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Short Communication

Bio-efficacy and phytotoxicity of glyphosate 41% SL on weed flora of tea and its effect on soil microbial activities

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Abstract

A field experiment was conducted at the farmers' field in Panchrukhi block of Kangra District (H.P.) during *kharif* 2019 to evaluate the bio-efficacy and phytotoxicity of glyphosate 41% SL in tea (*Camellia sinensis*). The experiment was laid out in a Randomized Block Design with ten treatments and was replicated thrice. The treatments comprised of six doses of a new formulation of glyphosate 41 % SL (All Clear, Anu Products Ltd.) 1.0, 2.0, 3.0, 4.0, 5.0 and 8.0 litre / ha, glyphosate 41 % SL (Roundup, Monsanto), glyphosate 71 % SG 3.0 kg / ha and weedy and weed free checks. Major weeds that were found to infest the experimental tea orchard included *Erigeron canadensis, Ageratum conyzoides, Cynodon dactylon, Imperata cylindrica, Paspalum conjugatum* and *Polygonum alatum*. The results revealed that in tea crop weeds can be effectively controlled with the application of glyphosate 41% SL (All Clear)3.0 litre/ha and 4.0 litre/ha. No phytotoxicity symptoms on tea were observed at any of dose of herbicide.

Key words: Bio-efficacy, glyphosate, tea, All Clear, weeds.

Globally loss of tea production on account of weed infestation has been estimated to be about 1.46 million kilogram which accounts for 14-15% of the global tea production (Opeke 2005). Weeds reduce the yield as well as quality of the made tea, besides competing for light, nutrients and moisture. Weeds remove 5-6 times more nitrogen, 5-12 times more phosphorus and 2-5 times more potassium than the beverage crop in early stages of crop growth leading to severe competition for these nutrients and ultimately lower yield. Weeds grow profusely from the time of tea planting until the tea canopy covers the inter-row spaces adequately. Uncontrolled weed growth can cause a loss of tea productivity to the extent of 50-70 per cent. Weed infestation and thereby damage to tea is more severe in young tea bushes up to two years of planting before canopy closure and during the period of pruning every three to four years. The period between April and September is very critical from tea productivity as well as quality point of view as this plucking season coincides with high rainfall and temperature which provides very favourable condition for weed growth (Devi *et al*. 2019). Besides competing for nutrients, water, light and space, weeds also harbour crop pests and pose many operational hazards in tea crop. Hence it is important to control weeds in an effective manner for ensuring higher productivity and quality. Keeping these points in mind, the present experiment was conducted to evaluate the bio-efficacy and phytotoxicity of new brand of glyphosate 41% SL (All Clear) against weed flora in tea and soil microbial activity.

A field experiment was conducted in established tea orchard located in Panchrukhi block of Himachal Pradesh (Latitude 32° 6' N, Longitude 76° 3' E and at an elevation of 1290.8 m above mean sea level) during

kharif season of 2019. The soil of the established tea orchard was silty clay loam in texture, acidic in reaction (pH 5.6), low in available nitrogen (276 kg/ha) and medium in available phosphorus (15.5 kg/ha) and potassium (160 kg/ha). The experiment was laid out in Randomized Block Design with three replications and comprised of ten treatments viz,, six doses of new formulation of glyphosate 41% SL All Clear (Anu Products Pvt. Ltd.) 1.0, 2.0, 3.0, 4.0, 5.0 and 8.0 litre/ha, glyphosate 41% SL (Roundup, Monsanto, standard check), glyphosate 71% SG, weed free and weedy check. Herbicides were sprayed at 3-4 leaf stage of the weeds using knapsack sprayer fitted with flat fan nozzle with the spray volume of 500 l/ha. Weed free condition was maintained by removing the weeds manually.

