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Research Article

Evaluation of different doses of glufosinate ammonium 13.5% SL for broad-spectrum weed control in tea under Assam condition

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Abstract

Field experiment was conducted at Jorhat, Assam with a view to study the efficacy of glufosinate ammonium 13.5% SL in controlling weeds in tea plantation. The major weed florae present in the experimental plots were grasses (*Axonopus compressus* (Sw.) Beauv., *Paspalum conjugatum* Berg.), sedge (*Kyllinga brevifolia* Rottb.) and broad leaf (*Borreria hispida* (L.) K. Schum., *Ageratum conyzoides* Linn., *Eupatorium odoratum* Linn.) weeds. The experiment was laid out in a randomised block design with 3 replications and 7 treatments. Treatment comprised 5 different doses of glufosinate ammonium 13.5% SL (1500, 2000, 2500, 3300, 4100mlha^{-1}) compared with glyphosate 41% SL @ 2500 ml ha^{-1}as standard herbicide and one untreated control. Results revealed that among the treatments, application of glufosinate ammonium 13.5% SL @ 3300 ml ha^{-1} and @ 4100 ml ha^{-1}effectively controlled all the weeds in tea upto 60 days after application (DAA) of treatments. Therefore, both the doses of glufosinate ammonium 13.5% SL were equally effective and there was no significant difference between two treatments in terms of weed density and dry weight. No weed growth was observed upto 60 DAA of both the doses irrespective of weed species and 100 per cent weed control efficiency (WCE) was observed under these treatments. In case of controlling monocot weeds, glufosinate ammonium 13.5% SL @ 3300mlha^{-1}and @ 4100mlha^{-1}were statistically at par with glyphosate 41% SL @ 2500mlha^{-1}(standard). Considering the requirement of herbicide, its effectiveness against diverse weed florae and phytotoxicity on tea crop, glufosinate ammonium 13.5% SL @ 3300mlha^{-1}is the best dose to manage the weeds in tea plantation.

***Key words*:** *Camellia sinensis* (L) O. Kuntze, Glufosinate Ammonium 13.5% SL, bio-efficacy, phytotoxicity.

Introduction

Tea (*Camellia sinensis* (L) O. Kuntze) is the major cash crop of Assam. It occupies an area of 3.48 lakh ha with a production of 688.70 Mkg (Anon., 2022). Being a perennial crop and consumes large amount of nutrients throughout the year, weed is one of the major pests in tea. Weeds compete with tea for all available resources. They suppress the growth of tea particularly young tea causing a serious yield loss, if not controlled in time. There are many weed control methods advocated for tea *viz*. cultural, manual, mechanical, chemical, ecological, biological *etc*. (Prematilake, 2003; Kumar *et al*., 2014 and Jana *et al*., 2025). Out of these, chemical weed control method is more popular as compared to other methods (Prematilake *et al*., 2004; Rajkhowa *et al*., 2005; Ilango *et al*., 2010 and Mirghasemi *et al*., 2012) due to its efficiency, saving of time as well as manpower, cost effectiveness and ease of operation. Moreover, collar regions and roots of tea are safe under chemical weed control (Mirghasemi *et al*., 2012). Although Glyphosate 41% is the most popular and widely used non-selective post emergent herbicide in tea, yet a few weeds escape from its toxicity and generally its efficacy is low in broad leaf weeds. Therefore, broad spectrum weed control is not possible with this herbicide. Glufosinate ammonium 13.5% SL is a new generation, broad spectrum, non-selective, post emergent and contact herbicide

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can be used as a substitute for Glyphosate 41% SL. Keeping in view the diversified weed species infesting tea crop, glufosinate ammonium 13.5% SL was tested to assess its efficacy against the weed florae in tea, to optimise its dose and to study the adverse effect of the herbicide, if any, on the crop.

