Influence of integrated weed management practices on soil respiration, soil enzymatic activity, nodulation and yield in groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Field experiment was conducted to study the influence of integrated weed management practices on nodulation, yield and soil enzymatic activities including respiration in groundnut. The weed free check (3 IC at 20, 30, 40 DAS + 2 HW at 45 DAS and 70 DAS) absolutely free from herbicides recorded more number of total nodules plant^{-1} as well as nodule dry weight, higher soil enzymatic activities *viz.,* phosphatase, dehydrogenase and soil respiration. Alachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS (82.98 µg) drastically reduced the soil enzymatic activity. Pre-emergence application of Pretilachlor @ 1.5 kg ha^{-1} + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS increased the pod yield of groundnut.

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Key words : Integrated weed management, Soil enzymatic activity, Hand weeding

INTRODUCTION

Groundnut plays an important role in boosting oilseed production in the country. It has an outstanding nutritive value with 40-45 per cent oil, 25 per cent protein and 18 per cent carbohydrates in addition to minerals, vitamins and essential amino acids. This crop can withstand short period of drought at the initial stages and also enrich soil through nitrogen fixation and through addition of organic matter in the form of leaves at maturity. Weed infestation declines the productivity about 18 per cent in oilseeds (Gupta, 2003). Adoption of either manual, mechanical, chemical or biological weed control method alone cannot solve the problem. Hence, effort was made to manage weeds through an integrated approach which is more economical and viable.

It is well known that enzymes in soil contribute to the total biological activities in the soil environment because they are intimately involved in catalyzing reactions necessary for organic matter decomposition, nutrient cycling, energy transfer, and environmental quality (Dick, 1994 and Dick, 1997). Enzyme activities often provide a unique integrative biological assessment of soil function, especially those catalyzing a wide range of soil biological processes, such as dehydrogenase, urease, phosphatase *etc.* (Nannipieri *et al.,* 2002). Enzyme activities control rates of soil nutrient cycling and are valuable indicators of soil microbial diversity. Measurement of the activity of the soil micro flora provides indices of the biological state of the soil and hence the soil fertility. Therefore, changes in soil biological and biochemical properties, such as the soil enzymes activities and soil respiration, may be indicative of and extremely sensitive to changes in soil health (Pankhurst *et al.,* 1995). In soil ecosystems, phosphatases are believed to play critical roles in P cycles (Speir and Ross, 1978) as evidence shows that they are correlated to P stress and plant growth also, good indicators of soil fertility. Soil enzyme activity acts as an additional diagnostic index of soil fertility and its changes as a result of human activity especially through intense agricultural practices. In view of this, the present investigation was carried out to find out the effect of integrated weed management practices on nodulation, yield and soil enzymatic activities in groundnut.

MATERIALS AND METHODS

A field experiment was conducted in a *Vertisol* at the main agricultural research station, Dharwad under long term experimental trial during *Kharif* 2008. The experiment was laid out in RBD with three replications and six treatments. The treatment combinations comprised of recommended herbicides and mechanical weeding practices *viz.,* T_1: Alachlor @ 1.5 kg ha^{-1} pre-emergence + 3 Inter cultivation (IC) at 20, 30, 40 DAS + 1 Hand weeding (HW) at 45 DAS, T_2: Pretilachlor @ 1.5 kg ha^{-}

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[1] pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS, T_3: Pendimethalin @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS, T_4: Butachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS T_5: Weed free check (3 IC at 20, 30, 40 DAS + 2 HW at 45 DAS and 70 DAS and T_6: Weedy check (No weeding no inter-cultivation). Groundnut cultivar, JL-24 was sown during first week of July 2007 by hand dibbling at a spacing of 30 cm x 10 cm. Number of nodules were counted on 60th day after sowing, dried in a oven at 65°C and the dry weight of nodules was recorded and expressed in g $plant^{-1}$. The fresh soil samples were taken from different treatments on 30 and 60 DAS and analyzed for soil enzymes such as phosphatase (µg pnp formed g^{-1}soil h^{-1}), dehydrogenase (µg TPF formed g^{-1}soil d^{-1}) and soil respiration (mg CO_2 per 100 g soil d^{-1}).

Fresh soil samples were obtained from the top 5 cm soil layer before harvesting as per the treatment schedule. The soil samples were passed through a 3 mm sieve, placed in black polythene bags and stored at 4°C.

