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Effect of different herbicides on weeds and lac yield in *bhalia* plantation

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ABSTRACT

Several herbicides were evaluated for their possibility of use in the lac production system under *Flemingia semialata* in the Research Farm of Indian Institute of Natural Resins and Gums, Ranchi. Among several herbicides evaluated, application of glyphosate at 1.0 kg/ha in *Flemingia semialata (*vernacularly called *bhalia)* plantation at 10 days prior to lac insect inoculation, resulted in significant reduction in weed density and dry weight with 88.6% weed control efficiency (WCE). Glyphosate was found safe to lac insect and superior to other tested herbicides and resulted in 38.8% higher sticklac yield over control. The weed free treatment (manual, weeding twice) recorded the highest sticklac yield (239.7 g/bush or 1918 kg/ha) but was uneconomical in comparison to herbicide treatments.

Keyword : Glyphosate, weed control efficiency, deleterious effect of herbicides, herbicides effect on non-target organisms.

Lac, a product of insect (*Kerria lacca* Kerr) origin has got potential to play an important role in improving the economy of rural people in the lac growing areas. For enhancing lac production, culture of lac insect is being encouraged and promoted on bushy type lac host plants of *Flemingia* spp on plantation basis (Bhattacharya and Jaiswal 2004, Singh *et al*. 2008). Weeds are a menace due to their adverse impact on lac host plantation as it (i) retards the growth of hosts by competiting for natural resources during raising of new plantations, and (ii) affects tillering of bushy hosts after coppicing as well as growth and development of host plants. Weeds also create an inconvenient condition in the field for the workers. Manual removal of weeds consumes a large quantum of labour force and expenditure. In such situations, use of herbicides becomes an obvious choice. Herbicides are not supposed to kill the insects due to non acting of specific enzymatic sites in the insects but there are reports of deleterious effect of herbicides on biogents *Neochetina* spp. (Sushikumar *et. al.* 2008).

MATERIALS AND METHODS

A field experiment was conducted at Institute Research Farm, Indian Institute of Natural Resins and Gums, Namkum , Ranchi, Jharkhand (23º23'N longitude, 85º23' E latitude and 650 m above MSL) during monsoon seasons of 2008 and 2009 to study the effect of potential herbicides for weed control and their safety to lac insect and host plants in established plantation (4 years old) of *Flemingia semialata*, a bushy lac host. The soil was sandy loam having 70.8% sand, 20.4% clay, 8.8% silt and acidic in reaction (pH 5.5). The herbicides included in this experiment was paraquat 0.4 kg/ha, glyphosate 1.0 kg / ha, glufosinate 1.0 kg/ha, atrazine 2.0 kg/ha and quizalofop-p-ethyl 0.2 kg/ha. In addition, weed free (weeding manually) and unweeded control were included for comparison. The experiment was laid out in randomized block design with three replications. The plot size was 5 x 3 m. The planting pattern of *F. semialata* was at paired row system adopting row to row distance of 0.5 m and plant to plant 1.0 m leaving 2.0 m space between two paired rows, accommodating 8000 plant/ha. Application of herbicides was done with the help of Knapsack sprayer fitted with flat fan nozzle in the plantation at 7 and 10 days prior to lac insect inoculation during 2008 and 2009, respectively. Simultaneously, weeds were removed manually in weed free treatment. There was no weed free treatment in 2008 and weed intensity incidence was recorded at 35 days after imposition of weed control treatments (DAT) by using a quadrate of 50 x 50 cm from two randomly selected places from each plot. Collected weeds were counted, identified species wise, segregated into grasses, broad leaved and sedges and then oven dried at 65ºC till constant weight was obtained. Weed control efficiency (WCE) was calculated as per standard methods. Weed data were subjected to square root transformation $\sqrt{(x+1)}$ before statistical analysis.

Shoots of *F. semialata* were put under lac culture in

The middle of July during both the years after six months of coppicing/ harvesting of lac crop for raising winter season lac crop (*aghani,* 2008-09 and 2009-10) with *kusmi* strain of Indian lac insect using a uniform rate of broodlac (lac encrustation with gravid female about to produce young nymphs) @ 50 g/ bush. The lac larvae settled on the shoots within 21 days of inoculation; subsequently empty brood, (*phunki*) were removed and scrapped. Pests (predators and parasitoids) of lac insect were managed by adopting recommended practices (Bhattacharya 2002). Thereafter, lac larvae settled on shoot of *F. semialata* were sampled at 30 days of inoculation for examination of lac insect mortality for all treatments under three replications from three plants distributed all over the plot. Samples of 5 cm length were prepared each from lower, middle and upper portion of lac larvae settled shoots and preserved in 4% formalin solution for recording of lac insect mortality.

