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Integrated weed management impact on soil biological indicators in cowpea

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ABSTRACT

Impact of integrated weed management practices involving stale seedbed, mulching with dried banana leaves, herbicides, *viz*. pre-emergence (PE) diclosulam, post-emergence (PoE) quizalofop-p-ethyl and imazethapyr and manual weeding on nodulation in bush cowpea and enzyme activity in soil was studied. Stale seedbed recorded significantly higher number of total nodules per plant. Dehydrogenase enzyme activity was also higher in stale seedbed however, urease enzyme activity did not have any significant effect at 15 and 30 DAS. Treatments with imazethapyr recorded lesser number of total nodules than treatments with diclosulam and quizalofop-p-ethyl. Among the herbicide treatments at 15 DAS, PE diclosulam registered significantly higher urease and dehydrogenase enzyme activity than weedy check and comparable activity with hand weeding treatment. Post-emergence imazethapyr showed a reduction in dehydrogenase and urease enzyme activity at 30 DAS compared to 15 DAS. However, PoE quizalofop-p-ethyl registered higher dehydrogenase and urease enzyme activity at 30 DAS compared to 15 DAS and values were comparable or higher than that of hand weeding treatment.

Integrated weed management involving chemical and non-chemical method is the viable solution for weed control in bush type vegetable cowpea. Soil enzyme activity are the indicators of soil health and are considered as biological fingerprints of management practices. If herbicides were applied to the soil, major portion of the applied herbicides accumulated in the top layer (0-15 cm) (Latha and Gopal 2010). Ramesh *et al.* (2000) reported that the herbicide, imazethapyr did not have any negative impact on urease activity in soil. However, Majumdar *et al.* (2010) revealed that quizalofop-p-ethyl inhibits the soil urease enzyme activity. Yang *et al.* (2003) observed that mulched plot recorded the highest enzyme activity. Diclosulam as pre plant surface spray 17.5 g/ha did not hamper nodulation in green gram and can be considered as a safe dose (Deepa *et al*. 2017). Pre-emergence (PE) pendimethalin 1.0 kg/ha *fb* quizalofop-p-ethyl and imazethapyr 50 g/ha recorded higher number of nodules per plant in green gram (Muthuram *et al*. 2018). Herbicides should effectively control the weeds but also safe to the crop and environment. Hence, present study was undertaken to evaluate the influence of different weed management practices on weed density, green pod yield and nodulation in bush type vegetable cowpea and soil enzyme activity.

Experiment was carried out at Coconut Research Station, Balaramapuram, Thiruvananthapuram, Kerala during *Kharif* 2019. During the cropping season 919 mm of rainfall was received and the average and minimum temperature was recorded 32.06 and 17.79^{0}C, respectively. Soil texture of the experimental site was red loam, acidic in reaction with high organic carbon content (0.79%), low N (206.3 kg/ha), high P (39.17 kg/ha) and medium K (137.28 kg/ha). The experiment was carried out in randomized block design with seedbed preparation and weed management practices as two factors in three replications. Seedbed preparation comprised of stale seedbed (SSB) and normal seedbed (no stale). Weed management practices comprised of dried banana leaf mulch10 t/ha, dried banana leaf mulch 10 t/ha *fb* imazethapyr 50 g/ha at 25 DAS, dried banana leaf mulch 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS, imazethapyr 50 g/ha at 15 DAS, diclosulam 12.5 g/ha (pre-emergence) *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS, diclosulam 12.5 g/ha (pre-emergence) *fb* hand weeding at 25 DAS, hand weeding at 20 and 40 DAS and weedy check. Diclosulam was applied on the day of sowing the cowpea seeds, imazethapyr and quizalopfop-p-ethyl were applied as per the treatment schedule. The spray fluid adopted for the experiment was 500 L/ha. Test

crop used for the study was '*Bhagyalakshmy*', a short duration variety (80 days). Farm yard manure (FYM) 20 t/ha was applied basally and NPK dose of 20: 30: 10 kg/ha was adopted. Nitrogen was applied in two splits (half as basal and half at 20 DAS), entire P and K as basal. To correct the acidity, 250 kg/ha of lime was applied and incorporated into the soil at the time of final ploughing.

