

Effect of Non-Conventional Weed Management Practices on Growth and Yield of Sesame, Green Gram and Black Gram

D. Nongmaithem, D. Pal

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Abstract The experiment was conducted during pre-kharif season in 2010 and 2011 to study the growth and yield of sesame, green gram and black gram due to different weed management practices including the botanical plant extracts. The experiment was conducted in split plot design replicated thrice, keeping the crops under the main plot treatment viz. sesame, green gram and black gram and nine weed management treatments in the sub-plot treatments. It was found that black gram and green gram recorded higher control of weeds than sesame. Among the weed management treatments, hand weeding recorded highest weed control efficiency which was followed by fenoxaprop-p-ethyl. Among the botanical plant extracts, *Ageratum conyzoides* extract recorded lowest population and dry weight of sedge and broadleaved weeds while *Ocimum sanctum* extract recorded the same in case of grassy weeds. Hand weeding recorded the highest yield of all the crops. Among the botanical plant extracts *Ageratum conyzoides* extract recorded highest growth attributes and yield in sesame and black gram while in

green gram, *Ocimum sanctum* extract recorded highest yield.

Keywords Black gram, Green gram, Plant extracts, Sesame, Weeds.

Introduction

The use of chemical herbicides for controlling weed pest has become an integral part of farming with the evolution of herbicides since 1940's. While herbicides are very important to agriculture, under certain circumstances, they may act as pollutants, deteriorating soils, ground as well as surface water as they enter the soil environment from direct interception of spray. The side effect of continuous and indiscriminate use of chemical herbicides for weed control has developed resistance to herbicide in weeds where it has been reported that globally, there are an estimated 297 resistant biotypes and 179 resistant species (108 dicots and 71 monocots) [1]. To challenge these problems, research has increased its effort to find out alternative farming strategies. Several plant extracts show a broad spectrum of activity against pests including weeds. 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 which can be an alternative in weed management strategy. The environmentally benign characteristics of these compounds pro-

D. Nongmaithem*, D. Pal
Department of Agronomy, Bidhan Chandra Krishi Viswa-
vidyalaya, Mohanpur, Nadia 741252, West Bengal, India
e-mail: debikanong@gmail.com
*Correspondence

vide the chance of unique modes of herbicidal attack viz., the potential to overcome herbicide resistance. The advantage of such natural compounds is the quickly breaking down process into the environment and so the possible application in sustainable agriculture. Moreover, the increasing development in bioinformatics and cheminformatics support development of new herbicides [2]. However, the initial and prior step before the utilization of plant extracts for use as herbicides is the identification of potential plant that could harness the weedicidal property.

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) having good irrigation cum drainage facility with soil pH of 6.8, organic carbon-0.51%, total nitrogen-250.23 kg ha⁻¹, available P₂O₅-21.75 kg ha⁻¹ and available K₂O-181.33 kg ha⁻¹. The experiment was conducted in split plot design replicated thrice, keeping the crops (C) under the main plot treatment, C₁: Sesame, C₂: Green gram, C₃: Black gram and nine weed management treatments (W) allocated in the sub-plot treatments, W₁: Untreated control, W₂: Hand Weeding at 20 DAS, W₃: 5% (w/v) *Ageratum conyzoides* aqueous extract, W₄: 5% (w/v) *Blumea lacera* aqueous extract, W₅: 5% (w/v) *Ocimum sanctum* aqueous extract, W₆: 5% (w/v) *Physalis minima* aqueous extract, W₇: 5% (w/v) *Amaranthus tricolor* aqueous extract, W₈: Quizalofop-p-ethyl 5 EC @ 50 g ha⁻¹ at 20 DAS, W₉: Fenoxaprop-p-ethyl 9 EC @ 30 g ha⁻¹ 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 varieties of crops used were: Sesame-Rama (Improved Selection-5), Green gram-Bireswar (WBM-34-1-1) and Black gram-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 for each of the crop in the experiment was applied. Sesame-30:60:30 kg ha⁻¹ N, P₂O₅ and K₂O respectively, green gram and black gram-20:40:40 kg ha⁻¹ N, P₂O₅ and K₂O respectively.

