International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 2224-2227

Received: 10-11-2019
Accepted: 12-12-2019

Devi Lal Dhaker
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Birendra Kumar
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Arnab Roy Chowdhury
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Mahendra Singh
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Shivam Maurya
Department of Plant Pathology, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar

Corresponding Author:
Devi Lal Dhaker
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Effect of chemical weed management practices on soil microbial population and yield in direct seeded rice

Devi Lal Dhaker, Birendra Kumar, Arnab Roy Chowdhury, Mahendra Singh and Shivam Maurya

DOI: https://doi.org/10.22271/chemi.2020.v8.i1ah.8602

Abstract
The use of herbicides in direct-seeded rice may affect the biological properties of the soil and thus influence the nutrient status, health and productivity of the soil. To study the effect of herbicides on soil microbial population and yield of direct-seeded rice. A field experiment was conducted RBD with eleven treatments at Agriculture Research Farm, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India during Kharif 2018. The results revealed that viable microbial population was influenced to varying degrees with different weed control treatments. The maximum bacterial count (14.86 X 10^6 CFU g^{-1} soil) was observed under the treatment T_4 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE fb Bispyribac sodium @ 25 g a.i. ha^{-1} POE) and minimum bacterial count was found under the treatment T_9 (Halosulfuron @ 67.5 g a.i. ha^{-1} + Azimsulfuron @ 30 g a.i. ha^{-1} POE) (11.46 X 10^6 CFU g^{-1} soil). the maximum actinomycetes count (17.82 X 10^5 CFU g^{-1} soil) was observed under the treatment T_1 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE) and the minimum actinomycetes count was observed under the treatment T_6 (Bispyribac sodium @ 25 g a.i. ha^{-1} POE) (14.05 X 10^5 CFU $g^{-1}$and , the maximum fungi count (10.55 X 10^4 CFU g^{-1} soil) was observed under the treatment T_9 (Halosulfuron @ 67.5 g a.i. ha^{-1} + Azimsulfuron @ 30 g a.i. ha^{-1} POE) and the minimum fungi count was observed under the treatment T_{10} (hand weeding) (7.60 X10^4 CFU g^{-1} soil).The maximum grain yield (5.50 t ha^{-1}) was observed in T_{10} (hand weeding) and it was followed (5.41 t ha^{-1}) by T_5 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE *fb* Bispyribac sodium @ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} POE). T_5 *fb* T_4 (5.08 t ha^{-1}) and T_9 (4.67 t ha^{-1}) and which was significantly superior over rest of the treatments. The minimum grains yield was recorded (2.70 t ha^{-1}). in T_{11} (weedy check) as post-emergence were safe for soil microbial populations at recommended rate application of herbicides.

Keywords: Actinomycetes, bacteria, direct seeded rice, fungi, herbicides

Introduction
Rice (*Oryza sativa* L.) is a main food grain crop of the world and more than 90% of rice worldwide is grown and consumed in Asia (Chauhan *et al.*, 2012). India is the second largest rice producing country in the world. It is the main staple food crop of India, covering an area of about 43.19 million hectares with total production of 110.15 million tonnes and average productivity is 2.55 tonnes ha^{-1} (Source: Annual report of Ministry of Agriculture and Farmers' Welfare, 2017-18). In Bihar, the area of rice is 3.33 million ha with production of 8.23 million tonnes and productivity is 2.4 t ha^{-1} (Source: State wise 4th advance estimate of principal crops during 2016-17, Ministry of Agriculture). Rice is mainly cultivated by transplanting in puddled field, which is the formation of hard pan and damages soil structure, though it helps in retention of more water and effective in weed control, but this needs more time, labour and energy. Farmers are keen to adopt direct seeding rice (DSR) in order to reduce water and labour cost by avoiding puddling of soil, nursery management and transplanting operations. It also improves soil structure, reduces greenhouse gas emission, facilitates timely sowing of succeeding wheat and crop diversification by early maturation of rice by 7-10 days (Verma *et al.*, 2017) [13]. In present-day time direct seeded rice could be a viable alternative to transplanted rice due to availability of short duration varieties. It is now fast replacing traditional transplanted rice in areas with good drainage and weed control (Balasubramanian and Hill (2002) [3].

