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Effect of pre and post emergent weedicides on soil microorganisms and nutrient uptake in *Kharif* maize (*Zea mays* L.)

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Abstract

A field experiment on effect of pre and post emergent weedicides on soil micro-organisms and enzymatic activities in maize was carried out during *Kharif*, 2024 at Main Agricultural Research Station, University of Agricultural Science, Raichur. The experiment was laid out in Randomized Complete Block Design with three replications and thirteen treatments. Among the different herbicide treatments, pyroxasulfone 85% WG @ 255 g a.i. ha⁻¹ as PE *fb* tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE had recorded significantly minimum population of bacteria, fungi, actinomycetes and dehydrogenase, urease, alkaline phosphatase activity at both first (12.11×10⁶, 13.67×10⁴, 55.33×10³ cfu g⁻¹soil, respectively) and (3.32 µg TPF, 9.26 µg NH₄-N g⁻¹, 5.57 µg PNP, g⁻¹ soil day⁻¹, respectively) second week after herbicide spray (14.33×10⁶, 13.33×10⁴, 60.67×10³ cfu g⁻¹soil, respectively) and (3.32 µg TPF, 10.26 µg NH₄-N g⁻¹, 3.32 µg PNP, g⁻¹ soil day⁻¹, respectively) higher nutrient uptake by maize (131.15, 29.06 and 125.16 kg ha⁻¹ of N, P and K, respectively), lower nutrient uptake by weeds (11.86, 3.58 and 7.98 kg ha⁻¹ of N, P and K, respectively) and higher nutrient availability at harvest (235.11, 52.69 and 258.16 kg ha⁻¹ of N, P₂O₅ and K₂O, respectively) which was statistically comparable with application of pyroxasulfone 85% WG @ 170 g a.i. ha⁻¹ as PE *fb* tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE and pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE *fb* tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE treatments. Weedy check recorded significantly higher microbial population at all the stages as compared to other herbicidal treatments, lower nutrient uptake by maize and higher nutrient uptake by weeds.

Keywords: Weedicide, bacteria, fungi, actinomycetes, dehydrogenase, urease, alkaline phosphatase, nutrient uptake

1. Introduction

Maize is the third most important cereal crop grown in India in terms of both area and production after rice and wheat, providing nutrients for humans, animals and serving as a basic raw material for the production of starch, oil, protein, alcoholic beverages, food sweeteners and more recently, fuel. The green plant made into silage has been used with much success in the dairy and beef industries. After harvest of the grain, the dried leaves and upper part including the flowers are still used today to provide relatively good forage for ruminant animals owned by many small farmers in developing countries. The erect stalks, which in some varieties are strong, have been used as long-lasting fences and walls. In developed countries more than 60 per cent of the production is used in compounded feeds for poultry, pigs and ruminant animals. In spite of the production potential, weed infestation in the maize fields affect its growth and yield as they compete with growth resources especially nutrient uptake with crop. Nutrient and moisture utilization by weed make the crop to starve resulting in yield reduction as observed by Paul (2023) [10]. Timely application of weedicides can control the weed population and improve the yield levels. The mechanical weed management has become too costly as there is shortage of labors and hence there is a scope for utilizing economic weed management strategy. Sequential application of pre and post-emergent herbicides or combination of herbicides and cultural methods is one such strategy. The use of pre and post emergent weedicides impact the soil microbes as long as their residues remain in soil as observed by Sheeja K Raj, Elizabeth (2017) [14].

Material and Methods

A field experiment was laid out in Randomized Complete Block Design with eleven treatments and three replications during *Kharif*, 2024 at Main Agricultural Research Station, UAS, Raichur. The soil of the experimental site was medium deep black and clayey in texture (21.12% sand, 21.57% silt and 57.31% clay with a bulk density of 1.29 g cm⁻³). Chemical analysis indicated that the experimental soil pH was slightly alkaline (8.13) with an electrical conductivity of 0.53 dS m⁻¹. The soil was medium in organic carbon content (0.41%), low in available nitrogen (232.15 kg ha⁻¹), medium in available phosphorus (23.33 kg ha⁻¹) and high in available potassium (378.80 kg ha⁻¹). The maize hybrid (NK-6240) seeds were sown with a spacing of 60×20 cm when there was sufficient moisture in vertisols of the experimental site. The crop was fertilized with recommended dose of fertilizers (150:75:37.5 kg NPK ha⁻¹, respectively). Pre and post emergent weedicide treatments were implemented as per the treatment details. The soil from experimental site was powdered and 10 g was mixed in 90 ml sterilized water to give 10⁻¹ dilution. Subsequently dilutions up to 10⁻⁶ were made by transferring serially 1 ml of the dilution into 9 ml water blank. The blanks and the media poured in the petriplates for isolating different microbes were sterilized for 3 hours in an autoclave at 121 °C and then inoculated with 0.1 ml of appropriate dilutions and spread using a sterile glass rod. Then, the inoculated plates were kept for incubation at 34 ± 1 °C for the appropriate time specified for each microbe's growth and emerged colonies were counted.

