standardized according to the intensity of weed problems and agro-climatic situations. Keeping all the facts in mind, the present study was conducted to evaluate the bio-efficacy of post-emergence application of glufosinate ammonium 13.5% SL (15% W/V) at different doses on weed control and yield of cotton for recommendation to the farmers.

MATERIALS AND METHODS

The field experiment was carried out at Instructional farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India, during rainy season of 2016 and 2017. The experiment consisted of 7 treatments (T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha, T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); and T_7, weedy control); under randomized block design, replicated thrice. The cotton hybrid 'KCH 14K 59 BGII' was sown in the third week of June at a spacing of 60 cm × 30 cm. Individual plot size was 5 m × 4 m. Seeds were soaked in water before sowing for easy breakdown of seed coat. Recommended dose of fertilizers @ 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha was applied through urea, single superphosphate and muriate of potash respectively. Entire doses of P_2O_5 and K_2O and half of nitrogen were applied at basal and the rest half of N in 3 equal splits at 50, 80 and 110 days after sowing (DAS). Glufosinate ammonium 13.5% SL (15% W/V) and paraquat dichloride 24% SL (*check herbicide*) were applied 40 days after sowing (DAS) at 3–5-leaf stage of weeds, with a spray volume of 500 litres/ha by knapsack sprayer fitted with hollow-cone nozzle for inter-row weed control in cotton. Plot with T_6 treatment was frequently hand-weeded (5 times at 20, 30, 45, 65 and 95 DAS) to keep it weed-free. Experimental soil was irrigated before sowing and after the end of rainy season when soil-moisture content receded, from the second fortnight of September onwards up to 10–12 days before harvesting of crop; further 4 irrigations were applied at periodic intervals of 12–15 days. Other agronomic management practices were carried out as per the recommendations. Weed density and dry weight of weeds were recorded 30 and 60 days after application (DAA) of herbicides. Plant height, number of sympodial branches/plant, dry weight/plant, bolls/plant, boll weight and seed-cotton yield were registered at harvesting. Dates of harvesting were 25 and 27 November in 2016 and 2017 respectively. Weed-control efficiency (WCE) was computed as:

$$\mathrm{WCE}\ (\%) = \{(X-Y)/X\} \times 100$$

where X = weed density (no./m^2) in control (untreated) plot and

Y = Weed density (no./m^2) in treated plot.

Data collected from the field were subjected to analysis of variance and the treatment means were compared for significance at 5% according to critical differences (CD) proposed by Gomez and Gomez (1984) using standard statistical software for further interpretation. For analysis of variance, weed population and dry weight data were undergone square root transformation due to their wide variations in original data set.

RESULTS AND DISCUSSION

Weed flora diversity

During the 2 consecutive years of experiment, the major weed floras observed in cotton field included were grasses like jungle rice [*Echinochloa colona* (L.) Link], large crabgrass [*Digitaria sanguinalis* (L.) Scop.]; sedges like purple nut sedge (*Cyperus rotundus* L.); and broad-leaf weeds like tropical spiderwort (*Commelina bengh alensis* L.)*, alligator weed [Alternanthera philoxeroides* (Mart.) Griseb.]. Some other noticeable weeds were: *Eleusine indica* (L.) Gaertn. *Panicum repens* L., *Paspalum distichum* L., *Cyperus esculentus* L., *Cyperus aromaticus* (Ridl.) Mattf. & Kukenthal, *Eclipta prostrate* (L.) L.; syn E. *alba* (L.) Hassk., *Trianthema portulacastrum* L., *Phyllanthus niruri* L., *Euphorbia hirta* L., *Amaranthus viridis* L., *Digera arvensis* Forsk., *Physalis minima* L., *Sonchus arvensis* L.*, Portuleca oleracea* L.*, Acmella paniculata Wall.* Ex DC.) R.K. Jansen; syn. *Spilanthus paniculata* Wall. ex DC.*, Stellaria media* (L.) Vill.*, Scoparia dulcis* L. etc. Freitas *et al.* (2003) and Oad *et al.* (2007) also reported such weed floras in cotton field.