Materials and methods

A field experiment was carried out in a clonal mature tea section (Section No. B/33) of Borbhetta Experimental Tea Estate, Jorhat, Assam, India during rainy season of 2018. The soil of the experimental area was sandy loam in texture and acidic in reaction (pH: 4.78). Tea crop (Clone: TV 1, TV 18, TV 25 and TV 26) was planted in 1987 at a spacing of 105cm x 75cm. The experiment was laid out in a randomised block design with three replications and seven treatments. Treatment comprised *viz.* T_1: Glufosinate Ammonium 13.5% SL @ 1500 ml ha^{-1}(225 g *a.i.* ha^{-1}), T_2: Glufosinate Ammonium 13.5% SL @ 2000 ml ha^{-1}(300 g *a.i.* ha^{-1}), T_3: Glufosinate Ammonium 13.5% SL @ 2500 ml ha^{-1}(375 g *a.i.* ha^{-1}), T_4: Glufosinate Ammonium 13.5% SL @ 3300 ml ha^{-1}(495 g *a.i.* ha^{-1}), T_5: Glufosinate Ammonium 13.5% SL @ 4100 ml ha^{-1} (615 g *a.i.* ha^{-1}), T_6: Glyphosate 41% SL @ 2500mlha^{-1}(1025 g *a.i.* ha^{-1}) as Standard and T_7: Untreated Control. The layout for the experiment was done before the application of treatments. Each plot was demarcated accommodating 60 bushes/net plot and separated by two rows of tea as guard rows. The herbicides were applied in a single day in the month of July with a Knapsack sprayer (Aspee make) fitted with a flood jet nozzle. The spray volume used for spraying was @ 400 litre/ha. The crop was grown as rain fed. The total rainfall received during the entire period of study was 915.1 mm. Maximum and minimum temperature ranged between 30.3 to 34.7^{0}C and 21.0 - 27.3^{0}C respectively. All the standard agronomic practices as well as pest management were done as per the package of practices followed at Tocklai Tea Research Institute, Jorhat.

Observations recorded

Weed Density

The density of different species of weeds was recorded before treatment application and also at 15, 30, 45 and 60 days after application of herbicides for respective treatments and untreated control. A quadrate with a dimension of 0.5 m x 0.5 m (0.25 m^2) was placed randomly at three spots in each plot and the weeds from that area were counted and average was worked out and expressed in weed No.m^{-2}.

Weed Dry Weight

For recording species-wise weed biomass in different treatments, a separate area of 0.5 m x 0.5 m (25 equal divisions) was marked at three spots in each plot including untreated control and the weeds in each marked quadrant were removed before application of treatment and at15, 30, 45 and 60DAA of treatments and labelled properly. The labelled samples were cleaned and oven dried at 65℃ for 72 hours and weighed to estimate the dry weight of weeds. Then the dry weight of weeds was recorded separately for each species and expressed as gm^2.

Weed Control Efficiency (WCE)

Weed control efficiency denotes the efficiency of the applied herbicide for comparison purpose. It is expressed as percentage of control of weeds over untreated control. Weed control efficiency of different treatments was computed on the basis of species wise dry weight recorded at 15, 30, 45 and 60DAA of treatments and untreated control by using the following formula:

$$WCE\ (\%) = \frac{W1 - W2}{W1} \times 100$$

W1= Weed dry weight in the untreated plot (T_7)

W2= Weed dry weight in the treated plot

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Phytotoxicity study on tea bushes

Phytotoxicity rating was done at 0-10 scale by counting the affected plants, if any, where Scale 0: No phytotoxicity, Scale 1: 1-10%,Scale 2: 11-20%, Scale 3: 21-30%, Scale 4: 31-40%, Scale 5: 41-50%, Scale 6: 51-60%, Scale 7: 61-70%, Scale 8: 71-80%, Scale 9: 81-90% and Scale 10: 91-100% phytotoxicity. Visual observations on leaf epinasty and hyponasty, leaf yellowing and necrosis and stunted growth of tea bushes were noted at 1, 3, 5, 7 and 10 DAA of the herbicide treatments.