Each soil sample was sieved through the 1000 micromesh to remove the bigger particles and debris and was used for isolation of bacteria by serial dilution agar plate technique using Nutrient Agar medium, enumeration of fungi using Martin's Rose Bengal Agar (MRBA) medium and enumeration of actinomycetes using Actinomycetes Isolate Agar medium by standard plate count method. The 10⁻⁶, 10⁻⁴ and 10⁻³ dilution of soil suspension was used for isolation, respectively. The plates were incubated for 24 hours, 4 days and 6 days, respectively at 28 °C. The colonies that appeared on the respective media were enumerated and expressed in terms of cfu g⁻¹ of soil on dry weight basis. The dehydrogenase activity in the soil samples was determined by following the procedure as described by Casida *et al.* (1964)^[2] and Ranganayaki *et al.*, (2006)^[11].

Nitrogen, phosphorus and potassium contents in plant samples and weeds at harvest were estimated by modified micro-kjeldhal method, Vanadomolybdate yellow colour method and flame photometric method, respectively as indicated by Jackson^[3] and Subbiah and Asija (1956)^[16]. Nutrient uptake was calculated by using the following formula

$$\text{Uptake of nutrients (kg ha}^{-1}\text{)} = \text{Nutrient concentration (\%)} \times \text{Biomass (kg ha}^{-1}\text{)}/100$$

Soil samples were collected from 0-30 cm depth after harvest of the crop from each treatment in all the three replications by using auger. Soil samples were air dried. The dried soil samples were finely grounded in a mechanical mortar and pestle and sieved through 2 mm mesh prior to analysis to ensure a homogeneous mixture for analysis. The soil samples were analyzed for available nitrogen, phosphorus and potassium contents. Available soil nitrogen was estimated by alkaline permanganate method. Available phosphorus was determined by Olsen's method using spectrophotometer. Available potassium was extracted with neutral normal ammonium acetate and its content was estimated by flame photometer as outlined by as

indicated by Jackson^[3] and Subbiah and Asija (1956)^[16]. Statistical analysis of data was done as per Fisher's analysis of variance technique for the experimental designs as outlined by Panse and Sukatme 1967^[8]. The treatment means were compared using least significant difference test at p=0.05 probability level using t-test.

3. Result and Discussion

a) Microbial population

The data on the microbial population (bacteria, fungus and actinomycetes) was recorded before herbicide spray, first week after herbicide spray, second week after herbicide spray and at harvest which differed significantly except before herbicide spray and at harvest as there was no complete treatment imposition and low residue activity of herbicides. After one week of pre-emergent and post-emergent herbicides application, significant difference was observed in the bacterial, fungal and Actinomycetes population. Among the different weed management practices (Table 1, 2 and 3). The major reduction in microbial population was noticed because of weedicide application. Among the different treatments, the maximum bacterial, fungal and Actinomycetes population was recorded in weedy check (28.67×106, 23.00×104, 84.00×103 cfu g⁻¹soil and 37.33×106, 30.67×104, 93.67×103 cfu g⁻¹soil respectively), while the minimum population of bacteria was observed in the treatment receiving application of pyroxasulfone 85% WG @ 255 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (12.11×106, 13.67×104, 55.33×103 cfu g⁻¹soil and 14.33×106, 13.33×104, 60.67×103 cfu g⁻¹soil respectively) after first week of herbicides spray. This was statistically on par with application of pyroxasulfone 85% WG @ 170 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (12.57×106, 14.00×104, 59.67×103 cfu g⁻¹soil and 14.67×106, 13.67×104, 65.33×103 cfu g⁻¹soil respectively) and pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (12.82×106, 14.33×104, 61.33×103 cfu g⁻¹soil and 16.33×106, 13.67×104, 68.33×103 cfu g⁻¹soil respectively).

Two weeks after pre and post-emergent herbicide spray also, notable variation was observed in the microbial population. Among the different treatments, the maximum bacterial, fungal and actinomycetes population (31.33×106, 25.33×104, 89.67×103 cfu g⁻¹soil and 38.67×106, 32.67×104, 94.00×103 cfu g⁻¹soil respectively) was recorded in weedy check, whereas minimum microbial populations were observed in the plots receiving application of pyroxasulfone 85% WG @ 255 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (15.32×106, 14.67×104, 62.67×103 cfu g⁻¹soil and 15.67×106, 14.33×104, 61.33×103 cfu g⁻¹soil respectively) after second week of herbicides spray. Which was statistically on par with application of pyroxasulfone 85% WG @ 170 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (15.94×106, 15.67×104, 67.33×103 cfu g⁻¹soil and 15.33×106, 14.67×104, 66.67×103 cfu g⁻¹soil respectively) and pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (16.18×106, 16.33×104, 68.33×103 cfu g⁻¹soil and 17.33×106, 14.33×104, 68.33×103 cfu g⁻¹soil respectively).

The significant variation and decrease in microbial population after one week of pre and post-emergent herbicides application might be because of the toxic effect of herbicides on the growth of bacteria in the rhizosphere soil which resulted in the death of these microorganisms. But interestingly, there was rise in the microbial population after two weeks after pre and post-emergent herbicide spray which could be due to depletion of herbicides in the soil either because of leaching with the rain

water into the soil or the toxic effects on the microbial population might be short-lived. It might also be due to consumption of carbon source present in the herbicide molecule by bacteria. Such outcomes were also noticed by Arunkumar *et al.* (2019) ^[1], Nirmalnath *et al.* (2009) ^[7], Parvathraddi, (2017) ^[9] and Srikanth *et al.* (2023) ^[15] in *Kharif* maize. Similarly, Sheeja K Raj, Elizabeth (2017) ^[14] also observed higher microbial population at 30, 45, 60, and 90 days after application of pyroxasulfone herbicide.

b) Enzymatic activity

The data on the enzymatic activity (dehydrogenase, urease and alkaline phosphatase) was analyzed before herbicide spray, first week after herbicide spray, second week after herbicide spray and at harvest which differed significantly except before herbicide spray and at harvest as there was no complete treatment imposition and low residue activity of herbicides. After one week of pre-emergent and post-emergent herbicides application, significant difference was observed in the dehydrogenase, urease and alkaline phosphatase enzymatic activity. Among the different weed management practices (Table 4, 5 and 6). The major reduction in microbial population was noticed because of herbicides application.

