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Influence of weed management on growth and yield of groundnut (*Arachis hypogaea*) in Gangetic plains of West Bengal, India

Pabitra Adhikary*[1], Partha Sarathi Patra[2] and Ratikanta Ghosh

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

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ABSTRACT

The field experiments were carried out at Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India during summer seasons of 2012 and 2013, to study the effect of weed management on growth and yield of groundnut (*Arachis hypogaea* L.) in gangetic plains of West Bengal. Weed biomass, weed control efficiency as well as the pods plant^{-1}, 100-seed weight, seed yield were significantly affected due to weed control treatments. Treatment receiving hand weeding twice recorded lowest weed biomass (3.44 g m^{-2}) and highest WCE (85.09 %). Highest seed yield (1025 kg ha^{-1}) was also recorded with hand weeding, which was significantly higher over other treatments. The results also showed that oxyfluorfen and chlorimuron-ethyl treatment applied at recommend rate were also effective in reducing the dry weight of weeds. Further the tested herbicides did not have significant effect on the crude protein and oil content in seeds.

Key words: *Arachis hypogaea*, Groundnut, Herbicides, Weeds control, Yield.

INTRODUCTION

Groundnut or peanut (*Arachis hypogaea* L.) is grown over 20 million hectares in the tropical and sub-tropical part of about one hundred countries in the world. The total annual world production amounts to about 25 million tons of unshelled nuts, 70% of which is contributed by India, China and U.S.A. (El Naim *et al*., 2010). Groundnut is an excellent source of nutrients contains 45–50% oil, 27–33% protein as well as essential minerals and vitamins. They play an important role in the dietary requirements of resource poor women and children and haulms are used as livestock feed. The main problems limiting production of groundnut are poor cultural practices as well as inadequate weed management (EL Naim *et al.*, 2010). Besides competing for nutrients, soil moisture, sunlight, weeds inhibit pegging, pod development in groundnut and interfere with harvest. In groundnut, less crop canopy during the first 6 weeks of growth favours strong competition with weeds causing significant reduction in yield (Shanwad *et al*., 2011). Therefore for attaining maximum yield, timely and effective weed control during the critical period of weed competition become necessary. Manual weeding, an age old practice for weed control in this crop is very laborious, time consuming and expensive, most importantly when there is dearth of manpower (Ikisan, 2000). In groundnut, chemical weed control has been found to be easier; less time consuming and more cost effective and efficient in reducing weed menace compared to hand weeding (Kumar., 2009). Hence the objective of this study was to see the effect of weed management practices on the growth and yield of groundnut.

MATERIALS AND METHODS

The experiment was conducted during two consecutive summer season of 2012 and 2013 at the "Instructional Farm" (latitude: 22°93'E, longitude: 88°53'N and altitude: 9.75 m) of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experimental soil was well drained, alluvial in nature and sandy loam in texture, having pH 6.87, organic carbon 0.573 %, available nitrogen 237.57 kg ha^{-1}, available phosphorus 23.45 kg ha^{-1} and available potassium 116.82 kg ha^{-1} respectively. The variety used in this experiment was JL-24 (Phule Pragati) with 8 treatments replicated three times with randomized block design. Each plot size was of 6 m x 5 m. The treatments consisted of W_1: Control, W_2: Two hand weeding at 20 and 40 DAS, W_3: Propaquizalofop 62.5 g ha^{-1}as pre-emergence (PE), W_4: Imazethapyr 100 g ha^{-1} as PE, W_5: Oxyfluorfen 202 g ha^{-1}as PE, W_6: Quizalofop-ethyl 37.5 g ha^{-1} as post-emergemce (PO), W_7: Fenoxaprop-ethyl 79 g ha^{-1} as PO, W_8: Chlorimuron-ethyl 12 g ha^{-1} as PO. Spraying was done with knapsack sprayer with floodjet deflector WFN 040 nozzle using 500 Littre of water ha^{-1}. All the recommended improved package of practices was followed in this experiment including the plant protection measures. One day before sowing, the seeds were treated by using *Trichoderma*

*Corresponding author's e-mail and address: pabitra.bdp@gmail.com.
[1]Krishi Vigyan Kendra, Ashokenagar– 743 223, North 24 Parganas, West Bengal, India.
[2]Department of Agronomy, Uttar Bangha Krishi Viswavidyalaya, Pundibari – 736165 , Coochbehar, West Bengal, India.

viridis @ 4 g kg^{-1} of groundnut seed. The treated seeds were kept under shade for overnight before sowing. Data on predominant weed species and biomass were recorded at harvest. The data were subjected to statistical analysis following analysis of variance method. The correlation studies were made to reveal the association among the variables in the investigation (Gomez and Gomez, 1984). As the error mean squares of the individual experiments were homogenous, combined analysis over the years were done through un-weighted analysis.