Total weed density at 45 DAS was determined by placing a quadrate of size 0.5 x 0.5 m at two spots in each treatment and average was worked out and expressed as no./m^2. Green pod yield was expressed in t/ha. Total number of nodules per plant was recorded at fifty per cent flowering stage. Composite samples were collected at 15 and 30 DAS for the analysis of soil dehydrogenase and urease enzyme activity. The methodology suggested by Casida *et al*. (1964) was employed for the determination of dehydrogenase activity and method suggested by Watts and Crisp (1954) was adopted for the estimation of urease activity in soil. Analysis of variance was done for the statistical analysis of data.

Effect on dehydrogenase enzyme activity

Weed management treatments recorded higher dehydrogenase enzyme activity (**Table 1**) at 15 and 30 DAS compared to weedy check. At 15 DAS, treatments not receiving herbicides recorded higher dehydrogenase enzyme activity and the treatments receiving PE diclosulam 12.5 g/ha registered dehydrogenase activity comparable with hand weeding treatment. At 30 DAS, mulching with dried banana leaf 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS recorded the highest dehydrogenase enzyme activity which was significantly superior to other treatments. The treatments with dried banana leaf mulch recorded higher dehydrogenase enzyme activity compared to other treatments which might be due to higher substrate availability. Interaction effect was significant only at 30 DAS (**Table 1)**. At 30 DAS, the treatment stale seedbed + mulching with dried banana leaf 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS registered the highest dehydrogenase activity. The treatment, normal seedbed + no weeding (weedy check) recorded the lowest dehydrogenase enzyme activity at 15 and 30 DAS. This might be owing to lesser substrate availability as a result of season long weed infestation.

Effect on urease enzyme activity

Seedbed preparation had no significant impact on urease enzyme activity at 15 and 30 DAS. Application of PE diclosulam 12.5 g/ha *fb* hand weeding at 25 DAS recorded the highest urease enzyme activity which was significantly higher compared to other treatments (**Table 1**). However, at 30 DAS, PE diclosulam 12.5 g/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS recorded the highest urease enzyme activity which was at par with PE diclosulam 12.5 g/ha *fb* hand weeding at 25 DAS and mulching with dried banana leaf 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS. The differences in the urease enzyme activity observed among the treatments might be due to changes in soil pH and soil temperature. Yang *et al*. (2006) reported that urease activity in soil was based on the soil microbial community, pH and temperature. Interaction effect was significant only at 30 DAS and the treatment normal seedbed + PE diclosulam 12.5 g/ha *fb* hand weeding at 25 DAS recorded the highest urease enzyme activity, which was statistically at par with stale seedbed + PE diclosulam 12.5 g/ha *fb* hand weeding at 25 DAS, normal seedbed + mulching with dried banana leaf 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS and stale seedbed + hand weeding at 20 and 40 DAS.

Effect on total number of nodules per plant

Compared to normal seedbed (9.00), SSB registered higher number of total nodules per plant (12.0). There was, 26.32 per cent increase in total nodules per plant. Enhancement in photosynthesis and translocation of photosynthates to the root nodules resulted in the development of a greater number of root nodules. Chatta *et al*. (2007) observed that poor plant growth adversely affected the nodule formation. Tehria *et al*. (2015) reported that in pea, nodule count was found to be the highest in SSB compared to herbicide treatment.