The population of enzymes one week after herbicides spray revealed that the maximum enzymatic activity was obtained in weedy check at 1st week after herbicide spray (1st WAHS) in pre-emergent herbicides (7.35 µg TPF, 16.68 µg NH₄-N g⁻¹, 8.48 µg PNP, g⁻¹ soil day⁻¹ dehydrogenase, urease and alkaline phosphatase respectively) and 1st week after herbicide spray (1st WAHS) in post-emergent herbicides (10.69 µg TPF, 17.62 µg NH₄-N g⁻¹, 9.06 µg PNP, g⁻¹ soil day⁻¹ dehydrogenase, urease and alkaline phosphatase respectively), while the minimum enzymatic activity was noticed in the treatment receiving pyroxasulfone 85% WG @ 255 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (3.32 µg TPF, 9.26 µg NH₄-N g⁻¹, 5.57 µg PNP, g⁻¹ soil day⁻¹) and (3.32 µg TPF, 10.26 µg NH₄-N g⁻¹, 3.32 µg PNP, g⁻¹ soil day⁻¹). This was statistically on par with application of pyroxasulfone 85% WG @ 170 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (3.59 µg TPF, 9.58 µg NH₄-N g⁻¹, 5.84 µg PNP, g⁻¹ soil day⁻¹) and (3.67 µg TPF, 10.43 µg NH₄-N g⁻¹, 3.61 µg PNP, g⁻¹ soil day⁻¹) and application of pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (3.84 µg TPF, 10.22 µg NH₄-N g⁻¹, 5.93 µg PNP, g⁻¹ soil day⁻¹) and (3.85 µg TPF, 10.52 µg NH₄-N g⁻¹, 3.78 µg PNP, g⁻¹ soil day⁻¹ dehydrogenase, urease and alkaline phosphatase respectively).

The soil samples analyzed after two weeks of pre and post-emergent herbicides application revealed that the maximum enzymatic activity was observed in weedy check treatment (8.06 µg TPF, 17.51 µg NH₄-N g⁻¹, 8.83 µg PNP, g⁻¹ soil day⁻¹) and (12.34 µg TPF, 18.26 µg NH₄-N g⁻¹, 9.26 µg PNP, g⁻¹ soil day⁻¹), whereas the minimum dehydrogenase, urease and alkaline phosphatase enzymatic activity was observed in the treatment received pyroxasulfone 85% WG @ 255 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (3.51 µg TPF, 9.31 µg NH₄-N g⁻¹, 5.80 µg PNP, g⁻¹ soil day⁻¹) and (3.65 µg TPF, 11.08 µg NH₄-N g⁻¹, 4.06 µg PNP, g⁻¹ soil day⁻¹), which was statistically on par with application of pyroxasulfone 85% WG @ 170 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (3.82 µg TPF, 10.03 µg NH₄-N g⁻¹, 5.92 µg PNP, g⁻¹ soil day⁻¹) and (3.91 µg TPF, 11.21 µg NH₄-N g⁻¹, 4.15 µg PNP, g⁻¹ soil day⁻¹) and also application of pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb

tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (3.97 µg TPF, 10.35 µg NH₄-N g⁻¹, 6.04 µg PNP, g⁻¹ soil day⁻¹) and (4.06 µg TPF, 11.39 µg NH₄-N g⁻¹, 4.28 µg PNP, g⁻¹ soil day⁻¹ dehydrogenase, urease and alkaline phosphatase respectively)

The variation in dehydrogenase, urease and alkaline phosphatase enzymatic activity might be due to the application of herbicides and the spread of those molecules in the soil that led to their toxic effect on the microbial population during first week of herbicide spray. Once the residue of the chemicals was degraded in the soil, there was gradual improvement in the microbial population after second week of herbicide application thereby clearly indicating increase in enzymatic activity as the chemicals effect was short-lived and completely depleted there after due to the regain in the microbial population. Similar variations in the enzymatic activity were also reported in the experiments of Parvathraddi (2017) ^[9], Sabiry and Babu (2019) ^[12], Arunkumar *et al.* (2019) ^[1], Paul *et al.* (2023) ^[10], Kaur *et al.* (2025) ^[5], Shrikanth (2023) ^[15] in *Kharif* maize. Additionally, Kaur *et al.* (2024) ^[4] and Sheeja and Elizabeth (2017) ^[14] noticed that after the initial inhibition, enzymatic activities began to recover in pyroxasulfone 127.5 a.i. ha⁻¹ treatment.

c. Nutrient uptake

a) Nutrient uptake by maize (kg ha⁻¹)

