In addition, soil biological properties are more effective as indicators of soil quality than physical and chemical properties as they often show a faster response to an environmental impact (Nannipieri and Badalucco 2003). As important and responsive biological properties, soil microbial biomass and enzyme activities are frequently recommended for evaluating the effects of herbicides on the soil environment (Juan *et al.*, 2017).

Soil microbial biomass represents the active part of soil organic matter and is involved in several functions in soil, presenting a rapid turnover of soil C, N, and P; while enzymes are a suitable indicator of the catabolic activity of soil microorganism (Nannipieri and Badalucco 2003). These biological properties are highly sensitive to detect soil disturbance after the application of chemicals, such as herbicides (Pertile *et al.*, 2020).

Considering the paramount importance of soil biological properties, the experiment was conducted to study the effect of pre and post

emergence herbicides on soil microflora in sweet corn.

## Materials and Methods

Field experiment was conducted at Department of Agronomy, College of Agriculture, Dhule during *Kharif* 2019 to study the effect of pre and post emergence herbicides on soil enzymes in sweet corn. The experiment was laid out in randomized block design with ten treatments replicated three times. Treatments composed of T<sub>1</sub>: weedy check, T<sub>2</sub>: weed free (two hand weeding), T<sub>3</sub>: atrazine @ 1000 g ha<sup>-1</sup> (PE) *fb* halosulfuron methyl @ 90 g ha<sup>-1</sup> (PoE), T<sub>4</sub>: atrazine @ 1000 g ha<sup>-1</sup> (PE) *fb* 2,4 D ethyl ester @ 1000 g ha<sup>-1</sup> (PoE), T<sub>5</sub>: pendimethalin @ 1000 g ha<sup>-1</sup> (PE) *fb* halosulfuron-methyl @ 90 g ha<sup>-1</sup> (PoE), T<sub>6</sub>: pendimethalin @ 1000 g ha<sup>-1</sup> (PE) *fb* tembotrione @ 120 g ha<sup>-1</sup> (PoE), T<sub>7</sub>: pendimethalin @ 1000 g ha<sup>-1</sup> (PE) *fb* 2,4 D ethyl ester @ 1000 g ha<sup>-1</sup> (PoE), T<sub>8</sub>: halosulfuron-methyl @ 90 g ha<sup>-1</sup> (PoE), T<sub>9</sub>: tembotrione @ 120 g ha<sup>-1</sup> (PoE) and T<sub>10</sub>: 2,4 D ethyl ester @ 1000 g ha<sup>-1</sup> (PoE). The pre emergence (PE) herbicides were applied on next day after sowing of sweet corn, however, the post emergence (PoE) herbicides were applied 30 days after sowing of sweet corn.

The soil of experimental site was medium black with the following chemical properties: pH 8.01, electrical conductivity (EC) 0.32 dS m<sup>-1</sup>, organic carbon (5.60 g kg<sup>-1</sup>), calcium carbonate (49 g kg<sup>-1</sup>), available N (202.34 kg ha<sup>-1</sup>), available (Olsen-P) P (17.32 kg ha<sup>-1</sup>), available (NH<sub>4</sub>OAc-K) K (402.25 kg ha<sup>-1</sup>), bacterial count (24.5 x 10<sup>7</sup> cfu g<sup>-1</sup> soil), fungal count (8.6 x 10<sup>4</sup> cfu g<sup>-1</sup> soil) and actinomycetes count (19.0 x 10<sup>6</sup> cfu g<sup>-1</sup> soil).

Representative moistened soil samples were collected from each plot before sowing, at 7, 15, 21, 30 and 45 DAS as well as at harvest. The fungal, bacterial and actinomycetes count

was determined by serial dilution plate method (Dhingra and Sinclair 1993).

