Environment and Ecology 41 (1) : 152—159, January—March 2023
ISSN 0970-0420

Performance of Pre-Emergence Herbicide in Summer Groundnut in Laterite Soil of West Bengal

Chayanika Bhowmik, Sujay Kumar Paul, Mahua Banerjee, Ganesh Chandra Malik, Duvvada Sarath Kumar, Monotosh Das Bairagya, Upasana Sahoo, Shreyasi Das

Received 12 September 2022, Accepted 3 November 2022, Published on 27 January 2023

ABSTRACT

A field experiment was conducted at Agricultural Farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan during 2017 and 2018, to study the effect of flumioxazin 50% SL applied as pre-emergence herbicide in summer groundnut (*Arachis hypogaea* L.). Flumioxazin was applied at 3 different doses at 75 g a.i/ha, 100 g a.i/ha, 125 g a.i/ha along with standard check of Imazethapyr 10 SL @ 100 g a.i/ha and Pendimethalin 30 % EC @ 750 g a.i/ha and was compared with untreated control, weed free check and hand weeding 20 and 40 days after sowing (DAS). Flumioxazin 50% SL @ 125 g/ha applied was able to control weed growth during early stages of crop. Flumioxazin 50% SL @ 125 g/ha at 3 DAS registered lower weed density, dry weight, weed index and higher weed control efficiency, better crop growth, highest net return and return per rupee invested. However, yield attributes and yield was highest for weed free plots which was at par to flumioxazin 50% SL @ 125 g/ha.

Keywords Growth, Pulse, Weed dynamics, Weed index, Weed management.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop and an important agricultural export commodity of India. India's diverse climatic conditions favor growing of groundnut in one or other part throughout the year. Groundnut covered an area of about 4.7 million hectare in 2019, scattered in over 25 states (Indiastat 2021). In West Bengal, the potential districts for rainfed groundnut are Midnapore, Purulia, Bankura, Birbhum, which accounts for 30% of total groundnut area of the state (Basu and Singh 2004). But, there is a gradual decrease of production from 9.18 MT in 2008 to 6.72 MT in 2019 (Indiastat 2021). Area wise, about 85% groundnut is grown as a rainfed crop during the *kharif* season where the vagaries of monsoon and seasonal biotic and abiotic stresses causes low productivity (Basu and Singh 2004). Production in other seasons is reduced due to poor management, unavailability/less availability of timely irrigation facilities, heavy weed infestation and

Chayanika Bhowmik[1], Sujay Kumar Paul[2]*, Mahua Banerjee[3], Ganesh Chandra Malik[4], Duvvada Sarath Kumar[5], Shreyasi Das[8]
[1,2,3,4,5,8]Department of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati, Sriniketan, WB 731236, India

Monotosh Das Bairagya[6]
[6]Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusandhan, Bhubaneswar, Odisha 751030, India

Upasana Sahoo[7]
[7]M.S. Swaminathan School of Agriculture, Centurion University, Paralakhemundi, Odisha 761207, India

Email: sujaykumarpaul.rs@visva-bharati.ac.in
*Corresponding author

lack of improved technologies. Although globally, India ranks first with respect to area and second in production of groundnut (Gayathri 2018) but in terms of productivity, it ranks eighth, lower by about 100 kg than the world average productivity (Madhusudhana 2013). Heavy weed infestation is the main factor, which reduces the yield of groundnut in *summer* season. Manual weeding measures are very effective but costly and suffer in areas of labor scarcity. In view of initial slow growth habit of the crop, mechanical and physical measures of weed control requires frequent operations as well as it becomes difficult due to peg initiation at the later stage (Kalhapure *et al*. 2013). These make weed management in groundnut cumbersome. For increasing the productivity and getting potential yield of the crop, proper weed management can play a vital role. Critical period of crop weed competition for groundnut crop is reported up to 40- 45 DAS (Kumari *et al*. 2020). For realization of good yield, pre emergence herbicide with persistence up to 40-45 days after sowing (DAS) can be helpful. Use of herbicides like Fluchloralin, Imazathapyr, Oxyfluorfen, Oxadiazon and Metolachlor has been used in groundnut cultivation (Basu and Singh 2004). Flumioxazin, is a member of diphenyl ether group of herbicides which inhibits protoporphyrinogenoxidise (PPO) (USEPA 2010). It acts by inhibiting heme and chlorophyll biosynthesis causing lipid membrane per-oxidation leading to a rapid loss of turgidity and foliar burns. It may effectively control weed problem in groundnut during the critical period of crop weed competition (Kumari *et al*. 2020). Hence, a comprehensive study was undertaken during summer seasons of 2017 and 2018 to study the effectiveness of different doses of flumioxazin in controlling weed in groundnut and in improving productivity and profitability of summer groundnut in the laterite soil of West Bengal.