The data on uptake of the nutrients viz., nitrogen (N), phosphorus (P) and potassium (K) by maize due to different weed management practices (Table 7) indicated that significantly higher uptake of N (143.25 kg ha⁻¹), P (32.34 kg ha⁻¹) and K (139.60 kg ha⁻¹) was recorded from weed free check, whereas lower nutrient uptake by maize was observed in weedy check plot (58.54, 14.03 and 52.77 kg ha⁻¹ of N, P and K, respectively). Among the herbicide treatments, pyroxasulfone 85% WG @ 255 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE had resulted in significantly higher uptake of nutrients (131.15, 29.06 and 125.16 kg ha⁻¹ of N, P and K, respectively) which was statistically on par with the application of pyroxasulfone 85% WG @ 170 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (126.96, 27.70 and 119.63 kg ha⁻¹ of N, P and K, respectively) pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (125.20, 27.15 and 116.76 kg ha⁻¹ of N, P and K, respectively) and atrazine 50% WP @ 1000 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (112.35, 26.82 and 113.90 kg ha⁻¹ of N, P and K, respectively).

Significantly higher uptake of nutrients by maize was significantly observed in weed free check which might be due to abundance of nutrients in the soil by way of complete weed destruction through repetition of hand weeding operation in the treatment. Significantly lower uptake of nutrients was noticed from weedy check. This might be due to improper availability of nutrients in the soil by way of higher weed growth through omission of all possible ways of weed control measures. Likewise, significantly higher uptake of nutrients was observed in pyroxasulfone and tembotrione applied plots which might be attributed to lower nutrient uptake by weeds due to the control of broad spectrum weeds by its weed controlling ability when applied at the right doses and at the right time. Similar results were reported in the earlier findings of Paul *et al.* (2023) ^[10], Lal *et al.* (2016) ^[6], Sahoo *et al.* (2016) ^[13],

b) Nutrient uptake by weeds (kg ha⁻¹)

The data recorded on uptake of nitrogen (N), phosphorus (P) and potassium (K) by weeds at harvest had shown significant

differences in the nutrients uptake due to different weed management practices (Table 7) showed that significantly higher uptake of nutrients by weeds (59.97, 12.44 and 38.30 kg ha⁻¹ of N, P and K, respectively) was observed in weedy check treatment. There was no nutrient uptake noticed in weed free check as there was complete removal of weeds. Among the herbicide treatments, application of pyroxasulfone 85% WG @ 255 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE had recorded significantly lower nutrients uptake (11.86, 3.58 and 7.98 kg ha⁻¹ of N, P and K, respectively) which was statistically on par with the application of pyroxasulfone 85% WG @ 170 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE (12.28, 3.72 and 8.44 kg ha⁻¹ of N, P and K, respectively) and pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. as POE (12.58, 3.90 and

8.49 kg ha⁻¹ of N, P and K, respectively).

Significantly higher uptake of nutrients by weeds was observed in weedy check treatment which might be due to higher weed density, weed dry weight and ability of weeds to utilize nutrients along with other resources vigorously by virtue of their wide adaptability and persistence even in harsh conditions. The zero uptake of nutrients in weed free check was because of complete removal of weeds in the treatment. Significantly lower nutrient uptake by weeds in pyroxasulfone and tembotrione treated plots might be attributed to death of weeds by bleaching effect of herbicides on them due to destruction of chlorophyll in the weed leaves. These findings are in line with the results of the experiments conducted by Paul *et al.* (2023) ^[10], Lal *et al.* (2016) ^[6], Sahoo *et al.* (2016) ^[13].

Table 1: Bacterial population in soil as influenced by different weed management practices in maize

Treatment	Bacterial population ($\times 10^6$ cfu g ⁻¹ soil)						
	Pre-emergent			Post-emergent			At harvest
	BHS	1 st WAHS	2 nd WAHS	BHS	1 st WAHS	2 nd WAHS	
T ₁ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	26.33 ^a	13.84 ^c	17.98 ^c	25.67 ^b	29.33 ^b	31.67 ^{bc}	26.00 ^{ab}
T ₂ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	25.00 ^a	12.76 ^c	16.22 ^c	23.33 ^{bc}	28.33 ^b	29.67 ^c	24.33 ^{ab}
T ₃ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	25.67 ^a	12.49 ^c	15.90 ^c	21.67 ^{bc}	27.67 ^b	28.33 ^c	22.33 ^{ab}
T ₄ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	25.33 ^a	12.26 ^c	15.29 ^c	21.33 ^{bc}	27.33 ^b	28.33 ^c	21.67 ^{ab}
T ₅ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	25.00 ^a	13.10 ^c	16.63 ^c	24.33 ^{bc}	28.67 ^b	29.67 ^c	24.67 ^{ab}
T ₆ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	26.33 ^a	13.81 ^c	17.94 ^c	25.67 ^b	18.33 ^c	19.67 ^d	26.33 ^{ab}
T ₇ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	25.67 ^a	12.82 ^c	16.18 ^c	22.67 ^{bc}	16.33 ^c	17.33 ^d	23.00 ^{ab}
T ₈ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	26.33 ^a	12.57 ^c	15.94 ^c	20.33 ^{bc}	14.67 ^c	15.33 ^d	20.67 ^{ab}
T ₉ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	25.00 ^a	12.11 ^c	15.32 ^c	19.33 ^c	14.33 ^c	15.67 ^d	19.67 ^b
T ₁₀ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	25.67 ^a	13.06 ^c	16.58 ^c	21.67 ^{bc}	18.67 ^c	19.33 ^d	22.00 ^{ab}
T ₁₁ : Hand weeding @ 20 DAS fb Intercultivation at 35 - 40 DAS	26.00 ^a	22.33 ^b	23.67 ^b	32.67 ^a	34.33 ^a	35.67 ^{ab}	26.33 ^{ab}
T ₁₂ : Weed free check	26.33 ^a	21.33 ^b	23.00 ^b	34.67 ^a	36.33 ^a	38.33 ^a	26.67 ^a
T ₁₃ : Weedy check	26.33 ^a	28.67 ^a	31.33 ^a	35.33 ^a	37.33 ^a	38.67 ^a	27.33 ^a
S.E.m. $\pm$	1.69	0.76	1.20	1.69	1.68	1.69	1.96
C.D. at 5%	NS	2.22	3.52	4.97	4.94	4.96	NS

