Journal of Crop and Weed, 17(1): 272-277 (2021)
ISSN- O : 2349 9400 ; P : 0974 6315
http://cwssbckv.org
www.cropandweed.com

Weed management in summer groundnut (*Arachis hypogaea* L.)

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Received : 09.08.2020 ; Revised : 23.01.2021 ; Accepted : 25.01.2021

DOI : https://doi.org/10.22271/09746315.2021.v17.i1.1436

ABSTRACT

A field experiment was conducted during 2019-20 in the summer rice fallows of Onattukara, Alapuzha, Kerala with the objectives to determine the best weed management option for the summer groundnut and to work out the economics of cultivation. RBD design was adopted with three replications. The treatments were T_1 -stale seed bed fb 1 hand weeding at 30 DAS; T_2 -imazethapyr + imazamox (PoE) @ 40 g ha^{-1} at 20 DAS; T_3 - imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS; T_4 - imazethapyr (PoE) @ 37.5 g ha^{-1} at 20 DAS; T_5 - imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS; T_6 -pendimethalin (PE) @ 1.0 kg ha^{-1}; T_7 - pendimethalin (PE) @ 1.0 kg ha^{-1} fb hand weeding at 30 DAS; T_8 – Hand weeding at 20 DAS and 45 DAS; T_9 – unweeded check. The study revealed that weed management methods had influence on growth and productivity of groundnut. The prominent weed species of the experimental field was broadleaved weeds followed by grasses and sedges. Negative value of weed index (-9.94 %) in imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) indicated its superiority over the hand weeding treatment (T_8). The higher benefit cost ratio of 2.46 was obtained in T_5 followed by T_3 and T_1. It can be concluded that post emergence application of imazethapyr @ 70 g ha^{-1} at 20 DAS (T_5) is the best weed management practice for summer groundnut in Onattukara tract considering the growth, yield and economics.

Keywords: Groundnut, imazethapyr, imazethapyr + imazamox, pendimethalin and weed index.

Groundnut or peanut (*Arachis hypogaea* L.) is the leading oil seed and forage crop of India. Nambi *et al*. (2019) reported that 67 per cent of India's oil seed production and 59 per cent of edible oils is contributed by groundnut. The edible oil demand is growing gradually. There has been a severe drop in the productivity as well as area of cultivation of groundnut. Hence to increase and stabilize the production of oilseeds, focused efforts are being made (Suseendra *et al*., 2019). Chaudhary *et al*. (2017) stated that weeds undesirably affect yield, quality and economic value as they compete for water, nutrients and light all through the growing season. They also reported a 60 to 80 per cent reduction in yield and decrease of harvesting efficiency due to the interference from combinations of grass and broadleaved weeds throughout the season. The groundnut crop production is subject to various agronomic management practices and there are numerous reasons for its low productivity. The low productivity of groundnut is mainly due to the problem of weed infestation.

The crop is extremely susceptible to weed competition than any other crop owing to its sluggish growth in initial stages and short growth and underground pod bearing habit. Sustainable yield losses in groundnut are caused more in the rainfed groundnut due to the weed flora which include diverse species from grasses to broad leaved weeds and sedges. Groundnut is an important summer oil seed crop and food grain legume of *Onattukara* region of Kerala which is spread over Alappuzha and Kollam districts. The sandy soils in this region, with its coarse texture and low water retention ability is congenial for groundnut peg penetration and development. In this context, weed management in groundnut will not only help to increase the yield and improve quality parameters but also will be a boon to increase income of the farmers. Hence the study was undertaken with the objectives to sort out the best weed management option for the summer groundnut and to work out the economics of cultivation.

MATERIALS AND METHODS

The experiment was conducted in the summer rice fallow of *Onattukara* region of Alappuzha district, Kerala during the period from December 2019 to April 2020. The location of the field is 9° 7' 32.052'' N latitude and 76° 34' 26.85'' E longitude and at an altitude of 3 m above mean sea level. The soil of the experiment at site is sandy loam under taxonomical order Entisol and acidic in nature. The soil was medium in organic carbon with low in available N and medium P and K.