Weed density and dry weight

The pooled results of study indicated that, the weed-management practices significantly reduced the weed density and dry weight compared to the weedy control (Tables 1, 2). No weed was noted under T_6 treatment where hand-weeding was done frequently as and when weeds emerged. This observation is in accordance to the findings of Bharathi *et al.* (2011) in cotton and Patra *et al.* (2016) in tea. Among the herbicidal treatments, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) was best in reduction of all types of weed population, followed by glufosinate ammonium 13.5% SL (15% w/v) @ 450 g/ha (T_3). However, the weed density was lower at 30 DAA than at 60 DAA. It might be owing to greater efficacy of herbicides in weed control soon after the application, which subsequently declined as days progressed. At 30 DAA, both T_3 and T_4 treatments were statistically at par in terms of weed density. However, at 60 DAA, there was a significant difference between the 2 treatments for weed density. Glufosinate ammonium 13.5% SL @ 525 g/ha showed better weed suppression effect over others, as its higher toxicity might have efficiently block the activity of glutamine synthetase, resulting in complete breakdown of ammonia metabolism (Hack *et al.,* 1994).

Dry weight of weeds is the best measure of efficacy of weed-management practices, since weed competes with crop for sunlight, moisture, nutrients and other resources for their growth. In the weedy control (T_7), weed biomass was the highest, as weeds were allowed to flourish offering higher competition to crop for various resources, while it was lowest in case of hand-weeding (T_6) because of engagement of manual labour in frequent weed removal at all observations (Tables 3, 4). It was in agreement with the findings of Cheema *et al.* (2005) and Giri *et al.* (2006). Among the herbicidal measures, the lowest dry weights of all category of weeds were observed when glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4). With lowering the dose of glufosinate ammonium 13.5% SL (15% W/V), both weed density and biomass increased significantly, which indicated that bio-efficacy of a herbicide improved when the herbicide was applied at higher doses. Our results confirmed the findings of Young *et al.* (2001) and Bharathi *et al.* (2011).

Weed-control efficiency

As a consequence of the results obtained in case of weed density and biomass, the weed control efficiency (WCE) also varied significantly among the herbicide treatments (Tables 5, 6). At 30 and 60 DAA, the highest WCEs (%) were registered in glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) irrespective of the category of weeds, followed by glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha (T_3), paraquat dichloride 24% SL @ 500 g/ha (T_5), glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha (T_2) and glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha (T_1). This result corroborated the find-

Table 1. Effect of weed-control treatments on weed density (no./m^2) as in cotton at 30 days after application (pooled data of 2016 and 2017)

Treatment	*Echinochloa colona*	*Digitaria sanguinalis*	Other monocots	*Cyperus rotundus*	*Commelina benghalensis*	*Alternanthera philoxeroides*	Other dicots
T_1	2.28 (4.69)	2.01 (3.56)	2.61 (6.30)	3.23 (9.97)	2.17 (4.21)	2.42 (5.38)	2.76 (7.14)
T_2	2.22 (4.45)	1.98 (3.44)	2.56 (6.06)	3.20 (9.74)	2.15 (4.11)	2.38 (5.17)	2.72 (6.91)
T_3	1.91 (3.14)	1.72 (2.44)	2.10 (3.93)	2.43 (5.39)	1.80 (2.75)	2.00 (3.50)	2.25 (4.56)
T_4	1.72 (2.45)	1.57 (1.98)	1.94 (3.27)	2.26 (4.61)	1.68 (2.31)	1.85 (2.92)	2.04 (3.66)
T_5	1.93 (3.24)	1.81 (2.77)	2.19 (4.28)	2.54 (5.96)	1.93 (3.21)	2.13 (4.05)	2.32 (4.90)
T_6	-	-	-	-	-	-	-
T_7	4.19 (17.04)	3.64 (12.78)	4.88 (23.28)	6.29 (39.08)	3.86 (14.44)	4.47 (19.50)	5.16 (26.12)
SEm±	0.06	0.05	0.05	0.05	0.04	0.06	0.07
CD (P=0.05)	0.19	0.15	0.16	0.15	0.13	0.18	0.21

Data represent square root-transformed value, i.e. $(x + 0.5)^{½}$. Figures in parentheses indicate original value
*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control

Table 2. Weed density (no./m^2) as influenced by weed-control treatments in cotton at 60 days after application (pooled data of 2016 and 2017)