Note: Means followed by same alphabet (s) within a column are not differed significantly by DMRT (P=0.05)

*Figures in parentheses indicate original values

cfu = Colony forming unit BHS = Before herbicide spray fb = followed by HW = Hand weeding a.i. = Active ingredient DAS = Days after sowing WG = Wettable granule IC = Intercultivation SC = Suspension concentrate WAHS = Week after herbicide spray

Table 2: Fungal population in soil as influenced by different weed management practices in maize

Treatment	Fungal population ($\times 10^4$ cfu g ⁻¹ soil)						
	Pre-emergent			Post-emergent			At harvest
	BHS	1 st WAHS	2 nd WAHS	BHS	1 st WAHS	2 nd WAHS	
T ₁ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	20.33 ^{ab}	16.33 ^{bc}	18.33 ^{bc}	18.67 ^{bc}	20.67 ^b	21.33 ^c	19.00 ^a
T ₂ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	20.00 ^{ab}	14.33 ^c	16.67 ^c	17.33 ^c	19.67 ^b	20.67 ^c	17.67 ^a
T ₃ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	19.33 ^{ab}	14.00 ^c	16.00 ^c	16.67 ^c	18.33 ^{bc}	20.33 ^c	17.00 ^a
T ₄ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE	18.67 ^{ab}	13.00 ^c	15.33 ^c	16.33 ^c	18.33 ^{bc}	20.33 ^c	17.00 ^a

<i>fb</i> Intercultivation at 35 - 40 DAS							
T ₅ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE <i>fb</i> Intercultivation at 35 - 40 DAS	20.33 ^{ab}	14.67 ^c	15.67 ^c	16.67 ^c	19.67 ^b	20.67 ^c	17.33 ^a
T ₆ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	20.33 ^{ab}	16.00 ^{bc}	18.31 ^{bc}	18.67 ^{bc}	13.33 ^c	14.67 ^d	19.00 ^a
T ₇ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	19.67 ^{ab}	14.33 ^c	16.33 ^c	17.67 ^c	13.67 ^c	14.33 ^d	18.33 ^a
T ₈ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	19.00 ^{ab}	14.00 ^c	15.67 ^c	16.67 ^c	13.67 ^c	14.67 ^d	17.00 ^a
T ₉ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	18.00 ^b	13.67 ^c	14.67 ^c	15.33 ^c	13.33 ^c	14.33 ^d	16.67 ^a
T ₁₀ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	19.00 ^{ab}	14.67 ^c	15.67 ^c	16.67 ^c	14.33 ^c	14.33 ^d	17.33 ^a
T ₁₁ : Hand weeding @ 20 DAS <i>fb</i> Intercultivation at 35 - 40 DAS	21.67 ^a	20.33 ^{ab}	22.67 ^{ab}	23.67 ^{ab}	25.67 ^a	27.33 ^b	20.33 ^a
T ₁₂ : Weed free check	20.67 ^{ab}	22.67 ^a	23.33 ^{ab}	24.67 ^a	26.33 ^a	28.67 ^{ab}	20.33 ^a
T ₁₃ : Weedy check	20.67 ^{ab}	23.00 ^a	25.33 ^a	28.33 ^a	30.67 ^a	32.67 ^a	20.67 ^a
S.Em. ±	1.06	1.63	1.63	1.65	1.64	1.65	1.63
C.D. at 5%	NS	4.78	4.80	4.83	4.81	4.85	NS

Note: Means followed by same alphabet (s) within a column are not differed significantly by DMRT (P=0.05)

*Figures in parentheses indicate original values

cfu = Colony forming unit BHS = Before herbicide spray fb = followed by HW = Hand weeding a.i.= Active ingredient DAS = Days after sowing WG = Wettable granule IC = Intercultivation SC = Suspension concentrate WAHS = Week after herbicide spray

Table 3: Actinomycetes population in soil as influenced by different weed management practices in maize

