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Weed Management in Summer Groundnut (*Arachis hypogaea* L.)

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ABSTRACT: A field investigation entitled "Weed management in summer groundnut (*Arachis hypogaea* L.)" was conducted in Summer season of 2023 at the AICRP on Groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri to study different weed management methods in summer groundnut. The experiment was laid out in randomized block design (RBD) with three replications. The experiment consists of ten treatments *viz.,* T_1 : Diclosulam 84% WDG @ 20 g a.i. ha^{-1} (PE); T_2 : Diclosulam 84% WDG @ 25 g a.i. ha^{-1} (PE); T_3 : Pendamethalin 30% E.C. @ 1.0 kg a.i. ha^{-1} (PE); T_4 : Diclosulam 84% WDG @ 20 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS; T_5 : Diclosulam 84% WDG @ 25 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS; T_6 : Diclosulam 84% WDG @ 20 g a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5% E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS; T_7 : Diclosulam 84% WDG @ 25 g a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5% E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS; T_8 : Pendamethalin 30% E.C. @ 1.0 kg a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5% E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS; T_9 : Weedy free check (at 20 and 40 DAS) and T_{10} : Weedy check. As regards yield attributing characters, significantly higher dry pod yield (32.56 q ha^{-1}), haulm yield (40.64 q ha^{-1}), biological yield (73.20 q ha^{-1}) were recorded under treatment weed free *i.e.,* T_9 than other treatments except application of diclosulam 84% WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS *i.e.,* T_5 which recorded dry pod yield (30.93 q ha^{-1}), haulm yield (38.14 q ha^{-1}), biological yield (69.07 q ha^{-1}) and diclosulam 84% WDG @ 20 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS *i.e.,* T_4 which recorded dry pod yield (30.30 q ha^{-1}), haulm yield (37.39 q ha^{-1}), biological yield (67.69 q ha^{-1}). Significantly the highest gross monetary returns was obtained in weed free treatment (₹ 168897 ha^{-1}). However, application of diclosulam 84% WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS recorded a significantly maximum net monetary returns (₹ 96867 ha^{-1}) and B:C ratio (2.53) than other weed management treatments except treatment or diclosulam 84% WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (₹ 93939 ha^{-1} and 2.49, respectively). While, weedy check obtained minimum gross monetary returns, net monetary returns and B:C ratio among all the treatments.

Keywords: Diclosulam, Groundnut, Pendimethalin, Weed management, Quizalofop-p-ethyl.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a "King of oilseeed" which occupies an important position in agricultural economy of India and claims premier position among the major oil producing countries in the world. Besides being an important oil seed crop, it also plays a major role in atmospheric nitrogen fixation. It belongs to the family leguminosae (*fabaceae*) possesing chromosome no. 2n=40. It contains 45-50 % oil and is one of the most important crops for producing edible oil. Groundnut is a rich source of protein 23-26 per cent (Kumar *et al.,* 2013). Groundnut was introduced by the Portuguese from Brazil to West Africa and then to South-Western India in the 16th century. Groundnut ranks second in production among the oilseed crops in India.

Groundnut is an important food, fodder and cash crop for the farmers of India. The commercially cultivated groundnut varieties belong to the species *viz.*, *hypogaea* (*verginia* or runner), *fastigiata* (*valencia*) and *vulgaris* (*spanish*). It is also known as peanut, earthnut, monkeynut, manilanut, pandanut as well as goober nut. Groundnut is rich source of oil (48-50 %) and high quality protein (21.4-36.4 %). Kernels are also eaten as roasted. Groundnut kernels are rich in vitamins *viz.,* A, B, and some members of B_2 group (Bhondve *et al.*, 2009).