Treatment	*Echinochloa colona*	*Digitaria sanguinalis*	Other monocots	*Cyperus rotundus*	*Commelina benghalensis*	*Alternanthera philoxeroides*	Other dicots
T_1	2.90 (7.93)	2.66 (6.58)	3.37 (10.84)	4.00 (15.53)	2.72 (6.88)	3.11 (9.17)	3.49 (11.68)
T_2	2.86 (7.69)	2.59 (6.22)	3.29 (10.30)	3.96 (15.18)	2.69 (6.76)	3.07 (8.96)	3.44 (11.34)
T_3	2.13 (4.03)	1.93 (3.23)	2.58 (6.15)	2.85 (7.62)	2.06 (3.76)	2.19 (4.28)	2.48 (5.67)
T_4	1.93 (3.23)	1.77 (2.63)	2.16 (4.15)	2.60 (6.28)	1.89 (3.09)	2.05 (3.71)	2.27 (4.65)
T_5	2.25 (4.58)	1.98 (3.43)	2.62 (6.39)	3.00 (8.50)	2.11 (3.96)	2.33 (4.95)	2.53 (5.91)
T_6	-	-	-	-	-	-	
T_7	4.86 (23.16)	4.31 (18.10)	5.63 (31.17)	6.75 (45.07)	4.46 (19.44)	5.23 (26.82)	5.87 (33.92)
SEm±	0.06	0.04	0.07	0.08	0.05	0.04	0.06
CD (P=0.05)	0.19	0.12	0.22	0.24	0.16	0.13	0.18

Data represent square root-transformed value, i.e. $(x + 0.5)^{½}$. Figures in parentheses indicate original value
*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control

ings of Patra *et al.* (2016) who reported that weed control efficiency of glufosinate ammonium 13.5% SL (15% W/V) improved with the increase of dose from 375 g/ha to 625 g/ha in tea. Among the weed types, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) exhibited greater WCEs (%) on *C. rotundus* (88.2), which was closely followed equally by other monocots and other dicots (86.0) at 30 DAA (Table 5). However, at 60 DAA, WCEs (%) of glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) were the highest on other monocots (86.7), followed by other dicots (86.3) (Table 6).

Growth, yield attributes and yield of cotton

Pooled results depicted that, the weed control practices exerted significant variations on growth, yield attributes and yield of cotton (Table 7). Hand-weeding (T_6) resulted in tallest cotton plants at harvesting (88.2 cm). Our results supported the findings of Oad *et al.* (2007). It might be owing to the fact that, no weeds were allowed to compete with crop for resources under frequently hand-weeded plot. However, among the herbicidal treatments, application of glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) was best in attaining plant height of 85.1 cm due to higher efficacy of controlling weeds with potential reduction of crop-weed competition, followed by glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha (T_3) (Table 7). Similarly, other than hand-weeding (T_6), glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) also ensured higher number of sympodial branches/plant than the other treatments (Table 7). Turkhede *et al.* (2002) and Giri *et al.* (1998) also concluded that, sympodial branches/plant were highest under hand-weeding treatment due zero crop-weed competition and increment of dose of herbicides also increased the same due to greater efficacy of weed

Table 3. Influence of weed-control treatments on dry weight of weeds (g/m^2) in cotton at 30 days after application (pooled data of 2016 and 2017)

Treatment	*Echinochloa colona*	*Digitaria sanguinalis*	Other monocots	*Cyperus rotundus*	*Commelina benghalensis*	*Alternanthera philoxeroides*	Other dicots
T_1	2.05 (3.72)	1.77 (2.64)	2.17 (4.22)	2.65 (6.54)	2.30 (4.81)	2.49 (5.73)	2.82 (7.45)
T_2	1.99 (3.48)	1.74 (2.53)	2.13(4.04)	2.62(6.37)	2.26 (4.60)	2.47 (5.60)	2.77(7.17)
T_3	1.79 (2.72)	1.59 (2.02)	1.91 (3.14)	2.16 (4.19)	1.95 (3.32)	2.12 (4.01)	2.38 (5.18)
T_4	1.67 (2.29)	1.45 (1.60)	1.71 (2.44)	1.95 (3.32)	1.73 (2.48)	1.96 (3.33)	2.18 (4.25)
T_5	1.86 (2.97)	1.64 (2.19)	1.96 (3.34)	2.24 (4.52)	2.03 (3.63)	2.19 (4.32)	2.46 (5.56)
T_6	–	–	–	–	–	–	–
T_7	3.79 (13.86)	3.15 (9.45)	4.00 (15.54)	5.10 (25.55)	4.22 (17.34)	4.73 (21.85)	5.36 (28.19)
SEm±	0.06	0.06	0.08	0.08	0.07	0.07	0.12
CD (P=0.05)	0.18	0.19	0.24	0.25	0.22	0.21	0.37

