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Efficacy of ammonium salt of Glyphosate 71% SG on weed management in cotton and its influence on soil micro-flora

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ABSTRACT

A field trail was conducted during the pre-kharif season of 2011 and 2012 Bidhan Chandra Krishi Viswavidyalaya, West Bengal to evaluate the weed management practices through ammonium salt of Glyphosate 71% SG and its influence on soil micro-flora in cotton. The application of Glyphosate 71% SG on inter row in cotton @ 3.5 l ha^{-1} recorded better weed control efficiency in comparison to its lower dose though the result showed at par results with hand weeding (at earlier stages), applications of Glyphosate 41% SL @ 3 l ha^{-1} and Paraquat dichloride 24%SL @ 2.5 l ha^{-1} increased the yield of cotton under irrigated condition. Initially after application herbicides with different doses reduced the microflora population significantly but after the degradation it increased microflora (bacteria, actinomycetes and fungi) population considerably.

Key word: Cotton, microflora, weed control efficiency, weed density, yield

Cotton (*Gossypium hirsutum*) occupies an important position among the fibre and cash crops in India, grown on 12.18 million hectare with a production and productivity of 35.20 million bales and 491 kg ha^{-1} respectively (Anon., 2012). India occupies the largest area under cotton cultivation and is the second largest producer next to China with 34 % of world area and 21% of world production (AICCIP, 2012-13). Cotton being a wide spaced and relatively slow growing crop during its initial stage, opportunity for weed for severe competition causing, yield reduction to an extent 50 to 85 per cent depending upon the nature and intensity of weeds (Prabhu *et al.*,2012). Due to increased scarcity of labourers, manual weeding is not economical even if it has higher weed control efficiency. Thus, we have to be relied upon herbicides to manage weeds efficiently (Nalini *et al.*, 2011). In order to control the weed there is a need for selection of new molecules of herbicides to achieve the optimum level of production.

MATERIALS AND METHODS

Field investigation was carried out at the Kalyani 'C' Block farm of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal with 7 treatments with 3 replication in a randomized complete block design during two consecutive *pre-kharif* seasons of 2011 and 2012. The weed management practices evaluated in the present study consisted of chemical weed control (ammonium salt of Glyphosate 71% SG) in different doses *i.e.,* 2.5, 3.0, 3.5 L ha^{-1}, Glyphosate 41% SL @ 3 l ha^{-1}), Paraquat dichloride 24% SL @ 2.5 l ha^{-1}, Hand weeding at 30 and 60 days after sowing (DAS) and unweeded control. Herbicides were applied at 35 DAS by knapsack sprayer with floodjet deflector WFN-040 nozzle with guard on the inter row space by using 500 L of water ha^{-1} under moist condition. One hand weeding at 60 DAS was done in all chemical treatments. Weed density and biomass were recorded at 90 DAS. For analysis of soil microbial population a composite soil sample was taken in between the rows at a depth of 0–15 cm of the experimental plots at *viz*. initial [0 days after application (DAA)], 3 DAA, 10 DAA, 30 DAA and 60 DAA and microbial analysis was done by serial dilution technique and pour plate method (Pramer and Schmidt, 1965). Microbial population count was done on agar plates containing appropriate media. The plates were incubated at 30ºC and counting was done on 3rd day of incubation. The data were subjected to statistical analyses by analysis of variance method (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Major weed flora

The total weed flora of the unweeded control plot was taken at 45 DAS during both the years, and it was imposed of 14 different weed species out of which 5 belonged to grasses, 2 to sedges and 7 to broad-leaf weeds with their relative weed density values of 41.3, 25.1 and 33.6%, respectively. The experimental field comprised the following weeds *viz*, *Echinocloa colonum*, *Digitaria sanguinalis*, *Panicum repens*,

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Dactyloctenium aegypticum and *Cynodon dactylon* among grasses; *Cyperus rotundus, Fimbristylis dichotoma* as sedges; and *Digera arvensis*, *Commelina benghalensis*, *Alternenthera philoxiroides*, *Eclipta alba*, *Hypericum japonicum*, *Stellaria media* and *Oldenlandia corymbosa*.