India is the second largest groundnut producing country in the world after China. The most important groundnut producing countries in the world are China, India, Nigeria, Sudan and USA etc. China ranks first in groundnut production with 17.57 million tonnes followed by India 6.73 million tonnes, Nigeria 4.45 lakh tonnes, Sudan 2.83 million tonnes and United States of America 2.49 million tonnes accounting for 36.01, 13.79, 9.12, 5.80 and 5.11 per cent of total world production (Anonymous, 2023). Gujarat is the leading producer of groundnut in India, generating over 46% of the nation's total groundnut output annually. Gujarat produces 46.45 lakh tonnes, Rajasthan 16.19 lakh

tonnes. Tamilnadu 10.33 lakh tonnes, Andhra Pradesh 8.48 lakh tonnes, Karnataka 5.02 lakh tonnes, Madhya Pradesh 3.50 lakh tonnes, Maharashtra 3.08 lakh tonnes, Telangana 2.65 lakh tonnes and West Bengal 1.56 lakh tonnes.

The progressive modernization of Indian agriculture involves intensive input use comprising fertilizers, irrigation and plant protection chemicals. Herbicide are more beneficial for getting quick control of weeds in short period which is gaining importance in recent years. The pre-emergence and post-emergence application of selective herbicides either prevents the germination of weed seeds or inhibits the growth of weed seedling. Thus, chemical weed control is a better supplement to conventional methods and forms an integral part of the modern crop production cultivation (Priya *et al.*, 2013). In recent years, new generation low dose high efficiency herbicide molecules are available which were found to exhibit high level of activity against all the categories of weeds with lesser half-life period coupled with low mammalian toxicity compared to high volume herbicides like pendimethalin. Thus, there is a need to evaluate the new low dose high efficient pre and post-emergence herbicides for obtaining broad-spectrum weed control in groundnut.

MATERIAL AND METHODS

A field experiment entitled "Weed management in summer groundnut (*Arachis hypogaea* L.)" was conducted at the AICRP on Groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri during Summer season of 2023. Grographically, the AICRP on Groundnut is situated in between 19° 47' N and 19° 57' N latitude and between 74° 32' E and 74°19' E longitude. The altitude above mean sea level is about 525 meters. The soil in the experimental field belongs to sandy clay loam having depth more than 30 cm and the topography is uniform and levelled. For assessment of initial soil fertility status representative initial soil sample was created and evaluated for physical and chemical soil parameters. The soil texture of the experimental site was found to be sandy clay loam. Soil was low in available nitrogen (172.34 kg ha^{-1}), medium in available phosphorus (17.43 kg ha^{-1}) and high in potassium (321.29 kg ha^{-1}). The soil was slightly alkaline in reaction (pH 8.12) with normal in electrical conductivity of 0.32 dS m^{-1}. In terms of climate, the experimental unit is located in a semi-arid region and subtropical zone with annual rainfall ranges between 307 to 619 mm. Agro-climatically this area falls under scarcity zone (drought prone area) of Maharashtra state with an annual rainfall range from 307 to 619 with average of 520 mm. Over the most of the accommodate area, rainfall and its distribution are unpredictable and variable. The average annual maximum temperature varies from 28.1°C to 38.3°C, on other side annual mean minimum temperature ranges from 9.3°C to 17.5°C. There were ten treatments used during the course of the experiment and they are comprised of T_1 : Diclosulam 84% WDG @ 20 g a.i. ha^{-1} (PE); T_2 : Diclosulam 84% WDG @ 25 g a.i. ha^{-1} (PE); T_3 : Pendamethalin 30% E.C. @ 1.0 kg a.i. ha^{-1} (PE); T_4 : Diclosulam 84% WDG @ 20 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS; T_5 : Diclosulam 84% WDG @ 25 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS; T_6 : Diclosulam 84% WDG @ 20 g a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5% E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS; T_7 : Diclosulam 84% WDG @ 25 g a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5% E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS; T_8 : Pendamethalin 30% E.C. @ 1.0 kg a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5% E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS; T_9 : Weedy free check (at 20 and 40 DAS) and T_{10} : Weedy check. Genetically pure seed of Groundnuut *var.* Phule Unnati was obtained from AICRP on Groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri. The recommended seed rate of 100 kg ha^{-1} was used. Sowing was done on 5th February 2023 by dibbling method with spacing 30 cm × 10 cm. Harvesting was done manually on 120 DAS of maturity. Immediately after uprooting, pods were separated from plants.