Statistical Analysis

All the data pertaining to the present investigation wherever needed, were statistically analysed for Randomized Block Design (RBD) described by Panse and Sukhatme (1985). Critical differences (CD) at 5% probability level were calculated only when the F value been found significant. In other cases, values of standard error of means have been provided. The final data (weed count and weed dry weight) was transformed using the formula $(X + 0.5)^{0.5}$ for analysis purpose.

Results and discussion

Bio-efficacy

The predominant weed species noted in the experimental site included both monocotyledonous (grass and sedge) and dicotyledonous (broad leaf) weeds. Among the monocot weeds, *Axonopus compressus* (Sw.) Beauv. and *Paspalum conjugatum* Berg. were the grasses, *Kyllinga brevifolia* Rottb. was the sedge and *Borreria hispida* (L.) K. Schum., *Ageratum conyzoides* Linn. as well as *Eupatorium odoratum* Linn. were the broad leaf weeds. Weeds were identified with the help of a memorandum authored by Dutta (1983). All the weeds were equally distributed and statistically not significant at the time of application of treatments.

Weed Population (No.m^{-2})

Among the herbicidal treatments, it was evident from the Table 1 and 2 that the effect of different doses of glufosinate ammonium 13.5% SL was found to be statistically significant in respect of density of weeds/m^2. No monocot weed growth was observed from 15 days onwards till 60 DAA for the treatment T_4 (glufosinate ammonium 13.5% SL @ 3300 mlha^{-1}), T_5 (glufosinate ammonium 13.5% SL @ 4100 ml ha^{-1}) and T_6 (glyphosate 41% SL@ 2500 ml ha^{-1} as Standard check).These treatments were statistically at par with each other for all the monocot weeds at 15, 30, 45 and 60 DAA of treatments and recorded significantly lower weed density than those of T_1 (glufosinate ammonium 13.5% SL @ 1500 ml ha^{-1}), T_2 (glufosinate ammonium 13.5% SL @ 2000 ml ha^{-1}), T_3 (glufosinate ammonium 13.5% SL @ 2500 ml ha^{-1}) and T_7 (Untreated control) in this respect. In case of controlling dicot broad leaf weeds, T_4 and T_5 were found to be superior to those of all the treatments irrespective of weed species and time of observations. In this regard, it can be said that T_4 and T_5 recorded the lower values of weed population than standard glyphosate 41% SL (T_6) and rest of the treatments. On the other hand, the highest values of weed population were noted in T_7 due to non-receiving of any treatment. Significant reduction in monocot weed population under T_4, T_5 and T_6 might be due to better efficacy of both the doses (3300 ml ha^{-1} and 4100 ml ha^{-1}) of glufosinate ammonium 13.5% SL and glyphosate 41%SL at recommended dose on monocot weed. In case of dicot weeds, glyphosate 41% @ 2500 ml ha^{-1}(T_6) was less effective than T_4 and T_5in respect of density of weeds/m^2. These findings were in alignment with the findings of Patra *et al*. (2016), Banerjee *et al*. (2018) and Kundu *et al*. (2020).

Weed Dry Weight (gm^{-2})

Dry matter of weed is the most important parameter to assess the weed competitiveness for the crop growth and productivity (Patra *et al*., 2016). Sparse weeds with high biomass might be more competitive for crops than dense weeds with lesser dry matter (Ramalingam *et al*., 2013). A perusal of data presented in Table 3 and Table 4

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clearly indicated that weed dry weight also followed almost similar trend with significantly lowest dry weight (0.71gm^{-2}) of all the three types of weeds were recorded in T_4,T_5 and $T_6$and the highest values were observed in T_7i.e. untreated control for all the monocot weeds upto 60 DAA of herbicide. The treatments T_4 and T_5 also recoded the lowest values (0.71gm^{-2}) of weed dry weight which were statistically significant over rest of the treatments in controlling broad leaf weeds on all the dates of observation. Significant reduction of weed dry weight after application of this product was also reported by Banerjee *et al*. (2018) and Kundu *et al*. (2020).

