Indian J.Sci.Res. 19(1): 01-05, 2018

ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

EFFECT OF HERBICIDES ON MICROBIAL BIOMASS CARBON IN MEDIUM AND HIGH ORGANIC MATTER SOILS UNDER RICE

K. AMRITHA[a1] AND K.M. DURGA DEVI[b]

[ab]Department of Soil Science and Agricultural Chemistry, College of Horticulture, Vellanikkara, Thrissur, India

ABSTRACT

A pot culture experiment was conducted to study the effect of pre emergence (pendimethalin and oxyfluorfen) and post emergence herbicides (cyhalofop-butyl and bispyribac-sodium) on microbial biomass carbon in medium and high organic matter soil with rice (variety:Jyothi) as a test crop. Results revealed that the herbicides had negative effect on microbial biomass carbon at all the intervals during the study period except at 60 DAHA (days after herbicide application). The adverse effects on microbial biomass carbon of the selected herbicides followed the order *viz*., pendimethalin>bispyribac-sodium>oxyfluorfen>cyhalofop-butyl. The adverse effects were of lower magnitude in the soils of high organic matter content. Therefore, the assay of microbial biomass carbon in the selected soil is useful to understand the potential adverse effect of herbicides on both medium and high organic matter soils.

KEYWORDS: Bispyribac-sodium, Cyhalofop-butyl, Microbial Biomass Carbon, Oxyfluorfen, Pendimethalin

Weed competition is one of the major factors limiting rice production in the tropics anddemand for food grain is expected to increase with rise in population. Area under rice in India is reported to be 44.1million ha, with a production of 106.64 million tones and productivity of 2416 kg ha^{-1}(Indiastat, 2015-16). To sustain and safegaurd food security in the country, the productivity of rice has to be enhanced under limited resources. Various biotic and abiotic stresses are the limiting factors in enhancing rice productivity. The major stress is imposed by competition due to weeds for water, nutrients, light, and space. Hence, weed management is indispensable in crop production.

Due to the scarcity and high cost of labour, weed management with herbicides is widely practiced. Herbicides are usually applied when the crops are absent or at early growth stages. Therefore, a major portion of these chemicals accumulate in the surface layer of soil (0-15cm) where most of the microbiological activities occur(Das and Kole, 2006). The persistence of herbicide residues in soil interact with microorganisms thereby altering the microbial diversity. Soil microbial biomass is the main driving force in the decomposition of organic materials and is frequently used as an early indicator of changes in soil resulting from soil management practices and environment stress (Brookes, 1995). Because of its high turn-over rate, microbial biomass carbon responds more rapidly to changes in soil microclimate than soil organic matter (Powlsonet al., 1987). Dipika (2014) reported that the application of herbicides exerted adverse effect on soil microbial biomass carbon.

Pendimethalin and oxyfluorfen are the most effective pre emergence herbicides for weed control in rice. Among the post emergence herbicides, bispyribac-sodium and cyhalofop-butyl are widely used in Kerala. Hence the present investigation was carried out to determine the effect of the above four herbicides on microbial biomass carbon in soils with medium and high organic matter content.

MATERIALS AND METHODS

A pot culture experiment was conducted at the Department of Soil Science and Agricultural chemistry, College of Horticulture, Kerala Agricultural University during *kharif* season of 2016.Representative soil samples were collected from four sites in Thrissur district of Kerala *viz*.,rice field having medium organic matter status with a history of herbicide application: S_1 Control, soil from non-cropped area having medium organic matterstatus and without a history of herbicide application: S_1 Absolute control, high organic matter soil with a history of herbicide application: S_2 Control, and high organic matter soil without history of herbicide application from non-cropped area: S_2 Absolute control. Details of the sampling sites are given in Table 1.

The experiment consisted of twelve treatments and six replications in factorial CRD (four herbicides under two soil types + four controls). Pre emergence herbicides (pendimethalin and oxyfluorfen) were applied at six days after sowing (DAS) and post emergence herbicides (bispyribac-sodium and cyhalofop-butyl) at 16 DAS. Soil samples were analysed at six intervals *viz*., two hours before herbicide application and then at 7, 15, 30, and 60 days after herbicide application and at harvest so as to evaluate the changes in microbial biomass carbon in medium and high organic matter soils.

[1]Corresponding Author

RESULTS AND DISCUSSION

Analysis of data on the microbial biomass carbon (MBC) showed significant difference among the soil types, treatments, and interaction between soil type and treatments at different intervals studied (Table 2).Microbial biomass carbon showed a decreasing trend upto 30 DAHA and thereafter drastic increase in MBC when it reaches 60 DAHA in all the interactions studied. This might be due to maximum rhizosphere effect of the root system which augmented the native microflora of the root system as 60 DAHA coincide with the panicle initiation stage. Decrease in microbial biomass carbon at harvest is mainly due to the lack of soil moisture and reduced rhizosphere activity at harvest stage. Aparna (2000) also reported a drastic decline in microbial biomass at harvest. High organic matter soils recorded higher microbial biomass carbon compared to medium organic matter soils due to enough substrate provided by high O.M. soil to support higher microbial biomass (Figure1).