Aqueous extracts were prepared by following the procedure of Cheema and Khaliq [3]. Leaves of plants were dried in shade at room temperature for a week and later dried at 40°C in oven for 48 h and grounded to powder. The dried powder material was soaked in water in the ratio 1:20 (w/v) for 24 h. Then the water extracts were collected by passing through sieves. The filtrates were boiled at 100°C for reducing the volume (3 l). The final extract was left to stand at 4°C for 30 minutes and then filtered. The experimental data were analyzed following the standard statistical method of Panse and Sukhatme [4]; Gomez and Gomez [5].

Results and Discussion

Weed population and dry weight

At 15 DAS, the crops gave no significant effect on all the categories of weeds. This 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, as the canopy structure was small enough to hinder the weed growth. Among the weed management treatments, since the botanicals were applied as pre-emergence at 1 DAS, there was control of weeds only in botanical plant extract treatments. However, since the hand weeding treatment and chemical herbicide treatments were implemented at 20 DAS, there was no control of the weeds at this stage of observation. At 15 DAS, the population and dry weight of weeds was found to be lowest in *Ageratum conyzoides* extract while *Ocimum sanctum* extract gave lowest population of grassy weeds. Kaur and Sharma [6] also found from their research that the *Ageratum conyzoides* may contain compounds that are phytotoxic in nature and indicates the potentiality of suppressing weeds also reported the herbicidal effect of the shoot extracts of *Ageratum conyzoides*. Purohit and Pandya [7] and Islam and Kato [8] also revealed the bioherbicidal property of *Ocimum sanctum* extract. Souza et al. [9] also reported that *Ocimum* species affected the seed germination and radicle and hypocotyl growth of different weeds. *Physalis minima* extract recorded lower weed population than the untreated control treatment. The bio-herbicidal property of *Physalis minima* extract was also reported by Swain et al. [10]. Among the

Table 1. Effect of treatments on population of weeds (no m⁻²) at 15 DAS and 45 DAS (Pooled data). C₁ : Sesame, C₂ : Green gram, C₃ : Black gram, W₁ : Untreated control, W₂ : Hand weeding at 20 DAS, W₃ : 5% (w/v) *Ageratum conyzoides* aqueous extract, W₄ : 5% (w/v) *Blumea lacera* aqueous extract, W₅ : 5% (w/v) *Ocimum sanctum* aqueous extract, W₆ : (w/v) *Physalis minima* aqueous extract, W₇ : 5% (w/v) *Amaranthus tricolor* aqueous extract, W₈ : Quizalofop-p-ethyl @ 50 g a.i. ha⁻¹, W₉ : Fenoxaprop-p-ethyl @ 30 g a.i. ha⁻¹. Figures in parentheses are square root transformed values.