Weed management treatments recorded higher number of total nodules per plant, however, variations were observed among the treatments due to the specific soil condition prevailed in each treatment. Effect of herbicide treatments on nodulation depends on the specific soil condition, moisture content, soil organic matter and weather condition (Walley *et al*. 2006). Among the treatments, PE diclosulam 12.5 g/ha *fb* hand weeding at 25 DAS recorded significantly higher number of nodules (17.50) which was followed by PE diclosulam 12.5 g/ha *fb* quizalofop-p-ethyl 50 g/ha. It was also revealed from the data that treatments with imazethapyr, *viz*. PoE imazethapyr 50 g/ha at 15 DAS and mulching with dried banana leaf 10 t/ha *fb* imazethapyr 50 g/ha at 25 DAS recorded lesser number of nodules (8.00 and 9.17 no. per plant) than quizalofop-p-ethyl, *viz*. mulching with dried banana leaf 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS and PE diclosulam 12.5 g/

ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS (12.83 and 13.17).

The treatment combination stale seedbed + PE application of diclosulam 12.5 g/ha *fb* hand weeding at 25 DAS recorded higher number of total nodules per plant (20.33) compared to other treatments (**Table 2**). This was owing to the fact that the beneficial effect of SSB coupled with diclosulam application resulted in the effective control of weeds enabled the crop to grow vigorously resulting in the effective transport of photosynthates from leaves to nodules.

Effect on total weed density and green pod yield of bush cowpea

Stale seedbed (SSB) recorded significantly lower total weed density at 45 DAS and higher green pod yield compared to no stale or normal seedbed **(Table 2)**. This might be due to the fact that removal of initial flushes of weeds prior to the sowing of cowpea seeds resulted in a competition free environment which might have contributed to higher green pod yield. Tehria *et al*. (2015) reported that SSB significantly brought down the density of weeds and higher yield in ground nut and Pea. Among the weed management practices, mulching with dried banana leaf 10 t/ha alone recorded the lowest total weed density and it was statistically at par with mulching with dried banana leaf 10 t/ha *fb* imazethapyr and quizalofop-p-ethyl 50 g/ha. The results also revealed that PoE application of imazethapyr 50 g/ha alone was not found effective in reducing the weed density in bush type vegetable cowpea. The result were in conformity with Kumavat *et al*. (2017) who observed that PoE application of imazethapyr alone was not effective in reducing the weed density in cluster bean. Result on green pod yield of bush type vegetable cowpea revealed that mulching with dried banana leaf 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS recorded the highest green pod yield. This might be due to the better control of weeds which reduced the crop weed competition, increased the availability and uptake of nutrients and resulted in higher green pod yield.

Interaction effect revealed that, stale seedbed + mulching with dried banana leaf 10 t/ha *fb* imazethapyr 50 g/ha at 25 DAS recorded the lowest total weed density which was statistically at par with mulching with dried banana leaf 10 t/ha alone and stale seedbed + mulching with dried banana leaf 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS. Though, the treatment stale seedbed + mulching with dried banana leaf 10 t/ha *fb* imazethapyr 50 g/ha at 25 DAS recorded the lowest weed density, the highest yield was recorded in seedbed + dried banana leaf mulching 10 t/ha *fb* quizalofop-p-ethyl 50 g/ha at 25 DAS. Under stale seedbed and normal seedbed, PoE imazethapyr 50 g/ha at 15 DAS recorded the highest density of weeds and the lowest green pod yield compared to other weed management treatments. The result clearly revealed that early stage weed control is essential for higher green pod yield in

Table 1. Effect of seedbed preparation and weed management practices on dehydrogenase and urease enzyme activity