The observations were recorded on weed density (No./m^2) and weed biomass (g/m^2) at 30, 45 and 60 days after herbicide application by placing a quadrat of 1 m x 1 m randomly in each plot. The data so collected on weed count and dry matter was subjected to square root transformation ($\sqrt{x+1.0}$) for statistical analysis. Weed control efficiency (WCE) was calculated on the basis of dry matter recorded at periodic intervals as per the formula suggested by Mani *et al*. (1973).

$$\text{Weed Control Efficiency (\%)} = \frac{\text{WDC - WDT}}{\text{WDC}} \times 100$$

WhereWDC= Weed dry weight in untreated control plot (g/m^2), and

WDT= Weed dry weight in treated plot (g/m^2)

The observations on phytotoxicity due to application of herbicides were recorded on 7, 15, 30, 45 and 60 days after herbicide application. The parameters viz., leaf injury on tip/surface, epinasty, hyponasty, necrosis, stunting, yellowing, wilting and chlorosis on tea were recorded visually and rated on a scale of 0-10 with 0 indicating no injury and 10 indicating complete phytotoxicity. Standard Plate Count Technique was used to study the effect of these herbicides on the microbial count in the soil (Wollum, 1983).

Weed flora

The dominant weed flora of the experimental field consisted of *Erigeron canadensis, Ageratum conyzoides, Cynodon dactylon, Imperata cylindrica, Paspalum conjugatum* and *Polygonum alatum*.

Weed density and weed biomass

Application of all the doses of the new formulation All Clear (glyphosate 41 % SL) along with standard herbicide check (Roundup) as well as the granular form of glyphosate (71 SG) significantly reduced the density of weeds at all the three stages of observation. Application of the lowest dose (1.0 litre / ha) of this new glyphosate formulation was not effective in controlling weeds in tea. The results so obtained clearly indicate the effectiveness of glyphosate, irrespective of the brand as well as formulations, for controlling weeds in tea. These findings are in close conformity with the findings of Ilango *et al*. (2010) and Bose *et al*. (2007).

As with the weed density, weed biomass was also significantly influenced by the different herbicide treatments with both the herbicide formulations of Glyphosate 41 % SL (All Clear, except at 1.0 litre/ha and standard check Roundup) along with granular form of glyphosate proving equally effective in significantly reducing the weed biomass at all the stages of observation. Significantly higher weed biomass at all the stages of observation was recorded in weedy check treatment. Application of the lowest dose of this new formulation All Clear (1.0 litre/ha) recorded significantly higher weed biomass as compared to all other herbicide treatments. Further it is evident from the data presented in Table 1 that the glyphosate was effective for managing all the types of weeds prevalent in tea crop for a period of about 60 days. Similar trend was observed for weed control efficiency (WCE) with all the herbicide treatments, except for the lowest dose of new glyphosate formulation All Clear (1.0 litre / ha) giving higher weed control efficiency indicating the effectiveness of all the formulations of glyphosate for controlling weeds infesting the tea crop. Kumar and Ghosh (2015) have also reported higher weed control efficiency with glyphosate in tea. No phytotoxicity symptoms regarding epinasty, hyponasty, vein clearing, necrosis, leaf top and surface injury and wilting of plants were observed on tea due to application of all the tested

formulations at 7, 15, 30, 45 and 60 DAS indicating the safety of this herbicide on tea crop, even at the highest dose.

The data on the effect of treatments on the microbial count in soil recorded at 30 days after spray have been given in table 2 which revealed that the bacterial, actinomycetes and fungal count in soil declined with glyphosate application, irrespective of the formulation, as compared to the initial values with the decline being more with higher dose of glyphosate. The microbial population increased in weedy check as well as in weed free treatment as compared to the initial values. The results so obtained indicated the adverse effect of glyphosate application on the soil microbial activity which must be considered before using this herbicide for longer period in tea plantations. Also this necessitates the identification of new herbicides that can effectively manage weeds in established tea orchards.

From the present study it can be concluded that weeds in tea can be effectively controlled with glyphosate 41% SL at 2.0 litre/ha and there was no phytotoxicity of this herbicide even up to the application rate of 8.0 litre/ha. Also the new formulation All Clear was equally effective as the standard check Roundup.