Being the farmers' friendly technology, area under direct seeded rice is increasing day by day in Bihar even though weed management is a difficult task in this crop. Problem of weeds is acute in direct seeded rice because of the absence of standing water in the field which suppresses weed in transplanted rice. Therefore, in direct seeded rice, favorable environmental conditions for the growth of different type of weed flora poses major complication to attain good yields. It is not uncommon to see fields full of diverse flora of weeds in this crop. Extent of loss may vary depending upon cultural methods, rice cultivars, weed species association, and their density and duration of competition. When herbicides are applied in soil, they may exert certain side effects on non-target organisms. Therefore, there has been considerable interest on the influence of herbicides on the soil microflora and microbially mediated processes. The increasing reliance of rice cultivation on herbicides has led to concern about their ecotoxicological behaviour in the rice field environment. Soil health and microbial diversity have become vital issues for the sustainable agriculture. Loss of microbial biodiversity can affect the functional stability of the soil microbial community and soil health. Generally, there are some negative effects of herbicides on the population level or composition of species. The impact of applied herbicides on the soil microbial populations were studied which included analysis of bacteria, actinomycetes and fungi counts.

Materials and Methods

A field experiment was conducted at Agriculture Research Farm, Bihar Agricultural University, Sabour, Bhagalpur, Bihar (longitude 87o2'42" East and latitude 25o15′40″ North at altitude of 46 meters above mean sea level in the heart of the vast Indo-Gangetic plains of North India.) during *Kharif* Season 2018. The soil of the experimental site was loamy sand in texture having normal soil reaction (pH 7.27) and electrical conductivity (0.27 dSm^{-1}), low in organic carbon (0.46%) and available N (180.61 kg ha^{-1}) and medium in available P (22.65 kg ha^{-1}) and K (206.88 kg ha^{-1}). The experiment comprised of 11 weed management practices, viz., alone application of Pendimethalin and Pyrazosulfuron were applied as pre-emergence while other herbicides as post-emergence at 20 days after sowing of crop *i.e.* treatments T_1 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE), T_2 (Pendimethalin @1000 g a.i. ha^{-1} PE), T_3 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE fb 2,4-DEE @ 750 g a.i. ha^{-1} POE), T_4 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE fb Bispyribac sodium @ 25 g a.i. ha^{-1} POE), T_5 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE fb Bispyribac sodium @ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} POE), T_6 (Bispyribac sodium @ 25 g a.i. ha^{-1} POE), T_7 (Bispyribac sodium@ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} POE), T_8 (Ethoxysulfuron @ 15 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} POE), T_9 (Halosulfuron @ 67.5 g a.i. ha^{-1} + Azimsulfuron @ 30 g a.i. ha^{-1} POE), T_{10} (Hand weeding 15, 30 and 45 DAS) and T_{11} (Weedy check) find out the effect of herbicides on soil microbial population and yield of direct-seeded rice. The experiment was laid out in randomized block design (RBD) with three replications. Rice variety 'Sabour sampanna dhan' (BRR0059) was seeded on 16^{th} June 2018. Sown tractor drawn conventional drill using with seed rate of 30 kg ha^{-1} in rows spaced at 20 cm. The recommended dose of fertilizers and plant protection measures for insect-pest and disease control were applied. Herbicide was sprayed by knapsack sprayer fitted with flat fan nozzle using 500 litres of water per hectare.