The design used for the experiment was Randomised Block Design (RBD) with 9 treatments and three replications. The treatments were T_1 -stale seed bed *fb* 1 hand weeding at 30 days after sowing (DAS); T_2 - imazethapyr + imazamox (PoE) @ 40 g ha^{-1} at 20 DAS; T_3 - imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS; T_4 - imazethapyr (PoE) @ 37.5 g ha^{-1} at 20 DAS; T_5 - imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS; T_6 - pendimethalin (PE) @ 1.0 kg ha^{-1}; T_7 - pendimethalin (PE) @ 1.0 kg ha^{-1} *fb* hand weeding at 30 DAS; T_8 -

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hand weeding at 20 DAS and 45 DAS; T_9 – unweeded check. As per package of practices of KAU (2016), FYM @ 2 t ha^{-1} and N: P_2O_5: K_2O @ 10:75:75 kg ha^{-1} as basal and lime @ 1.5 t ha^{-1} were applied uniformly to all treatments. For stale seedbed, the land was prepared to fine tilth and a pre-sowing irrigation was given in order to germinate the viable weed seeds in the seedbed and left undisturbed for 14 days. The germinated weeds were removed by hand weeding and slight raking of soil. Weed management was done as per the treatments. Pre-emergence application was done at 3 DAS and post-emergence applications at 20 DAS, using a knapsack sprayer fitted with a flat fan nozzle with a discharge of 500 L ha^{-1}. Manual hand weedings were given at 20 and 45 DAS. Earthing up was done at 50 DAS to make peg penetration easier after flowering.

Observation on weeds were taken randomly at 15, 30 and 45 DAS by using quadrat of 0.5 m^2 and later converted to 1 m^2. These were used for identifying weed flora composition, weed density and weed dry weight. Weed control efficiency (Mani and Gautham, 1973) and weed index (Gill and Vijayakumar, 1969) were estimated using standard procedures.

$$WCE = \frac{WDWC - WDWT}{WDWC} \times 100$$

Where,

WCE - Weed control efficiency

WDWC – Weed dry weight in control plot (untreated)

WDWT – Weed dry weight in treated plot

$$WI = \frac{X - Y}{X} \times 100$$

Where,

WI – Weed index

X – Yield obtained from weed free plot (hand weeding treatment)

Y – Yield obtained from treated plot (the plot for which WI has to be determined)

The data was analyzed statistically by using analysis of variance technique for RBD (Gomez and Gomez, 1984) and the significance was tested using F test. Wherever the F values were found significant, critical difference was calculated at five per cent probability level. The critical difference was used for effective comparison among the treatment means. For analysis of weed parameters *viz*., weed density and weed control efficiency, corresponding transformed values (dx+1) were used as suggested by Gomez and Gomez (1984). Economic parameters were not statistically analyzed.

RESULTS AND DISCUSSION

Weed flora, weed density and weed dry weight

The weed flora of a crop varied with agro ecological units and crop management practices. Weeds in experimental field comprised of diverse species of grasses, broadleaved weeds and sedge. The sandy loam soil of *Onattuara* tract favors predominance of broadleaved weeds in field. The most dominant weed species observed was *Portulaca oleraceae*. There were only two grassy weeds, *Cynodon dactylon* and *Eleusine indica.* The only sedge observed in the experimental field was *Cyperus rotundus*. Similar findings were also reported by Nambi *et al*. (2019). Weed density is related to the total population of grasses, broadleaved weeds and sedges (Table 1). At 15 DAS, pre-emergence herbicide treatments showed the lowest weed density. At 30 DAS, the weed density was lower in T_2, T_5, T_7 and T_8. At 45 DAS, weed density was lower in stale seed bed *fb* 1 hand weeding at 30 DAS (T_1), imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) and pendimethalin (PE) *fb* hand weeding at 30 DAS (T_7). Olorunmaiye and Olorunmaiye (2009) reported that pre-emergence herbicide treatments without supplementary hoe, weeding could not provide season long weed control because of their short persistence. The results clearly indicated that pre-emergence application of pendimethalin without supplementary hand weeding at 30 DAS was not able to control weed population at later stages of crop. The results revealed that all chemical, stale and manual weeding treatments lowered weed density over weedy check.