Treatment	Actinomycetes population ($\times 10^3$ cfu g ⁻¹ soil)						
	Pre-emergent			Post-emergent			At harvest
	BHS	1 st WAHS	2 nd WAHS	BHS	1 st WAHS	2 nd WAHS	
T ₁ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE <i>fb</i> Intercultivation at 35 - 40 DAS	79.33 ^a	65.33 ^{bcd}	71.33 ^{bcd}	72.67 ^b	73.33 ^b	74.67 ^b	73.33 ^a
T ₂ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE <i>fb</i> Intercultivation at 35 - 40 DAS	75.33 ^a	61.33 ^{bcd}	69.67 ^{bcd}	70.33 ^b	70.67 ^{bc}	71.33 ^{bc}	71.67 ^a
T ₃ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE <i>fb</i> Intercultivation at 35 - 40 DAS	75.00 ^a	60.00 ^{bcd}	66.67 ^{bcd}	67.67 ^b	68.33 ^{bc}	69.67 ^{bc}	68.33 ^a
T ₄ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE <i>fb</i> Intercultivation at 35 - 40 DAS	73.00 ^a	56.67 ^{cd}	61.33 ^d	62.33 ^b	63.67 ^{bc}	64.33 ^{bc}	63.67 ^a
T ₅ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE <i>fb</i> Intercultivation at 35 - 40 DAS	76.67 ^a	63.33 ^{bcd}	71.00 ^{bcd}	71.67 ^b	72.67 ^b	73.67 ^b	72.33 ^a
T ₆ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	78.67 ^a	64.67 ^{bcd}	70.67 ^{bcd}	71.33 ^b	68.67 ^{bc}	69.33 ^{bc}	71.00 ^a
T ₇ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	76.00 ^a	61.33 ^{bcd}	68.33 ^{bcd}	69.67 ^b	67.33 ^{bc}	68.33 ^{bc}	70.33 ^a
T ₈ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	75.00 ^a	59.67 ^{bcd}	67.33 ^{bcd}	67.67 ^b	65.33 ^{bc}	66.67 ^{bc}	68.33 ^a
T ₉ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	74.33 ^a	55.33 ^d	62.67 ^{cd}	62.33 ^b	60.67 ^c	61.33 ^c	63.67 ^a
T ₁₀ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE <i>fb</i> Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	77.67 ^a	63.00 ^{bcd}	70.00 ^{bcd}	71.33 ^b	68.67 ^{bc}	69.33 ^{bc}	71.67 ^a
T ₁₁ : Hand weeding @ 20 DAS <i>fb</i> Intercultivation at 35 - 40 DAS	74.67 ^a	70.67 ^b	73.00 ^b	84.67 ^a	87.67 ^a	89.67 ^a	74.33 ^a
T ₁₂ : Weed free check	78.67 ^a	69.67 ^{bc}	72.33 ^{bc}	89.33 ^a	91.67 ^a	93.67 ^a	75.33 ^a
T ₁₃ : Weedy check	78.33 ^a	84.00 ^a	89.67 ^a	90.67 ^a	93.67 ^a	94.00 ^a	75.67 ^a
S.Em. ±	2.10	4.11	3.04	3.09	3.09	3.11	3.58
C.D. at 5%	NS	12.07	8.92	9.09	9.08	9.12	NS

Note: Means followed by same alphabet (s) within a column are not differed significantly by DMRT (P=0.05)

*Figures in parentheses indicate original values

cfu = Colony forming unit BHS = Before herbicide spray fb = followed by HW = Hand weeding a.i.= Active ingredient DAS = Days after sowing WG = Wettable granular IC = Intercultivation SC = Suspension concentrate WAHS = Week after herbicide spray

Table 4: Dehydrogenase enzymatic activity in soil as influenced by different weed management practices in maize

Treatment	Dehydrogenase activity (μ g TPF g ⁻¹ soil day ⁻¹)						
	Pre-emergent			Post-emergent			At harvest
	BHS	1 st WAHS	2 nd WAHS	BHS	1 st WAHS	2 nd WAHS	
T ₁ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE <i>fb</i> Intercultivation at 35 - 40 DAS	5.56 ^a	4.14 ^b	4.22 ^b	4.28 ^b	7.64 ^b	8.82 ^b	4.36 ^a
T ₂ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE <i>fb</i>	5.23 ^a	3.81 ^b	3.95 ^b	4.05 ^b	6.16 ^b	8.01 ^b	4.12 ^a

Intercultivation at 35 - 40 DAS							
T ₃ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	5.11 ^a	3.62 ^b	3.80 ^b	3.88 ^b	6.09 ^b	7.87 ^b	3.91 ^a
T ₄ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	5.56 ^a	3.33 ^b	3.49 ^b	3.56 ^b	6.94 ^b	7.24 ^b	3.63 ^a
T ₅ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	5.23 ^a	4.02 ^b	4.16 ^b	4.19 ^b	7.58 ^b	8.66 ^b	4.25 ^a
T ₆ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	5.11 ^a	4.11 ^b	4.25 ^b	4.29 ^b	4.16 ^c	4.79 ^c	4.30 ^a
T ₇ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	5.52 ^a	3.84 ^b	3.97 ^b	4.04 ^b	3.85 ^c	4.06 ^c	4.06 ^a
T ₈ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	5.23 ^a	3.59 ^b	3.82 ^b	3.89 ^b	3.67 ^c	3.91 ^c	3.92 ^a
T ₉ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	5.56 ^a	3.32 ^b	3.51 ^b	3.58 ^b	3.32 ^c	3.65 ^c	3.61 ^a
T ₁₀ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	5.50 ^a	4.01 ^b	4.15 ^b	4.18 ^b	4.07 ^c	4.58 ^c	4.22 ^a
T ₁₁ : Hand weeding @ 20 DAS fb Intercultivation at 35 - 40 DAS	5.11 ^a	7.11 ^a	7.98 ^a	8.05 ^a	10.53 ^a	12.24 ^a	4.48 ^a
T ₁₂ : Weed free check	5.56 ^a	7.31 ^a	8.04 ^a	8.09 ^a	10.61 ^a	12.30 ^a	4.51 ^a
T ₁₃ : Weedy check	5.52 ^a	7.35 ^a	8.06 ^a	8.12 ^a	10.69 ^a	12.34 ^a	4.55 ^a
S.Em. ±	0.29	0.29	0.34	0.35	0.50	0.55	0.33
C.D. at 5%	NS	0.85	1.01	1.01	1.46	1.62	NS