Treatments	15 DAS			45 DAS		
	Grass	Sedge	Broad leaved weed	Grass	Sedge	Broad leaved weed
Crops (C)						
C ₁	4.85 (23.69)	4.69 (21.81)	4.56 (20.69)	7.39 (56.17)	8.81 (78.33)	6.92 (48.98)
C ₂	4.62 (21.33)	4.75 (22.37)	4.71 (21.83)	7.07 (50.69)	8.40 (71.24)	6.58 (43.72)
C ₃	4.43 (19.91)	4.65 (21.57)	4.59 (20.96)	6.25 (39.72)	7.68 (60.35)	6.10 (37.89)
SEm±	0.114	0.055	0.057	0.077	0.101	0.064
CD (p=0.05)	NS	NS	NS	0.252	0.328	0.207
Weed management treatments (W)						
W ₁	5.38 (29.28)	5.03 (24.94)	4.78 (22.44)	8.30 (69.39)	9.84 (96.61)	7.99 (63.83)
W ₂	4.85 (23.72)	4.80 (22.72)	4.53 (20.22)	5.05 (25.22)	5.96 (35.72)	4.91 (24.11)
W ₃	4.27 (18.11)	3.91 (14.94)	4.09 (16.44)	7.21 (52.00)	8.01 (64.22)	6.17 (37.83)
W ₄	4.37 (19.06)	4.13 (16.78)	4.35 (18.61)	7.52 (56.44)	8.70 (75.61)	6.58 (43.00)
W ₅	4.00 (15.78)	4.27 (17.94)	4.47 (19.78)	6.97 (48.72)	8.35 (69.78)	6.98 (48.61)
W ₆	4.43 (19.44)	4.78 (22.44)	4.65 (21.33)	7.73 (59.67)	9.04 (81.61)	7.37 (54.11)
W ₇	4.56 (20.56)	4.97 (24.33)	4.85 (23.22)	8.06 (64.94)	9.19 (84.78)	7.70 (59.06)
W ₈	4.81 (23.28)	5.22 (27.06)	4.95 (24.56)	5.79 (33.56)	7.98 (63.56)	5.65 (32.00)
W ₉	5.07 (25.56)	5.14 (26.11)	4.91 (23.83)	5.48 (29.78)	7.60 (57.89)	5.43 (29.22)
SEm±	0.124	0.064	0.069	0.109	0.118	0.116
CD (p=0.05)	0.347	0.179	0.195	0.306	0.330	0.327

botanicals, *Amaranthus tricolor* extract exhibited the lowest efficiency in controlling of weeds. However, the inhibitory potential of *Amaranthus tricolor* on some crops was reported by Dhole et al. [11], which might also inhibit weeds. The lower population of weeds observed in the botanical plant extract treatments might be due to the presence of suppressive water soluble allelochemicals associated with the respective botanicals. 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. [12].

With the advancement of the crop growth stages, there was significant effect on the population as well as dry weight of the crops. The weed population (Table 1) and dry weight (Table 2) of weeds was found to be highest in sesame while green gram and recorded lower values. This might be attributed to the weed smothering ability of legumes with good canopy were more efficient than sesame for smothering of weeds. Ghosh et al. [13] also expressed similar opinions, where legumes with good canopy were more efficient than sesame for weed control. Among the weed management treatments, untreated control and hand weeding treatments recorded the highest and lowest population as well as dry weight respectively of all the categories of weeds. Hand weeding at 20 DAS removed all types of weeds. Hence, at 45 DAS the population as well as dry weight of weeds were very low and recorded highest weed control efficiency

Table 2. Effect of treatments on dry weight of weeds (g m^{-2}) at 15 DAS and 45 DAS and weed control efficiency (%) 45 DAS (Pooled data).

Treatments	15 DAS			45 DAS			Weed control efficiency
	Grass	Sedge	Broad leaved weed	Grass	Sedge	Broad leaved weed	
Crops (C)							
C ₁	3.74	4.54	3.51	11.83	13.86	7.51	14.18
C ₂	3.63	4.58	3.60	11.23	11.46	6.93	20.09
C ₃	3.52	4.47	3.53	10.60	9.32	6.59	23.48
SEm±	0.078	0.050	0.034	0.135	0.300	0.029	
CD ($p=0.05$)	NS	NS	NS	0.442	0.980	0.093	
Weed management treatments (W)							
W ₁	4.55	5.37	5.08	13.47	15.07	8.42	
W ₂	4.37	5.37	4.92	8.75	6.10	5.16	45.75
W ₃	2.88	3.33	2.14	11.47	10.97	6.87	20.55
W ₄	2.95	3.48	2.29	11.84	12.71	7.09	14.20
W ₅	2.73	3.58	2.26	11.03	11.79	7.47	17.87
W ₆	3.13	4.04	2.37	12.16	13.61	7.90	8.61
W ₇	3.21	4.20	2.45	12.74	14.15	8.19	4.68
W ₈	4.33	5.73	5.23	9.99	10.14	6.16	28.70
W ₉	4.50	5.65	5.18	9.52	9.39	5.85	32.88
SEm±	0.093	0.073	0.043	0.256	0.327	0.112	
CD ($p=0.05$)	0.246	0.204	0.119	0.718	0.917	0.314	

