



ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 1883-1885
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www.thepharmajournal.com
Received: 09-02-2022
Accepted: 22-03-2022

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Influence of carfentrazone ethyl & other herbicides on soil physico-chemical properties and their residual effect on yield of succeeding lentil

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Abstract

Study on response of soil physico-chemical properties and growth & yield of Lentil to herbicides used for Rice-Legume crop sequence. Soil Physical properties like bulk density, water holding capacity and moisture content of soil did not vary after harvest of DSR (60 DAA) due to Carfentrazone ethyl, Pyrazosulfuron, Penoxulam, Bispyribac sodium as compared to the initial. No account of changes in soil chemical properties like soil pH and EC at 60 DAA with carfentrazone, results also clearly showed organic carbon, total available N, P₂O₅ & K₂O contents did not vary. Lentil sown in *Rabi* to discern the residual effect of herbicides on germination of Lentil (88.37 - 91.33%) in different treatments. Highest plant population obtained with Pendimethalin 30 EC, it has acquired fascinated results of seed yield (50.16 q ha⁻¹) and ensuing premium treatment for higher grain yield was Carfentrazone Ethyl 40 DF (890.46 q ha⁻¹).

Keywords: Direct seed rice, Carfentrazone-ethyl, soil physico-chemical properties, Lentil

Introduction

Direct sown rice (DSR) is a labor – water - energy saving method, besides it has abundance of weeds of which sedges and broad-leaved were very dogged. Hence the major option is to identify suitable herbicides for effective management of sedges and BLWs under different herbicidal interventions. While choosing a specific herbicide for specific crop, it is vital to acquainted with scientific reports of herbicides and their reactions inside soil with a view to analyzing the environmental destiny of herbicides. Soil is an important component of the environment, in the context of the accretion and putrefaction of herbicides, soils are pigeon-holed by sorption properties due to the existence of mineral, colloidal and organic matter particles and the presence of various microorganisms. Fortune of herbicides applied directly on soil or plants depends on a host and various conditions, including soil type, pH, organic matter, organic carbon content, moisture content, the nature of the soil colloids, the flow of liquid and air through soil. Therefore, herbicides introduced into the soil adsorb on soil particles, from where they can be entering into the food chain (Kaczynski and Łozowicka, 2015; Wang *et al.*, 2010). However, the most important aspect in the context of herbicide biodegradation is the ability of microorganisms to produce secondary metabolites that function as signaling molecules in the initiation of plant-microbial symbiosis. Therefore, a key aspect of this research should be an in-depth analysis of the physico- chemical properties soil exposed to herbicides.

Materials and Methods

1. Kharif DSR: The experiment was conducted with seven treatments replicated thrice with a randomized block design. Plot size 5 m × 4 m. The crop was grown during consecutive *kharif* (DSR) 2019 & *rabi* (lentil) 2020 at the Mondouri Teaching Farm (89° E longitudes, 23° N latitude) of Bidhan Chandra Krishi Vishwavidyalaya, Nadia, West Bengal, India. Seven treatments follow Carfentrazone Ethyl@ 25 g ha⁻¹, Pyrazosulfuron Ethyl 10 WP @ 80 g ha⁻¹, Penoxulam 24 SC @ 25 g ha⁻¹, & Pendimethalin 30 EC @ 750 ml ha⁻¹. Spraying was done with a knapsack sprayer with flood jet deflector WFN 040 nozzle with 500 L/hm² of water. Cultivation methods includes, IET-4786 (Shatabdi) an indica variety, full dose of phosphorus, potash each at 30 kg/hm² were applied as basal. Nitrogen at 60 kg/hm² (using urea as source) was applied in four splits at 5, 25, 45 and 65 DAT. One day before sowing, the seeds were treated with *Trichoderma viridis* at 4 g/kg of rice besides the rhizobium treatment.