Note: Means followed by same alphabet (s) within a column are not differed significantly by DMRT (P=0.05)

*Figures in parentheses indicate original values

TPF = Triphenyl tetrazolium formazan BHS = before herbicide spray WAHS = Week after herbicide spray a.i.= Active ingredient DAS = Days after sowing fb = followed by HW = Hand weeding IC = Intercultivation NS = Non-significant SC = Suspension concentrate WG = Wettable granual

Table 5: Urease enzymatic activity in soil as influenced by different weed management practices in maize

Treatment	Urease (µg NH ₄ -N g ⁻¹ soil hr ⁻¹)						
	Pre-emergent			Post-emergent			At harvest
	BHS	1 st WAHS	2 nd WAHS	BHS	1 st WAHS	2 nd WAHS	
T ₁ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	15.22 ^a	11.63 ^b	12.02 ^b	14.76 ^b	15.22 ^b	16.08 ^a	14.51 ^a
T ₂ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	15.16 ^a	10.16 ^b	10.39 ^{bc}	14.07 ^b	14.51 ^b	15.46 ^a	14.24 ^a
T ₃ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	15.29 ^a	9.52 ^b	10.08 ^{bc}	13.80 ^b	14.33 ^b	15.27 ^a	14.22 ^a
T ₄ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	16.18 ^a	9.29 ^b	9.37 ^c	13.27 ^b	14.21 ^b	15.18 ^a	13.43 ^a
T ₅ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	15.29 ^a	10.65 ^b	11.20 ^{bc}	14.54 ^b	15.13 ^b	15.94 ^a	14.50 ^a
T ₆ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	16.24 ^a	11.59 ^b	12.07 ^b	14.73 ^b	10.86 ^c	11.83 ^b	14.62 ^a
T ₇ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	15.16 ^a	10.22 ^b	10.35 ^{bc}	14.06 ^b	10.52 ^c	11.39 ^b	14.00 ^a
T ₈ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	16.14 ^a	9.58 ^b	10.03 ^{bc}	13.79 ^b	10.43 ^c	11.21 ^b	13.77 ^a
T ₉ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	16.22 ^a	9.26 ^b	9.31 ^c	13.25 ^b	10.26 ^c	11.08 ^b	13.61 ^a
T ₁₀ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	15.29 ^a	10.71 ^b	11.26 ^{bc}	14.52 ^b	10.74 ^c	11.52 ^b	14.44 ^a
T ₁₁ : Hand weeding @ 20 DAS fb Intercultivation at 35 - 40 DAS	16.20 ^a	16.52 ^a	17.48 ^a	17.53 ^a	17.62 ^a	18.23 ^a	15.26 ^a
T ₁₂ : Weed free check	15.36 ^a	16.07 ^a	17.39 ^a	17.42 ^a	17.55 ^a	18.22 ^a	15.33 ^a
T ₁₃ : Weedy check	16.22 ^a	16.68 ^a	17.51 ^a	17.56 ^a	17.62 ^a	18.26 ^a	15.37 ^a
S.Em. ±	1.37	0.99	0.70	0.87	0.71	1.00	1.61
C.D. at 5%	NS	2.91	2.06	2.55	2.08	2.94	NS

Note: Means followed by same alphabet (s) within a column are not differed significantly by DMRT (P=0.05)

*Figures in parentheses indicate original values

BHS = before herbicide spray WAHS = Week after herbicide spray a.i.= Active ingredient DAS = Days after sowing fb = followed by HW = Hand weeding IC = Intercultivation NS = Non-significant SC = Suspension concentrate WG = Wettable granual

Table 6: Alkaline phosphatase enzymatic activity in soil as influenced by different weed management practices in maize

Treatment	Alkaline phosphatase ($\mu\text{g PNP g}^{-1} \text{ soil hr}^{-1}$)						
	Pre-emergent			Post-emergent			At harvest
	BHS	1 st WAHS	2 nd WAHS	BHS	1 st WAHS	2 nd WAHS	
T ₁ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	8.22 ^a	6.18 ^b	6.55 ^b	6.64 ^b	6.87 ^b	7.85 ^b	6.67 ^a
T ₂ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	8.25 ^a	5.93 ^b	6.05 ^b	6.11 ^b	6.45 ^b	7.34 ^b	6.16 ^a
T ₃ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	8.01 ^a	5.84 ^b	5.91 ^b	6.02 ^b	6.38 ^b	7.27 ^b	6.10 ^a
T ₄ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	8.24 ^a	5.57 ^b	5.81 ^b	5.89 ^b	6.24 ^b	7.14 ^b	5.96 ^a
T ₅ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	8.30 ^a	6.02 ^b	6.30 ^b	6.38 ^b	6.52 ^b	7.62 ^b	6.41 ^a
T ₆ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	8.19 ^a	6.18 ^b	6.57 ^b	6.66 ^b	3.98 ^c	4.79 ^c	6.68 ^a
T ₇ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	8.24 ^a	5.93 ^b	6.04 ^b	6.09 ^b	3.78 ^c	4.28 ^c	6.12 ^a
T ₈ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	8.06 ^a	5.84 ^b	5.92 ^b	6.01 ^b	3.61 ^c	4.15 ^c	6.07 ^a
T ₉ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	8.32 ^a	5.57 ^b	5.80 ^b	5.96 ^b	3.32 ^c	4.06 ^c	6.01 ^a
T ₁₀ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	8.22 ^a	6.02 ^b	6.32 ^b	6.41 ^b	3.91 ^c	4.56 ^c	6.28 ^a
T ₁₁ : Hand weeding @ 20 DAS fb Intercultivation at 35 - 40 DAS	8.17 ^a	8.22 ^a	8.65 ^a	8.73 ^a	8.86 ^a	9.02 ^a	7.34 ^a
T ₁₂ : Weed free check	8.26 ^a	8.31 ^a	8.72 ^a	8.81 ^a	8.93 ^a	9.11 ^a	7.52 ^a
T ₁₃ : Weedy check	8.41 ^a	8.48 ^a	8.83 ^a	8.94 ^a	9.06 ^a	9.26 ^a	7.57 ^a
S.Em. $\pm$	0.56	0.50	0.50	0.50	0.35	0.30	0.50
C.D. at 5%	NS	1.47	1.47	1.48	1.02	0.87	NS