Weed density and weed biomass

Different weed-control treatments significantly reduced the weed density and their dry weights in comparision unweeded control. The unweeded control recorded the highest weed population and their dry weights (Table 1) while hand weeding showed the lowest weed population and weed biomass among all the treatments. However, among the chemical herbicides, ammonium salt of Glyphosate 71% SG @ 3.5 l ha^{-1} + 1 HW recorded the lowest grasses, sedges and broad leaved weed density and weed biomass which was statistically at par with application of Glyphosate 41% SL @ 3 l ha^{-1} + 1 HW and Paraquat dichloride 24% SL @ 2.5 l ha^{-1} + 1 HW and hand weeding twice at 15 and 30 DAS. Similar result due to higher doses of herbicides was also reported by Bera and Ghosh (2013).

Weed control efficiency (WCE)

Highest WCE was recorded in the plot subjected to two hand weedings. Among the different chemical weed management practices, ammonium salt of Glyphosate 71% SG @ 3.5 l ha^{-1} + 1 HW recorded the highest weed control efficiency at 90 DAS (74.3 % WCE) which was closely followed by lower doses of ammonium salt of Glyphosate 71% SG (Table 2). Further, the weed control efficiency with application of ammonium Salt of Glyphosate 71% SG was at par with the standard Glyphosate 41% SL and Paraquat dichloride 24% SL @ 2.5 l ha^{-1} in cotton at later stages. Lowest weed control efficiency was observed in ammonium salt of Glyphosate 71% SG @ 2.5 l ha^{-1} + 1 HW. The higher WCE was due to higher doses of herbicides also reported by Nalini *et al.,* (2011). Since its introduction in 1974, ghyphosate has been used widely for control of weeds. In recent years, glyphosate has been widely used as broad spectrum herbicide (Bhowmick, 2010).

Table 1: Effect of weed-management treatments on weed density and weed biomass (Pooled)

Treat-ments	Weed density at 90 DAS (No. m^{-2})				Weed biomass at 90 DAS (g m^{-2})			
	Grasses	Sedges	Broad leaves	Total	Grasses	Sedges	Broad leaves	Total
T_1	43.6(6.64)	31.4(5.64)	18.2(4.32)	93.3(9.68)	10.5	8.2	3.7	22.4
T_2	35.8 (6.02)	25.6 (5.10)	14.1 (3.82)	75.4 (8.71)	8.9	6.8	2.4	18.2
T_3	35.2 (5.97)	24.3 (4.97)	13.2 (3.70)	72.7 (8.55)	8.1	6.7	2.2	16.9
T_4	36.0 (6.04)	26.5 (5.19)	15.1 (3.94)	77.6 (8.83)	9.2	7.4	2.6	19.3
T_5	35.9 (6.03)	26.7 (5.21)	15.4 (3.98)	78.1 (8.86)	9.5	7.3	2.9	19.7
T_6	17.7 (4.26)	17.3 (4.21)	8.1 (2.93)	43.2 (6.61)	6.3	5.2	1.9	12.1
T_7	90.8 (9.55)	54.9 (7.44)	73.9 (8.62)	219.6 (14.83)	30.6	19.1	16.3	66.1
SEm(±)	**0.75**	**0.49**	**0.50**	**1.72**	**1.30**	**0.15**	**0.11**	**0.48**
LSD(0.05)	**2.30**	**1.53**	**1.52**	**5.29**	**4.01**	**0.45**	**0.32**	**1.49**

T_1- Glyphosate 71% SG @ 2.5 L ha^{-1} + 1 HW, T_2- Glyphosate 71% SG @ 3 L ha^{-1} + 1 HW, T_3- Glyphosate 71% SG @ 3.5 L ha^{-1} + 1 HW, T_4 - Glyphosate 41% SL @ 3 L ha^{-1} + 1 HW, T_5- Paraquat dichloride 24% SL @ 2.5 L ha^{-1} + 1 HW, T_6- Hand weeding twice at 30 & 60 DAS, T_7- Unweeded control. Figures in the parenthesis are square root transformed value.