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Data collection and analysis of Soil physico-chemical properties of experimental soil like soil pH, organic carbon content, total nitrogen content, available phosphorus content and available potassium content, were estimated by combined glass electrode pH meter method, Walkley and Black's rapid titration method, modified macro Kjeldahl method, Olsen's method and flame photometer method, respectively (Jackson, 1973). The data were subjected to statistical analysis by analysis of variance method. The correlation studies were made to reveal the association among the variables in the investigation (Gomez and Gomez, 1984) [7].

2. Succeeding Lentil: Lentil variety Moitree (WB-77) sown in undisturbed layout of experimental plots (spacing 30 x 10 cm) to know the residual effect of pre- and post-emergence herbicides applied to *kharif DSR*. The recommended package of practices of Bidhan Chandra Krishi Viswavidyalaya were adopted to raise the Lentil crop. Germination percentage was calculated as per the formula (number of seeds germinated by number of seeds sown) in the experimental field. Plant population obtained by four quadrates each with an area of 0.25 m² (0.25 m * 0.5 m) were randomly fixed at four different places in the net plot area and the plant population was recorded in each quadrate after gap filling and at harvest. To get dry matter accumulation plants enclosed in an area of 0.25 m² from the sampling area were removed at maturity, collected were sundried and later oven dried at 60°C till a constant weight was obtained. The data was computed and expressed in kg ha⁻¹. The total number of pods were counted from the ten randomly selected plants in the plot area and averaged plant⁻¹. Seed yield obtained by harvesting lentil, after drying subjected it for threshing. After threshing, weight of grain was recorded plot-wise and expressed in kg ha⁻¹.

Results and discussion

Physico-chemical properties of soil

The mean physical properties (bulk density, water holding capacity and moisture content) and chemical properties (pH,

electrical conductivity, organic carbon, total nitrogen content, available phosphorus (P₂O₅) and potash (K₂O) contents) of the initial soil of the experimental field are presented in Tables 1 and 2. The results showed the soil of the experimental field is with a mean soil pH of 7.2 and medium fertility status with low water holding capacity. The bulk density, water holding capacity and moisture content of soil did not vary after harvesting of direct seeded *kharif* rice (60 DAA) due to application of herbicides as compared to the initial (Table 1). The soil pH and electrical conductivity at 60 DAA did not differ with the testing of herbicides. The data presented in Table 2 clearly also showed that the organic carbon, total nitrogen, available phosphorus (P₂O₅) and potash (K₂O) contents did not vary significantly with applied herbicides.

Residual effect on yield of succeeding lentil

Residual effect of herbicides and they did not exert significant influence on germination of succeeding Lentil (88.37 to 91.33% germination) in different treatments (Table No.3). The highest population of succeeding Lentil obtained with Pendimethalin 30 EC @ 750 ml ha⁻¹ applied to preceding rice crop, which was however on parity with Pyrazosulfuron Ethyl 10 WP @ 80 g ha⁻¹ and Carfentrazone Ethyl 40 DF @ 25 g ha⁻¹. All these treatments imposed to preceding rice crop obtained broad- spectrum weed control including all sedges and BLWs that led to reduced weed seed bank or density of tubers and their germination in current season crop *i.e.* succeeding Lentil, which in turn reduced the density and dry weight of weeds due to sequential application of herbicides. Among all weed control treatments, weed free treatments has registered significantly high yield (911.8 q ha⁻¹). Pendimethalin 30 EC @ 750 ml ha⁻¹ has acquired fascinated results for seed yield (50.16 q ha⁻¹) which is significantly higher over all the treatments and was on par with Pyrazosulfuron Ethyl 10 WP @ 80 g ha⁻¹ (898.22 q ha⁻¹). The next best treatment for higher grain yield was Carfentrazone Ethyl 40 DF @ 25 g ha⁻¹ (890.46 q ha⁻¹).