RESULTS AND DISCUSSION

A. Yield character

(i) Dry Pod Yield. The data pertaining to dry pod yield (q ha^{-1}) of groundnut as affected by different weed control treatments are presented in Table 1. The mean dry pod yield was 26.39 q ha^{-1}.

In summer groundnut, application of weed free treatment (32.56 q ha^{-1}) recorded significantly highest dry pod yield than rest of all treatment but, it was at par with the application of diclosulam 84 % WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (30.93 q ha^{-1}) and diclosulam 84 % WDG @ 20 g ha^{-1} (PE) *fb* hand weeding at 30 and 60 DAS (30.30 q ha^{-1}). In comparative study of different herbicidal treatments the diclosulam 84 % WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS recorded highest dry pod yield as compare to rest of all treatments.

Thus, the effective weed control achieved in the earlier mentioned different herbicidal treatments resulted in enhancing various growth and yield contributing characters of groundnut and finally gave significantly higher pod yield over weedy check. These results are in concurrence with Kamble *et al.* (2003); Malunjkar *et al.* (2012); Dhadge *et al.* (2014).

(ii) Halum yield. The data regarding haulm yield of summer groundnut are in Table 1. The mean haulm yield was 35.85 q ha^{-1}.

The data pertaining to the effects of different herbicide treatment on haulm yield is revealed that significantly highest haulm yield was recorded by weed free treatment (40.64 q ha^{-1}) which was statistically at par with the treatments application of diclosulam 84 % WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (38.14 q ha^{-1}) and diclosulam 84 % WDG @ 20 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (37.39 q ha^{-1}) over rest of all treatments. The lowest value of haulm yield was documented from the weedy check (29.49 q ha^{-1}) resulted due to severe crop weed competition as weeds utilize large amount of moisture and nutrients than crop.

The lowest value of haulm yield was documented from the weedy check (29.49 q ha^{-1}) resulted due to severe crop weed competition as weeds utilize large amount of moisture and nutrients than crop. Similar type of opinion was given by Bhale *et al.* (2012); Dhadge *et al.* (2014); Dixit *et al.* (2016); Sharma *et al.* (2015); Kumar *et al*. (2019).

(iii) Biological yield. The data related to biological yield (q ha^{-1}) as influenced by different herbicide treatments are given in Table 1. The mean biological yield was 62.18 q ha^{-1}. Biological yield revealed that significantly highest biological yield was obtained from weed free treatment (73.20 q ha^{-1}) except the treatments application of diclosulam 84 % WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (69.07 q ha^{-1}) and diclosulam 84 % WDG @ 20 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (67.69 q ha^{-1}) which were at par with the treatment weed free treatment and significantly superior over rest of the treatments. The significantly lower biological yield was recorded in weedy check (44.36 q ha^{-1}).

The higher yield of an effective weed control treatments can be attributed to reduced weed competition, as the crop does not face nutritional or water stress due to weed infestation and as a result, proper utilization of light, nutrient, moisture and space was done by groundnut crop for growth and development, which reflects its effect on productive growth of groundnut in term of crop yield.

The least biological yield was documented from the weedy check (58.69 qha^{-1}) which might be due to severe crop weed competition as weeds utilize large amount of moisture and nutrients than crop. Similar results were conformity with Bhale *et al.* (2012); Dhadge *et al.* (2014); Dixit *et al.* (2016); Sharma *et al.* (2015).

(iv) Harvest Index (%). The data regarding to harvest index as influenced by different herbicide treatments are given in Table 1.