Four samples of rhizospheric soil under each treatment were taken from 0-15 cm soil depth and mixed so as to have a representative sample of the treatment. The 10 g of soil samples were placed in an Erlenmeyer flask containing 90 ml of sterilized distilled water, and shaken for 30 min. Ten-fold series dilutions were prepared, and appropriate dilutions were plated in specific media. For the isolation of bacteria, fungi and actinomycetes, the Plate Count Agar, Czapek-Dox Agar (Thom and Raper, 1945) [12] and Kenknight and Munaier's Medium, respectively were used. The numbers of colony forming cells were determined in each plot by serial dilution pour plate method (Subba, 1986) [11]. The obtained field experiment data were analyzed by using standard procedure for Randomized Block Design (RBD) with the help of a computer applying analysis of variance (ANOVA) technique (Snedecor and Cochron, 1971) [8]. The differences among treatments were compared by applying "F" test of significance at 5 per cent of probability and P values was used to examine differences among treatment means.

Result and Discussion

Effect of various herbicides treatments on microbial population

Counts of bacteria, fungi and actinomycetes were no significantly affected by different herbicides treatments at maturity of the crop (Table 1). Among different herbicides treatments, there were no significantly lower counts of fungi, actinomycetes and bacteria were found in the weed free and weedy check. Higher microbial populations in the herbicidal treatments at maturity stages of observation might be due to healthy and conducive environment for the microorganisms as compared to the control and also more root exudation which is the carbon source for microbial multiplication and their growth. There was increase in the biological properties of the soil in well aerated aerobic soil conditions found in direct seeded rice hence might be ascribed to the improvement in the nutrient status as well as physical conditions of the soil which resulted in better growth of the microorganisms. The degradation of herbicides may be serving as carbon source for growth of microbes. Bera *et al*. (2013) [4] However, before degradation, herbicides have toxic effects on microorganisms, reducing their abundance, activity and consequently, the diversity of their communities. The herbicides their degradation products generally take some time to accumulate in the soil and then affect the soil microflora. Actinobacteria were less affected as compared to bacteria and fungi. Actinobacteria are reported relatively resistant to herbicides and get affected at high concentration only as reported by Sondhia (2008) [9].

The maximum bacterial count (14.86 X 10^6 CFU g^{-1} soil) was observed under the treatment T_4 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE fb Bispyribac sodium @ 25 g a.i. ha^{-1} POE) and minimum bacterial count was found under the treatment T_9 (Halosulfuron @ 67.5 g a.i. ha^{-1} + Azimsulfuron @ 30 g a.i. ha^{-1} POE) (11.46 X 10^6 CFU g^{-1} soil). the maximum actinomycetes count (17.82 X 10^5 CFU g^{-1} soil) was observed under the treatment T_1 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE) and the minimum actinomycetes count was observed under the treatment T_6 (Bispyribac sodium @ 25 g a.i. ha^{-1} POE) (14.05 X 10^5 CFU g^{-1} and , the maximum fungi count (10.55 X 10^4 CFU g^{-1} soil) was observed under the treatment T_9 (Halosulfuron @ 67.5 g a.i. ha^{-1} + Azimsulfuron @ 30 g a.i. ha^{-1} POE) and the minimum fungi count was observed under the treatment T10 (hand weeding) (7.60 X10^4 CFU g^{-1} soil).

The maximum grain yield (5.50 t ha^{-1}) were observed in T10 (hand weeding) and it is followed (5.41 t ha^{-1}) by T_5 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE *fb* Bispyribac sodium @ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} POE). T_5 *fb* T_4 (5.08 t ha^{-1}), T_9 (4.67 t ha^{-1}) and it was significantly superior over rest of the treatments. The minimum grains yield was recorded (2.70 t ha^{-1}). in T_{11} (weedy check). Similarly, results were in conformity with the findings of Sanodiya and Singh (2017) [7] and *Yadav et al.* (2009) [14]. The maximum straw yield (6.69 t ha^{-1}) was observed in T_{10} (hand weeding) and it is followed (6.69 t ha^{-1}) by T_5 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE *fb* Bispyribac sodium @ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} POE). T_5 *fb* T_4 (6.35 t ha^{-1}), T_6 (5.90 t ha^{-1}), T_7 (6.06 t ha^{-1}), T_8 (5.37 t ha^{-1}), T_9 (6.19 t ha^{-1}). The minimum straw yield was recorded (3.97 t ha^{-1}) in T_{11} (weedy check).

