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Response of native soil microbial population to micro-sprinkler herbigation with pre-emergence and lay-by herbicide applications in onion (*Allium cepa* var. *aggregatum*)

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Abstract

A field experiment was conducted during the *Rabi* season of 2018 at the Agricultural College and Research Institute, Madurai, to evaluate the effect of herbigation on the native soil microbial population. The field experiment was laid out in randomised block design with ten treatments involving pre emergence (first application) and layby (second) application of herbicides namely pendimethalin and oxyfluorfen at different doses applied through normal method of application (spraying) and herbigation by micro sprinklers. The microbial count was estimated at different intervals after herbicide application. The results revealed that native microbial (bacterial, fungal and actinomycetes) population of the treated plots were significantly decreased immediately after herbicide application at all doses of both the herbicides. Later microbial population was gradually recovered with time and it reaches even more than the original level. Further, this study clearly indicates that herbigation (application of herbicides through micro sprinkler) both pre emergence and lay by application causes only a transient effect and doesn't affect the microbial population over period of time and its effect was very similar to the normal method of herbicide application.

Keywords: Herbigation, herbicides, pendimethalin, oxyfluorfen, micro-sprinkler

Introduction

Weeds are the largest biological constraint to increasing the production of crops by competing with them for all sources of inputs. It makes the plant starve and thrust. Removal of such weeds is a necessary task to get higher production. In this period of developing labour crisis, weed management through chemical herbicides was economically more effective. Pre emergence applications (first) of herbicides maintain the field as weed free at initial stages of crop growth. Later, development of a second flush of weeds causes major problems in reproductive stages. That may be controlled by hand weeding or post emergence herbicide application or layby (Second) application of pre emergence herbicides. Layby application is the sequential application of pre emergence herbicides followed by hand weeding. Compared to hand weeding and post emergence herbicides, layby application showed better management of weeds (Pradhap *et al.*, 2017) [9]. The normal method of herbicide application by knapsack sprayer is drudgery work, takes considerable time, energy and expense. On the other hand, herbigation through sprinklers and micro sprinklers is an emerging technology and cost of fuel, manpower, and equipment are reduced by using micro sprinklers for irrigation as well as chemigation.

Onion crop is less competitive to weeds because of their short stature and slender leaves. Weed infestation at any stage of onion crop will affect the yield. While applying herbicides with irrigation water, the uniformity of spread and herbicide activity was increased and also the function of solubility, adsorption and volatility was influenced by herbigation. Application of herbicides through micro sprinkler irrigation system gives good efficiency of weed control (Ogg, 1983) [8]. In the above background, the present study was carried to find out the effect of pre emergence and layby application of herbicides through micro sprinkler on native microbial population of the onion field.

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Materials and Methods

A field experiment was conducted during *Rabi* season of 2018 at Agricultural College and Research Institute, Madurai. The experimental farm is geologically located at 9°54' N latitude and 78°54' E longitude with an altitude of 147 m above the mean sea level. The experiment was laid out in Randomized Block Design

with ten treatments and replicated thrice. After initial field preparation, raised beds were formed and micro sprinkler irrigation system was laid out. Thirty five days old onion seedlings (Variety Co5) were transplanted in the raised beds.

Treatment details

T ₁	:	PEA of 0.75 kg a.i. ha ⁻¹ pendimethalin (100% RD) by micro sprinklers + 1 HW at 20 DAT
T ₂	:	PEA of 0.125 kg a.i. ha ⁻¹ oxyfluorfen (100% RD) by micro sprinklers + 1 HW at 20 DAT
T ₃	:	PEA of 0.75 kg a.i. ha ⁻¹ pendimethalin (100%RD) by micro sprinklers + 1 HW fb 2 nd application of 0.375 kg a.i. ha ⁻¹ (50% RD) at 20 DAT
T ₄	:	PEA of 0.75 kg a.i. ha ⁻¹ pendimethalin (100%RD) by micro sprinklers + 1 HW fb 2 nd application of 0.56 kg a.i. ha ⁻¹ (75% RD) at 20 DAT
T ₅	:	PEA of 0.125 kg a.i. ha ⁻¹ oxyfluorfen (100%RD) by micro sprinklers + 1 HW fb 2 nd application of 0.0624 kg a.i. ha ⁻¹ (50% RD) at 20 DAT
T ₆	:	PEA of 0.125 kg a.i. ha ⁻¹ oxyfluorfen (100% RD) by micro sprinklers + 1 HW fb 2 nd application of 0.0937 kg a.i. ha ⁻¹ (75% RD) at 20 DAT
T ₇	:	PEA of 0.75 kg a.i. ha ⁻¹ pendimethalin (100% RD) by sprayer + 1 HW at 20 DAT
T ₈	:	PEA of 0.125 kg a.i. ha ⁻¹ oxyfluorfen (100% RD) by sprayer + 1 HW at 20 DAT
T ₉	:	Weedy check
T ₁₀	:	Weed free check

Irrigation

Irrigation was done through micro sprinklers of 34 litres hr⁻¹ flow rate. The irrigation system comprises of mainline (73 mm), sub mains (40 mm) and 16 mm laterals. Laterals are connected at 2 m distance in the sub main and each sprinkler head at laterals were placed in 2 m distance at the top of 16 mm raiser pipes of one metre height.