The data pertaining to harvest index was not significantly affected by different weed management treatments. The treatment weed free check recorded maximum harvest index (44.81 %) followed by the treatments application diclosulam 84 % WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (44.68 %) and diclosulam 84 % WDG @ 20 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (44.61 %). The lowest harvest index was recorded by weedy check (33.45 %). This might be due to weedy check plot has minimum pod yield and biological yield. Due to higher weed crop competition weed acquire more space, nutrient, moisture and CO2 as compare to groundnut crop. This reduces pod yield and biological yield leading to minimum harvesting index. Similar trend of observations were reported by Chaitanya *et al.* (2012).

Table 1: Dry pod yield, halum yield, biological yield, harvest index and increase in yield over weedy check of groundnut as influenced by different herbicide treatments.

Treatments		Dry pod yield (q ha^{-1})	Halum yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)
T_1 :	Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE)	24.03	34.84	58.87	40.76
T_2 :	Diclosulam 84 % WDG @ 25 g a.i. ha^{-1} (PE)	24.56	35.02	59.59	41.20
T_3 :	Pendamethalin 30 % E.C. @ 1.0 kg a.i. ha^{-1} (PE)	23.19	34.10	57.29	40.63
T_4 :	Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS	30.30	37.39	67.69	44.61
T_5 :	Diclosulam 84 % WDG @ 25 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS	30.93	38.14	69.07	44.68
T_6 :	Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE) *fb* Quizalofop-p-Ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS	27.99	36.21	64.20	43.71
T_7 :	Diclosulam 84 % WDG @ 25 g a.i. ha^{-1} (PE) *fb* Quizalofop-p-ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS	28.36	36.86	65.22	43.44
T_8 :	Pendamethalin 30 % E.C. @ 1.0 kg a.i. ha^{-1} (PE) *fb* Quizalofop-p-ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS	27.11	35.84	62.95	43.04
T_9 :	Weed free (at 20 and 40 DAS)	32.56	40.64	73.20	44.81
T_{10} :	Weedy Check	14.88	29.49	44.36	33.45
	SEm ±	1.39	1.23	2.24	2.09
	CD (P=0.05)	4.19	3.69	6.70	NS
	General Mean	26.39	35.85	62.18	42.03

B. Economics

The data pertaining to the effect of different herbicide treatments on economics of groundnut are presented in Table 2.

(i) Gross monetary return. Gross monetary returns were significantly influenced by different herbicide treatment. Significantly maximum gross monetary returns were observed in weed free check treatment (₹ 168897 ha^{-1}) over the treatments T_1 *i.e.,* Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE), T_2 *i.e.,* Diclosulam 84 % WDG @ 25 g a.i. ha^{-1} (PE), T_3 *i.e.,* Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE) and T_{10} i.e. Weedy check. The lowest gross monetary returns were observed in weedy check (₹ 78806 ha^{-1}). Due to effective weed control in weed free check, it reduces the weed crop competition as a result vigorous crop growth was obtained which resulted in to higher yield as well as gross monetary returns.

Similar result were recorded by Malunjkar *et al.* (2012); Kalhapure *et al*. (2013); Patro *et al*. (2014); Kalaichelvi *et al.* (2015); Meena *et al*. (2021); Musa *et al.* (2022).

(ii) Cost of cultivation. Cost of cultivation were significantly influenced by different herbicide treatments. Maximum cost of cultivation was observed in weed free treatment (₹ 68359 ha^{-1}) due to high cost of labours and additional requirement of hand weeding which was followed by diclosulam 84 % WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (₹ 63504 ha^{-1}) and diclosulam 84 % WDG @ 20 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS (₹ 63153 ha^{-1}). The lowest cost of cultivation were observed in weedy check (₹ 53597 ha^{-1}).

Similar result were recorded by Malunjkar *et al.* (2012); Kalhapure *et al*. (2013); Patro *et al*. (2014); Kalaichelvi *et al.* (2015); Meena *et al*. (2021); Musa *et al.* (2022).