MATERIALS AND METHODS

Two years field study was conducted during summer seasons of 2017 and 2018 at Agricultural Farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal situated at $23^0$39' N, $87^0$42' E and 58.90 m above mean sea level. The soil was sandy loam, having pH 4.5 (1:2.5 soil:water ratio), EC 0.56 ds/m, 113 kg/ha available nitrogen (Alkaline permanganate method), 13.56 kg/ha available P (Bray's P-1), 120 kg/ha available K (Flame photometer method) and 0.40% organic carbon (Walkley and Black Titration method).

Groundnut cv 'TAG 24' was sown at a seed rate of 100 kg/ha in rows spaced 30 cm and plant to plant distance 10 cm. Fertilizers applied as basal was 30 kg/ha nitrogen, 60 kg/ha P_2O_5 and 30 kg/ha K_2O. The experiment was laid out in Randomized Block Design replicated thrice.

The treatment details are Flumioxazin 50% SL @ 75 g/ha at 3 DAS (T_1), Flumioxazin 50% SL @ 100 g/ha at 3 DAS (T_2), Flumioxazin 50% SL @ 125 g/ha at 3 DAS (T_3), Imazethapyr 10 SL @ 100 g/ha at 3 DAS (T_4), Pendimethalin 30 % EC @ 750 g/ha at 3 DAS (T_5), Untreated control (T_6), Weed free check (T_7) and Hand weeding 20 and 40 DAS (T_8).

Sowing was done on 12th March, 2017 in the first season and on 5th March, 2018 in the second season. The crop was grown following good agronomic practices and harvested on 10th July 2017 and 6th July 2018. Weed count and dry weight were recorded at 30 and 45 DAS following standard procedures. Observations on crop growth attributes were recorded at 45 and 60 DAS while yield attributes and yield observations were taken at harvest. Weed control efficiency (Mani *et al*. 1973) and weed index (Gill and Kumar 1969) was calculated based on the data recorded as per standard formula.

The data on weed density and dry weight of weed were square root $\sqrt{(X+0.5)}$ transformed before statistical analysis using Analysis of Variance method, to improve the homogeneity of the variance separately for each year. However, original values are included in parenthesis. The significance of different source of variations was tested by "Error Mean Square Method" of Fisher Snedecor's "F" test at probability level 0.05.

RESULTS AND DISCUSSION

Effect of weed management techniques on weed density

All weed control treatments recorded significantly

Table 1. Effect of weed management practices on weed population of weeds (no./m^2) of groundnut (Pooled data of two years). Figures in parentheses are the original values. Square root transformation was done √(X+0.5) before statistical analysis.

Treatments	Density of grassy weeds (No./sq m)		Density of broad leaved weeds (No./sq m)		Density of sedges (No./sq m)	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
T_1-Flumioxazin 50% SL @ 75 g/ha at 3 DAS	2.26 (4.61)	2.65 (6.52)	1.93 (3.22)	2.24 (4.52)	1.93 (3.22)	2.08 (3.83)
T_2-Flumioxazin 50% SL @ 100 g/ha at 3 DAS	1.65 (2.22)	2.21 (4.38)	1.56 (1.93)	1.86 (2.96)	1.56 (1.93)	1.74 (2.53)
T_3-Flumioxazin 50% SL @ 125 g/ha at 3 DAS	1.55 (1.90)	1.81 (2.78)	1.19 (0.92)	1.72 (2.46)	1.17 (0.87)	1.29 (1.16)
T_4-Imazethapyr 10 SL @ 100 g/ha at 3 DAS	2.47 (5.60)	3.1 (9.11)	2.08 (3.83)	2.72 (6.90)	2.52 (5.85)	2.64 (6.47)
T_5-Pendimethalin 30 % EC @ 750 g/ha at 3DAS	2.61 (6.31)	3.12 (9.23)	2.79 (7.28)	3.07 (8.92)	3.12 (9.23)	3.02 (8.62)
T_6-Untreated control	2.91 (7.97)	3.39 (10.99)	3.13 (9.30)	3.48 (11.61)	3.22 (9.87)	3.38 (10.92)
T_7-Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_8-Hand weeding 20 and 40 DAS	1.72 (2.46)	2.42 (5.36)	1.86 (2.96)	2.47 (5.60)	1.86 (2.96)	2.08 (3.83)
SEm(±)	0.18	0.23	0.09	0.1	0.33	0.12
LSD (p=0.05)	0.54	0.69	0.27	0.3	0.99	0.36