## Results and Discussion

### Bacterial count

The periodical bacterial count in soil was significantly influenced at 7, 15, 21, 30 and 45 days after application by pre and post emergence herbicides during the field experiment (Table 1). Significantly higher bacterial count was observed in the weed free (two hand weeding) treatment (T<sub>2</sub>) as compared to rest of the treatments. In the weed free (two hand weeding) treatment (T<sub>2</sub>) the bacterial count was increased at 7, 15, 21, 30 and 45 DAS (27.61, 29.06, 29.11, 29.29 and 27.56 x 10<sup>7</sup> cfu g<sup>-1</sup> soil, respectively) as compared to initial value (24.5 x 10<sup>7</sup> cfu g<sup>-1</sup> soil), however, the magnitude of increase of bacterial count was higher at 21 DAS (18.81 %) and 30 DAS (19.55 %), which might be due to the top dressing of nitrogen to sweet corn at these stages. In the weedy treatments (T<sub>1</sub>) the bacterial count was increased slightly at 7 DAS (25.75 x 10<sup>7</sup> cfu g<sup>-1</sup> soil) and 15 DAS (28.06 x 10<sup>7</sup> cfu g<sup>-1</sup> soil), however, it was decreased at 21 DAS, 30 DAS and 45 DAS. The bacterial count at 45 DAS was 21.72 x 10<sup>7</sup> cfu g<sup>-1</sup> soil with 11.34 % decrease over initial value.

In the treatments of pre-emergence and post emergence application of herbicides, the bacterial count was slightly increased (7.26 to 8.40 %) over initial value at 7 DAS, there after, it was reduced gradually at 15 DAS, 21 DAS, 30 DAS and 45 DAS. The magnitude of reduction of bacterial count was higher in the treatment of pendimethalin @ 1000 g ha<sup>-1</sup> (PE) followed by 2,4 D ethyl ester @ 1000 g ha<sup>-1</sup> (PoE), which recorded significantly lower bacterial count of 17.31 x 10<sup>7</sup> cfu g<sup>-1</sup> soil at 45 DAS. However, this treatment was statistically at par with all the treatments of

herbicide application. In the treatments of post emergence application of herbicides, the bacterial count was slightly increased from 7.79 to 9.10 % over initial value at 7 DAS and increased 4.65 to 8.28 % at 15 DAS, thereafter it was gradually reduced at 21 DAS, 30 DAS and 45 DAS. It was also observed that soil bacterial count was considerably decreased with advanced period of field experimentation due to application of pre and post emergence herbicides.

The weed free treatment (two hand weeding) recorded significantly higher bacterial count 22.24 x 10<sup>7</sup> cfu g<sup>-1</sup> soil at harvest of sweet corn with 9.22 % decrease in bacterial count over initial value of 24.5 x 10<sup>7</sup> cfu g<sup>-1</sup> soil. It was followed by the treatment of weedy check (T<sub>1</sub>), which recorded the bacterial count of 19.95 x 10<sup>7</sup> cfu g<sup>-1</sup> soil with the decrease of 18.57 % over initial value. The treatment of pendimethalin @ 1000 g ha<sup>-1</sup> (PE) followed by halosulfuron-methyl @ 90 g ha<sup>-1</sup> (PoE) recorded significantly lower bacterial count of 17.85 x 10<sup>7</sup> cfu g<sup>-1</sup> soil with the decrease of 27.14 % over initial value. The results revealed that an application of Tembotrione @ 120 g ha<sup>-1</sup> as post emergence herbicide (T<sub>9</sub>) has less adverse effect on soil bacterial population at harvest than the other herbicides treatments under study.

The reduction in bacterial count due to application of herbicides was also reported by Abbas *et al.*, (2014) and Patel *et al.*, (2019). The reduction in periodical soil bacterial count due to pre and post emergence herbicides are associated with disruption in the amino acid assimilation abilities of soil bacteria leading to their death (Allievi and Gigliotti 2001). The reduction in periodical soil bacterial count might be because of the adverse effect of pre and post emergence herbicides on metabolic activities of soil bacteria (Milosevic and Govedarica 2000).