(iii) Net monetary return. The net monetary returns were significantly influenced by different herbicide treatments. Significantly highest net monetary returns was observed in the treatments weed free (₹ 100538 ha^{-1}) over the treatments, T_1 *i.e.,* Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE), T_3 *i.e.,* Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE) and T_{10} i.e. Weedy check. The lowest net monetary returns were observed in weedy check (25209 ₹ ha^{-1}).

Higher dry pod and haulam yields as well as lower cost of cultivation costs, were responsible for the higher net monetary returns in treatment diclosulam 84 % WDG @ 20 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS. The above findings are consistent with the results of Malunjkar *et al.* (2012); Kalhapure *et al*. (2013); Patro *et al*. (2014); Kalaichelvi *et al.* (2015); Meena *et al.* (2021); Musa *et al.* (2022).

(iv) B:C ratio. The data pertaining to the effect of different herbicide treatments on Benefit: cost ratio presented in Table 2. The highest benefit cost ratio was recorded by the treatments application of diclosulam 84 % WDG @ 25 g ha^{-1} (PE) *fb* hand weeding 20 and 40 DAS (2.53) which is followed by application of diclosulam 84 % WDG @ 20 g ha^{-1} (PE) *fb* hand weeding 20 and 30 DAS (2.49), Weed free (2.47), diclosulam 84 WDG @ 25 g a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 30 and 60 DAS (2.45) and diclosulam 84 WDG @ 20 g a.i. ha^{-1} (PE) *fb* quizalofop-p-ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 30 and 60 DAS (2.43). The lowest benefit cost ratio was observed in weedy check (1.47).

These results are in agreement with those of Malunjkar *et al.* (2012); Kalhapure *et al*. (2013); Gunri *et al.* (2014); Mavarkar *et al*. (2015) ; Andhale and Kathmale (2019).

Table 2: Gross monetary return, cost of cultivation, net monetary returns and B:C ratio as influenced by different herbicide treatments.

Treatments		Gross monetary returns (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net monetary returns (₹ ha^{-1})	B:C ratio
T_1 :	Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE)	125377	55325	70052	2.27
T_2 :	Diclosulam 84 % WDG @ 25 g a.i. ha^{-1} (PE)	128070	55676	72394	2.30
T_3 :	Pendamethalin 30 % E.C. @ 1.0 kg a.i. ha^{-1} (PE)	121081	56119	64962	2.16
T_4 :	Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS	157092	63153	93939	2.49
T_5 :	Diclosulam 84 % WDG @ 25 g a.i. ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS	160371	63504	96867	2.53
T_6 :	Diclosulam 84 % WDG @ 20 g a.i. ha^{-1} (PE) *fb* Quizalofop-p-Ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS	145365	59806	85559	2.43
T_7 :	Diclosulam 84 % WDG @ 25 g a.i. ha^{-1} (PE) *fb* Quizalofop-p-ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS	147330	60157	87173	2.45
T_8 :	Pendamethalin 30 % E.C. @ 1.0 kg a.i. ha^{-1} (PE) *fb* Quizalofop-p-ethyl 5 % E.C. 50 g a.i. ha^{-1} (PoE) at 20 and 40 DAS	140926	60263	80663	2.34
T_9 :	Weed free (at 20 and 40 DAS)	168897	68359	100538	2.47
T_{10} :	Weedy Check	78806	53597	25209	1.47
	SEm ±	9630	-	9630	-
	CD (P=0.05)	28871	-	28871	-
	General Mean	137331	-	137331	-

CONCLUSIONS

Amongst a application of different herbicidal treatments to summer groundnut crop, the treatment diclosulam 84% WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS recorded significantly higher growth and yield attributing characters. Similarly, it also resulted into higher dry pod, haulm and biological yield (30.93, 38.14 and 69.07 q ha^{-1}, respectively) and harvest index (44.68 %), except weed free treatment. Among weed management treatments, the application of diclosulam 84% WDG @ 25 g ha^{-1} (PE) *fb* hand weeding at 20 and 40 DAS obtained maximum net monetary return (₹ 96867 ha^{-1}) and B:C ratio (2.53) than rest of all treatments.

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