During the initial period, less dry weight was observed in stale seed bed and in pre-emergence herbicide treatments due to lower weed population. At 30 DAS, hand weeding (T_8), imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) and imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS (T_3) and pendimethalin (PE) @ 1 kg ha^{-1} *fb* 1 hand weeding at 30 DAS (T_7) recorded lower weed biomass (Table 2). At 45 DAS, stale seed bed *fb* 1 hand weeding at 30 DAS (T_1) recorded lower weed dry weight and was on par with T_3, T_5, T_7 and T_8. These treatments reduced the crop weed competition which had favoured crop growth and provided higher pod and haulm yield. The lowest yield in weedy check may due to the highest dry weight of weeds and weed density. The higher total weed population, weed dry weight, weed index and lower weed control efficiency was recorded in weedy check. Goud *et al.* (2013), Lhungdim *et al.* (2013) and Lal *et al*. (2018) quoted similar findings.

Table 1: Effect of weed management on weed density and weed dry weight at 15, 30 and 45 DAS

Treatments	Weed density per m^2			Weed dry weight, g m^{-2}		
	15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS
T_1 : stale seed bed *fb* 1 hand weeding at 30 DAS	6.97 (48.49)	13.70 (186.60)	10.03 (100.00)	32.00	133.93	80.00
T_2 : imazethapyr + imazamox (PoE) @ 40 g ha^{-1} at 20 DAS	13.64 (186.87)	11.83 (139.20)	16.85 (283.75)	123.33	116.20	227.00
T_3 : imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS	12.89 (165.66)	13.30 (176.06)	16.68 (278.33)	109.33	91.87	130.67
T_4 : imazethapyr (PoE) @ 37.5 g ha^{-1} at 20 DAS	15.48 (241.92)	12.64 (159.04)	12.61 (158.33)	159.67	104.97	222.67
T_5 : imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS	15.07 (226.77)	11.94 (141.67)	12.16 (147.08)	149.67	87.37	87.33
T_6 : pendimethalin (PE) @ 1 kg ha^{-1}	4.90 (23.23)	13.01 (168.26)	15.76 (255.00)	15.33	111.05	204.00
T_7 : pendimethalin (PE) @ 1 kg ha^{-1} *fb* 1 hand weeding at 30 DAS	4.80 (22.22)	11.36 (128.00)	10.49 (109.17)	14.67	88.44	117.67
T_8 : hand weeding at 20 DAS and 45 DAS	10.16 (103.03)	11.35 (127.89)	13.17 (173.33)	68.00	83.75	138.67
T_9 : unweeded check	16.31 (267.17)	14.93 (221.84)	18.62 (345.83)	176.33	141.66	276.67
SEm (±)	**0.66**	**0.26**	**0.83**	**11.81**	**6.54**	**19.77**
LSD(0.05)	**1.991**	**0.789**	**2.502**	**35.705**	**19.787**	**59.767**

Note: Original values in the parenthesis are subjected to $\sqrt{x+1}$ *transformation.*

Table 2: Effect of weed management on weed index and weed control efficiency, %

Treatments	Weed index	Weed control efficiency		
		15 DAS	30 DAS	45 DAS
T_1 : stale seed bed *fb* 1 hand weeding at 30 DAS	4.02	9.09 (81.68)	2.50 (5.57)	8.48 (70.95)
T_2 : imazethapyr + imazamox (PoE) @ 40 g ha^{-1} at 20 DAS	25.99	5.56 (30.12)	4.21 (17.67)	4.33 (18.18)
T_3 : imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS	5.62	6.17 (37.22)	5.96 (34.84)	7.34 (52.90)
T_4 : imazethapyr (PoE) @ 37.5 g ha^{-1} at 20 DAS	16.31	3.11 (10.02)	5.01 (25.38)	4.24 (19.23)
T_5 : imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS	-9.94	3.79 (14.09)	6.21 (37.91)	8.32 (68.44)
T_6 : pendimethalin (PE) @ 1 kg ha^{-1}	21.18	9.58 (90.76)	4.63 (21.13)	4.43 (25.18)
T_7 : pendimethalin (PE) @ 1 kg ha^{-1} *fb* 1 hand weeding at 30 DAS	15.69	9.61 (91.41)	6.21 (37.57)	7.63 (57.35)
T_8 : hand weeding at 20 DAS and 45 DAS	0.00	7.76 (59.78)	6.44 (40.96)	7.09 (49.54)
T_9 : unweeded check	46.83	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
SEm (±)	**7.95**	**0.41**	**0.48**	**0.72**
LSD (0.05)	**24.032**	**1.250**	**1.439**	**2.172**