## Fungal count

The periodical fungal count in soil was significantly influenced at 7, 15, 21, 30 and 45 days after application by pre and post emergence herbicides during the field experiment (Table 2). The weed free (two hand weeding) treatment ( $T_2$ ) recorded significantly higher fungal count as compared to rest of the treatments. In the weed free (two hand weeding) treatment ( $T_2$ ) the fungal count was increased at 7, 15, 21, 30 and 45 DAS (9.59, 10.02, 10.13, 9.93 and  $9.70 \times 10^4$  cfu  $g^{-1}$  soil, respectively) as compared to initial value ( $8.6 \times 10^4$  cfu  $g^{-1}$  soil). In the weedy treatments ( $T_1$ ) the fungal count was increased slightly at 7 DAS ( $8.84 \times 10^4$  cfu  $g^{-1}$  soil) and 15 DAS ( $8.79 \times 10^4$  cfu  $g^{-1}$  soil), however, it was decreased at 21 DAS, 30 DAS and 45 DAS. The fungal count at 45 DAS was  $7.47 \times 10^4$  cfu  $g^{-1}$  soil with 13.13 % decrease over initial value of  $8.6 \times 10^4$  cfu  $g^{-1}$  soil.

In the treatments of pre-emergence and post emergence application of herbicides ( $T_3$  to  $T_7$ ), the fungal count was slightly increased (2.44 to 4.18 %) over initial value at 7 DAS, thereafter, it was reduced gradually at 15 DAS, 21 DAS, 30 DAS and 45 DAS. Significantly lower value of fungal count ( $5.81 \times 10^4$  cfu  $g^{-1}$  soil) was recorded in the treatment of pendimethalin @ 1000 g  $ha^{-1}$  (PE) followed by 2,4 D ethyl ester @ 1000 g  $ha^{-1}$  (PoE) at 45 DAS. However, this treatment was statistically at par with all the treatments of herbicide application ( $T_2$  to  $T_6$  and  $T_8$  to  $T_{10}$ ). In the treatments of post emergence application of herbicides ( $T_8$  to  $T_{10}$ ), the fungal count was slightly increased from 4.18 to 5.89 % over initial value at 7 DAS and increased 1.74 to 5.81 % at 15 DAS, thereafter it was gradually decreased at 21 DAS, 30 DAS and 45 DAS. The soil fungal count was considerably decreased with advanced period of field experimentation due to application of pre and post emergence herbicides.