First irrigation was given immediately after transplanting. Life irrigation was given three days after transplanting and successive irrigations were scheduled once in three days based on the daily pan evaporation (100 per cent PE).

Herbigation

Pre emergence herbicides pendimethalin and oxyfluorfen were applied as per the treatment details at 3 DAT and the second application of the herbicides were given at 20 DAT as layby application after hand weeding as per the treatment details. For herbigation, the required quantity of herbicide was mixed in a container and a small suction pump was used to inject the above herbicidal solution to selected laterals as per the treatment when the soil was under fully saturated condition. Ten minutes after start of the irrigation, herbicidal solution was injected and again the normal water was injected to empty the system.

Microbial analysis

Soil samples were collected from the rhizosphere region (0-30 cm soil depth) at each treatment before herbigation, immediately after herbigation (3 DAT), after layby (second) application (25 DAT) and 40 DAT. Collected samples were serially diluted upto 10⁻⁷, 10⁻⁴ and 10⁻⁶ dilution factor for estimation of bacteria, fungi and actinomycetes respectively. One ml of aliquot was added to media plates, viz. Nutrient Agar for bacteria (Allen 1959) [1], Martin Rose Bengal Agar for fungi (Martin 1950) [5], Kin Knights and Munaier Agar (Allen 1959) [1] for actinomycetes. The plates were incubated in optimum temperature in three replications. The microbial colonies were developed in stipulated incubation period (3 days for bacteria; 5 days for fungi and 7 days for actinomycetes) and then the total culturable colony forming units (Cfus/g of the sample) were counted.

Results and Discussion

Bacterial, fungal and actinomycetes populations of the different treatments were estimated at various crop growth stages. At 3 DAT (immediately after herbigation), herbicide applied (both herbigation and normal method application) treatments registered significantly lower bacterial population over non herbicide applied treatments. Among the herbicidal applied treatments,

oxyfluorfen applied treatments T₂, T₅, T₆, T₈ recorded the more decreased bacterial population (28%, 32%, 35%, 30% respectively) than pendimethalin applied plots T₁, T₃, T₄, T₇ (23%, 25%, 22%, 23% respectively). Similar trend of results was obtained for the fungal population also. The oxyfluorfen applied treatments T₂, T₅, T₆, T₈ registered more decreased fungal population (35%, 32%, 38%, 38% respectively) than in the pendimethalin applied plots T₁, T₃, T₄, T₇ (23%, 23%, 24%, 27% respectively). This might be due to the impact of toxicity in herbicides on the microbes (Nalayini and Kandasamy, 2003) [6]. With reference to actinomycetes population, only numerical deviation was observed and statistically all treatments were on par. The method of application of herbicides (normal method and micro sprinkler herbigation) had no significant influence over microbial population. Similar type of findings were achieved by Nalayini *et al.* (2013) [7] in drip herbigation.

At 25 DAT, after layby (second) application of both the herbicides significantly reduced the bacterial and fungal population and however, no significant difference was registered between different dose of herbicides (50 and 75 per cent of recommended doses). Recovery of both bacterial and fungal population was observed in only pre emergence herbicide (both normal method and micro sprinkler herbigation) applied treatments. More similar to 3 DAT, layby oxyfluorfen applied treatments (T₅ & T₆) recorded more decreased population than pendimethalin applied treatments (T₃ & T₄) and there was no significant increase in Actinomycetes population.

At 40 DAT, bacterial and fungal population was increased in all plots over control (T₉, T₁₀) where herbicides were not applied. Among the herbicide applied treatments, oxyfluorfen applied treatments (T₅ and T₆) recorded the highest bacterial and fungal population. Bacterial population was increased to the tune of 17% and 15% and fungal population was increased to the tune of 19% and 13% in T₅ and T₆ respectively and however, no considerable increase in actinomycetes population was noticed in the above treatments. This might be due to degradation of herbicides by microorganisms (Silambarasan *et al.*, 2017) [10]. Generally, herbicides are degraded by means of photochemical, chemical or microbial in nature. Microorganisms feed the organic compounds of the herbicide and multiplied in higher rate (Janjua *et al.*, 1996) [2].