RESULTS AND DISCUSSION

Effect on weeds: Total numbers of 20 weed species were recorded, indicating a species-rich weed community in the experimental field. Among them, the most dominant species were annual broad-leaved weeds. Weed flora in groundnut consisted of *Eleusine indica, Dactyloctaneum aegyptium, Digitaria sanguinalis, Cyperus rotundus, Cyperus difformis, Fimbristylis dichotoma, Alternanthera philoxeroides, Digera arevensis, Commelina benghalensis, Phyllanthus niruri, Spilanthus paniculata, Euphorbia hirta, Physalis minima, Portuloaca oleracea and Boerhaavia diffusa*.

The effect of herbicides on total number of weed and dry weights is shown in Table 1. Oxyfluorfen used as pre-emergence had the lowest total growth of weeds followed by propaquizalofop and imazethapyr. The lowest number of weeds (10.00 m^{-2}) and biomass (3.44 g m^{-2}) were recorded in plots treated with hand weeding twice. Considering the total weed dry biomass, among pre-emergence application of herbicides, oxyfluorfen (4.68 g m^{-2}) was found most effective for weed control in groundnut field, compared to propaquizalofop (10.23 g m^{-2}) and imazethapyr (12.22 g m^{-2}). While among post-emergence herbicides, the lowest weed biomass was observed in plots treated with chlorimuron-ethyl (Table 1) followed by fenoxaprop-ethyl and quizalofop-ethyl, respectively. However, the maximum density and dry biomass of weeds was noticed under weedy check control. All the weed control treatments were effective in reducing the weed density and weed biomass compared with weedy check plots. Hand weeding twice failed to give season long weed control. As it had removed the weeds grown at a point of time, irrigation and inversion of soil during earthing up promoted the germination of weeds and allowed to compete with the crop. However, application of oxyfluorfen and chlorimuron-ethyl effectively controlled weed species as evident from the weed index values and weed control efficiency compared to other weed control treatments. Variations in the effect of different herbicides on weeds were due to their different mode of action and weed species. The reduction in weed density and biomass in plots raised under Propaquizalofop, imazethapyr, quizalofop-ethyl and fenoxaprop-ethyl were not misnomer as further fresh flush of weeds were arrested by these treatments. Similar results had been reported by Agasimani *et al*., (1992).

Effect on crop: Herbicidal effect on nodulation in groundnut crop was very prominent (Table 1). The number of root nodules varied from treatment to treatment (21.41 to 56.11). The maximum number of nodules per plant was recorded with the pre-emergence application of oxyfluorfen (56.11) followed by hand weeding treatment (55.56). Almost similar data was recorded with propaquizalofop and imazethapyr (45.8 and 44.0, respectively). For post-emergence treatments, the maximum nodules per plant were noticed with chlorimuron-ethyl (48.44). Data presented in Table 1 showed that there was a significant difference between pre-emergence and post-emergence herbicides with plant height ($p<0.05$). Among pre-emergence treatments, oxyfluorfen caused the greatest groundnut height (49.47 cm). Moreover, among the post-emergence treatments, the maximum height (48.09 cm) was recorded under chlorimuron-ethyl treatment (Table 1). The lowest plant height was observed in the control treatment (32.12 cm). Results in table 1 also revealed that all the weed control treatments increased the dry weight of groundnut plant. The highest increasing percentage was resulted from hand weeding (6230 kg ha^{-1}) followed by oxyfluorfen (6119 kg ha^{-1}) and chlorimuron-ethyl (5973 kg ha^{-1}) treatment. The minimum was recorded in control plot (3200 kg ha^{-1}). Among the weed control methods, hand weeding recorded the highest plant dry matter production followed by application of oxyfluorfen and chlorimuron-ethyl due to lower weed density and lesser weeds growth (Gnanamurthy and