**Table.1** Bacterial count in soil as influenced by application of herbicides

Sr. No	Treatments	Bacterial count ( $\times 10^7$ cfu $g^{-1}$ soil)					
		7 DAS	15 DAS	21 DAS	30 DAS	45 DAS	At harvest
1.	Weedy	25.75 <sup>b</sup>	25.64 <sup>ab</sup>	23.59 <sup>b</sup>	23.57 <sup>b</sup>	21.72 <sup>b</sup>	19.95 <sup>b</sup>
2.	Weed free (two hand weedings)	27.61 <sup>a</sup>	28.06 <sup>a</sup>	29.11 <sup>a</sup>	29.29 <sup>a</sup>	27.56 <sup>a</sup>	22.24 <sup>a</sup>
3.	Atrazine @ 1000 g $ha^{-1}$ (PE) <i>fb</i> halosulfuron methyl @ 90 g $ha^{-1}$ (PoE)	26.28 <sup>b</sup>	23.91 <sup>b</sup>	19.37 <sup>c</sup>	18.81 <sup>cd</sup>	17.68 <sup>c</sup>	18.71 <sup>bc</sup>
4.	Atrazine @ 1000 g $ha^{-1}$ (PE) <i>fb</i> 2,4 D ethyl ester @ 1000 g $ha^{-1}$ (PoE)	26.36 <sup>b</sup>	23.67 <sup>b</sup>	19.55 <sup>c</sup>	18.68 <sup>cd</sup>	17.54 <sup>c</sup>	18.82 <sup>bc</sup>
5.	Pendimethalin @ 1000 g $ha^{-1}$ (PE) <i>fb</i> halosulfuron-methyl @ 90 g $ha^{-1}$ (PoE)	26.34 <sup>b</sup>	23.64 <sup>b</sup>	19.62 <sup>c</sup>	19.31 <sup>cd</sup>	18.23 <sup>c</sup>	17.85 <sup>c</sup>
6.	Pendimethalin @ 1000 g $ha^{-1}$ (PE) <i>fb</i> tembotrione @ 120 g $ha^{-1}$ (PoE)	26.39 <sup>b</sup>	23.66 <sup>b</sup>	20.50 <sup>c</sup>	17.04 <sup>d</sup>	17.49 <sup>c</sup>	18.26 <sup>bc</sup>
7.	Pendimethalin @ 1000 g $ha^{-1}$ (PE) <i>fb</i> 2,4 D ethyl ester @ 1000 g $ha^{-1}$ (PoE)	26.56 <sup>a</sup>	23.79 <sup>b</sup>	19.51 <sup>c</sup>	17.86 <sup>d</sup>	17.31 <sup>c</sup>	18.15 <sup>c</sup>
8.	Halosulfuron-methyl @ 90 g $ha^{-1}$ (PoE)	26.41 <sup>b</sup>	25.64 <sup>ab</sup>	20.90 <sup>c</sup>	20.61 <sup>c</sup>	18.35 <sup>c</sup>	18.65 <sup>bc</sup>
9.	Tembotrione @ 120 g $ha^{-1}$ (PoE)	26.49 <sup>b</sup>	26.53 <sup>ab</sup>	22.46 <sup>bc</sup>	20.69 <sup>c</sup>	18.16 <sup>c</sup>	18.99 <sup>bc</sup>
10.	2,4 D ethyl ester @ 1000 g $ha^{-1}$ (PoE)	26.73 <sup>ab</sup>	26.43 <sup>ab</sup>	20.85 <sup>c</sup>	20.54 <sup>cd</sup>	18.37 <sup>c</sup>	18.91 <sup>bc</sup>
	SE(m) $\pm$	0.36	1.17	0.89	0.90	0.48	0.60
	CD at 5 %	1.07	3.49	2.67	2.70	1.44	1.78