In layby application, only 50% and 75% of the recommended dose of herbicide was added in the crop field and this has increased soil microorganism over a period of time. Lupwayi *et al.* (2004) [4] and Lupwayi *et al.* (2007) [3] reported that when the herbicides are applied at or below the recommended level, the native microbial population of the soil was not affected.

Table 1: Effect of herbigation on native microbial population in onion field

T. No.	Treatments	Bacterial population (cfu X 10 ⁻⁷ g ⁻¹ of dry soil)				Fungal population (cfu X 10 ⁻⁴ g ⁻¹ of dry soil)				Actinomycetes population (cfu X 10 ⁻⁶ g ⁻¹ of dry soil)			
		Before herbigation	Immediately after herbigation	25 DAT	40 DAT	Before herbigation	Immediately after herbigation	25 DAT	40 DAT	Before herbigation	Immediately after herbigation	25 DAT	40 DAT
T ₁	PEA of 0.75 kg a.i. ha ⁻¹ Pendimethalin (100% RD) by micro sprinklers + 1 HW at 20 DAT	19.52	16.69	27.62	35.96	9.51	7.63	15.14	17.59	28.51	26.28	32.59	34.64
T ₂	PEA of 0.125 kg a.i. ha ⁻¹ Oxyfluorfen (100% RD) by micro sprinklers + 1 HW at 20 DAT	19.07	15.57	26.23	35.62	9.19	6.45	15.92	18.24	27.92	25.16	32.15	34.19
T ₃	PEA of 0.75 kg a.i. ha ⁻¹ Pendimethalin (100% RD) by micro sprinklers + 1 HW fb 2 nd application of 0.375 kg a.i. ha ⁻¹ (50% RD) at 20 DAT	18.62	16.30	23.68	36.91	8.94	7.62	12.57	19.52	27.01	26.49	31.95	35.85
T ₄	PEA of 0.75 kg a.i. ha ⁻¹ Pendimethalin (100% RD) by micro sprinklers + 1 HW fb 2 nd application of 0.56 kg a.i. ha ⁻¹ (75% RD) at 20 DAT	19.36	16.86	23.93	36.31	9.38	7.51	13.01	19.23	28.59	26.84	31.54	34.01
T ₅	PEA of 0.125 kg a.i. ha ⁻¹ Oxyfluorfen (100% RD) by micro sprinklers + 1 HW fb 2 nd application of 0.0624 kg a.i. ha ⁻¹ (50% RD) at 20 DAT	18.59	14.66	21.15	38.53	9.46	6.69	12.28	20.96	28.15	25.12	31.01	35.62
T ₆	PEA of 0.125 kg a.i. ha ⁻¹ Oxyfluorfen (100% RD) by micro sprinklers + 1 HW fb 2 nd application of 0.0937 kg a.i. ha ⁻¹ (75% RD) at 20 DAT	18.37	14.02	20.48	38.08	10.80	6.16	12.06	19.91	27.41	24.20	31.32	35.94
T ₇	PEA of 0.75 kg a.i. ha ⁻¹ Pendimethalin (100% RD) by sprayer + 1 HW at 20 DAT	18.21	16.53	28.63	34.28	9.76	7.21	14.99	17.38	27.96	25.67	32.27	35.16
T ₈	PEA of 0.125 kg a.i. ha ⁻¹ Oxyfluorfen (100% RD) by sprayer + 1 HW at 20 DAT	19.75	15.21	27.52	35.06	9.53	6.15	15.56	17.64	28.23	25.46	32.85	34.98
T ₉	Weedy check	19.08	22.45	26.01	34.25	9.62	9.92	15.32	18.02	27.64	28.81	32.96	34.12
T ₁₀	Weed free check	19.70	21.60	26.62	33.01	9.16	9.86	14.91	17.58	28.47	29.01	32.16	34.82
	SEd	0.99	0.90	1.45	1.37	0.49	0.43	0.86	0.99	1.70	1.73	1.94	1.61
	CD(p=0.05)	NS	1.94	2.65	2.51	NS	0.49	1.57	1.82	NS	NS	NS	NS

HW- Hand weeding, DAT- Days after transplanting, PEA – Pre emergence application

Conclusion

From this study it is concluded that both pre emergence (first application) and layby (second) application of herbicides through micro sprinklers caused some reduction of microbial population on immediately after application. However, population gradually recovered with time and finally reaches even more than original level due to degradation of herbicides by microorganisms. Hence, an application of herbicides through normal method as well as micro sprinkler irrigation caused only transient effect on microorganisms (reduced initially immediately after application and builds up automatically over time passes on).

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