Table 1: Effect of herbicidal treatments on the soil physico-chemical properties during 2019-20 for DSR

Treatment	Dose (g / ml ha ⁻¹)	Bulk density (mg/m ²)		Water holding capacity (%)		pH		EC (mmhos/cm)	
		At crop sowing	At crop harvest	At crop sowing	At crop harvest	At crop sowing	At crop harvest	At crop sowing	At crop harvest
Pyrazosulfuron Ethyl 10 WP	80 g	1.24	1.25	35.18	35.63	7.18	7.24	0.81	0.83
Penoxulam 24 SC	25 g	1.26	1.28	36.23	37.62	7.23	7.16	0.79	0.80
Carfentrazone Ethyl 40 DF	25 g	1.28	1.30	34.75	35.28	7.22	7.36	0.83	0.84
Bispyribac Sodium 10EC	25g	1.23	1.24	35.18	34.76	7.31	7.48	0.82	0.84
Pendimethalin 30 EC	750 ml	1.25	1.26	36.20	37.18	7.18	7.32	0.78	0.80
Weed free		1.26	1.28	34.86	33.68	7.28	7.46	0.80	0.82
Weedy check		1.22	1.23	35.72	34.96	7.32	7.58	0.84	0.83
S.Em. ±		0.02	0.02	0.47	1.33	0.05	0.14	0.02	0.01
CD at 5%		NS	NS	NS	NS	NS	NS	NS	NS

NS – Non significant

Table 2: Effect of herbicidal treatments on the soil physico-chemical properties during 2019-20

Treatment	Dose (g / ml ha ⁻¹)	Organic carbon (%)		Nitrogen (kg/ha)		P ₂ O ₅ (kg/ha)		K ₂ O (kg/ha)	
		At crop sowing	At crop harvest	At crop sowing	At crop harvest	At crop sowing	At crop harvest	At crop sowing	At crop harvest
Pyrazosulfuron Ethyl 10 WP	80 g	0.42	0.43	174.2	170.6	24.7	20.6	147.1	143.2
Penoxulam 24 SC	25 g	0.41	0.43	173.6	169.6	27.4	23.8	149.2	144.5
Carfentrazone Ethyl 40 DF	25 g	0.45	0.44	170.8	165.3	25.7	20.8	145.5	139.8
Bispyribac Sodium 10EC	25g	0.43	0.45	172.6	170.3	23.8	20.4	148.4	146.2
Pendimethalin 30 EC	750 ml	0.42	0.41	171.8	168.3	27.3	24.8	146.5	142.7

Weed free		0.44	0.45	170.2	170.2	26.8	25.3	147.7	146.8
Weedy check		0.43	0.44	172.7	169.8	24.7	21.6	149.9	146.3
S.Em. \pm		0.01	0.01	1.35	1.78	1.21	1.57	1.47	2.34
CD at 5%		NS	NS	NS	NS	NS	NS	NS	NS

NS – Non significant

Table 3: Effect of herbicidal treatments on the succeeding lentil crop during 2019-20

Treatment (applied in main paddy crop)	Dose (kg or l/ha)	Crop germination (%) (15 DAS)	Plant population /m ² (30 DAS)	Yield (kg/ha)
Pyrazosulfuron Ethyl 10 WP	80 g	89.862	21.6	898.22
Penoxulam 24 SC	25 g	89.352	20.1	874.94
Carfentrazone Ethyl 40 DF	25 g	89.556	21.2	890.46
Bispyribac Sodium 10EC	25g	88.434	19.8	888.24
Pendimethalin 30 EC	750 ml	90.066	21.4	902.1
Weed free	-	90.882	22.4	911.8
Weedy check	-	90.27	22.0	901.04
S.Em. \pm	-	0.98	0.87	17.02
CD at 5%	-	NS	NS	NS

NS – Non significant.

Conclusion

Experiment conducted during 2019-20 clearly lead us to conclude that low volume herbicides Carfentrazone Ethyl 40 DF with a dose of 25 g ha⁻¹ can most effectively smother the sedges and broad-leaved weeds of DSR with no adverse effect on soil physico-chemical properties and also acquired high yield of succeeding lentil without any residual effect on germination and plant population of lentil.

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