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Table 1. Effect of weed control treatments on weed density (No./m^2) and weed biomass by weeds (g/m^2) in tea

Treatment	Dose (g/ha)	Weed density (No./m^2)				Weed biomass (g/m^2)			
		Before spray	30 DAS	45 DAS	60 DAS	Before spray	30 DAS	45 DAS	60 DAS
Glyphosate 41% SL (All Clear)	1.0 litre/ha	5.9 (34.7)	3.2 (9.3)	3.7 (13.3)	5.1 (25.3)	4.8 (22.0)	2.2 (3.9)	2.4 (5.0)	4.2 (16.4)
Glyphosate 41% SL (All Clear)	2.0 litre / ha	5.3 (26.7)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	4.1 (16.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Glyphosate 41% SL (All Clear)	3.0 litre / ha	6.5 (41.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	5.1 (25.5)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Glyphosate 41% SL (All Clear)	4.0 litre / ha	5.7 (32.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	4.6 (20.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Glyphosate 41% SL (All Clear)	5.0 litre / ha	6.6 (42.7)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	5.0 (24.6)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Glyphosate 41% SL (All Clear)	8.0 litre / ha	5.5 (26.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	4.3 (17.5)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Glyphosate 41% SL (Roundup)	2.0 litre / ha	5.8 (33.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	4.6 (20.4)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Glyphosate 71% SG (Excel – mera)	3.0 kg/ ha	5.2 (26.7)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	4.2 (16.4)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Weedy Check	Untreated control	6.1 (36.0)	6.3 (40.0)	7.6 (57.3)	9.0 (81.3)	4.7 (21.3)	5.1 (25.0)	6.7 (43.7)	9.0 (81.3)
Weed free check		6.7 (44.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	4.9 (23.5)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
CD (P=0.05)		NS	0.6	0.7	0.6	NS	0.4	0.5	0.7

Values in the parenthesis are the means of original values, Data subjected to $\sqrt{x+1}$square root transformation, DAS – Days after spray.

Table 2. Effect of weed control treatments on weed control efficiency (%), phytotoxicity and microbial activity in soil

Treatment	Dose (g/ha)	Weed control efficiency (%)			Phytotoxicity rating					Microbial Count (x 10^3 CFU / g soil)		
		30 DAS	45 DAS	60 DAS	7 DAS	15 DAS	30 DAS	45 DAS	60 DAS	Bacteria	Actinomycetes	Fungi
Glyphosate 41% SL (All Clear)	1.0 litre / ha	84.4	88.5	79.8	0	0	0	0	0	49.4	23.8	11.5
Glyphosate 41% SL (All Clear)	2.0 litre / ha	100	100	100	0	0	0	0	0	47.2	22.9	10.2
Glyphosate 41% SL (All Clear)	3.0 litre / ha	100	100	100	0	0	0	0	0	44.5	22.4	8.9
Glyphosate 41% SL (All Clear)	4.0 litre / ha	100	100	100	0	0	0	0	0	43.0	21.7	7.6
Glyphosate 41% SL (All Clear)	5.0 litre / ha	100	100	100	0	0	0	0	0	42.5	21.4	6.3
Glyphosate 41% SL (All Clear)	8.0 litre / ha	100	100	100	0	0	0	0	0	43.0	20.1	4.8
Glyphosate 41% SL (Roundup)	2.0 litre / ha	100	100	100	0	0	0	0	0	46.5	23.5	10.4
Glyphosate 71% SG (Excel – mera)	3.0 kg / ha	100	100	100	0	0	0	0	0	44.9	22.4	8.5
Weedy Check	Untreated control	-	-	-	0	0	0	0	0	58.7	24.7	16.4
Weed free check		100	100	100	0	0	0	0	0	59.0	24.0	15.9
Initial Value		-	-	-	-	-	-	-	-	52.7	22.2	15.3

DAS: days after spray

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