Data represent square root-transformed value, i.e. $(x + 0.5)^{½}$. Figures in parentheses indicate original value
*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control

Table 4. Dry weight of weeds (g/m^2) as influenced by weed-control treatments in cotton at 60 days after application (pooled data of 2016 and 2017)

Treatment	*Echinochloa colona*	*Digitaria sanguinalis*	Other monocots	*Cyperus rotundus*	*Commelina benghalensis*	*Alternanthera philoxeroides*	Other dicots
T_1	2.79 (7.28)	2.35 (5.01)	2.97 (8.33)	3.38 (10.92)	3.13 (9.29)	3.48 (11.61)	4.03 (15.71)
T_2	2.76 (7.10)	2.33 (4.92)	2.94(8.13)	3.34(10.67)	3.12 (9.22)	3.45 (11.39)	4.01(15.55)
T_3	2.23 (4.47)	1.89 (3.09)	2.35 (5.01)	2.57 (6.13)	2.43 (5.40)	2.64 (6.45)	3.15(9.43)
T_4	2.01 (3.56)	1.69 (2.37)	2.05 (3.70)	2.30 (4.81)	2.19 (4.30)	2.37 (5.10)	2.94 (8.13)
T_5	2.32 (4.88)	1.96 (3.35)	2.40 (5.26)	2.64 (6.50)	2.46 (5.56)	2.71 (6.82)	3.20 (9.73)
T_6	-	-	-	-	-	-	
T_7	4.69 (21.47)	3.93 (14.94)	5.02 (24.74)	5.83 (33.47)	5.31 (27.75)	6.00 (35.55)	7.01 (48.67)
SEm±	0.09	0.07	0.11	0.09	0.08	0.09	0.13
CD (P=0.05)	0.27	0.22	0.33	0.28	0.25	0.28	0.39

Data represent square root-transformed value, i.e. $(x + 0.5)^{½}$. Figures in parentheses indicate original value
*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control

control. Since cotton plants were permitted to utilize all the resources in frequently hand-weeded plot (T_6), dry-matter weight/plant was highest there. Among the chemical measures, application of glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) outperformed others in production of dry-matter/plant (Table 7).

The negative effects of weeds on yield attributes of cotton, viz. number of bolls/plant and boll weight (g) were suppressed through various weed-management options. Pooled results showed that, hand-weeding (weed-free control) (T_6) was found superior among all treatments and resulted in the highest number of bolls/plant and boll weight. However, application of glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) also recorded high number of bolls/plant and boll weight, followed by glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha (T_3) and these were

Table 5. Weed control efficiency (%) as influenced by weed control treatments in cotton at 30 DAA (pooled data of 2016 and 2017)

Treatment	*Echinochloa colona*	*Digitaria sanguinalis*	Other monocots	*Cyperus rotundus*	*Commelina benghalensis*	*Alternanthera philoxeroides*	Other dicots
T_1	72.5	72.1	72.9	74.5	70.8	72.4	72.7
T_2	73.9	73.1	74.0	75.1	71.5	73.5	73.5
T_3	81.6	80.9	83.1	86.2	81.0	82.1	82.5
T_4	85.6	84.5	86.0	88.2	84.0	85.0	86.0
T_5	81.0	78.3	81.6	84.7	77.8	79.2	81.2
T_7	–	–	–	–	–	–	–

*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control

Table 6. Effect of on weed-control treatments on weed-control efficiency (%)in cotton at 60 days after application (pooled data of 2016 and 2017)

Treatment	*Echinochloa colona*	*Digitaria sanguinalis*	Other monocots	*Cyperus rotundus*	*Commelina benghalensis*	*Alternanthera philoxeroides*	Other dicots
T_1	65.8	63.6	65.2	65.5	64.6	65.8	65.6
T_2	66.8	65.7	67.0	66.3	65.2	66.6	66.6
T_3	82.6	82.2	80.3	83.1	80.7	84.0	83.3
T_4	86.1	85.5	86.7	86.1	84.1	86.2	86.3
T_5	80.2	81.0	79.5	81.1	79.7	81.6	82.6
T_7	-	-	-	-	-	-	-

