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Weed control through smothering crops and use of plant extracts as bioherbicides

D. Nongmaithem*, D. Pal and R.K. Ghosh

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal 741 252

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ABSTRACT

A field experiment was conducted at BCKV, Mohanpur during the pre-*Kharif* season of 2010 and 2011 to observe the weed smothering ability of different crops and also to evaluate the bio-herbicidal potential of plant extracts on weeds. The study revealed that among the crops, significantly lowest population of different categories of weeds were found under black gram while highest population was recorded under sesame. Among the weed management practices, hand weeding at 20 DAS resulted in lowest population of all categories of weeds at 30 DAS. Among the botanical plant extracts, *Ageratum conyzoides* extract 5% (w/v) recorded lowest sedge and broad-leaved weed population while lowest grassy weed population was recorded under *Ocimum sanctum* extract 5% (w/v). The highest weed control efficiency was recorded under hand weeding treatment followed by fenoxaprop-p-ethyl while among the botanical plant extract, *Ageratum conyzoides* recorded the highest.

Key words: Bioherbicids, Herbicides, Plant extracts, Smoothering effect, Weed control

Synthetic herbicides continue to be a key component in most weed management strategies, but, the indiscriminate use of chemical herbicides for weed control in the last 50 years has resulted in serious ecological and environmental problems and developed resistance to herbicide in weeds and to challenge these problems, research has increased its effort to find out alternative strategies. The negative effects of commercial herbicide use on environmental contamination and human health make necessary to diversify weed management options (Duke 1986). The increasing concern about the toxicity of synthetic herbicides has boosted the search for eco-friendly and sustainable weed management practices. Plants offer an excellent source of biologically active natural products and have enormous potential to inspire and influence modern agrochemical research. Natural compounds from plants provide potential for new herbicidal solutions, or lead compounds for new herbicides (Duke *et al*. 2000, Vyvyan 2002). A number of classes of allelochemicals causing inhibition of germination and growth of weeds have been identified (Wu *et al*. 1999). Plant extracts (compound mixtures) potentially possess multiple phytotoxic compounds and hence multiple modes of simultaneous herbicidal attack, making it more difficult for weeds to develop herbicide resistance and most products show wide windows of crop safety. Present study was undertaken to observe the weed smothering ability of different crops (sesame, greengram and blackgram) and to test the bio-herbicidal properties of some commonly available plants on the weeds of different crops for their management.

***Corresponding author:** debikanong@gmail.com

MATERIALS AND METHODS

The field experiment was conducted at the Instructional Farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal having medium land topography during pre-*Kharif* season of 2010 and 2011. The experimental soil was Gangetic new alluvial (inceptisol) with sandy clay loam texture, having good irrigation cum drainage facility and medium soil fertility status with neutral soil pH. The experiment was conducted in split plot design replicated thrice, keeping the crops (C) under the main plot treatment, sesame, greengram, black gram and nine weed management treatments allocated in the subplot treatments, *viz.* untreated control, hand weeding at 20 DAS, 5% (w/v) *Ageratum conyzoides* aqueous extract, W_4: 5% (w/v) *Blumea lacera* aqueous extract, W_5: 5% (w/v) *Ocimum sanctum* aqueous extract, W_6: 5% (w/v) *Physalis minima* aqueous extract, W_7: 5% (w/v) *Amaranthus tricolor* aqueous extract, W_8: Quizalofop-p-ethyl 5 EC 50 g/ha at 20 DAS, W_9: Fenoxaprop-p-ethyl 9 EC 30 g/ha at 20 DAS. All the botanical extract treatments were applied as pre-emergence at 1 DAS and added with surfactant Tween 80 0.25%. The net plot area was 3 × 2 m. The varieties of crops used were: Sesame- *Rama (Improved Selection-5)*, Greengram- *Bireswar (WBM – 34-1-1)* and Blackgram- *Sarada (WBU-108)*. A spacing of 30 ×

10 cm from row to row and plant to plant respectively for all the crops was maintained. The recommended dose of fertilizer to each crop was applied.