of 45.75%. After the application of chemical herbicides at 20 DAS, there was reduction in the population of weeds at 45 DAS. Among the two herbicides used in the experiment, Fenoxaprop-p-ethyl exhibited more suppression of all categories of weeds than quizalofop-p-ethyl (W₈) which might be due to the contact as well as systemic action of the former herbicide while quizalofop-p-ethyl exhibited only systemic action. Similar type of observations was also reported by Sitangshu [14]. Among the botanical plant extracts, the trend observed at 15 DAS was same as at 45 DAS. However, it was observed that the control of weeds by the botanicals decreased with respect to 15 DAS. The probable reason might be due to the degradation of chemicals present in the extracts which might be in the form of leaching or volatilization. Hence, the suppressing ability of the allelochemicals reduced leading to the regaining of growth of weeds and ultimately increased the dry weights of all the weeds. However, among the botanicals, *Ocimum sanctum* extract recorded lowest population and dry weight of grassy weeds while *Ageratum conyzoides* extract recorded

lowest population and dry weight of sedge and broadleaved weeds. The degree of suppression of weeds by different botanical treatments vary among themselves and this might be due to the concentration dependent factor of the allelopathic plant species as also stated by Ismail and Chong [15] and Alagesaboopathi and Thamilazhagan [16].

Growth and yield attributes

The growth attributes in different crops differed significantly and it was partly due to the weed management treatments and largely due to their genetic inherent characteristics.

Among the weed management treatments, the severe competition of the weeds with the crops in untreated control deprived the crops of growth resources like nutrients, light water, resulting in lowest height of all the crops in this treatment. Hand weeding treatment recorded highest plant height (Table 3) of all the crops which was followed by fenoxaprop-p-

Table 3. Effect of treatments on plant height (cm), no. of branches plant⁻¹, LAI, seed yield (t/ha⁻¹) and stalk yield (t ha⁻¹) (Pooled data).

Weed management treatments (W)	Plant height (cm)				No. of branches plant ⁻¹				Crops (C) LAI			
	C ₁	C ₂	C ₃	Mean	C ₁	C ₂	C ₃	Mean	C ₁	C ₂	C ₃	Mean
W ₁	65.97	37.28	33.51	45.58	1.82	2.67	3.20	2.56	0.99	1.14	1.08	1.07
W ₂	84.71	46.83	45.41	58.98	2.47	3.85	3.99	3.44	1.32	1.71	1.83	1.62
W ₃	74.14	42.15	40.24	52.18	2.12	3.32	3.48	2.97	1.19	1.25	1.36	1.27
W ₄	70.96	40.07	35.53	48.85	1.94	3.12	3.31	2.79	1.07	1.17	1.17	1.14
W ₅	72.50	43.06	38.15	51.24	2.01	3.33	3.48	2.94	1.18	1.28	1.34	1.27
W ₆	69.23	40.77	38.16	49.38	1.89	3.17	3.37	2.81	1.13	1.21	1.30	1.21
W ₇	67.47	39.51	36.66	47.88	1.86	3.09	3.37	2.77	1.02	1.17	1.25	1.15
W ₈	77.74	45.15	42.81	55.23	2.26	3.58	3.78	3.21	1.26	1.31	1.40	1.32
W ₉	78.61	46.37	43.68	56.22	2.27	3.62	3.81	3.23	1.29	1.34	1.43	1.35
Mean	73.48	42.35	39.35		2.07	3.30	3.65		1.16	1.29	1.35	
Interaction	C	W	C×W	W×C	C	W	C×W	W×C	C	W	C×W	W×C
SEm±	0.980	0.510	0.883	1.286	0.070	0.031	0.054	0.086	0.012	0.019	0.033	0.033
CD (p = 0.05)	3.197	1.431	2.511	4.193	0.228	0.088	0.154	0.282	0.040	0.053	0.092	0.106

Table 3. Continued.