Weed management practice	Dehydrogenase enzyme activity (µg triphenyl formazan (TPF) g^{-1} soil/day^{-1})						Urease enzyme activity (µg urea hydrolysed g^{-1}soil $4h^{-1}$)					
	Seed bed preparation (S)											
	15 DAS			30 DAS			15 DAS			30 DAS		
	Seed bed preparation											
	SSB	Normal seed bed	Mean	SSB	Normal seed bed	Mean	SSB	Normal seed bed	Mean	SSB	Normal seed bed	Mean
Dried banana leaf mulch 10 t/ha	4.44	4.21	4.33	5.01	3.11	4.06	355.2	379.7	367.5	392.1	446.4	416.3
Dried banana leaf mulch 10 t/ha *fb* PoE imazethapyr 50 g/ha at 25 DAS	4.81	3.87	4.34	6.59	3.46	5.03	360.1	384.8	372.4	371.7	476.2	424.3
Dried banana leaf mulch 10 t/ha *fb* PoE quizalofop-p-ethyl 50 g/ha at 25 DAS	4.50	4.04	4.27	6.64	6.03	6.34	359.2	370.0	365.0	447.3	476.2	461.7
PoE imazethapyr 50 g/ha at 15 DAS	4.47	4.31	4.39	3.38	3.69	3.54	387.2	372.3	379.8	359.2	392.1	375.7
PE Diclosulam *fb* PoE quizalofop-p-ethyl 50 g/ha at 25 DAS	3.29	2.77	3.03	3.32	3.69	3.56	386.6	419.1	403.0	444.8	519.4	482.1
PE Diclosulam *fb* HW at 25 DAS	3.11	2.88	3.00	3.71	3.50	3.60	428.9	452.1	440.5	476.7	479.1	477.4
Hand weeding at 20 and 40 DAS	3.57	3.05	3.31	3.87	3.86	3.87	362.8	330.6	346.6	457.6	384.4	419.5
Weedy check	2.88	2.73	2.81	3.54	3.10	3.32	380.0	348.0	364.0	346.2	316.6	331.4
Mean	3.82	3.55	0.35	4.53	3.79	0.55	377.6	382.1		411.6	435.5	
LSD (p=0.05)	Seed bed preparation (S)		0.18			0.27			NS			NS
	Weed management practices (W)		0.35			0.55			35.5			50.3
	Seed bed preparation X Weed management practices (S X W)		NS			0.78			NS			71.1

PE: pre-emergence, PoE: post-emergence, HW: Hand weeding, NS: non-significant

Table 2. Effect of seedbed preparation and weed management practices on total number of nodules per plant at 50% flowering stage, total weed density at 45 DAS and green pod yield of bush type vegetable cowpea

Weed management practices	Total no. of nodules per plant at 50 per cent flowering stage			Total weed density (no./m^2)			Green pod yield (t/ha)		
	Seed bed preparation								
	SSB	Normal seed bed	Mean	SSB	Normal seed bed	Mean	SSB	Normal seed bed	Mean
Dried banana leaf mulch 10 t/ha	8.53	8.67	8.50	3.61(12)	4.58(20)	4.12(16)	7.23	6.79	7.01
Dried banana leaf mulch 10 t/ha *fb* PoE imazethapyr 50 g/ha at 25 DAS	6.67	9.33	8.00	3.42(11)	4.99(24)	4.28(17)	7.48	7.19	7.34
Dried banana leaf mulch 10 t/ha *fb* PoE quizalofop-p-ethyl 50 g/ha at 25 DAS	12.00	13.67	12.83	4.22(17)	4.72(21)	4.51(19)	7.73	7.45	7.59
PoE imazethapyr 50 g/ha at 15 DAS	9.00	9.33	9.17	7.46(55)	7.71(59)	7.58(57)	5.49	4.72	5.10
PE Diclosulam *fb* PoE quizalofop-p-ethyl 50 g/ha at 25 DAS	18.67	7.67	13.17	5.55(30)	5.63(31)	559(30)	6.05	5.73	5.88
PE Diclosulam *fb* HW at 25 DAS	20.33	14.67	17.50	4.99(24)	7.42(54)	6.32(39)	5.99	5.28	5.63
Hand weeding at 20 and 40 DAS	12.67	7.00	9.83	6.39(40)	5.59(29)	5.97(35)	6.43	5.62	6.02
Weedy check	8.33	5.67	7.00	9.22(84)	11.24(126)	10.20(105)	3.90	2.33	3.11
Mean	12.00	9.50		5.92(34)	6.81(45)		6.29	5.64	
LSD (p=0.05)	Seed bed preparation (S)		0.67			0.29			0.18
	Weed management practices (W)		1.34			0.58			0.35
	Seed bed preparation X Weed management practices (SXW)		1.89			0.82			0.50