Growth parameters and seed cotton yield

There was no significant variation in respect of leaf area index among the different treatments. In case of boll $plant^{-1}$ and boll weight ammonium salt of Glyphosate 71% SG @ 3.5 l ha^{-1} and twice hand weeding showed statistically at par result which was followed by lower doses of ammonium salt of Glyphosate 71% SG @ 3 l ha^{-1}. Among the different chemical treatments, ammonium salt of Glyphosate 71% SG @ 3.5 l ha^{-1} + 1 HW resulted highest seed cotton yield (Table 2) which was 38.6% higher than unweeded control however it remained statistically at par with two hand weeding. The next best treatment was the ammonium salt of Glyphosate 71% SG @ 3 l ha^{-1} + 1 HW. Gnanavel and Babu (2008) also reported the maximum seed cotton yield with herbicide

Table 2: Effect of weed-management treatments on WCE, growth parameters and yield of cotton (Pooled)

Treat-ments	Weed control efficiency (WCE) at 90 DAS				Leaf area index	Total boll plant^{-1}	Boll weight (g)	Seed cotton yield (t ha^{-1})
	Grasses	Sedges	Broad leaves	Total				
T_1	65.5	57.5	77.2	66.1	3.71	19	3.21	1.153
T_2	70.9	64.5	84.9	72.5	4.04	22	4.13	1.412
T_3	73.6	65.0	86.5	74.3	4.12	24	4.18	1.427
T_4	69.8	61.4	83.5	70.7	3.84	21	3.82	1.309
T_5	69.0	61.8	81.9	70.1	3.96	22	3.78	1.324
T_6	79.3	72.4	88.1	81.7	3.99	23	4.05	1.417
T_7	-	-	-	-	3.68	17	2.19	1.029
SEm(±)	**-**	**-**	**-**	**-**	**0.07**	**0.31**	**0.12**	**0.043**
LSD(0.05)	-	-	-	-	**NS**	**0.94**	**0.31**	**0.116**

T_1- Glyphosate 71% SG @ 2.5 l a.i. ha^{-1} + 1 HW, T_2- Glyphosate 71% SG @ 3 l a.i. ha^{-1} + 1 HW, T_3- Glyphosate 71% SG @ 3.5 l a.i. ha^{-1} + 1 HW, T_4- Glyphosate 41% SL @ 3 l a.i. ha^{-1} + 1 HW, T_5- Paraquat dichloride 24% SL @ 2.5 l a.i. ha^{-1} + 1 HW, T_6- Hand weeding twice at 30 & 60 DAS, T_7- Unweeded control.

coupled with hand weeding. Cotton being a wide spaced and slow growing crop is sensitive to weed competition at early stages of growth than at later stages. Due to heavy infestation of weeds under unweeded control, there was 12 to 38 % reduction in seed cotton yield. Presence of weeds throughout the growing season caused poor crop growth and caused yield reduction in unweeded check (Bhoi *et al.*, 2007). The yield level of ammonium salt of Glyphosate 71% SG @ 3.5 l ha^{-1} + 1 HW was at par with other two treatments Glyphosate 41% SL @ 3 l ha^{-1} + 1 HW and Paraquat dichloride 24% SL @ 2.5 l ha^{-1} + 1 HW.

Soil micro-flora population

The effects of ammonium salt of Glyphosate 71% SG on soil microflora *viz*. total bacteria, actinomycetes and fungi as recorded at different days after application (0, 3, 10, 20 and 45 DAA) were discussed below.