At harvest stage the microbial viz., bacteria, actinomycetes and fungi population under all herbicide's treatments were found more when compared with weed free and weedy treatments. might be due to the more availability of carbon from the root exudation and from the degradation of herbicides. It could be further inferred that the microbial population started to regain after the weeds were also killed by the herbicides and got mixed in the soil and these might have served to increase the nutrients (Omara and Ghandor, 2018) [6] The bacterial population in herbicide treated plots was more or less similar to the unsprayed control plots in later stages indicating that herbicides have no detrimental effect on soil health at applied doses. Anderson (2003) reported that herbicides generally appear to have no adverse effect on total bacterial population in soil except at concentrations exceeding recommended rates.

The viable microbial counts were found to be statistically similar under the influence of different weed control treatments at harvest (Table.1). The monitoring period is a most important part for the assessment of pesticide effects and crop growth periods has been recommended for the recognition of persistent effects on soils.

Table 1: Effect of chemical weed management practices on microbial population of soil at harvest in direct-seeded rice

Treatment	Description	Bacteria (CFU×10^6 g^{-1} soil)	Actinomycetes (CFU×10^5 g^{-1} soil)	Fungi (CFU×10^4 g^{-1} soil)
T_1	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE	12.76	17.82	8.73
T_2	Pendimethalin @ 1000 g *a.i.* ha^{-1} PE	14.22	15.11	10.07
T_3	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE *fb* 2,4-DEE @ 750 g *a.i.* ha^{-1} POE	14.48	15.11	8.67
T_4	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE *fb* Bispyribac sodium @ 25 g *a.i.* ha^{-1} POE	14.86	15.46	7.97
T_5	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE *fb* Bispyribac sodium @ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g *a.i.* ha^{-1} POE	14.48	15.99	6.73
T_6	Bispyribac sodium @ 25 g *a.i.* ha^{-1} POE	13.54	14.05	8.87
T_7	Bispyribac sodium@ 20 g *a.i.* ha^{-1}. + Pyrazosulfuron @ 20 g *a.i.* ha^{-1} POE	12.22	17.25	9.43
T_8	Ethoxysulfuron @ 15 g *a.i.* ha^{-1} + Pyrazosulfuron @ 20 g *a.i.* ha^{-1} POE	13.14	15.89	9.37
T_9	Halosulfuron @ 67.5 g *a.i.* ha^{-1} + Azimsulfuron @ 30 g *a.i.* ha^{-1} POE	11.46	15.23	10.55
T_{10}	Hand weeding (15,30 and 45 DAS)	13.45	14.44	7.60
T_{11}	Weed check	14.63	15.87	9.60
	SEm ±	1.35	1.40	0.91
	CD (P=0.05)	NS	NS	NS

Tables 2: Effect of chemical weed management practices on grain, straw yield and Harvest index of direct seeded rice

Treatments	Description	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE	3.60	4.99
T_2	Pendimethalin @ 1000 g *a.i.* ha^{-1} PE	3.50	5.01
T_3	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE *fb* 2,4-DEE @ 750 g *a.i.* ha^{-1} POE	3.90	5.26
T_4	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE *fb* Bispyribac sodium @ 25 g *a.i.* ha^{-1} POE	5.08	6.35
T_5	Pyrazosulfuron @ 25 g *a.i.* ha^{-1} PE *fb* Bispyribac sodium @ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g *a.i.* ha^{-1} POE	5.41	6.67
T_6	Bispyribac sodium @ 25 g *a.i.* ha^{-1} POE	4.25	5.90
T_7	Bispyribac sodium@ 20 g *a.i.* ha^{-1}. + Pyrazosulfuron @ 20 g *a.i.* ha^{-1} POE	4.51	6.06
T_8	Ethoxysulfuron @ 15 g *a.i.* ha^{-1} + Pyrazosulfuron @ 20 g *a.i.* ha^{-1} POE	3.94	5.37
T_9	Halosulfuron @ 67.5 g *a.i.* ha^{-1} + Azimsulfuron @ 30 g *a.i.* ha^{-1} POE	4.67	6.20
T_{10}	Hand weeding (15,30 and 45 DAS)	5.50	6.69
T_{11}	Weed check	2.70	3.97
	SEm ±	0.28	0.44
	CD (P=0.05)	0.82	1.31