TABLE 1: Effect of treatments on weed and yield plant of groundnut

Treatments	*Weed density (no.m^{-2})	*Weed dry biomass (g m^{-2})	Nodules $plant^{-1}$	Plant height (cm)	Plant biomass (kg ha^{-1})
W_1: Control	6.63 (44.00)	4.79 (23.08)	21.41	32.12	3200
W_2: Two hand weeding	3.17 (10.00)	1.88 (3.44)	55.56	48.37	6230
W_3: Propaquizalofop 62.5 g ha^{-1}	4.80 (23.00)	3.18 (10.23)	45.78	44.61	5473
W_4: Imazethapyr 100 g ha^{-1}	5.38 (29.00)	3.48 (12.22)	48.44	46.19	5172
W_5: Oxyfluorfen 202 g ha^{-1}	4.00 (16.00)	2.14 (4.68)	56.11	49.47	6119
W_6: Quizalofop-ethyl 37.5 g ha^{-1}	4.68 (21.89)	3.15 (10.20)	42.01	47.33	5828
W_7: Fenoxaprop-ethyl 79 g ha^{-1}	5.20 (27.00)	3.61 (13.12)	40.10	40.81	5581
W_8: Chlorimuron-ethyl 12 g ha^{-1}	3.96 (15.67)	2.17 (4.73)	44.00	48.09	5973
LSD (P= 0.05)	**0.18**	**0.15**	**3.19**	**1.73**	**281.51**

*Data subjected to square root transformation; values in parentheses are original

Balasubramaniyam 1995). The inhibitory effect of protein synthesis by oxyfluorfen was found to be associated with its effectiveness in controlling weed growth (Deal *et al*. 1980). It might be due to the favorable environment created for the emergence of fresh weeds at later stages by removal of weeds at 20 DAS. Higher plants DMP in different herbicides were due to their effectiveness to check the season long weed control.

Effect on weed control indices (WCE, HEI, WPI, CRI and WI): Weed control efficiency (WCE) differed significantly due to weed management treatments (Table 2). At harvest, two hand weeding recorded higher weed control efficiency (85.09 %), followed by oxyfluorfen (79.72 %) and chlorimuron-ethyl (79.51 %). While, the other herbicidal treatments provided lower weed control efficiency (75.37 %). So far herbicide efficiency index (HEI) is concerned, all the herbicides showed minimum value as compared to hand weeding. Maximum (1.0) weed persistence index (WPI), was recorded in control plot and maximum crop resistance index (CRI) was noticed in hand weeded plots. Significant differences in weed index were observed due to various weed control treatments (Table 3). Oxyfluorfen showed its superiority among the herbicides and recorded significantly lower weed index (2.63) followed by chlorimuron-ethyl (5.49). Propaquizalofop, imazethapyr, fenoxaprop-ethyl and quizalofop-ethyl were intermediate. The weedy check recorded significantly higher weed index (61.73). Weed persistence index indicates the resistance of weeds against various tested herbicides and to confirm the effectiveness of the herbicidal efficiency of the selected treatments to kill the weeds. The respective lowest and highest values of weed persistence index and the highest and lowest crop resistance index under hand weeding and control treatments were earlier reported by Sukhadia *et al*., 1998 and Qasem, 2006.

Effect on yield components and yield: Significant differences were noticed in yield parameters such as number of matured pods per plant, 100- seed weight, pod yield and seed yield (Table 3). Among all the treatments, weedy check recorded significantly lowest results. In most cases, plots received two hand weeding at 30 and 60 DAS gave the highest values of these parameters. For instance, with respect to seed yield, oxyfluorfen and chlorimuron-ethyl gave maximum yields of 998.00 and 968.67 kg ha^{-1} respectively. The lowest seed yield of groundnut was recorded in weedy check plots and showed the same trend as that of number of matured pods plant^{-1} and 100-seed weight. All the weed control treatments significantly increased the yield and yield attributes than the weedy check (control) treatment. Reason for the better yield advantage in all the weed control treatments is traceable to reduction in weed competition (Awodoyin *et al*., 2005 and Abouziena *et al*., 2008). Among all the weed control treatments, hand weeding gave the highest pod yield and seed yield and this was followed with either oxyfluorfen or chlorimuron-ethyl. Similar result was found by Ahmed *et al*., (2011). The enhancement of yield parameters, oxyfluorfen and chlorimuron-ethyl may be explained by better weed control efficiency, 100- seed weight and number of matured per plant that were respectively enhanced compared to other treatments. The findings were not out of new in that similar findings have been reported by Shanwad *et al.* (2011) and Etejere *et al.* (2013). It suffices