**Table.2** Fungal count in soil as influenced by application of herbicides

Sr. No.	Treatments	Fungal count ( $\times 10^4$ cfu $g^{-1}$ soil)					
		7 DAS	15 DAS	21 DAS	30 DAS	45 DAS	At harvest
1.	Weedy	8.84 <sup>c</sup>	8.79 <sup>bc</sup>	8.10 <sup>b</sup>	8.16 <sup>b</sup>	7.47 <sup>b</sup>	6.78 <sup>b</sup>
2.	Weed free (two hand weedings)	9.59 <sup>a</sup>	10.02 <sup>a</sup>	10.13 <sup>a</sup>	9.93 <sup>a</sup>	9.70 <sup>a</sup>	7.86 <sup>a</sup>
3.	Atrazine @ 1000 g ha <sup>-1</sup> (PE) fb halosulfuron methyl @ 90 g ha <sup>-1</sup> (PoE)	8.81	8.53 <sup>bc</sup>	6.60 <sup>c</sup>	6.53 <sup>cd</sup>	6.06 <sup>c</sup>	6.35 <sup>b</sup>
4.	Atrazine @ 1000 g ha <sup>-1</sup> (PE) fb 2,4 D ethyl ester @ 1000 g ha <sup>-1</sup> (PoE)	8.86 <sup>b</sup>	8.25 <sup>c</sup>	6.70 <sup>c</sup>	6.41 <sup>cd</sup>	5.97 <sup>c</sup>	6.27 <sup>b</sup>
5.	Pendimethalin @ 1000 g ha <sup>-1</sup> (PE) fb halosulfuron-methyl @ 90 g ha <sup>-1</sup> (PoE)	8.86 <sup>b</sup>	8.10 <sup>c</sup>	6.78 <sup>c</sup>	6.52 <sup>cd</sup>	6.06 <sup>c</sup>	6.23 <sup>b</sup>
6.	Pendimethalin @ 1000 g ha <sup>-1</sup> (PE) fb tembotrione @ 120 g ha <sup>-1</sup> (PoE)	8.88 <sup>b</sup>	8.10 <sup>c</sup>	7.03 <sup>c</sup>	6.62 <sup>cd</sup>	6.02 <sup>c</sup>	6.31 <sup>b</sup>
7.	Pendimethalin @ 1000 g ha <sup>-1</sup> (PE) fb 2,4 D ethyl ester @ 1000 g ha <sup>-1</sup> (PoE)	8.96 <sup>b</sup>	8.22 <sup>c</sup>	6.64 <sup>c</sup>	6.20 <sup>d</sup>	5.81 <sup>c</sup>	6.22 <sup>b</sup>
8.	Halosulfuron-methyl @ 90 g ha <sup>-1</sup> (PoE)	8.93 <sup>b</sup>	8.75 <sup>bc</sup>	7.35 <sup>bc</sup>	7.10 <sup>c</sup>	6.18 <sup>c</sup>	6.42 <sup>b</sup>
9.	Tembotrione @ 120 g ha <sup>-1</sup> (PoE)	8.96 <sup>b</sup>	9.10 <sup>b</sup>	7.65 <sup>bc</sup>	7.08 <sup>c</sup>	6.00 <sup>c</sup>	6.41 <sup>b</sup>
10.	2,4 D ethyl ester @ 1000 g ha <sup>-1</sup> (PoE)	9.04 <sup>b</sup>	8.92 <sup>b</sup>	7.27 <sup>c</sup>	7.04 <sup>c</sup>	6.30 <sup>c</sup>	6.43 <sup>b</sup>
	SE(m) $\pm$	0.065	0.21	0.27	0.25	0.26	0.22
	CD at 5 %	0.19	0.64	0.81	0.77	0.79	0.67

**Table.3** Actinomycetes count in soil as influenced by application of herbicides

Sr. No	Treatments	Actinomycetes ( $\times 10^6$ cfu $g^{-1}$ soil)					
		7 DAS	15 DAS	21 DAS	30 DAS	45 DAS	At harvest
1.	Weedy	19.35 <sup>b</sup>	19.47 <sup>bc</sup>	18.47 <sup>bc</sup>	18.48 <sup>b</sup>	16.85 <sup>b</sup>	14.26 <sup>b</sup>
2.	Weed free (two hand weedings)	21.17 <sup>a</sup>	22.59 <sup>a</sup>	23.91 <sup>a</sup>	24.33 <sup>a</sup>	21.59 <sup>a</sup>	17.43 <sup>a</sup>
3.	Atrazine @ 1000 g ha <sup>-1</sup> (PE) fb halosulfuron methyl @ 90 g ha <sup>-1</sup> (PoE)	19.66 <sup>b</sup>	18.96 <sup>c</sup>	15.73 <sup>c</sup>	15.14 <sup>c</sup>	13.63 <sup>c</sup>	13.39 <sup>b</sup>
4.	Atrazine @ 1000 g ha <sup>-1</sup> (PE) fb 2,4 D ethyl ester @ 1000 g ha <sup>-1</sup> (PoE)	19.68 <sup>b</sup>	18.78 <sup>c</sup>	15.42 <sup>c</sup>	15.12 <sup>c</sup>	13.61 <sup>c</sup>	13.52 <sup>b</sup>
5.	Pendimethalin @ 1000 g ha <sup>-1</sup> (PE) fb halosulfuron-methyl @ 90 g ha <sup>-1</sup> (PoE)	19.65 <sup>b</sup>	18.59 <sup>c</sup>	18.98 <sup>b</sup>	15.22 <sup>c</sup>	13.80 <sup>c</sup>	13.28 <sup>b</sup>
6.	Pendimethalin @ 1000 g ha <sup>-1</sup> (PE) fb tembotrione @ 120 g ha <sup>-1</sup> (PoE)	19.76 <sup>b</sup>	18.59 <sup>c</sup>	16.13 <sup>bc</sup>	15.51 <sup>c</sup>	14.13 <sup>c</sup>	13.33 <sup>b</sup>
7.	Pendimethalin @ 1000 g ha <sup>-1</sup> (PE) fb 2,4 D ethyl ester @ 1000 g ha <sup>-1</sup> (PoE)	19.86 <sup>b</sup>	18.76 <sup>c</sup>	15.94 <sup>bc</sup>	15.00 <sup>c</sup>	13.28 <sup>c</sup>	13.37 <sup>b</sup>
8.	Halosulfuron-methyl @ 90 g ha <sup>-1</sup> (PoE)	19.88 <sup>b</sup>	19.59 <sup>bc</sup>	16.93 <sup>bc</sup>	16.14 <sup>c</sup>	13.79 <sup>c</sup>	13.51 <sup>b</sup>
9.	Tembotrione @ 120 g ha <sup>-1</sup> (PoE)	19.84 <sup>b</sup>	20.14 <sup>b</sup>	17.37 <sup>bc</sup>	15.91 <sup>c</sup>	13.49 <sup>c</sup>	13.39 <sup>b</sup>
10.	2,4 D ethyl ester @ 1000 g ha <sup>-1</sup> (PoE)	20.00 <sup>b</sup>	19.86 <sup>bc</sup>	16.63 <sup>bc</sup>	16.08 <sup>c</sup>	13.78 <sup>c</sup>	13.44 <sup>b</sup>
	SE(m) $\pm$	0.24	0.32	1.04	0.47	0.48	0.36
	CD at 5 %	0.72	1.08	3.12	1.41	1.44	1.09