The extent of decline in microbial biomass carbon was also studied and it was highest at harvest followed by 30 DAHA(Table 3).Reduction in microbial biomass carbon varied from 0.84 to 21.22 per cent and 8.44 to 32.59 per cent at 30DAHA and harvest respectively (Table 3). At harvest, microbial biomass carbon decreased and it was mainly due to the effect of moisture and decline in root activity at late maturity stage of rice.Among the herbicide treatments, maximum reduction in MBC was observed in pendimethailn treatment followed by bispyribac-sodium, oxyfluorfen, and cyhalofop-butyl. This was in accordance with mammalian toxicity (LD_{50}) of the respective herbicides and their persistence in the soil in terms of half- life (RSC, 1987).

Percentage reduction was comparatively lower in high organic matter soils throughout the intervals and the same could be attributed to the buffering action of organic matter. Among the pre emergence herbicides, maximum adverse effect on microbial biomass carbon was exerted by pendimethalin than oxyfluorfen. In the case of post emergence herbicides, bispyribac-sodium exerted adverse impact on microbial biomass carbon compared cyhalofop-butyl.

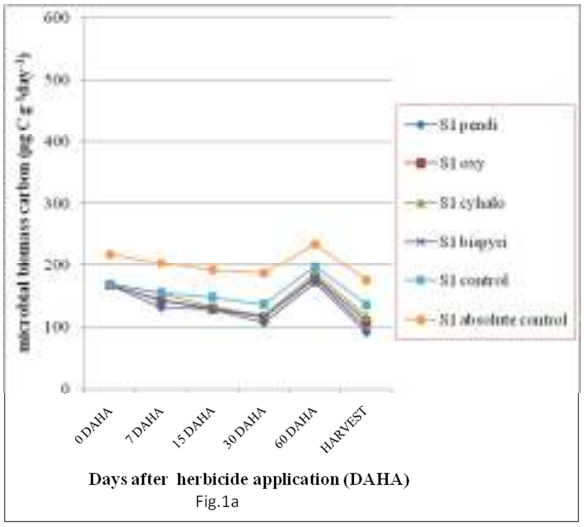

Fig.1a

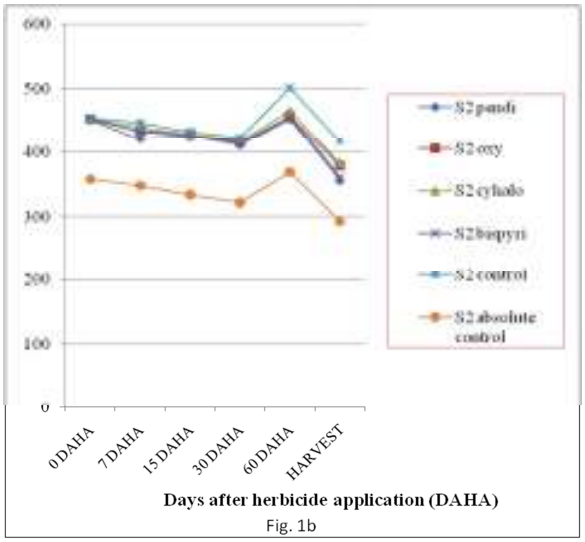

Fig. 1b

Figure 1: Effect of herbicide application on microbial biomass carbon in a) medium and b) high organic matter soils

Table 1: Details of the soil sampling sites

Soils / soil sampling sites		Texture	pH	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Microbial biomass carbon (µg C $g^{-1}day^{-1}$)
Medium O.M. (S_1) soils	Control (rice field)	Sandy clay loam	5.36	0.85	237.98	21.62	124.80	153.31
	Absolute control (non-cropped area)	Sandy clay loam	5.68	1.08	258.40	23.35	199.36	192.12
High O.M. (S_2) soils	Control (rice field)	Clay	5.01	2.47	296.30	27.90	325.61	421.10
	Absolute control (non-cropped area)	Sandy clay loam	5.20	1.92	269.69	24.76	260.96	322.01

*O.M: Organic matter

Control: Rice field with a history of herbicide application

Absolute control: Non-cropped area without a history of herbicide application

Microbial biomass carbon was assayed as per the procedure described by Jenkinson and Powlson (1976).