There was no significant influence on the population of total bacteria in the *rhizosphere* of pre-*kharif* cotton at initial stage (before application) but after the application of ammonium salt of Glyphosate 71% SG and 41% SL along with Paraquat dichloride 24% SL significant variations were observed between the treated and untreated experimental plots. The population of total bacteria decreased up to 30 DAA as compared to the observation before spraying and then increased for herbicidal treatments. Twice hand weeding and control recorded steady but very slow increase of the population (Fig.1). Thereafter at 60 DAA, the population increased considerably in the herbicidal treated plots as compared to hand weeding and untreated control plots (Fig. 1). At 60 DAA, the herbicidal treatments recorded 36.24% to 96.90% higher population of total bacteria than the control. The microbial population decreases considerably after the application of herbicide up to different dates may be due to release of toxic material and different persistence periods of different chemical herbicides in different soil ecosystems. But after the decomposition of the herbicides, the bacteria population increased considerably as they utilized the organic sources particularly carbon of the decomposed herbicides to build up their body. Ghosh *et al.* (2012) reported that for all the cases of herbicidal treatments, total bacteria recovered from initial loss and exceeded than initial counts.

The herbicide ammonium salt of Glyphosate 71% SG and Paraquat dichloride 24% SL, tested in this experiment, showed that there was significant adverse effect on the population of fungi after application of the herbicides but later the data showed that there was slightly higher count of fungi than the initial one (Fig.2). Because of chemical degradation and no toxic effect in the soil, the population of fungi increased significantly at 60 DAA. There is a slow and steady increased of fungi population in case of twice hand weeding and unweeded control plot. On average herbicidal treatments recorded 14.21 to 59.06 % higher population of total fungi than control at 60 DAA.

In case of actinomycetes, the herbicide treatments also follow the similar patter as in case of total bacteria and fungi. After application the population decreased but later they recovered and built up their population

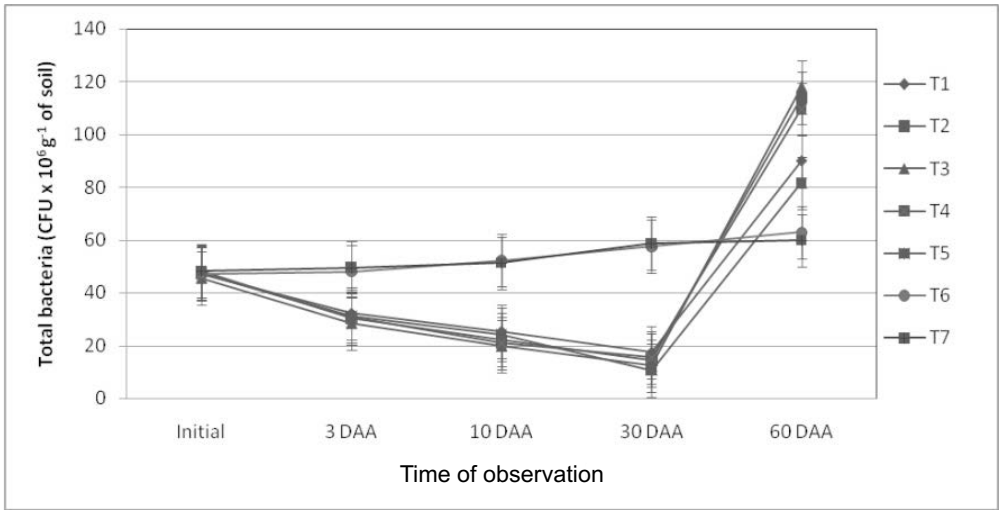

Fig. 1: Influence of treatments on total bacteria (CFU x 10^6 g^{-1} of soil) **bar denotes standard error (±)*