lower weed density than the untreated control (Table 1) during the period of study at 30 and 45 DAS. Flumioxazin is efficient in restricting weed growth by blocking heme and chlorophyll biosynthesis resulting in the accumulation of phototoxic porphyrins in plants and animal tissues (USEPA 2010). Groundnut plots treated with T_3, showed maximum chemical herbicidal effect at all the stages of crop growth. The treatment was found 76.16% and 74.70% more effective in controlling grassy weeds as compared to the untreated control plots at 30 and 45 DAS respectively. Treatment, T_3 effectively reduced grasses by 66.07% and 69.48% as compared to standard check, T_4 at the studied growth stages. Plots of T_8, at 20 DAS and 40 DAS as weed control measure was found at par with T_1, T_2, T_3 plots in controlling grasses. Herbicidal treatment, T_3 was most effective in controlling broad leaved weeds; which controlled about 87.36% and 86.44% more weeds than standard check, T_5 at 30 and 45 DAS. This is in accordance with research by English, 2003 who reported that Flumioxazin benefits groundnut cultivation by controlling broadleaf weeds, which is not controlled by the dinitroanilines or chloracetamides. During the period of study, T_3 significantly controlled sedges in groundnut, which was 91.18% and 89.38% lower as compared to T_6 at 30 and 45 DAS. During 30 DAS, herbicidal effect of T_3 treated plots were statistically at par with T_2 treated plots in controlling sedges.

Effect of weed management techniques on weed dry weight

Grasses were better controlled by T_3 treatment in comparison to other chemical and manual weed control treatments (Table 2). At both the growth stages, standard check treatments, T_4 (2.09 g/m^2, 2.42 g/m^2) and T_5 (2.26 g/m^2, 2.81 g/m^2) recorded significantly higher dry weight of grasses as compared to that of T_3 (0.06 g/m^2, 0.17 g/m^2) treated plots. Flumioxazin provides a different mode of action from other commonly used peanut herbicides, and can be used as a good management tool (Braun *et al*. 2000). Herbicidal spray of T_3, effectively reduced growth of broad leaved weeds (0.35 g/m^2 and 0.38 g/m^2) in the groundnut crop at 30 and 45 DAS respectively. However, weed free check showed least dry weight of broadleaved weeds, which was at par to T_8 and T_3 treated plots. Sedges are among the most troublesome and difficult to control (Naczi and Ford 2008). Dry weight

Table 2. Effect of weed management practices on dry weight of weeds (g/m^2) of groundnut (Pooled data of two years). Figures in parentheses are the original values. Square root transformation was done √(X+0.5) before statistical analysis.

