International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(3): 1892-1899

Received: 16-03-2020
Accepted: 18-04-2020

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Effect of integrated weed management on weed studies on summer groundnut (*Arachis hypogaea* L.) under sub-montane region of Maharashtra

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DOI: https://doi.org/10.22271/chemi.2020.v8.i3z.9482

Abstract
A field experiment was conducted during summer 2018 at Post Graduate Agronomy Research Farm, RCSM, College of Agriculture Kolhapur. The study was conducted with the objectives to study the effect of integrated weed management practices on weed studies on growth and yield of summer groundnut (*Arachis hypogaea* L.) variety KDG-123 under Sub-Montane region of Maharashtra. The experiment was laid under randomized block design (RBD) with eight treatments and three replications. The treatment weed free check recorded lowest dicot and monocot weed intensity which was followed by the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS. The yield was found significantly highest in weed free check. The significantly highest weed control efficiency was recorded by weed free check (87.36%). However, the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (77.23%) and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS (75.44%) which were comparable with weed free check. The significantly lowest weed control efficiency was recorded in weedy check. At harvest the lowest weed index was recorded in weed free check and followed by the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha-1 + one hand weeding at 30 DAS (9.72%) and pre-emergence application of pendimethalin @ 1 kg a.i ha-1 + one hoeing at 30 DAS (10.32%), T2, T3, T7 and T4 and superior over weedy check. The highest weed index was recorded by the treatment weedy check (24.97%).
The integrated weed management treatments pendimethalin @ 1 kg a.i ha-1 + one hand weeding at 30 DAS (T_6) and pendimethalin @ 1 kg a.i ha-1 + one hand weeding at 30 DAS (T_5) were found statistically at par with each other and significantly superior over rest of the treatments.

Keywords: Summer groundnut, Integrated weed management, weed intensity, uptake, yield, pendimethalin

Introduction
Groundnut (*Arachis hypogaea* L.) is an annual legume crop, belongs to family Leguminoceae. It is known as king of vegetable oilseeds, poor man's nut. Groundnut oil is good for nutritive value and culinary purpose. The demand for edible oil is rising day by day. Groundnut is most popular oilseed crop grown all three seasons. It is cultivated in about 120 countries under different agro-climatic zones between 40°S and 40°N (Anonymous, 2013) [3]. Groundnut is most important oilseed crop in India as well as Maharashtra. It contributes more than 50% edible oil production of country. In India 80% groundnut produced is used for oil extraction, 11% as seed, 8% used as direct food and only 1% groundnut is exported (Anonymous, 2011) [2].

In India it is well documented that productivity of groundnut under Indian condition is reduced due to numbers of factors *viz.* biotic and abiotic stresses. It is well documented that, yield loss due to weed infestation amounts to 80% in groundnut (Murthy *et al*., 1994) [12] while, weed infestation in summer groundnut (*Arachis hypogaea* L.) is one of the main factors for loss in yields to the tune of 17-84 per cent (Sasikala *et al*., 2006) [18]. Therefore, various weed management practices has been adopted to minimize the weed infestation thereby increasing the yield potential of summer groundnut which is need of the hour. Weeding and hoeing are common cultural and manual weed management methods for groundnut, but with considering the scarcity of labours, these methods are very costly and tedious. Mechanically operated power weeder can't be used after peg initiation of groundnut, On the other hand, use of

herbicides is also limited due to their selectively. Hence the agronomic investigation was conducted to find out practically convenient and economically feasible combination of chemical and cultural methods of weed management in groundnut. Thus, summer cultivation is gaining the importance among the farmers it may be due to favorable climatic conditions, less incidence of pest and diseases.

Materials and methods

The field experiment was conducted during summer season of 2018 at Post Graduate Agronomy Research Farm, RCSM, College of Agriculture Kolhapur. The soil of the experimental plot was sandy clay loam with 90 cm depth, low in available N (234.94 kg ha^{-1}), moderately high in available P_2O_5 (22.85 kg ha^{-1}) and moderately high in available K_2O (271.20 kg ha^{-1}). The status of organic carbon, electrical conductivity and pH were 0.27%, 0.23 dSm^{-1}, 7.6 respectively.