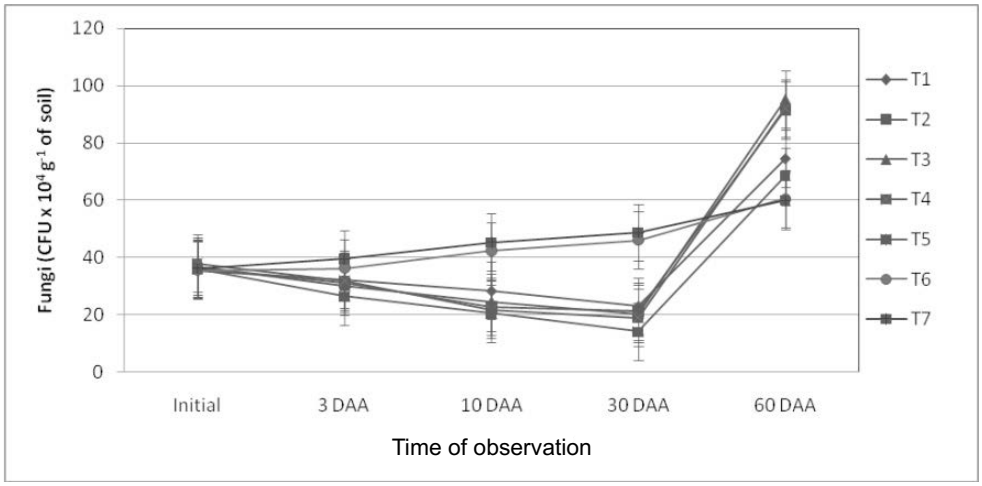

Fig. 2: Influence of treatments on total fungi (CFU x 10^4 g^{-1} of soil) **bar denotes standard error (±)*

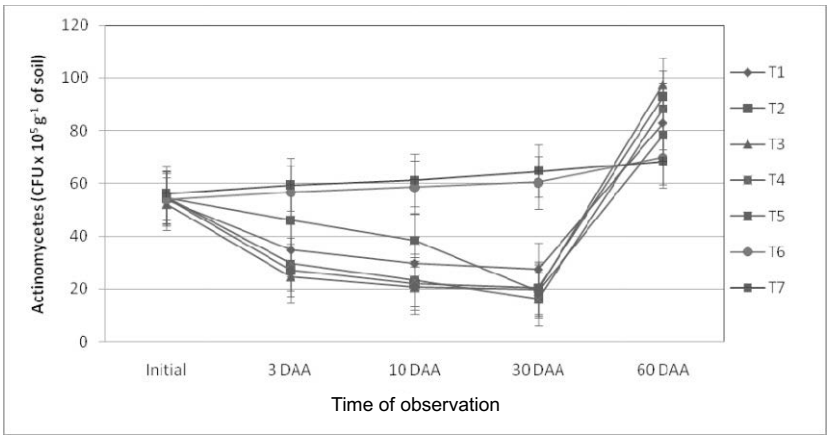

Fig. 3: Influence of treatments on total actinomycetes (CFU x 10^5 g^{-1} of soil) **bar denotes standard error (±)*

T_1- Glyphosate 71% SG @ 2.5 l ha^{-1} + 1 HW, T_2- Glyphosate 71% SG @ 3 l ha^{-1} + 1 HW, T_3- Glyphosate 71% SG @ 3.5 l ha^{-1} + 1 HW, T_4- Glyphosate 41% SL @ 3 l ha^{-1} + 1 HW, T_5- Paraquat dichloride 24% SL @ 2.5 l ha^{-1} + 1 HW, T_6- Hand weeding twice at 30 & 60 DAS, T_7- Unweeded control.

which was much higher that the initial count (Fig.3). This might be due to the toxic effect of the applied chemicals. Sapundjieva *et al.* (2008) also reported that herbicides application reduced the actinomycetes population in soil.

So, from the above findings it has been cleared that though at the initial phage, there was some population reduction of soil micro-flora but later stage of crop growth it overcame and exhibited more population than the initial one. This finding is similar with the findings recorded by Sokolova and Gulidova (2010).

Based on the results, it can be concluded that though the microbial population of the soil in the *rhizosphere* region of the cotton decreased after 30 days of herbicide application, it increased thereafter when the herbicides got decomposed and the population became even higher than initial stage. Overall there was no long-term adverse effect of herbicidal weed management (ammonium salt of Glyphosate 71% SG) on the microbial population of the soil in the *rhizosphere* region of the cotton. Considering effect on weed management, soil microflora, growth and yield of cotton, ammonium salt of Glyphosate 71% SG @ 3 l ha^{-1} can be successful alternative of twice hand weeding.

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