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Soil Physico-Chemical Properties and Microflora as Influenced by Bispyribac Sodium 10% SC in Transplanted *Kharif* Rice

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Abstract: The effects of bispyribac sodium 10% SC and butachlor 50% SC on soil physico-chemical properties and microflora in transplanted *kharif* rice were investigated over two seasons (2010 and 2011). Effects of the herbicide on bulk density, water holding capacity, moisture content, soil pH, organic matter content, electrical conductivity, as well as total nitrogen, available phosphorus and available potassium contents were analyzed along with microflora population (total bacteria, actinomycetes and fungi). No significant changes in soil physico-chemical properties were observed. Herbicide treatments resulted in decreases in microbial counts initially. With the degradation of applied herbicides within a considerable time, the microflora populations even exceeded the initial count at 60 d after application of the herbicide.
Key words: herbicide; bispyribac sodium; physico-chemical property; soil; microflora population; rice

The global drive for sustainable agricultural systems involves optimizing agricultural resources to satisfy human needs and at the same time maintaining the quality of the environment and sustaining natural resources. In achieving this optimization, herbicide use is of great importance. Herbicides are substances used to kill or suppress the growth of unwanted plants and vegetations (Cork and Krueger, 1992). During the past decades, a large number of herbicides have been introduced as pre- or post-emergence weed killers in many countries of the world. In India, herbicides have been effectively used to control weeds in agricultural systems. As farmers continue to realize the usefulness of herbicides, larger quantities would be applied to the soil. But the fate of these compounds in the soil is becoming increasingly important since they can be leached down, in which case groundwater is contaminated or if immobile, they would persist on the top soil (Ayansina et al, 2003). These herbicides can then accumulate to toxic levels in the soil and become harmful to microorganisms, plants, wildlife and even human (Amakiri, 1982). Bispyribac-sodium {sodium 2,6-bis [(4, 6-dimethoxy-2-pyrimidinyl) oxy] benzoate}, first developed by Japan Kumiai Chemical, belongs to the pyrimidinyl oxybenzoic acid group (Wu and Mei, 2011). Bispyribac sodium has been applied post-emergence to control many weeds. Paddy herbicides while protecting rice seedlings selectively, destroy the weeds and indirectly bring an increase in grain yields (Fischer et al, 2000). Bispyribac sodium is a systemic herbicide that moves throughout the plant tissue and works by interfering with production of a plant enzyme necessary for growth, acetolactate synthase (ALS). This experiment was designed to furnish the information regarding the effects of bispyribac sodium 10% SC on physico-chemical properties and soil microflora in transplanted *kharif* rice after application of the herbicide.

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MATERIALS AND METHODS

Study site

The experiment was conducted with six treatments replicated four times with a randomized block design. Each plot size was of 5 m × 4 m. The crop was grown during consecutive two *kharif* seasons of 2010 and 2011 at the 'C' block farm (latitude: 22°57′ E, longitude: 88°20′ N and altitude: 9.75 m) of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India.

Treatments

The six treatments were as follows: post-emergence application of bispyribac sodium 10% SC at 10, 20 and 30 g/hm^2 at 15 d after transplanting (DAT), butachlor 50% SC at 1 500 g/hm^2 at 3 DAT, hand weeding and untreated control. Spraying was done

with a knapsack sprayer with floodjet deflector WFN-040 nozzle with 500 L/hm^2 of water.

Cultivation methods

The rice variety used in this experiment was IET-4786 (Shatabdi), which is an indica variety. Full doses of phosphorus (using single super phosphate as source) and potash (using muriate of potash) each at 30 kg/hm^2 were applied as basal. Nitrogen at 60 kg/hm^2 (using urea as source) was applied in four splits at 5, 25, 45 and 65 DAT. One day before sowing, the seeds were treated by using *Trichoderma viridis* at 4 g/kg of rice seeds besides the *Rhizobium* treatment. The treated seeds were kept under shade for overnight before sowing in the main field.

Data collection and analysis

Soil physic-chemical properties

The physico-chemical properties of experimental soil: texture, 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).

Microbial population

Soil samples from the experimental plots were collected from the space between the rows at a depth of 0–15 cm on different dates *viz*. initial [pretreatment, 0 d after application (DAA)], 3 DAA, 10 DAA, 30 DAA and 60 DAA. The soil samples from different places per replication for the same weed control treatment were pulled together and then requisite composite samples of each treatment were taken for microbial analysis by dilution plating following standard methods. Soil dilutions were prepared in sterile distilled water by constant shaking and plating was done separately in replicates in specific media: Total bacteria (Thornton's agar medium at 10^{-6} dilutions), fungi (Martin's rose bengal streptomycin agar medium at 10^{-4} dilutions), actinomycetes (Jensen's agar medium at 10^{-5} dilutions). The enumeration of the microbial population was done on agar plants containing appropriate media following serial dilution technique and pour plate method (Pramer and Schmidt, 1965): plates were incubated at 30 °C. The counts were taken on the 3rd day of incubation.

Statistical Analysis

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). As the error mean squares of the individual experiments were homogenous, combined analysis over the years were done through unweighted analysis. Here, the interactions between years and treatments were not significant.

RESULTS

Physico-chemical properties of soil

The mean mechanical properties (sand, silt and clay contents); physical properties (bulk density, water holding capacity and moisture content) and chemical properties (pH, electrical conductivity, organic carbon, total nitrogen content, available phosphorus (P_2O_5) and potash (K_2O) 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 sandy loam in texture with a mean soil pH of 6.78 and medium fertility status with low water holding capacity.

Table 1. Physical and mechanical properties of experimental soil before and after treatments (pooled data).

Treatment	Physical property						Mechanical property					
	Bulk density (g/cm^3)		Moisture content (%)		Water holding capacity (%)		Sand content (%)		Silt content (%)		Clay content (%)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
T1	1.45	1.48	15.69	15.42	41.12	40.27	61.83	66.08	23.45	25.08	14.72	13.71
T2	1.53	1.47	15.33	15.32	41.22	41.47	62.43	66.08	24.49	25.18	13.08	13.61
T3	1.52	1.48	15.47	15.63	40.77	40.97	62.77	66.08	24.27	25.08	12.96	13.71
T4	1.54	1.49	15.35	15.99	40.71	41.83	61.79	65.26	23.32	23.29	14.89	16.32
T5	1.48	1.51	15.56	15.47	40.41	42.46	62.49	65.31	24.61	24.50	12.90	15.06
T6	1.46	1.44	15.41	15.72	40.27	40.53	62.62	66.28	23.60	24.70	13.78	13.63
Mean	1.50	1.48	15.47	15.59	40.75	41.26	62.32	65.85	23.96	24.64	13.72	14.34
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

T1, Bispyribac sodium 10% SC at 10 g/hm^2; T2, Bispyribac sodium 10% SC at 20 g/hm^2; T3, Bispyribac sodium 10% SC at 30 g/hm^2; T4, Butachlor 50% EC at 1 500 g/hm^2; T5, Hand weeding; T6, Untreated control. NS, Not significant.