Conclusion

Based on above findings it may be concluded that, herbicides treatment T_5 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE fb Bispyribac sodium @ 20 g a.i. ha^{-1} + Pyrazosulfuron @ 20 g a.i. ha^{-1} POE) after sowing gave highest grain and straw yield *fb* T_4 (Pyrazosulfuron @ 25 g a.i. ha^{-1} PE fb Bispyribac sodium @ 25 g a.i. ha^{-1} POE) whereas, microbial populations in the herbicide treated plots were more or less similar to the unsprayed control plots thus indicating that herbicides have no detrimental effect on soil health at the applied doses.

References

1. Anderson TH. Microbial eco-physiological indicators to assess soil quality, Agriculture, Ecosystems and Environment activities in two soils, Australian Journal of Soil Research. 2003; 36:449-456.
2. Annual report of Ministry of Agriculture and Farmers' Welfare, 2017-18
3. Balasubramanian V, Hill JE. Direct seeding of rice in Asia: Emerging issues and strategic research needs for the 21st century. In Direct Seeding: Research Strategies

and Opportunities. Pandey *et al*. Eds IRRI, Los Banos, Philippines, 2002, 15-39.
4. Bera S, Ghosh RK. Soil Microflora and Weed Management as Influenced by Atrazine 50% WP in Sugarcane. Universal Journal of Agricultural Research. 2013; 1(2):41-47.
5. Chauhan BS. Weed ecology and weed management strategies for dry-seeded rice in Asia 2012. Weed Tech 26:1–13.
6. Omara A, El D, Ghandor AE. Effect of Thiobencab and Penoxsulam Herbicides on Soil Microbial Population and Weed Control in Transplanted Rice. Global Advanced Research Journal of Microbiology. 2018; 7(5):084-094.
7. Sanodiya P, Singh MK. Integrated weed management in direct-seeded rice. Indian Journal of Weed Science. 2017; 49(1):10-14.
8. Snedecor GW, Cochron WG. Statistical meth-ods. 6th edition. Oxford and IBH Pub. Co. New Delhi, 1971, 593.
9. Sondhia S. Herbicide residue in soil, water and food chain: An Indian Perspective 2008 p. 31. In: Proceeding of Biennial Conference, Indian Society of Weed Science, on February 27-28, 2008, RAU, Pusa, India.
10. State wise 4th advance estimate of principal crops during 2016-17, Ministry of Agriculture
11. Subba RNS. *Rhizobium* and root nodulation. In: soil microorganisms and plant growth. Oxford IBH New Delhi, 1986.
12. Thom C, Raper KB. A manual of the *Aspergilli*. Williams and Wilkins Co. Baltimore, U.S.A, 1945.
13. Verma A, Sharma BC, Nandan B, Sharma R, Shah I, Banotra M. Weed Dynamics, Nutrient Removal and Crop Productivity as Influenced by Weed Management Practices in Direct Seeded Basmati Rice Preceded by Wheat in Irrigated Sub Tropics of Jammu 2017. International Journal Current Microbiology Applied Science. 6(7): 2316-2332.
14. Yadav DB, Yadav A, Punia SS. Evaluation of Bispyribac-sodium for Weed Control in Transplanted Rice. Indian J Weed Sci. 2009; 41(1 & 2):23-27.