Table 1. Effect of glufosinate ammonium 13.5% SL on density (No. m^{-2}) of monocot weeds at different days after application (DAA)

Treatments	*Axonopus compressus* (Sw.) Beauv.				*Paspalum conjugatum* Berg.				*Kyllinga brevifolia* Rottb.			
	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA
T_1	6.20 (38.00)	6.07 (36.33)	6.69 (44.33)	7.54 (56.33)	5.28 (27.33)	5.05 (25.00)	5.55 (30.33)	6.01 (35.67)	6.34 (39.67)	6.28 (39.00)	6.99 (48.33)	7.88 (61.67)
T_2	5.64 (31.33)	5.46 (29.33)	5.90 (34.33)	6.36 (40.00)	4.70 (21.67)	4.44 (19.33)	4.73 (22.00)	5.17 (26.33)	5.58 (30.67)	5.46 (29.33)	5.99 (35.33)	6.67 (44.00)
T_3	4.81 (22.67)	4.38 (18.67)	4.64 (21.00)	5.08 (25.33)	4.06 (16.00)	3.58 (12.33)	3.67 (13.00)	4.22 (17.33)	5.04 (25.00)	4.84 (23.00)	5.11 (25.67)	5.66 (31.67)
T_4	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_5	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_6	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_7	7.38 (54.00)	7.67 (58.33)	8.09 (65.00)	8.49 (71.67)	6.36 (40.00)	6.84 (46.33)	7.31 (53.00)	7.60 (57.33)	7.79 (60.33)	8.21 (67.00)	8.69 (75.00)	8.99 (80.33)
S. Em (±)	0.10	0.06	0.09	0.08	0.11	0.12	0.12	0.14	0.2	0.17	0.14	0.15
CD (0.05)	0.22	0.14	0.20	0.18	0.24	0.26	0.26	0.31	0.43	0.36	0.3	0.33

Figures in parenthesis indicate the original values

Table 2. Effect of glufosinate ammonium 13.5% SL on density (No. m^{-2}) of dicot weeds at different days after application (DAA)

Treatments	*Borreria hispida* (L.) K. Schum.				*Ageratum conyzoides* Linn.				*Eupatorium odoratum* Linn.			
	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA
T_1	7.86 (61.33)	7.45 (55.00)	7.13 (50.33)	6.59 (43.00)	7.52 (56.00)	7.22 (51.67)	6.87 (46.67)	6.49 (41.67)	1.77 (2.67)	1.77 (2.67)	1.77 (2.67)	1.77 (2.67)
T_2	6.96 (48.00)	6.57 (42.67)	6.15 (37.33)	5.64 (31.33)	7.01 (48.67)	6.77 (45.33)	6.36 (40.00)	6.04 (36.00)	1.77 (2.67)	1.77 (2.67)	1.77 (2.67)	1.77 (2.67)
T_3	6.39 (40.33)	5.79 (33.00)	5.37 (28.33)	4.74 (22.00)	5.84 (33.67)	5.43 (29.00)	4.98 (24.33)	4.30 (18.00)	1.68 (2.33)	1.46 (1.67)	1.46 (1.67)	1.46 (1.67)
T_4	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_5	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.000)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_6	8.31 (68.67)	8.13 (65.67)	8.03 (64.00)	7.97 (63.00)	8.24 (67.33)	8.07 (64.67)	7.91 (62.00)	7.76 (59.67)	1.94 (3.33)	1.94 (3.33)	2.04 (3.67)	2.04 (3.67)
T_7	9.44 (88.67)	9.89 (97.33)	10.42 (108.00)	10.99 (120.33)	8.73 (75.67)	9.10 (82.33)	9.19 (84.00)	9.34 (86.67)	1.86 (3.00)	1.95 (3.33)	2.04 (3.67)	2.20 (4.33)
S. Em (±)	0.15	0.15	0.09	0.11	0.06	0.04	0.07	0.07	0.16	0.14	0.12	0.12
CD (0.05)	0.33	0.32	0.21	0.25	0.14	0.08	0.16	0.16	0.34	0.31	0.25	0.25