PE: Pre-emergence, PoE: post-emergence, HW: Hand weeding, Values in parentheses are original values and values are subjected to square root transformation ($\sqrt{x+1}$)

cowpea. Due to initial slow growth of cowpea, weeds emerge fast and gain competitive advantage over the crop and caused reduction in pod yield.

It was concluded that the herbicides, PE diclosulam 12.5 g/ha and PoE quizalofop-p-ethyl 50 g/ha did not have any inhibitory effect on total number of nodules per plant, dehydrogenase and urease enzyme activity. However, PoE application of imazethapyr 50 g/ha showed reduction in the total number of nodules and an inhibition in the dehydrogenase and urease enzyme activity in soil.

REFERENCES

Casida LE, Klein DA and Santoo T. 1964. Soil dehydrogenase activity. *Soil Science* 98: 371–376.

Chatta MU, Ali A and Bilal M. 2007. Influence of planting techniques on growth and yield of spring planted sugarcane. *Pakistan Journal of Agriculture Science* **44**: 452–456.

Deepa L, Desai BK, Latha HS and Mahadevswamy. 2017. Biotoxic effect of diclosulam 84% WDG on growth, nodulation and nitrogen content of green gram. *International Journal of Agriculture Science* **9** (32): 4468–4470.

Kumawat P, Kaushik MK, Meena VK, Chouhan BS, Meena RK and Kumar R. 2017. Effect of weed management and fertility levels on productivity of cluster bean [*Cyamopsistetragonoloba* (L.) Taub]. *Legume Research* **40**(5): 884–889.

Latha PC and GopalG. 2010. Influence of herbicides on cellulolytic, proteolytic and phosphate solubilizing bacteria. *International Journal of Plant Protection* **3**(1): 83–88.

Majumdar B, Saha AR, Sarkar S, Maji B and Mahapatra BS. 2010. Effect of herbicides and fungicides application on fibre yield and nutrient uptake by jute (*Corchorus olitorius*), residual nutrient status and soil quality. *Indian Journal of Agricultural Science* **80**(10): 878–883.

Muthuram T, Krishnan R and Baradhan G. 2018. Productivity enhancement of irrigated green gram (*Vigna radiata*) through integrated weed management. *Plant Archives* **1**(18): 101–105.

Ramesh A, Joshi OP and Billore SD. 2000. Effect of herbicides on soil dehydrogenase and urease activity in soybean (*Glycine max*). *Indian Journal of Agricultural Science* **70**: 218–219.

Tehria SK, Rana SS and Kumar S. 2015. Nutrient uptake by weeds and pea as influenced by phosphorus and weed management. *Indian Journal of Weed Science* **47**(2): 144–149.

Walley F, Taylor A and Lupwayi. 2006. Herbicide effects on pulse crop nodulation and nitrogen fixation. *Farm Tech Proceedings*. pp. 121–123.

Watts GW and Crisp JD. 1954. Combined effect of cadmium and butachlor on soil enzyme activities and microbial community structure. *Environmental Geology* **51**: 1093–1284.

Yang YJ, Dungan RS, Ibekwe AM, Solano CV, Crohn DM and Crowley DE. 2003. Effect of organic mulches on soil bacterial communities one year after application. *Biology and Fertility of Soils* **38**: 273–281.

Yang YZ, Liu S, Zheng D and Feng S. 2006. Effects of cadmium, zinc and lead on soil enzyme activities. *Journal of Environmental Science* **18**: 1135–1141.