The fungal count was significantly higher ( $7.86 \times 10^4$  cfu  $g^{-1}$  soil) in the treatment of weed free treatment (two hand weeding) at harvest of sweet corn. It was followed by the treatment of weedy check (T<sub>1</sub>), which recorded the fungal count  $6.78 \times 10^4$  cfu  $g^{-1}$

soil. The results revealed that an application of 2,4 D ethyl ester @ 1000 g ha<sup>-1</sup> as post emergence herbicide (T<sub>10</sub>) has less adverse effect on soil fungal population than the other herbicides treatments under study. The per cent decrease in the fungal count was 8.60 %,

21.16 % and 25.23 to 27.67 % in the weed free treatment (two hand weeding), weedy check (T<sub>1</sub>) and treatments of pre and post emergence herbicides (T<sub>3</sub> to T<sub>10</sub>), respectively over the initial value of  $8.6 \times 10^4$  cfu g<sup>-1</sup> soil. The reduction in fungi count due to application of herbicides was also reported by Abbas *et al.*, (2014) and Patel *et al.*, (2019). The reduction in soil fungi population due to pre and post emergence herbicides are associated with suppress cell division as a consequence of disturbing nucleic acid metabolism and protein synthesis (Askif 2004).

### **Actinomycetes count**

The weed free (two hand weeding) treatment (T<sub>2</sub>) recorded significantly higher actinomycetes count as compared to rest of the treatments (Table 3). In the weed free (two hand weeding) treatment (T<sub>2</sub>) the actinomycetes count was increased at 7, 15, 21, 30 and 45 DAS (19.35, 19.47, 18.47, 18.48 and  $16.65 \times 10^6$  cfu g<sup>-1</sup> soil, respectively) as compared to initial value ( $19 \times 10^6$  cfu g<sup>-1</sup> soil). Higher value of actinomycetes count was reported at 21 DAS ( $23.91 \times 10^6$  cfu g<sup>-1</sup> soil) and 30 DAS ( $24.33 \times 10^6$  cfu g<sup>-1</sup> soil). The actinomycetes count was increased slightly initially at 7 DAS ( $19.35 \times 10^6$  cfu g<sup>-1</sup> soil) and 15 DAS ( $19.47 \times 10^6$  cfu g<sup>-1</sup> soil) in the weedy treatments (T<sub>1</sub>), however, reduction in the actinomycetes count was observed at 21 DAS, 30 DAS and 45 DAS. The actinomycetes count at 45 DAS was  $16.85 \times 10^6$  cfu g<sup>-1</sup> soil with 11.31 % decrease over initial value.