Five grams of soil sample was taken in boiling tube. To this 10 ml of distilled water, 0.25 ml of toluene and 1 ml of 10 mM p-nitrophenyl phosphate (PNP) were added. The mixture was incubated at room temperature for 1 h and then 5 ml of 0.5 M $CaCl_2$ and 20 ml of 0.5 M NaOH were added. The content was filtered using Whatman No. 42 and volume made up to 50 ml with distilled water. The colour intensity was read at 420 nm. The concentration of phosphatase was obtained from standard graph (Evazi and Tabatabai, 1979). The phosphatase activity was expressed as micro gram of p-nitrophenol released per gram of soil per hour (µg pnp formed g^{-1} soil h^{-1}).

Five grams of soil sample was taken in boiling tube. To this 1 ml of 2, 3, 5- tri phenyl tetrazolium chloride (2%) was added followed by 1 ml of 1 per cent glucose and 2.5 ml of distilled water. The mixture was incubated for 24 h. After that 10 ml of methanol was added and again incubated for another 5 h. The content was filtered through Whatman No. 1 filter paper. The samples were washed thoroughly with methanol. The red colour developed was read at 485 nm (Casida *et al.*, 1964). The dehydrogenase activity was expressed as micro gram of triphenyl farmazon formed per gram of soil per day (µg TPF formed g^{-1} soil d^{-1}). The concentration of dehydrogenase in the sample was obtained from the standard graph using triphenyl farmazon.

Soil respiration (carbon dioxide evolution) was measured using a continuous gas flow system as described by Grossbard and Marsh (1974).

RESULTS AND DISCUSSION

Weed free check (3 IC at 20, 30, 40 DAS + 2 HW at 45 DAS and 70 DAS) recorded significantly more number of total nodules $plant^{-1}$ (167.33) which was absolutely free from herbicides than the other treatments (Table 1). Similarly higher nodule dry weight (0.47 g $plant^{-1}$) was also observed in the same treatment combination. Pendimethalin @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS recorded lesser number of nodules (68.60) and this might be due the toxic effect of herbicides on nodulation as suggested by Yadav *et al.* (1990).

The data on the effect of integrated weed management on yield are presented in Table 2. Groundnut pod yield varied significantly due to integrated weed management practices. Higher pod yield (2793 kg ha^{-1}) was recorded with Pretilachlor @ 1.5 kg ha^{-1} pre-emergence coupled with 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS than the weedy check. The yield recorded was 70 per cent higher than weedy check (1640 kg ha^{-1}). Higher haulm yield was noticed with the application of

Table 1 : Nodule number and nodule dry weight as influenced by integrated weed management practices in groundnut

Sr. No.	Treatments		Nodule number 60 DAS	Nodule dry weight (g $plant^{-1}$) at 60 DAS
1.	T_1	Alachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	75.67	0.29
2.	T_2	Pretilachlor @ 1.5 kg ha^{-1} pre- emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	69.62	0.08
3.	T_3	Pendimethalin @ 1.5 kg ha-1 pre-emergence+3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	68.60	0.38
4.	T_4	Butachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	146.00	0.29
5.	T_5	Weed free check (3 IC at 20, 30, 40 DAS + 2 HW at 45 DAS and 70 DAS	167.33	0.47
6.	T_6	Weedy check (No weeding no inter cultivation)	116.00	0.33
	S. E. ±		6.52	0.02
	C.D. (P=0.05)		20.08	0.05

HW-Hand weeding, DAS-Days after sowing and IC-Inter cultivation

Table 2 : Pod yield and haulm yield (kg ha^{-1}) of groundnut as influenced by integrated weed management practices

Sr. No.		Treatments	Groundnut pod yield (kg ha^{-1})	Groundnut haulm yield (kg ha^{-1})
1.	T_1	Alachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	2633	3400
2.	T_2	Pretilachlor @ 1.5 kg ha^{-1} pre- emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	2793	3633
3.	T_3	Pendimethalin @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	2467	3800
4.	T_4	Butachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	2533	3373
5.	T_5	Weed free check (3 IC at 20, 30, 40 DAS + 2 HW at 45 DAS and 70 DAS	2500	3667
6.	T_6	Weedy check (No weeding no inter cultivation)	1640	2640
		S.E. ±	206	NS
		C.D. (P=0.05)	610	-

HW-Hand weeding, DAS-Days after sowing and IC-Inter cultivation NS=Non-significant

Pendimethalin @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS as against weedy check. This increase in yield might be due to suppression of weeds by herbicide along with integrated management. Pretilachlor is effective in controlling weeds and increasing the yields of dry-seeded rice as reported by Singh *et al.* (2007).