Treatments	Dry weight of grassy weeds (g/sq m)		Dry weight of broadleaved weeds (g/sq m)		Dry weight of sedges (g/sq m)	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
T_1-Flumioxazin 50% SL @ 75 g/ha at 3 DAS	1.12 (0.75)	1.21 (0.96)	1.5 (1.75)	1.76 (2.60)	1.36 (1.35)	1.44 (1.57)
T_2-Flumioxazin 50% SL @ 100 g/ha at 3 DAS	0.86 (0.24)	0.92 (0.35)	1.52 (1.81)	1.72 (2.46)	1.1 (0.71)	1.15 (0.82)
T_3-Flumioxazin 50% SL @ 125 g/ha at 3 DAS	0.75 (0.06)	0.82 (0.17)	0.92 (0.35)	0.94 (0.38)	0.85 (0.22)	0.93 (0.36)
T_4-Imazethapyr 10 SL @ 100 g/ha at 3 DAS	1.61 (2.09)	1.71 (2.42)	1.92 (3.19)	2.01 (3.54)	1.47 (1.66)	1.49 (1.72)
T_5-Pendimethalin 30 % EC @ 750 g/ha at 3 DAS	1.66 (2.26)	1.82 (2.81)	2.05 (3.70)	2.22 (4.43)	1.79 (2.70)	1.7 (2.39)
T_6-Untreated control	1.88 (3.03)	2.59 (6.22)	2.21 (4.38)	2.46 (5.55)	2.06 (3.74)	2.26 (4.61)
T_7-Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_8-Hand weeding 20 and 40 DAS	0.87 (0.26)	1.23 (1.01)	0.79 (0.12)	1.26 (0.78)	1.45 (1.60)	1.56 (1.93)
SEm (±)	0.11	0.11	0.03	0.14	0.1	0.14
LSD (p=0.05)	0.33	0.33	0.09	0.42	0.3	0.42

studies revealed, T_3 was significantly superior to T_2 in controlling growth of sedges in the treated plots at 30 and 45 DAS. T_3 treated plots controlled 91.85% and 84.93% sedges as compared to standard check, T_5 at 30 and 45 DAS. The results were in conformity with Braun *et al*. (2000), who reported that pre-emergence application of flumioxazin provide control of many tough to control weeds across the peanut growing areas. After studying, it was seen that, T_3 treatment effectively reduced the dry matter accumulation of weeds upto 45 DAS i.e. the most critical stage of crop-weed competition for groundnut (Table 2).

Effect of weed management techniques on growth parameters of groundnut

There was no significant difference between the plant height of the treated plots at 45 and 60 DAS. However, among all the weed management strategies, plant height of groundnut was highest in weed free check plots (Table 3). Dry matter accumulation of crop was significantly higher in weed free plots at all growth stages studied. Among the chemical weed management practices, dry matter accumulation of groundnut was considerably higher in T_3 treated plots which, was statistically at par with T_8 (Table 3). Better dry matter accumulation can be linked to better growth of crops in the initial stages, in a weed free environment, due to lesser/no competition of crop with weeds for nutrients and other resources. The lowest dry weight of groundnut was observed under untreated control in all the growth stages recorded. Similar observations on pre-emergence herbicides were also recorded by Singh and Singh (2009).

LAI data of groundnut revealed that the highest value was in weed free plot, which was statistically at par with treatments, T_1, T_2 and T_3 treated plots at 45 and 60 DAS. Among the herbicide treated plots, LAI of groundnut crops treated with T_3 was found statistically at par at 45 DAS with T_1, T_2 and T8 (Table 3). Similar results were also observed by Suseendran *et al*. 2019. The timely and effective control of weeds leads to better availability of nutrients, moisture and solar radiation to the crop plants, leading to higher supply of carbohydrates, which resulted in increased growth, attributes than unweeded control (Channappagouder *et al*. 2008). Lower LAI recorded in plots treated with T_4, T_5 and T_6 was due to higher crop-weed competition in those plots.

Table 3. Effect of weed management practices on dry matter accumulation (g/m²) groundnut (Pooled data of two years).

Treatments	Plant height (cm)		Dry matter accumulation (g/sq m)		LAI of groundnut	
	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS
T_1-Flumioxazin 50% SL @ 75 g/ha at 3 DAS	16.50	26.47	177.67	247.19	1.39	1.55
T_2-Flumioxazin 50% SL @ 100 g/ha at 3 DAS	19.00	29.00	241.00	346.78	1.40	1.57
T_3-Flumioxazin 50% SL @ 125 g/ha at 3 DAS	19.40	29.47	329.00	514.11	1.53	2.01
T_4-Imazethapyr 10 SL @ 100 g/ha at 3 DAS	18.50	28.50	264.33	375.56	1.10	1.41
T_5-Pendimethalin 30 % EC @ 750 g/ha at 3 DAS	18.20	28.30	173.00	318.68	1.07	1.38
T_6-Untreated control	14.42	25.67	130.67	259.57	0.94	1.08
T_7-Weed free check	19.71	29.70	366.67	555.19	1.57	2.06
T_8-Hand weeding 20 and 40 DAS	19.40	29.33	316.67	446.99	1.43	1.74
SEm (±)	1.59	1.55	9.68	13.39	0.08	0.06
LSD (p=0.05)	2.34(NS)	4.77 (NS)	29.04	40.17	0.24	0.18