Matured lac crop was harvested in the last week of February during both the years. After harvesting, scrapping of lac encrustation (twigs bearing lac) was done with the help of scrapping knife to obtain sticklac.

RESULTS AND DISCUSSIONS

Effect on weed

Main weed flora of the experimental field constituted of seven species of grasses (*Digiteria sanguinalis*, *Setaria verticillata*, *Cynodon dactylon*, *Brachiaria ramosa*, *Eleusine indica*, *Echinocloa colona* and *Dactyloctenium aegypticum;* ten species of broad leaved weeds : *Ageratum conyzoides*, *Alternanthera sessilis*, *Emelia sonchyfolia*, *Spilanthes acmella*, *Commelina benghalensis*, *Phyllanthus niruri*, *Stellaria media Scoperia dulsis*, *Oldenlandia corymbosa* and *Desmodium trifolium*) and three species of sedges *Cyperus iria*, *Cyperus rotundus* and *Cyperus defformis*. The mean relative density of grasses, broadleaved and sedges in weedy plots recorded were 33, 56, 54, 43 and 12%. The grasses constituted 35.95% broadleaved 49.28% and sedges 14.77% of total weed population. All treatments caused significant reduction in weed density and dry weight of all categories of weeds as compared to unweeded control (Table 1). Non-selective herbicides *i.e.* paraquat, glyphosate and glufosinate significantly lowered the weed population and dry weight except sedges as compared to selective herbicides atrazine and quizalofop. The minimum weed population (12.95/m^2) and dry weight (8.94 g/ m^2) of weeds were recorded under glyphosate and hand weeding treatments, respectively. Among the tested herbicides, glyphosate was found to be superior, exhibiting 88.57% weed control efficiency which was only 1.53% lower than that of hand weeding

Table 1. Effect of different weed control treatments on weed density, dry matter production and weed control efficiency in *F. semialata* plantation

Treatments	Herbicide rate (kg/ha)	Weed density (no/ m^2)			Weed dry weight (g/m^2)			Weed control efficiency (%)
		Grasses	Broad leaved	Sedges	Grasses	Broad leaved	Sedges	
Paraquat	0.4	6.7 (47.0)	9.5 (90.0)	2.1 (6.0)	4.6 (20.9)	6.4 (40.4)	1.6 (2.0)	77.6
Glyphosate	1.0	4.9 (23.5)	5.9 (48.0)	2.1 (4.0)	3.4 (10.86)	4.4 (20.70)	1.3 (0.68)	88.6
Glufosinate	1.0	6.6 (45.0)	8.2 (72.0)	2.2 (6.7)	4.1 (16.0)	5.7 (32.4)	2.9 (8.9)	79.7
Atrazine	2.0	9.29 (86.0)	14.3 (214.0)	2.2 (6.7)	7.2 (51.7)	10.4 (107.48)	1.8 (3.03)	42.5
Quizalofop	0.2	7.8 (61.0)	13.3 (184.0)	5.2 (26.6)	6.0 (35.2)	10.8 (115.0)	3.2 (1.0)	43.3
Weed free	--	4.8 (22.0)	7.6 (57.5)	2.5 (5.3)	3.3 (9.9)	4.2 (17.1)	1.4 (1.4)	89.9
Un weeded (control)	--	16.3 (266.0)	18.4 (336.0)	6.9 (46.7)	9.8 (95.5)	12.4 (155.2)	5.6 (31.4)	--
LSD (P=0.05)	--	2.1	2.2	2.7	1.8	3.0	2.0	

Figures in parenthesis are original values subjected to transformation $\sqrt{(x+1)}$

twice. Singh (1990) has also reported decrease of weed population and its dry weight through application of herbicides in *bhalia* nursery. Atrazine and quizalofop recorded highest weed density and dry weight among the herbicide treated plots due to their poor weed control efficiency, which was 42.5 and 43.3%, respectively and the latter was least effective against sedges and quizalafop is grass only herbicide, how it can have effect on some broadleaf weeds or sedges. Quizalofop was mainly effective against grasses. Its effect was well visualized in weed biomass of different types of weed. The weight of grasses was effected significantly, than of broadleaved weed which remained at per to unweeded control. Only, weight of sedge was found to be reduced but density remained unaffected, which could be due to sampling error.

Effect on lac insect

Application of herbicides in established plantation of *F. semialata* for weed control did not show any adverse effect on lac larvae. Based on the data of two years, the lowest mortality (13.76%) of lac insect was registered with glyphosate where as highest with paraquat (19.18%). No significantly adverse effect of chemical weed control treatments on lac insect was observed during its early stages prominent on any portion of shoot (Table 2) Sushilkumar *et. al.* (2009) reported bioagent mortality by effect of herbicide but in the present study herbicides were sprayed 7 to 10 days prior to lac insect inoculation, hence effect of herbicide on lac mortality was ruled out. A seperate study is required to see the effect of herbicide by applying directly and indirectly after the lac insect inoculation.