The Kolhapur is situated on an elevation of 548 meters above the mean sea level on 16^0 42'.548 North latitude and 74^0 14'.329 East longitudinal and falls under the Sub-montane zone of NARP. The annual mean maximum temperature ranges between 34^0C and 40^0C while, the annual mean minimum temperature varies from 6^0C to 10^0C. The mean humidity ranges between 78 to 95 per cent. The total rainfall received during summer season (March to June) of 2018 was 63.9 mm received during 12^{th} to 26^{th} meteorological week. The highest evaporation ranged from 7.5 to 1.4 mm per day, minimum temperature varied from 9.4^0C to 21.4^0C and maximum temperature ranged from 27.40C to 38.40C. The relative humidity during the morning ranged between 68.1 to 90.5 percent and evening noted 25.8 to 78.5 percent.

The field experiment was laid under randomized block design (RBD) with eight treatments viz. (T1)Weedy check, (T2) One hoeing at 15 DAS + 1 HW at 30 DAS, (T3) One hoeing at 15 DAS + Quizalofop-p-ethyl @ 0.05 Kg.a.i.ha-1 at 25 DAS,(T4) Pendimethalin PE @ 1 Kg.a.i.ha-1, (T5) Pendimethalin PE @ 1 Kg.a.i.ha-1 + One Hoeing at 30 DAS, (T6) Pendimethalin PE @ 1 Kg.a.i.ha-1 + HW at 30 DAS, (T7) Pendimethalin @ 1 kg a.i. ha-1 + Quizalofop-p-ethyl @ 0.05 Kg.a.i.ha-1 at 25 DAS (POE) at 30 DAS and (T8) Weed free check. Each experimental unit was replicated thrice with 4.50 m x 3.0 m gross plot and 4.10 m x 2.40 m net plot size. The summer groundnut variety was KDG-123 sown by dibbling on First fortnight of February, 2018 at the spacing of 30 cm × 10 cm. The recommended dose of fertilizers 25:50:00 NPK kg ha^{-1} and FYM @ 5 tonnes ha^{-1} was applied at the time of sowing as basal dose and seeds were treated with *Rhizobium japonicum* @ 250 gm per 10 kg seeds and dried under shade and then used for sowing.

The various biometric observations of five randomly selected plants from each net plot were recorded. The bamboo pegs were fixed near the observational plants for easy location.

Weed intensity study

A quadrat (1m x 1m) was randomly placed in each net plot and the species wise weed count in the area of each quadrant was recorded. The total weeds per m2 were recorded as per treatments.

Dry matter

The weeds from the plot of hand weeding treatments were carefully removed with the help of weeding hook at each weeding. All the weeds from net plot were collected and they were air dried and then oven dried at 65 ± 5^0C temperature till constant weight obtained. Similarly, at harvest of crop all the weeds from all treatments from net plot were removed, oven dried and dry weight was recorded separately.

Weed control efficiency

$$\text{Weed Control Efficiency (\%)} = \frac{WDC - WDT}{WDC} \times 100$$

Where as,

WDC - Weed dry matter (g) in weedy plot

WDT - Weed dry matter (g) in treated plot

Weed index

Weed index of each treatment was calculated by using following formula **(**Gill and Kumar, 1969).

$$\text{Weed Index (\%)} = \frac{X - Y}{X} \times 100$$

Where,

X - Yield (kg) from weed free plot

Y – Yield (kg) from the treatment of which weed index is to be worked out.

Plant (weed) analysis - collection and preparation of plant samples

The plant (weed) samples collected at harvest were cleaned and then dried in hot air oven at 65 ± 5^0C. Further, these samples were grind to considerable fineness in a willey mill and stored in plastic bags for further analysis.

Digestion of plant samples

The powdered plant (weed) sample of 0.5 g passed through 100 mm sieve was pre-digested with concentrated nitric acid over night. Further, pre-digested samples were treated with mixture of tri-acid (nitric acid: sulphuric acid: perchloric acid in ratio of (10:1:4) and kept on sand bath for digestion. After complete digestion the precipitate was dissolved in 6 N HCl and transferred to the 100 ml volumetric flask through Whatman NO.42 filter paper by thoroughly washing with double distilled water and finally the volume was made to 100 ml and preserved for further analysis.