Weed management treatments (W)	Seed yield				Crops (C)				Stalk yield			
	C ₁	C ₂	C ₃	Mean	C ₁	C ₂	C ₃	Mean	C ₁	C ₂	C ₃	Mean
W ₁	0.61	0.93	1.15	0.90	2.78	2.42	2.65	2.62				
W ₂	0.91	1.36	1.60	1.29	3.41	2.93	3.13	3.16				
W ₃	0.77	1.15	1.40	1.11	3.11	2.68	2.93	2.90				
W ₄	0.71	1.05	1.21	0.99	3.03	2.53	2.76	2.77				
W ₅	0.73	1.20	1.37	1.10	3.07	2.71	2.94	2.91				
W ₆	0.69	1.10	1.30	1.03	2.97	2.59	2.83	2.80				
W ₇	0.66	0.99	1.25	0.96	2.85	2.47	2.76	2.69				
W ₈	0.85	1.33	1.52	1.23	3.23	2.91	3.12	3.08				
W ₉	0.83	1.30	1.50	1.21	3.19	2.86	3.07	3.04				
Mean	0.75	1.16	1.37		3.07	2.68	2.91					
Interaction	C	W	C×W	W×C	C	W	C×W	W×C				
SEm±	0.012	0.019	NS	NS	0.019	0.034	NS	NS				
CD (p=0.05)	0.039	0.053	NS	NS	0.061	0.096	NS	NS				

ethyl treatment. The highest plant height with hand weeding treatment was mainly due to the fact that hand weeding removed all types of weed flora since the beginning of crop growth. Among the botanical plant extract treatments, *Ageratum conyzoides* extract recorded highest plant height in sesame and

black gram which may be due to the higher efficiency of weed control, while in case of green gram, *Ocimum sanctum* extract showed highest plant height. The number of primary branches plant⁻¹ (Table 3) and was found to be highest in hand weeding followed by chemical herbicide treatments. The possible reason

could be the higher weed control of efficiency and consequently maximum capacity for utilization of available resource, whereas lowest number of branches plant⁻¹ and LAI in the untreated control could be attributed to the weed competition. Among the botanical plant extract treatments, *Ageratum conyzoides* extract recorded highest number of primary branches plant⁻¹ as well as LAI in sesame and black gram while *Ocimum sanctum* extract treatment recorded highest value in green gram.

Hand weeding treatment recorded highest seed yield (Table 3) in all the crops which might be due to better control of weeds and reduction of crop weed competition throughout the growth stages of the crop. Chaudhari et al. [17] also reported similarly in green gram. The high seed yield in hand weeding at 20 DAS, might be due to the removal of weeds which coincide with the critical period of crop weed competition of sesame (15-45 DAS) which also reported by Duary and Hazra [18] and 20–40 DAS in case of green gram and black gram which was also opined by Sheoran et al. [19]. All the weed control methods increased seed yield over untreated control and is believed to be a direct or indirect expression of a reduction in weed-crop competition which helped to increased seed yield. The uncontrolled growth of the weeds robbed up the growth resources such as plant nutrients, soil moisture, which would be available to the crops and thereby resulted poor growth and yield attributing characters which were reflected on the seed and stalk yield of all crops. Among the botanical treatments, *Ageratum conyzoides* extract recorded highest seed yield in sesame and black gram due to the better control of weeds, while *Ocimum sanctum* extract recorded highest in green gram. However, *Amaranthus tricolor* extract recorded the lowest yield and this might be due to lesser weed control efficiency. It appears that herbicide treatment recorded more seed and stalk yield than the botanical treatments due to better weed control efficiency. However, herbicide alone is less effective in comparison to hand weeding treatment. Establishment of better physical condition of soil due to hand weeding along with more conserved nutrients, resulting from lower crop-weed competition might be the probable reason for the higher yield in hand weeding treatment.

Conclusion

Among the different plant extracts used in the experiment, it can be concluded that *Ageratum conyzoides* extract @ 5% (w/v) can be used as pre-emergence herbicide for controlling weeds particularly sedge and broadleaved weeds and *Ocimum sanctum* extract @ 5% (w/v) for grassy weeds in the initial stage of crop growth.

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