Note: Means followed by same alphabet (s) within a column are not differed significantly by DMRT (P=0.05)

*Figures in parentheses indicate original values

PNP= P-nitrophenyl phosphate BHS = before herbicide spray WAHS = Week after herbicide spray a.i.= Active ingredient DAS = Days after sowing fb = followed by HW = Hand weeding IC = Intercultivation NS = Non-significant SC = Suspension concentrate WG = Wettable granual

Table 7: Nutrient uptake by maize and weeds at harvest as influenced by different weed management practices in maize

Treatment	Maize (kg ha ⁻¹)			Weeds (kg ha ⁻¹)		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
T ₁ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	61.20 ^h	14.71 ^{fg}	59.28 ^{hi}	36.61 ^b	10.20 ^b	27.88 ^b
T ₂ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	79.68 ^{fg}	16.59 ^{efg}	71.27 ^{fgh}	27.35 ^d	8.14 ^c	21.62 ^c
T ₃ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	84.77 ^{fg}	18.98 ^{def}	76.10 ^{fg}	24.00 ^e	7.96 ^c	19.47 ^d
T ₄ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	93.30 ^{ef}	19.90 ^{de}	83.93 ^{ef}	22.66 ^e	7.56 ^c	18.11 ^d
T ₅ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Intercultivation at 35 - 40 DAS	72.74 ^{gh}	15.83 ^{efg}	66.40 ^{ghi}	30.53 ^c	9.83 ^b	23.29 ^c
T ₆ : Pyroxasulfone 85% WG @ 85 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	110.41 ^{cde}	23.24 ^{cd}	101.10 ^{cd}	15.72 ^{fg}	5.32 ^{de}	10.85 ^f
T ₇ : Pyroxasulfone 85% WG @ 127.5 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	125.20 ^{abc}	27.15 ^{bc}	116.76 ^{bc}	12.58 ^{hi}	3.90 ^{fg}	8.49 ^g
T ₈ : Pyroxasulfone 85% WG @ 170 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	126.96 ^{abc}	27.70 ^b	119.63 ^b	12.28 ^{hi}	3.72 ^g	8.44 ^g
T ₉ : Pyroxasulfone 85% WG @ 255 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	131.15 ^{ab}	29.06 ^{ab}	125.16 ^{ab}	11.86 ⁱ	3.58 ^g	7.98 ^g
T ₁₀ : Atrazine 50% WP @ 1000 g a.i. ha ⁻¹ as PE fb Tembotrione 34.4% SC @ 48 g a.i. ha ⁻¹ as POE	112.35 ^{bcd}	26.82 ^{bc}	113.90 ^{bc}	14.84 ^{gh}	4.77 ^{ef}	10.13 ^{fg}
T ₁₁ : Hand weeding @ 20 DAS fb Intercultivation at 35 - 40 DAS	104.60 ^{de}	22.33 ^d	95.63 ^{de}	17.84 ^f	5.98 ^d	13.11 ^e
T ₁₂ : Weed free check	143.25 ^a	32.34 ^a	139.60 ^a	0.00 ^j	0.00 ^h	0.00 ^h
T ₁₃ : Weedy check	58.54 ^h	14.03 ^g	52.77 ⁱ	59.97 ^a	12.44 ^a	38.30 ^a
S.Em. $\pm$	6.01	1.38	5.11	0.91	0.34	0.70
C.D. at 5%	17.64	4.06	15.00	2.67	0.98	2.06

Note: Means followed by same alphabet (s) within a column are not differed significantly by DMRT (P=0.05)

*Figures in parentheses indicate original values

a.i.= Active ingredient DAS = Days after sowing fb = followed by HW = Hand weeding IC = Intercultivation SC = Suspension concentrate WG = Wettable granual

4. Conclusion

The weedy check treatment recorded significantly higher microbial population as compare to herbicide applied treatments. Among the herbicide applied treatment, the pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE was the safer dose both for microbial population and enzymatic activity. As the study also revealed that nutrient uptake by weeds in weedy check plot was significantly higher compared to other treatments indicating the impact of weed presence in maize field. Hence pyroxasulfone 85% WG @ 127.5 g a.i. ha⁻¹ as PE fb tembotrione 34.4% SC @ 48 g a.i. ha⁻¹ as POE can be used as an effective weed management practice in maize for better weed control, higher grain yield and monetary benefits.

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