Note: Original values in the parenthesis are subjected to $\sqrt{x+1}$ *transformation.*

Table 3: Effect of weed management on growth parameters and yield attributes of groundnut at harvest

Treatments		Plant height (cm)	Number of branches	Leaf area per plant (cm^2)	Number of pods per plant	100 kernel weight(g)
T_1 :	stale seed bed *fb* 1 hand weeding at 30 DAS	63.00	6.50	803.94	34.73	41.7
T_2 :	imazethapyr + imazamox (PoE) @ 40 g ha^{-1} at 20 DAS	61.00	6.20	757.67	34.07	37.7
T_3 :	imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS	60.33	6.07	855.78	39.47	41.3
T_4 :	imazethapyr (PoE) @ 37.5 g ha^{-1} at 20 DAS	57.33	5.87	706.67	32.40	46.0
T_5 :	imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS	69.00	6.97	926.58	43.20	48.3
T_6 :	pendimethalin (PE) @ 1 kg ha^{-1}	59.67	6.23	704.50	24.40	37.0
T_7 :	pendimethalin (PE) @ 1 kg ha^{-1} *fb* 1 hand weeding at 30 DAS	66.67	6.07	765.90	37.60	42.0
T_8 :	hand weeding at 20 DAS and 45 DAS	65.33	6.30	806.67	32.67	39.7
T_9 :	unweeded check	55.67	5.47	667.33	19.33	32.3
SEm (±)		**2.48**	**0.23**	**42.50**	**2.80**	**2.41**
LSD (0.05)		**7.489**	**0.688**	**128.511**	**8.464**	**7.300**

Table 4: Effect of weed management on shelling percentage, yield and economics of groundnut

Treatments		Shelling percentage	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Net income (₹ ha^{-1})	BCR
T_1 :	stale seed bed *fb* 1 hand weeding at 30 DAS	71.82	1522	3433	72471	2.05
T_2 :	imazethapyr + imazamox (PoE) @ 40 g ha^{-1} at 20 DAS	69.28	1154	2813	42919	1.66
T_3 :	imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS	68.22	1402	3300	72794	2.12
T_4 :	imazethapyr (PoE) @ 37.5 g ha^{-1} at 20 DAS	69.27	1343	3053	57918	1.89
T_5 :	imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS	72.95	1652	3502	95611	2.46
T_6 :	pendimethalin (PE) @ 1 kg ha^{-1}	67.40	1270	3130	50308	1.78
T_7 :	pendimethalin (PE) @ 1 kg ha^{-1} *fb* 1 hand weeding at 30 DAS	70.79	1333	3052	52585	1.74
T_8 :	hand weeding at 20 DAS and 45 DAS	71.15	1588	3467	73079	1.99
T_9 :	unweeded check	66.87	857	2300	16099	1.26
SEm (±)		**1.24**	**96.61**	**215.72**		
LSD (0.05)		**3.749**	**292.124**	**652.290**		

At 15 DAS, the highest weed control efficiency (91.41 %) was recorded for pendimethalin (PE) @ 1 kg ha^{-1} *fb* 1 hand weeding at 30 DAS (T_7) and was on par with stale seed bed (T_1) and pendimethalin (PE) @ 1 kg ha^{-1} (T_6). At 30 DAS, hand weeding treatment (T_8) recorded the highest weed control efficiency (40.96 %) which was followed by T_5 (37.91 %), T_3, T_4 and T_7. At 45 DAS, stale seed bed *fb* hand weeding @ at 30 DAS (T_1) recorded the highest weed control efficiency (70.95 %), closely followed by imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) with a WCE of 68.44 %. Majumder *et al*. (2009) reported that weeds should be controlled from 15 days after emergence and up to 50 days to avoid yield losses in groundnut. The most critical period of weed competition was from three to six week after sowing in groundnut (Satyapriya *et al*., 2013). In this experiment imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) recorded higher WCE at 30 and 45 days leading to reduced weed interference at the most critical period of growth. The lowest weed control efficiency at all the stages were recorded in unweeded check (T_9).