Figures in parenthesis indicate the original values

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Table 3. Effect of glufosinate ammonium 13.5% SL on dry weight (G M^{-2}) of monocot weeds at different days after application (DAA)

Treatments	*Axonopus compressus* (Sw.) Beauv.				*Paspalum conjugatum* Berg.				*Kyllinga brevifolia* Rottb.			
	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA
T_1	4.36 (18.54)	4.24 (17.44)	4.69 (21.47)	5.19 (26.44)	4.35 (18.45)	4.24 (17.52)	4.49 (19.65)	4.97 (24.24)	4.97 (24.21)	4.90 (23.53)	5.35 (28.11)	5.86 (33.89)
T_2	4.23 (17.37)	4.00 (15.47)	4.43 (19.17)	4.88 (23.31)	4.24 (17.46)	3.99 (15.46)	4.33 (18.26)	4.72 (21.78)	4.70 (21.56)	4.54 (20.11)	5.12 (25.72)	5.61 (30.99)
T_3	3.58 (12.30)	3.35 (10.71)	3.68 (13.01)	4.19 (17.05)	3.60 (12.46)	3.35 (10.75)	3.53 (11.99)	3.96 (15.21)	4.20 (17.15)	4.30 (17.99)	4.68 (21.38)	5.11 (25.66)
T_4	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_5	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_6	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_7	5.37 (28.35)	5.88 (34.03)	6.46 (41.18)	6.99 (48.40)	5.39 (28.57)	6.01 (35.59)	6.34 (39.65)	6.86 (46.59)	6.45 (41.14)	6.96 (48.01)	7.50 (55.75)	7.98 (63.11)
S. Em (±)	0.07	0.03	0.07	0.05	0.11	0.06	0.05	0.1	0.09	0.08	0.06	0.05
CD (0.05)	0.16	0.06	0.15	0.11	0.24	0.12	0.11	0.21	0.20	0.18	0.14	0.11

Figures in parenthesis indicate the original values

Table 4. Effect of glufosinate ammonium 13.5% SL on dry weight (g m^{-2}) of dicot weeds at different days after application (DAA).

Treatments	*Borreria hispida* (L.) K. Schum.				*Ageratum conyzoides* Linn.				*Eupatorium odoratum* Linn.			
	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA
T_1	6.19 (37.78)	5.90 (34.29)	5.47 (29.43)	5.34 (27.98)	6.02 (35.78)	5.76 (32.67)	5.34 (27.98)	5.19 (26.43)	3.23 (9.94)	3.42 (11.18)	3.61 (12.51)	3.84 (14.25)
T_2	5.46 (29.35)	5.13 (25.84)	4.50 (19.78)	4.41 (18.97)	5.37 (28.34)	4.92 (23.74)	4.41 (18.97)	4.27 (17.78)	3.21 (9.83)	3.29 (10.30)	3.55 (12.08)	3.65 (12.84)
T_3	4.56 (20.32)	4.03 (15.71)	3.60 (12.47)	3.23 (9.94)	4.46 (19.40)	3.85 (14.33)	3.24 (10.03)	3.21 (9.80)	2.92 (8.02)	2.60 (6.24)	2.37 (5.14)	2.18 (4.25)
T_4	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_5	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_6	6.06 (36.22)	5.83 (33.54)	5.96 (35.05)	6.29 (39.11)	5.63 (31.24)	5.35 (28.09)	5.19 (26.40)	5.06 (25.12)	3.73 (13.39)	3.88 (14.55)	3.98 (15.33)	4.19 (17.05)
T_7	6.68 (44.15)	7.18 (51.01)	7.81 (60.58)	8.36 (69.40)	6.83 (46.24)	7.32 (53.10)	7.99 (63.42)	8.41 (70.28)	3.74 (13.48)	3.90 (14.73)	4.11 (16.38)	4.34 (18.32)
S. Em (±)	0.05	0.04	0.05	0.06	0.09	0.06	0.05	0.06	0.08	0.07	0.06	0.05
CD (0.05)	0.11	0.09	0.11	0.12	0.20	0.13	0.10	0.14	0.17	0.15	0.13	0.10