The plant extracts and herbicides were sprayed as per the necessary treatments with a knap sack sprayer with flood jet deflector nozzle size WFN 0.040 with great care to ensure uniform spraying after proper calibration. Data on weeds were recorded in a quadrat (0.5 × 0.5 m) per plot and converted to 1 m^2. Weeds were counted and removed for recording their dry weights. These data were subjected to square root transformation

The data collected were subjected to statistical analysis appropriate to the design by following the procedure laid out by Gomez and Gomez 1984. The significance of different sources of variations was tested by Fisher's and Snedecor's F-test at probability level of 0.05. For the determination of critical difference at 5% level of significance, the statistical tables formulated by Fisher and Yates (1979) tables were consulted. The values wherever necessary were transformed into square root values as applicable for respective statistical analyses (Panse and Sukhatme 1978).

Aqueous extracts were prepared by following the procedure of Cheema and Khaliq (2000). Leaves of plants (*A. conyzoides, B. lacera* and *P. minima*) were collected from BCKV campus whereas that of *O. sanctum* and *A.tricolor* from Jaguli area. After collection, leaves were dried in shade at room temperature for a week and later dried at 40^0C in oven for 48 h and grounded to powder. The dried powder material was soaked in water in the ratio 1:5 (w/v) for 24 hours. Then the water extracts were collected by passing through sieves. The filtrates were boiled at 100^0C for reducing the volume (3 litres). The final extract was left to stand at 4^0C for 30 M and then filtered. The concentrated extract was collected for spraying in the specific treatment plots.

RESULTS AND DISCUSSION

Major weed species observed in the experimental field were: *Cynodon dactylon*, *Echinochloa colona*, *Eleusine indica*, *Digitaria sanguinalis*, *Dactyloctenium aegyptium*, *Cyperus rotundus*, *Euphorbia hirta*, *Alternanthera philoxeroides*, *Trianthema portulacastrum*, *Cleome viscosa*, *Blainvillea latifolia* and *Digera arvensis*.

At 15 DAS, the weeds (grass, sedge and broad-leaved weed) did not vary significantly under different crops which might be attributed to the fact that at this stage the crops did not have the ability of smothering the weeds due to the initial establishment of the crops, particularly the canopy structure of the crop. At 30 DAS, the weeds (grass, sedge and broad-leaved) vary significantly under different crops. The population of weeds were found lowest under blackgram followed by greengram while highest was obtained in sesame treatment, having lowest weed control efficiency of 27.72%. Blackgram recorded highest weed control efficiency of 36.22% followed by greengram with 32.36%. This might be due to the weed smothering ability of the legumes due to profuse canopy which also resulted in higher weed control efficiency. Ghosh *et al.* (2007) also expressed similar opinions, where legumes with good canopy were more efficient than sesame for weed control. Among the two legume crops, though the difference was not so large, population of weeds were found to be lower in black gram than green gram. The reason might be due to more branched stature of this crop compared to greengram resulting in denser canopy which resulted in higher suppression of weeds. Ali (1988) also expressed the weed smothering potential of black gram where the crop has been reported to smother weed flora appreciably by 20-45%.

Under different weed management, the grassy weed at 15 DAS treatments varied significantly where *Ocimum sanctum* extract recorded least grassy weed population followed by *Ageratum conyzoides* extract which did not vary significantly with each other. Sharma and Singh (2004) and Souza *et al.* (2009) also revealed the bioherbicidal property of *Ocimum sanctum* extracts. In case of sedge, weed population at 15 DAS, maximum control was found in *Ageratum conyzoides* extract followed by *Blumea lacera* extract. The maximum control of broad leaved weed at 15 DAS was recorded in *Ageratum conyzoides* extract. Kato *et al.* (2001) also reported the herbicidal effect of the shoot extracts of *Ageratum conyzoides.* Trand *et al.* (2004) also gave similar views in field conditions. At 15 DAS, there was no control of weeds in hand weeding and chemical herbicide plots since the treatments were implemented at 20 DAS.

The lower density of weeds in the plant extract treatments might be due to the presence of suppressive water soluble allelochemicals associated with the respective plant extracts. The biochemical interactions might have occurred when the water soluble chemicals present in the botanical extracts came in contact with the embryo of the weed seeds after application which influenced the germination, survival, growth and development of weeds. The inhibition of weeds might have occurred through different toxic mechanism such as reduction in germination or lengthening of germination process or slowing seedling growth which was also reported by Ercoli *et al.* (2007).