TABLE 2: Effect of treatments on weed indices in groundnut

Treatments	WCE (%)	HEI	WPI	CRI	WI
W_1: Control	0	0	1	1	61.73
W_2: Two hand weeding	85.09	0.110	0.66	α	0
W_3: Propaquizalofop 62.5 g ha^{-1}	55.68	0.029	0.85	3.87	11.98
W_4: Imazethapyr 100 g ha^{-1}	47.06	0.014	0.80	3.07	12.48
W_5: Oxyfluorfen 202 g ha^{-1}	79.72	0.076	0.56	9.42	2.63
W_6: Quizalofop-ethyl 37.5 g ha^{-1}	55.81	0.017	0.89	4.11	32.03
W_7: Fenoxaprop-ethyl 79 g ha^{-1}	43.15	0.017	0.93	3.06	24.05
W_8: Chlorimuron-ethyl 12 g ha^{-1}	79.51	0.071	0.58	9.12	5.49

TABLE 3: Effect of treatments on yield and yield attributes of groundnut

Treatments	Pods plant^{-1}	100 – seed weight (g)	Pod Yield(kg ha^{-1})	Seed Yield(kg ha^{-1})
W_1: Control	8.67	28.00	622.89	392.22
W_2: Two hand weeding	17.78	36.44	1407.66	1025.00
W_3: Propaquizalofop 62.5 g ha^{-1}	13.89	33.33	1266.00	902.33
W_4: Imazethapyr 100 g ha^{-1}	13.78	32.40	1257.89	897.11
W_5: Oxyfluorfen 202 g ha^{-1}	16.56	35.67	1385.44	998.00
W_6: Quizalofop-ethyl 37.5 g ha^{-1}	13.44	33.10	1025.67	696.66
W_7: Fenoxaprop-ethyl 79 g ha^{-1}	14.22	34.78	1108.00	778.44
W_8: Chlorimuron-ethyl 12 g ha^{-1}	16.44	35.33	1344.00	968.67
LSD (P= 0.05)	**0.86**	**0.83**	**75.34**	**60.58**

to mention here that the lower yield recorded where propaquizalofop, imazethapyr, quizalofop-ethyl and fenoxaprop-ethyl were applied could be as a result of inability of those treatments to provide season long weed control which in consequences enhanced fresh luxuriant growth of weeds at later stages of crop growth and compete with crop for available resources. Apart from the above factors, being a C_3 plant, climatic fluctuations, especially the sunshine hours, temperature gradients, and precipitation had significant influence on the productivity of groundnut (Pallas and Samish 1974). The high productivity of groundnut during the late summer season might be due to the prevalence of lengthy hours of sunshine and high temperature during flowering and pod development stages. The perusal of the earlier results revealed that the weed free conditions during the entire crop growth period resulted in appreciable improvement in growth components like plant height, leaf area index and subsequently plant dry matter production. Hence, an accountable increase in haulm yield was obtained with weed free condition (Kanagam and Chinnamuthu, 2009).

Effect on shelling (%), oil (%) and protein (%): Data presented in Table 4 indicated that different weed control measures did not influence significantly the crude protein and oil content in peanut seed. The results are concerned with Ibrahim (1995) who indicated that application of pendimethalin at 2023 g ha^{-1} as pre-emergence did not affect crude protein and oil content in peanut seed compared with non-chemical control treatments.

TABLE 4: Effect of treatments on shelling (%), oil content (%) and protein content (%) in groundnut

Treatments	Shelling percentage (%)	Oil content (%)	Protein content (%)
W_1: Control	62.97	41.71	31.21
W_2: Two hand weeding	72.82	43.09	34.33
W_3: Propaquizalofop 62.5 g ha^{-1}	71.27	41.78	31.08
W_4: Imazethapyr 100 g ha^{-1}	71.32	41.83	33.00
W_5: Oxyfluorfen 202 g ha^{-1}	72.04	42.69	34.41
W_6: Quizalofop-ethyl 37.5 g ha^{-1}	67.92	40.95	30.49
W_7: Fenoxaprop-ethyl 79 g ha^{-1}	70.26	43.21	32.57
W_8: Chlorimuron-ethyl 12 g ha^{-1}	72.07	41.90	33.88
LSD (P= 0.05)	-	NS	NS

CONCLUSION

It may be concluded from this study that either hand weeding twice or pre-emergence application of oxyfluorfen or post-mergence application of chlorimuron-ethyl at their recommended dose could be adopted for effective management of weeds and higher production of groundnut in the region.

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