Figures in parenthesis indicate the original values

Weed Control Efficiency (%)

The efficacy data recorded at different intervals clearly indicated that 100 per cent WCE was observed in T_4, T_5 and $T_6$from 15 days onwards upto 60 DAA of herbicides for all the monocot weeds (Table 5 and Table 6). In case of broadleaf dicots, T_6 could not show 100% WCE at any date of observation after application of treatment. Higher percentage of WCE under T_4 and T_5indicated the superiority of the product for controlling weed florae in tea plantation as compared to application of the earlier recommended most popular herbicide i.e. glyphosate 41% SL (T_6). Banerjee *et al*. (2018) and Kundu *et al*. (2020) also found similar results in this respect.

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Table 5. Effect of glufosinate ammonium 13.5% SL on Weed Control Efficiency (%) of monocot weeds at different days after application (DAA).

Treatments	*Axonopus compressus* (Sw.) Beauv.				*Paspalum conjugatum* Berg.				*Kyllinga brevifolia* Rottb.			
	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA
T_1	34.60	48.75	47.86	45.37	35.42	50.77	50.44	47.97	41.15	50.99	49.58	46.30
T_2	38.73	54.54	53.45	51.84	38.89	56.56	53.95	53.25	47.59	58.11	53.87	50.90
T_3	56.61	68.53	68.41	64.77	56.39	69.79	69.76	67.35	58.31	62.53	61.65	59.34
T_4	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T_5	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T_6	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T_7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6. Effect of glufosinate ammonium 13.5% SL on Weed Control Efficiency (%) of dicot weeds at different days after application (DAA).

Treatments	*Borreria hispida* (L.) K. Schum.				*Ageratum conyzoides* Linn.				*Eupatorium odoratum* Linn.			
	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA	15 DAA	30 DAA	45 DAA	60 DAA
T_1	14.43	32.78	51.42	59.68	22.62	38.47	55.88	62.39	26.26	24.10	23.63	22.22
T_2	33.52	49.34	67.35	72.67	38.71	55.29	70.09	74.70	27.08	30.07	26.25	29.91
T_3	53.98	69.16	79.42	85.68	58.04	73.01	84.18	86.06	40.50	57.64	68.62	76.80
T_4	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T_5	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T_6	17.96	34.25	42.14	43.65	32.44	47.10	58.37	64.26	0.67	1.22	6.41	6.93
T_7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Phytotoxicity

In case of phytotoxicity study, it was found that any dose of glufosinate ammonium 13.5% SL did not show any phytotoxicity symptoms like yellowing, necrosis, epinasty, hyponasty and stunting on tea bushes at all the observations (1, 3, 5, 7 and 10 DAA of herbicides) indicating that this herbicide can be applied safely in tea crop at recommended rate in tea for effective weed management. These results were in conformity with the findings of Banerjee *et al*. (2018) and Kundu *et al*. (2020) where they stated that they also had not observed any phytotoxicity symptom for any of the doses tried.

Conclusion

From the above study, it can be concluded that, both the doses (3300 ml ha^{-1} and 4100 ml ha^{-1}) of glufosinate ammonium 13.5% SL were equally effective in controlling weeds in tea plantation without showing any phytotoxicity symptom on tea bushes. Considering the requirement of herbicide, application of glufosinate ammonium 13.5% SL @ 3300 ml ha^{-1} will be more economical to manage the diversified weed florae in tea plantation.

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