Table 1. Effect of treatments on weed population (no./m²) at 15 DAS and 30 DAS and weed control efficiency (pooled data)

Treatment	At 15 DAS			At 30 DAS			Weed control efficiency (%) at 30 DAS
	Grass	Sedge	Broad-leaved weeds	Grass	Sedge	Broad-leaved weeds	
Crops							
Sesame	4.85 (23.69)	4.69 (21.81)	4.56 (20.69)	6.28 (41.76)	7.76 (61.41)	5.18 (27.69)	27.72
Greengram	4.62 (21.33)	4.75 (22.37)	4.71 (21.83)	5.91 (36.41)	7.30 (54.41)	5.02 (25.63)	32.36
Blackgram	4.43 (19.91)	4.65 (21.57)	4.59 (20.96)	5.26 (29.56)	6.42 (43.59)	4.65 (22.31)	36.22
LSD (P=0.05)	NS	NS	NS	0.315	0.339	0.069	-
Weed management							
Untreated control	5.38 (29.28)	5.03 (24.94)	4.78 (22.44)	7.40 (56.39)	8.81 (77.28)	5.85 (34.00)	-
Hand weeding at 20 DAS	4.85 (23.72)	4.80 (22.72)	4.53 (20.22)	3.27 (10.50)	4.06 (17.33)	2.55 (6.78)	69.73
5% (w/v) *Ageratum conyzoides* aqueous extract	4.27 (18.11)	3.91 (14.94)	4.09 (16.44)	6.38 (40.44)	6.91 (47.89)	5.07 (25.50)	32.59
5% (w/v) *Blumea lacera* aqueous extract	4.37 (19.06)	4.13 (16.78)	4.35 (18.61)	6.60 (43.33)	7.61 (57.78)	5.20 (26.83)	23.29
5% (w/v) *Ocimum sanctum* aqueous extract	4.00 (15.78)	4.27 (17.94)	4.47 (19.78)	6.09 (36.78)	7.20 (51.94)	5.37 (28.72)	28.67
5% (w/v) *Physalis minima* aqueous extract	4.43 (19.44)	4.78 (22.44)	4.65 (21.33)	6.66 (44.22)	7.98 (63.78)	5.54 (30.44)	15.14
5% (w/v) *Amaranthus tricolor* aqueous extract	4.56 (20.56)	4.97 (24.33)	4.85 (23.22)	7.32 (53.61)	8.46 (71.94)	5.73 (32.50)	9.44
Quizalofop-p-ethyl 50g/ha	4.81 (23.28)	5.22 (27.06)	4.95 (24.56)	4.42 (20.00)	6.80 (46.22)	4.68 (21.72)	52.14
Fenoxaprop-p-ethyl 30g/ha	5.07 (25.56)	5.14 (26.11)	4.91 (23.83)	4.20 (17.89)	6.63 (44.06)	4.55 (20.39)	57.87
LSD (P=0.05)	0.347	0.179	0.195	0.379	0.381	0.281	-

Figures in parentheses are original values, which are subjected to square root transformation ($\sqrt{x + 0.5}$)

At 30 DAS, highest population of all categories of weeds was recorded in untreated control treatment while lowest population was found in hand weeding treatment, which was followed by chemical herbicide treatments which were statistically ont par with each other. Among the plant extracts, *Ocimum sanctum* extract recorded lowest population of grassy weed which was followed by *Ageratum conyzoides* extract which did not vary significantly with each other. In case of sedge and broad-leaved weed, *Ageratum conyzoides* extract recorded lowest sedge weed population and it was statistically at par with fenoxaprop-p-ethyl treatment.

After the application of chemical herbicide treatments at 20 DAS, there was reduction in the population of weeds at 30 DAS, where the reduction was more pronounced in grassy weed. Chin and Pandey, (1991) also obtained similar results where application of fenoxaprop-ethyl resulted in a significant reduction in monocotyledon weeds. Among the two herbicides used in the experiment, though the results obtained from both the treatments were statistically at par, fenoxaprop-p-ethyl exhibited more suppression of all categories of weeds than quizalofop-p-ethyl, which might be due to the contact as well as systemic action of the former herbicide while quizalofop-p-ethyl exhibited only systemic action. Fenoxaprop-p-ethyl treatment recorded higher weed control efficiency of 57.9% than Quizalofop-p-ethyl treatment which recorded 52.1%. Similar type of observations were also reported by Sitangshu (2006) while working in jute in West Bengal where fenoxaprop-p-ethyl showed highest WCE (86.6%), closely followed by quizalofop-p-ethyl (79%). Result showed that at 30 DAS, highest weed control efficiency of 69.7% was recorded by hand weeding treatment while among the plant extract treatments *Ageratum conyzoides* extract recorded highest weed control efficiency (32.6%).

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