Effect on lac crop

There was no herbicidal toxicity on lac crop. Increase in stick lac yield was observed due to different weed control treatments (Table 3). The efficiency of controlling weeds by two hand weeding was reflected in the stick lac yield production in 2009-10. The highest stick lac yield (239.7 g/ bush or 1918 kg/ ha) was obtained in the plot kept

Table 2. Lac insect mortality as influenced by different weed control treatments in *F. semialata* plantation

Treatments	Herbicide dose (kg/ha)	Larval mortality (%) on different portion of shooots							
		2008				2009			
		Lower	Middle	Upper	Mean	Lower	Middle	Upper	Mean
Paraquat	0.4	12.3	8.6	13.0	11.3	40.8	24.3	16.1	27.06
Glyphosate	1.0	7.9	14.9	11.51	11.43	14.4	17.9	16.0	16.1
Glufosinate	1.0	10.2	10.1	9.6	9.97	26.7	17.1	28.3	24.03
Atrazine	2.0	11.7	13.1	15.7	13.5	30.0	17.3	18.8	22.3
Quizalofop	0.2	7.4	12.6	15.4	11.8	29.9	20.0	15.1	21.67
Weed free	--	--	--	--	--	14.9	17.9	18.7	17.17
Un weeded (control)	--	9.1	14.2	13.3	12.2	18.6	11.2	29.2	19.67
LSD (P=0.05)		NS	NS	NS	NS	NS	NS	NS	NS

NB: There was no weed free treatment in 2008-09

Table 3. Sticklac yield in *F. semialata* as influenced by different weed control treatments

Treatments	Herbicide dose (kg/ha)	Sticklac yield (g/bush)			Sticklac yield (kg/ha)		
		2008-09	2009-10	Mean	2008-09	2009-10	Mean
Paraquat	0.4	192.7	222.29	207.49	1542	1778	1660
Glyphosate	1.0	200.6	223.64	212.12	1605	1789	1697
Glufosinate	1.0	190.2	219.79	204.99	1521	1758	1639
Atrazine	2.0	169.73	204.06	186.89	1358	1606	1482
Quizalofop	0.2	165.63	152.38	159.00	1325	1219	1272
Weed free	--	--	239.7	239.7	--	1918	1918
Un weeded (control)	--	165.53	140.12	152.85	1324	1118	1221
LSD (P=0.05)		NS	42.63	24.4	NS	314	195

*Significant difference

weed free by hand weeding twice. This could be obviously due to better control of weeds and production of minimum dry weight bio-mass. All herbicides except quizalofop registered significantly higher sticklac yield than weedy check during 2009-10. During 2008-09, though, there was increase in sticklac yield on account of weed control treatments, however, effect was found to be non-significant. Application of glyphosate performed better and recorded 212.12g sticklac per bush (16.05 q/ha) which was 38.78% higher and 13% lower over unweeded (control) and weed free (manually) treatments, respectively in pooled results which was at par with paraquat and glufosinate. Glyphosate applied 10 days prior to lac insect inoculation at 3 to 4 leaved stages of weed was most effective to check all weed growth. Safety to lac insect and the host plant was ensured with the herbicide. The same may be recommended for *F. semialata* plantation (established).

Table 4. Economics of lac production under different weed control treatments

Treatments	Herbicide dose (kg/ha)	Gross profit (Rs/ha)	Cost of production (Rs/ha)	Net Profit (Rs/ha)	Net return per rupee invested (Rs)
Paraquat	0.4	121800	57909	63891	2.10
Glyphosate	1.0	123550	58814	64736	2.10
Glufosinate	1.0	122600	63734	58866	1.92
Atrazine	2.0	108800	59020	49780	1.84
Quizalofop	0.2	90050	69820	20230	1.29
Weed free	--	131200	83400	46900	1.57
Un weeded (control)	--	86150	55800	30350	1.54

Economics

Amongst the weed control treatments, highest net return (Rs 64,736/ha) and net return per rupee investment (Rs 2.1) were accrued under application of glyphosate at 1.0 kg/ha, compared to other treatments (Table 4). Though, the gross profit was higher in weed free treatment, net profit and net return per rupee investment were low, compared to most of the herbicides mainly due to higher cost of production, as large number of labourers were engaged to maintain weed free condition.

Based on the experiment, it can be concluded that potential production and effective weed control can be achieved by manual weeding which is not feasible and uneconomical too. These results are in accordance with that of Raghvani *et al.* (1987).

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