*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control

Table 7. Effect of weed-control treatments on growth, yield attributes and yield of cotton (pooled data of 2016 and 2017)

Treatment	Plant height (cm)	Sympodial branches/ plant	Dry matter weight/plant (g)	Bolls/plant	Boll weight (g)	Seed-cotton yield (t/ha)
T_1	79.5	14.9	135.5	23.1	3.18	1.75
T_2	80.0	15.4	137.6	24.0	3.51	1.79
T_3	83.5	16.1	141.5	26.8	3.68	1.89
T_4	85.1	16.3	144.7	27.0	3.73	1.98
T_5	82.0	15.9	138.2	25.0	3.64	1.86
T_6	88.2	17.4	147.4	29.2	3.84	2.14
T_7	66.9	9.7	114.7	12.0	2.40	1.08
SEm±	0.73	0.30	1.22	0.37	0.04	0.07
CD (P=0.05)	2.17	0.89	3.65	1.11	0.12	0.21

*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control

Table 8. Economics of cotton under weed-management practices (pooled data of 2016 and 2017)

Treatment	Cost of cultivation (×10³ ₹/ha)	Gross return (×10³ ₹/ha)	Net return (×10³ ₹/ha)	Benefit : cost
T_1	36.9	70.0	33.1	1.90
T_2	37.1	71.6	34.5	1.93
T_3	37.3	75.6	38.3	2.03
T_4	37.5	79.2	41.7	2.11
T_5	36.9	74.2	37.3	2.01
T_6	53.9	85.4	31.5	1.59
T_7	35.0	43.2	8.2	1.23

*T_1, Glufosinate ammonium 13.5% SL (15% W/V) @ 300 g/ha; T_2, Glufosinate ammonium 13.5% SL (15% W/V) @ 375 g/ha; T_3, glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha; T_4, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha; T_5, paraquat dichloride 24% SL @ 500 g/ha; T_6, hand-weeding (weed-free control); T_7, weedy control; Price of seed cotton in both the years: ₹ 40,000/t

statistically at par with each other (Table 7). Anjum *et al.* (2007) reported that, bolls/plant and boll weight got significantly reduced in the weedy control plot as compared to weed-free and herbicide-treated plots. Seed-cotton yield also followed similar trend (Table 7). The Maximum seed-cotton yield was obtained from hand-weeded plot (2.14 t/ha), with an increase of 98.15% seed-cotton yield over the weedy control. Among the herbicidal treatments, the maximum seed-cotton yield was obtained through application of glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (1.98 t/ha) which was 83.33% higher seed-cotton yield than weedy control. However, the seed-cotton yield obtained under T_4 treatment was statistically at par with hand-weeding (T_6). The increment in growth, yield attributes and seed-cotton yield with the use of glufosinate ammonium 13.5% SL (15% W/V) was also observed by Bharathi *et al.* (2011) owing to its higher efficacy in controlling resource stealing weeds.

Economics

Economics of cotton cultivation under various weed-management options (Table 8) indicated that, chemical weed-management resulted in greater economic benefits than hand-weeding (weed-free control). It was owing to the fact that frequent hand-weeding although recorded the highest seed-cotton yield and therefore gross return; the treatment incurred the highest cost of cultivation (₹53,871/ha) for involvement of high wage-paid labourers for frequent weeding operations. Among the herbicidal applications, glufosinate ammonium 13.5% SL (15% W/V) @ 525 g/ha (T_4) realized the highest mean net return (₹41,689/ha) and benefit : cost ratio (2.11), closely followed by glufosinate ammonium 13.5% SL (15% W/V) @ 450 g/ha (T_3). Efficacies of controlling the weeds by herbicidal applications directly exerted effects on seed-cotton yield and consequently on the above-mentioned production economics. Weedy control (T_7) fetched the lowest mean net return (₹8,199/ha) and benefit : cost ratio (1.23), as weeds robbed most of the growth resources and the crop failed to express its natural yield potential. Our result in confirmed the observations of Das *et al.* (2014) in blackgram and Shivashankar *et al.* (2017) in Bt-cotton.

It was concluded that, chemical weed control is a potential alternative of labour-intensive hand-weeding in cotton and therefore, post-emergence application of glufosinate ammonium 13.5% SL (15% W/V) at 525 g/ha or 450 g/ha can be recommended to cotton-growers of new alluvial zone of West Bengal for ensuring better weed control, yield and economics of cotton.

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