The actinomycetes count was slightly increased (3.47 to 4.52 %) over initial value at 7 DAS, thereafter, it was reduced gradually at 15 DAS, 21 DAS, 30 DAS and 45 DAS in the treatments of pre-emergence and post emergence application of herbicides (T<sub>3</sub> to T<sub>7</sub>). The treatment of pendimethalin @ 1000 g

ha<sup>-1</sup> (PE) followed by 2,4 D ethyl ester @ 1000 g ha<sup>-1</sup> (PoE) recorded significantly lower actinomycetes count of  $13.28 \times 10^6$  cfu g<sup>-1</sup> soil at 45 DAS. However, this treatment was statistically at par with all the treatments of herbicide application. In the treatments of post emergence application of herbicides (T<sub>8</sub> to T<sub>10</sub>), the actinomycetes count was slightly increased from 3.10 to 6.0 % over initial value ( $19 \times 10^6$  cfu g<sup>-1</sup> soil) at 7 DAS and at 15 DAS, thereafter it was gradually reduced at 21 DAS, 30 DAS and 45 DAS.

The weed free treatment (two hand weeding) recorded significantly higher actinomycetes count ( $17.43 \times 10^6$  cfu g<sup>-1</sup> soil) at harvest of sweet corn. It was followed by the treatment of weedy check (T<sub>1</sub>), which recorded the actinomycetes count  $14.26 \times 10^6$  cfu g<sup>-1</sup> soil. The results revealed that an application of pendimethalin @ 1000 g ha<sup>-1</sup> as pre emergence followed by tembotrione @ 120 g ha<sup>-1</sup> as post emergence herbicide (T<sub>6</sub>) has less adverse effect on soil actinomycetes population than the other herbicides treatments under study. In general, the detrimental effect of pre and post emergence herbicides on actinomycetes count in soil was in the order of pendimethalin (PE) *fb* 2,4 D ethyl ester (PoE) > tembotrione (PoE) > atrazine (PE) *fb* 2,4 D ethyl ester (PoE) > atazine (PE) *fb* halosulfuron methyl (PoE) > 2,4 D ethyl ester (PoE) > halosulfuron-methyl (PoE) > pendimethalin (PE) *fb* halosulfuron-methyl (PoE) > pendimethalin (PE) *fb* tembotrione (PoE).

The per cent decrease in the actinomycetes count was 8.26 %, 24.94 % and 28.84 to 30.10 % in the weed free treatment (two hand weeding), weedy check (T<sub>1</sub>) and treatments of pre and post emergence herbicides (T<sub>3</sub> to T<sub>10</sub>), respectively over the initial value of  $19 \times 10^6$  cfu g<sup>-1</sup> soil. The reduction in actinomycetes population may be due to degradation of herbicides into secondary metabolites, which

can be more hazardous to the soil actinomycetes population than the herbicide itself. Similar results were also reported by Latha and Gopal (2010) and Adhikary *et al.*, (2014).

In conclusion the application of tembotrione @ 120 g ha<sup>-1</sup> as post emergence herbicide (T<sub>9</sub>) showed less adverse effect on soil bacterial population at harvest than the other herbicides treatments. Application of 2,4 D ethyl ester @ 1000 g ha<sup>-1</sup> as post emergence herbicide (T<sub>10</sub>) showed less adverse effect on soil fungal population than the other herbicides treatments. Application of halosulfuron-methyl @ 90 g ha<sup>-1</sup> as post emergence herbicide (T<sub>8</sub>) showed less adverse effect on soil actinomycetes population than the other herbicides treatments under study.

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