The data related to soil enzymatic activities and respiration has shown in Table 3. At 30 DAS weed free check (treatment without any herbicides) recorded maximum phosphatase activity (88.69 µg) followed by alachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS (82.98 µg). Least phosphatase activity was recorded in the weedy check (47.15 µg). A profound increase was noticed in phosphatase activity recorded on the 60th day as compared to that on the 30th day after sowing. Maximum activity was achieved with alachlor @ 1.5 kg ha^{-1} as pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW (119.05 µg). In general, phosphatase activity in soil treated with herbicide was lower than in the untreated *i.e.* weed free check. Voets *et al.* (1974) observed that long-term applications of herbicide in sugarcane significantly reduced the activity of phosphatase, invertase, β-glucosidase, and urease in soils. However, this was thought to be due to a reduction of biological activity rather than a direct effect on the catabolic behavior of these enzymes.

Among the different treatments the highest dehydrogenase (5.95 µg) activity was observed in weed free check (treatment without any herbicides) followed by butachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS (5.37µg) at 30 DAS. Least activity was noticed in alachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS

Table 3 : Soil enzymatic activities and respiration as influenced by integrated weed management practices in groundnut

Sr. No.		Treatments	Phosphatase (µg pnp formed g^{-1} soil h^{-1})		Dehydrogenase (µg TPF formed g^{-1} soil d^{-1})		Soil respiration (mg CO_2 per 100 g soil d^{-1})	
			30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
1.	T_1	Alachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	82.98	91.08	2.74	3.58	79.12	83.40
2.	T_2	Pretilachlor @ 1.5 kg ha^{-1} pre- emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	57.64	71.91	4.84	5.21	77.07	82.87
3.	T_3	Pendimethalin @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	61.69	80.84	3.10	6.22	11.07	59.11
4.	T_4	Butachlor @ 1.5 kg ha^{-1} pre-emergence + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS	77.98	83.57	5.37	5.53	32.72	67.91
5.	T_5	Weed free check (3 IC at 20, 30, 40 DAS + 2 HW at 45 DAS and 70 DAS	88.69	119.05	5.95	5.45	85.84	92.41
6.	T_6	Weedy check (No weeding no inter cultivation)	47.15	57.14	3.51	3.81	48.57	66.07
		S.E. ±	0.11	0.13	0.01	0.48	0.14	0.32
		C.D. (P=0.01)	0.99	0.41	0.02	1.48	0.43	0.98

HW-Hand weeding, DAS-Days after sowing and IC-Inter cultivation

(2.74 µg). However, there was a notable increase in the dehydrogenase activity at 60 DAS in all the treatments. Earlier reports have shown that herbicides may enhance or inhibit soil enzyme activities (Quilt *et al.,* 1979; Davies and Greaves, 1981) under long term or short term conditions.

The soil respiratory activity was significantly reduced by the pre-emergence application of pendimethalin @ 1.5 kg ha^{-1} + 3 IC at 20, 30, 40 DAS + 1 HW at 45 DAS on 30 DAS (11.07 mg CO_2 per 100 g soil d^{-1}) and 60 DAS (59.41 mg CO_2 per 100 g soil d^{-1}). However, maximum soil respiratory activity was observed with hand weeding on 30 DAS (85.84 mg CO_2 per 100 g soil d^{-1}) and 60 DAS (92.4 mg CO_2 per 100 g soil d^{-1}). Higher respiration in the soil indicates greater diversity of microbes which indirectly measures the soil biological health. Lower respiration might be due to lower microbial activity.

The present investigation on the impact of integrated weed management has elucidated the transient impact of long term application of herbicides on the soil microbiology. Weed management through hand weeding operation without any herbicide improved the nodulation in groundnut. Integration of hand weeding, inter-cultivation at different intervals and recommended herbicide improved the yield of groundnut.

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