Effect of weed management techniques on yield attributes

The yield attributes like number of pods per plant, number of seeds per pod and 100 seeds weight was recorded and statistically analyzed. The number of pods/plant was highest in the T_7, which was statistically at par T, T_2 and T_3 treated plants (Table 4). Similar results of highest number of pods in T_7 was also confirmed by Kalhapure *et al*. (2013). Higher accumulation of crop dry matter along with better weed control produced more number of pods in the treatments, where weeds were better controlled.

Table 4. Effect of weed management practices on yield attributes of groundnut (Pooled data of two years).

Treatments	No. of pods/plant	No. of seeds/pod	100 seed weight (g)
T_1-Flumioxazin 50% SL @ 75 g/ha at 3 DAS	15.93	1.67	36.36
T_2-Flumioxazin 50% SL @ 100 g/ha at 3 DAS	18.93	2.60	37.03
T_3-Flumioxazin 50% SL @ 125 g/ha at 3 DAS	19.77	2.67	39.70
T_4-Imazethapyr 10 SL @ 100 g/ha at 3 DAS	13.87	1.67	37.50
T_5-Pendimethalin 30% EC @ 750 g/ha at 3 DAS	12.77	1.40	35.70
T_6-Untreated control	9.10	1.00	32.40
T_7-Weed free check	20.57	3.5	42.96
T_8-Hand weeding 20 and 40 DAS	19.00	1.67	38.80
SEm (±)	1.53	0.18	0.68
LSD (p=0.05)	4.47	0.54	2.00

The highest number of seeds per pod was registered in T_7 plots. Among the herbicidal treatments, the highest number of seeds per pod was observed in T_3, which was statistically at par with T_2 treated plots. The highest seed index was registered in the T_7 plots.

Among the herbicidal treatments, higher seed weight of 100 seeds was found in T_3 plot, which was statistically at par with that of T_8 and was significantly superior to all other treatments. Better dry matter accumulation in plants in weed free plots led to more seed weight at harvest. Better initial weed control in T_3 treated plots provided ample opportunity for good crop growth.

Effect of weed management techniques on yield

The yield of pods and haulm yield was found highest in the weed free plots, which was statistically at par with that of T_3 treated plots. Pod yield of T_3 treated groundnut plot was found 38.01 % and 13.74% higher than T_5 and T_8 plots respectively. Haulm yield of T_3 plots was found at par with T_8 (Table 5). Higher pod yield and haulm yield may be due to application of broad-spectrum herbicide as pre-emergence, which might have prevented or suppressed the germination of weed species and provided weed free environment for the crop plants (Kalhapure *et al*. 2013). Among the treatments, there was no statistically significant difference in harvest index. Weed free plot recorded maximum shelling percentage (72.17 %) but there was no significant difference among treatments. Among the herbicidal treatment, shelling percent of

Table 5. Effect of weed management practices on yield of groundnut (Pooled data of two years).

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)	Harvest index (%)	Shelling percent (%)	Weed index
T_1-Flumioxazin 50% SL @ 75 g/ha at 3 DAS	2072.00	2456.20	45.76	59.34	36.24
T_2-Flumioxazin 50% SL @ 100 g/ha at 3 DAS	2680.00	2792.00	48.98	65.50	22.95
T_3-Flumioxazin 50% SL @ 125 g/ha at 3 DAS	3314.00	3530.40	48.42	70.97	3.63
T_4-Imazethapyr 10 SL @ 100 g/ha at 3 DAS	2057.44	2625.40	43.94	59.90	34.06
T_5-Pendimethalin 30 % EC @ 750 g/ha at 3 DAS	2054.32	2620.27	43.95	58.28	34.18
T_6-Untreated control	950.00	1260.20	42.98	54.40	86.62
T_7-Weed free check	3369.00	3733.08	47.44	72.17	0.00
T_8-Hand weeding 20 and 40 DAS	2858.33	3296.80	46.44	69.40	13.33
SEm (±)	56.13	90.83	1.76	1.95	-
LSD (p=0.05)	165.19	280.47	NS	5.72 (NS)	-

T_3 plot was found to be highest which was closely followed by T_2.