Table 2: Effect of herbicide application on microbial biomass carbon in medium (S_1) and high organic matter soils (S_2)

Treatments	Microbial biomass carbon (µg C $g^{-1}day^{-1}$)											
	0 DAHA		7DAHA		15DAHA		30DAHA		60 DAHA		Harvest	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
Pendimethalin	168.10^{d}	453.10^{a}	131.00^{h}	422.38^{c}	128.00^{f}	425.28^{b}	107.45^{g}	412.18^{b}	171.40^{hi}	454.35^{c}	91.30^{i}	356.43^{c}
Oxyfluorfen	168.10^{d}	453.83^{a}	143.03^{g}	436.07^{b}	129.33^{f}	429.40^{ab}	115.62^{fg}	417.75^{ab}	180.37^{gh}	458.47^{c}	109.30^{gh}	379.23^{b}
Cyhalofop-butyl	168.83^{d}	454.58^{a}	153.50^{f}	441.32^{ab}	132.00^{f}	430.20^{ab}	118.28^{f}	420.85^{ab}	185.98^{g}	467.00^{b}	117.43^{g}	383.33^{b}
Bispyribac - sodium	168.10^{d}	454.40^{a}	142.50^{g}	434.18^{b}	129.14^{f}	426.63^{b}	115.37^{fg}	414.58^{b}	177.83^{h}	457.98^{c}	99.44^{hi}	361.37^{c}
Control	168.83^{d}	455.32^{a}	155.58^{f}	447.88^{a}	147.92^{e}	433.83^{a}	136.40^{e}	424.42^{a}	197.33^{f}	502.73^{a}	135.43^{f}	418.68^{a}
Absolute control	218.28^{c}	358.28^{b}	202.97^{e}	348.83^{d}	191.53^{d}	334.20^{c}	186.67^{d}	322.18^{c}	234.47^{e}	369.53^{d}	175.10^{e}	293.07^{d}
CD (0.05)	10.37		7.27		6.67		9.60		8.06		12.32	

Table 3: Percentage reduction in microbial biomass carbon with respect to control at different days after herbicide application

Treatments	Reduction in microbial biomass carbon (%)= (MBC $C - MBC\ T / MBC\ C) \ x\ 100$									
	7DAHA		15DAHA		30DAHA		60DAHA		Harvest	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
Pendimethalin	15.80	5.69	13.46	1.97	21.22	2.88	13.14	9.62	32.59	14.87
Oxyfluorfen	8.07	2.64	12.56	1.02	15.23	1.57	8.60	8.80	19.30	9.42
Cyhalofop- butyl	1.34	1.47	10.76	0.84	13.29	0.84	5.75	7.11	13.29	8.44
Bispyribac- sodium	8.41	3.06	12.70	1.66	15.42	2.32	9.88	8.90	26.58	13.69

MBCC: Microbial biomass carbon in control
MBC T: Microbial biomass carbon in herbicide treatments
S_1: Medium O.M. soil
S_2: High O.M. soil

Microbial biomass carbon was found to be sensitive to herbicide application.Among the selected herbicides pendimethalin exerted adverse effect on microbial biomass carbon followed by bispyribac-sodium, oxyfluorfen, and cyhalofop-butyl at all the intervals. Soils with high organic matter content reduced the adverse effects of applied herbicides

ACKNOWLEDGEMENT

The study formed as part of M.Sc. (Ag.) programme of first author and financial support from Kerala Agricultural University and theauthorities of 27th swadeshi science congress for giving the opportunityis gratefully acknowledged.

REFERENCES

Aparna B., 2000. Distribution, characterization and dynamics of soil enzymes in selected soils of Kerala.Ph.D. (Ag.) thesis, Kerala Agricultural University, Thrissur, 365p.

Brookes P.C., 1995. The use of microbial parameters in monitoring soil pollution by heavy metals. Biol. Fertil. Soils, **19**:269-279.

Das A.C. and Kole S.C., 2006. Effect of some root associative bacteria on germination of seeds, nitrogenase activity and dry matter production by rice plants. J. Crop Weed, **2**(2):47-51.

Dipika, 2014. Effect of different post emergence herbicides on microbiological and biochemical properties of rice soil. M. Sc. (Ag.) thesis, Indira Gandhi KrishiVishwavidyalaya, Raipur, 99p.

Indiastat, 2015-16. State wise area and production of cereals and millets in India [online]. Available:http://www.indiaagristat.com/agriculture/2/cerealsandmillets/963995/rice/17194/stats.

Jenkinson D.S. and Powlson D.S. 1976. A method for measuring soil biomass. Soil Biol. Biochem., **8**: 209-213.

Powlson D.S., Brookes P. C. and Christensen B.T., 1987. Measurement of soil microbial biomass provides an early indication of changes in total soil organic matter due to straw incorporation. Soil Biol. Biochem., **19**:159–164.

RSC [Royal Society of Chemistry], 1987. Agro Chemical Hand book, 2nd edition (Hartley, D., ed.). The Royal Society of Chemistry, Nottingham, UK, pp. 111-936.