Negative value of weed index (-9.94 %) in imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) indicated its superiority over hand weeding treatment (T_8) (Table 2). The lowest weed index registered in T_5 might be due to higher yield registered in the treatment. Better control

of weeds resulted in reduced crop weed competition which paved the way for better availability and uptake of nutrients and resulted in higher yield. It remained statistically at par with stale seed bed *fb* 1 hand weeding at 30 DAS (T_1), imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS (T_3) and hand weeding twice (T_8). The highest weed index (46.83 %) was recorded for unweeded check (T_9). Season long crop weed competition in unweeded check had significant effect on growth and yield attributes and resulted in the lowest yield and the highest weed index.

Effect of weed management on growth, yield and yield attributes

Groundnut crop is more prone to weed infestation because of its slow growth in the early phases, short stature and underground pod bearing habit. All growth attributes of groundnut was found to be the lowest throughout the growing period in untreated control due to higher weed density and the highest crop weed competition. Effective control of weeds is expected to have better availability of moisture, nutrients and solar radiation to the crop plants, thereby increasing total chlorophyll content, photosynthetic rate and nitrate reductase activity leading to higher supply of carbohydrates which resulted in higher increase in growth attributes than untreated control.

At 45, 60 DAS and at harvest taller plants (32.48 cm, 37.67 cm and 69 cm, respectively) were observed with imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) which was comparable with hand weeding at 20 and 45 DAS (T_8), pendimethalin (PE) @ 1 kg ha^{-1} *fb* hand weeding at 30 DAS (T_7) and stale seed bed *fb* 1 hand weeding at 30 DAS (T_1). The highest number of branches per plant was observed in post emergence application of imazethapyr @ 70 g ha^{-1} at 20 DAS (T_5), stale seed bed (T_1) and hand weeding treatment (T_8). It may be attributed to vigorous plant growth with less competition for light, nutrients, and free space in weed free environment. Among the herbicide treatments, the highest leaf area was found in imazethapyr @ 70 g ha^{-1} at 20 DAS (T_5) followed by imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS (T_3) and were on par with hand weeding (T_8) treatment.

The yield attributes *viz.,* number of pods per plant, and 100 seed weight were significantly influenced by weed management methods (Table 3). The number of pods were higher in post emergence application imazethapyr @ 70 g ha^{-1} at 20 DAS (T_5), imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS (T_3) and pre-emergence application of pendimethalin *fb* hand weeding at 30 DAS (T_7) that leads to higher seed yield in these treatments. Higher 100 kernel weight (48.3 g) was recorded in post emergence application of imazethapyr @ 70 g ha^{-1} at 20 DAS (T_5) which was on par with T_3, T_4, T_1 and T_7.

The growth and yield attributes obtained at different growth stages of groundnut have revealed the influence of weed management on its productivity. Higher kernel yield (1652 kg ha^{-1}) was obtained from imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5), which was comparable with hand weeding at 20 and 45 DAS (T_8), imazethapyr + imazamox (PoE) @ 70 g ha^{-1} at 20 DAS (T_3) and stale seed bed *fb* 1 hand weeding at 30 DAS (T_1). Higher kernel yield may be due to lower weed density and biomass and higher weed control efficiency. The percentage yield was increased over weedy check in T_5, T_8 and T_1 were 93, 85 and 78 %, respectively. Higher haulm yield (3502 kg ha^{-1}) was recorded with post emergence application of imazethapyr @ 70 g ha^{-1} at 20 DAS (T_5) which was comparable with all the treatments except T_9 and T_2.

Effect of weed management on economics

The economic analysis also showed the same trend as that of kernel yield of groundnut. The analyzed data revealed less cost of cultivation from the herbicide treatments due to savage of labour when compared to hand weeding and stale seed bed technique. The highest net income (Rs. 95611) was obtained from imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) which was followed by hand weeding and stale seed bed treatments. The BCR (2.46) was higher for imazethapyr (PoE) @ 70 g ha^{-1} at 20 DAS (T_5) followed by imazethapyr + imazamox (PoE) @ 80 g ha^{-1} at 20 DAS (2.12) (T_3) and stale seed bed *fb* 1 hand weeding at 30 DAS (2.05) (T_1), respectively (Table 4). The lowest BCR (1.26) was for unweeded check (T_9). The variations in BCR could be attributed to cost of cultivation and gross return.

It can be concluded from the study that post emergence application of imazethapyr @ 70 g ha^{-1} at 20 DAS (T_5) is the effective weed management practice for summer groundnut in *Onattukara* tract considering the growth, yield and economics.

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