Effect of weed management techniques on weed index (WI) and weed control efficiency (WCE)

Weed index signifies the efficiency of a particular treatment as compared to a weed free treatment. It is the percent yield loss caused due to weeds as compared to T_7 (weed free check) (Gill and Kumar 1969). Higher weed index means greater loss as observed in T_6 plants (86.62). With increase in the dose of Flumioxazin, WI decreased simultaneously (Table 5). Ghosh 2000 also confirmed the loss in pod yield ranges from 13% to 100% depending upon the season, cultivars, weed composition and duration of crop-weed competition and the packages of practices adopted. Among the herbicide treatments, lowest weed index was recorded for T_3 followed by treatment T_2. WI of T_8 was in range between T_2 and T_3.

WCE depicts the percentage reduction in dry weight of weeds under treated plot in comparison to weed free plots (Mani *et al*. 1973). Best WCE at 30 and 45 DAS was observed, in T_3 for control of grasses and sedges. Good result in controlling broad-leaved weeds was observed during 30 and 45 DAS in T_8 treated plots, which was closely followed by T_3 treatment (Table 6). Similar results of WCE with T_8 was also observed by Dutta *et al*. (2005).

Economics of weed management

The observations on cost of cultivation for different treatments revealed that any kind of weed management practices recorded higher cost of cultivation over that of untreated control. The highest cultivation cost was for T_7 plots followed by T_8. The highest value of gross return (₹/ha) was obtained from weed free

Table 6. Effect of weed management practices on weed control efficiency in grassy weeds, broad-leaved weeds and sedges of groundnut (Pooled data of two years).

Treatments	WCE of grasses		WCE of broad leaved weeds		WCE of sedges	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
T_1-Flumioxazin 50% SL @ 75 g/ha at 3 DAS	75.25	84.57	60.05	53.15	63.90	65.94
T_2-Flumioxazin 50% SL @ 100 g/ha at 3 DAS	92.08	94.37	58.68	55.68	81.01	82.21
T_3-Flumioxazin 50% SL @ 125 g/ha at 3 DAS	98.02	97.27	92.01	93.15	94.12	92.19
T_4-Imazethapyr 10 SL @ 100 g/ha at 3 DAS	31.02	61.09	27.17	36.22	55.61	62.69
T_5-Pendimethalin 30 % EC @ 750 g/ha at 3 DAS	25.41	54.82	15.53	20.18	27.81	48.16
T_6-Untreated control	0.00	0.00	0.00	0.00	0.00	0.00
T_7-Weed free check	100.00	100.00	100.00	100.00	100.00	100.00
T_8-Hand weeding 20 and 40 DAS	91.42	83.76	97.26	85.94	57.22	58.13

Table 7. Economics of weed management practices on groundnut (Pooled data of two years).

Treatments	Cost of cultivation (₹ /ha)	Gross return (₹ /ha)	Net return (₹ /ha)	Return per rupee invested (₹)
T_1-Flumioxazin 50% SL @ 75 g/ha at 3 DAS	53800	81246	27446	0.81
T_2-Flumioxazin 50% SL @ 100 g/ha at 3DAS	54150	101855	47705	1.39
T_3-Flumioxazin 50% SL @ 125 g/ha at 3 DAS	54500	129707	75207	2.18
T_4-Imazethapyr 10 SL @ 100 g/ha at 3 DAS	54150	80787	26637	0.78
T_5-Pendimethalin 30 % EC @ 750 g/ha at 3 DAS	54000	80663	26663	0.78
T_6-Untreated control	22480	37331	14851	0.66
T_7-Weed free check	69000	131946	62946	1.28
T_8-Hand weeding 20 and 40 DAS	63200	112024	48824	1.13
SEm (±)	-	3299	3299	0.05
LSD (p=0.05)	-	10006	10006	0.16

plots, T_7 which was statistically at par with T_3 plots (Table 7). Gross return of T_3 was 37.71% more than T_4 and 37.81% more as compared to T_5. T_3 recorded the highest net return, which was 35.08% higher than T_8. Higher pod and haulm yield gave higher return from T_3 (₹ 68292/ha) treated plots while the lowest was observed for T_6, untreated control plot (₹ 4120/ha). The highest return per rupee invested was for T_3, which was due to better crop growth, lesser groundnut-weed competition leading to higher pod and haulm yield.

Weed management practices showed positive and favourable effect on improving the growth parameters, yield components and yield of groundnut recorded at various stages of crop growth. Flumioxazin 50% SL is a good profitable alternative for weed management of broad spectrum of weeds in summer groundnut. T_3 plots were statistically significant in terms of weed density, weed dry weight, plant dry weight and LAI. Treatment, T_3 gave better yield and net return. It effectively controlled weeds for significant duration, which gave the crop an initial weed free situation thus enhancing its growth and improving the yield contributing attributes. Combination of Flumioxazin with other herbicides in groundnut during other seasons can be further studied to analyze its efficacy in other seasons as well.

ACKNOWLEDGMENT

The authors would like to acknowledge the Sumitomo Chemical Co Ltd for sponsoring the study.

REFERENCES

Basu MS, Singh NB (2004) Groundnut Research in India. National Research Center for Groundnut.

Braun JC, Cranmer JR, Altom JV (2000) Valor™ herbicide: A new pre-emergence herbicide in peanuts. *Proce Ann Meing-Southern Weed Sci Soc* 53: 158-158.

Channappagoudar BB, Koti RV, Biradar NR, Bharmagoudar TD (2008) Influence of herbicides on physiological and biochemical parameters in radish. *Karnataka J Agric Sci* 21(1): 8-11.

Dutta D, Bandyopadhyay P, Banerjee P (2005) Integrated weed management in rainfed groundnut (*Arachis hypogaea*) in acid lateritic soils of West Bengal. *J Crop Weed* 2(1): 47-51.

English RG (2003) The basis of selectivity for flumioxazin use in peanut and associated weeds (Doctoral dissertation, University of Georgia).

Gayathri J (2018) A trend analysis of area, production, and yield of groundnut in India. *J Econo* 6(3): 15-21.

Ghosh DC (2000) Weed management in rainfed groundnut (*Arachishypogaea*). *Ind J Weed Sci* 32(1 - 2): 92-93.

Gill GS, Kumar V (1969) Weed index, a new method for reporting weed control trials. *Ind J Agron* 142: 96-98.

Indiastat (2021) Season-wise Area, Production and Productivity of Groundnut in India (1949-1950 to 2020-2021-2nd Advance Estimates), Retrieved on May 19, 2021. URL: https://www.indiastat.com/table/agriculture/season-wise-area-production-productivity-groundnut/17354.

Kalhapure AH, Shete BT, Bodake PS (2013) Integration of chemical and cultural methods for weed management in groundnut. *Ind J Weed Sci* 45(2): 116-119.

Kumari S, Banerjee M, Raj RK, Chaudhuri A, Paul SK (2020) Effect of weed management practices on yield, quality and economics of groundnut (*Arachis hypogaea* L.) during summer season. *Int J Chem Studies* 8(2): 2562-2565.

Madhusudhana B (2013) A survey on area, production and productivity of groundnut crop in India. *IOSR J Econo Finance* 1(3): 1-7.

Mani VS, Malla ML, Gautam KC (1973) Weed-killing chemicals in potato cultivation. *Ind Farmi*.

Naczi RF, Ford BA (2008) Sedges: uses, diversity and systematics

of the Cyperaceae. Missouri Botanical Garden Press.
Singh H, Singh S (2009) Weed management and soil micro-organisms studies in irrigated summer groundnut (*Arachis hypogaea* L.). *Ind J Weed Sci* 41(1 - 2): 103-107.
Suseendran K, Kalaiselvi D, Kalaiyarasan C, Jawahar S, Ramesh S (2019) Impact of weed flora in groundnut (*Arachis hypogaea* L.) in clay loam soils in dharmapuri district, Tamil Nadu, India. *Pl Archi* 19(1): 679-682.
USEPA (2010) EFED Section 3 registration of flumioxazin to be used for control of weeds in bayous, canals, and other aquatic areas. Memorandum by N.E. Federoff and L. Liu, Environmental Fate and Effects Division (EFED). Courtesy of EFED.