Nitrogen, phosphorus and potassium content in weeds

To determine the nitrogen content the weed sample was digested with concentrated sulphuric acid and digestion mixture ($CuSO_4$ +K_2SO_4 + selenium powder) and the distillate was titrated against standard acid (Jackson, 1973) [8].

The phosphorus content in the digested sample was determined by Vanadomolybdate phosphoric yellow color method (Jackson, 1973) [8].

The potassium content in the digested samples was determined by flame photometer after making appropriate dilution (Jackson, 1973) [8].

Pod and haulm yield

After picking the pods and after drying, pod yield of net plot was recorded and used to compute pod yield in q ha^{-1}.Whereas the haulm yield was computed by subtracting the corresponding pod yield from biological yield and expressed in q ha^{-1}.

Biological yield

The produce (pod + haulm) from each net plot area after complete sun drying was weighed for recording biological yield and expressed as q ha^{-1}.

Harvest index

It is the ratio of economic yield to the biological yield, which was worked out by following formula (Donald and Hamblin, 1976) and expressed in per cent.

$$\text{Harvest index (\%)} = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

The data obtained under study was statistically analyzed by using standard method of "analysis of variance" as reported by Panse and Sukhatme (1967) [14]. The standard error was worked out for each factor under study and the critical difference (C.D.) at 5% level of significance was worked out whenever the results were significant.

Results and discussion

Weed studies

Weed intensity of monocot and dicot weeds

The data pertaining to the effect of different weed management treatments on weed intensity of monocot and dicot weeds are presented in Table 1 and 2 respectively.

The effect of different treatments on mean number of monocot and dicot weeds at 15, 30, 45, 60, 75 DAS and at harvest were significantly influenced by various weed management treatments which shows the intensity of weeds obtain under different weed control treatments and the effects of different weed management treatments on weed population.

Effect of treatments

The weed intensity at 15 DAS pertaining to monocot and dicot weeds were lower in treatments pre emergence application of pendimethalin as compared to rest of the treatments**.** It is because in most of the treatments the weed control practices were not followed. At this stage the initial weed intensity was significantly minimum in plot treated with the treatment pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS except the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS, pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS were at par with treatment pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS..

Weed intensity at 30 DAS for monocot and dicot weeds were recorded significantly lowest in treatment weed free check but which was at par with treatments one hoeing at 15 DAS + one hand weeding at 30 DAS, one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} over rest of the treatments.

Weed intensity at 45, 60, 75 DAS and at harvest regarding monocot and dicot weeds were recorded significantly lowest in weed free check and which was at par with the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS and followed by the other treatments one hoeing at 15 DAS + one hand weeding at 30 DAS, one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS, pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} except weedy check treatment.

Throughout the crop growth period significantly lowest weed intensity was observed in weed free check except at 15 DAS as compared to rest of the treatments. This resulted into lower weed intensity and weed crop competition which reflected it to favorable environmental condition for the crop growth and yield. The weedy check recorded significantly highest weed intensity resulted in higher weed crop competition for nutrient, sunlight and water which was hampered crop growth resulted in low yield. Similar trend of observations were reported by Gunri *et al*., (2014) [7], Mahadkar *et al*., (1993) [11] and Yadhav *et al*., (1983) [22].

Table 1: Weed intensity of monocot weeds in groundnut as influenced periodically by different treatments

Treatments	Weed intensity of monocot weeds (m^{-2})					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1 -Weedy check	12.64	22.83	33.33	45.28	48.26	51.91
T_2 -One hoeing at 15 DAS + 1HW at 30 DAS	11.72	8.25	7.01	7.91	10.18	12.08
T_3- One hoeing at 15 DAS + Quizalofop - p- ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS.	10.34	8.57	7.28	8.09	10.31	12.46
T_4-Pendimethalin @ 1 kg a.i. ha^{-1}(PE)	8.85	8.89	9.37	10.58	12.07	14.20
T_5- Pendimethalin @ 1 kg a.i.ha^{-1} (PE)+ 1 Hoeing at 30 DAS	8.45	10.63	6.25	7.47	9.50	9.51
T_6-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + 1 HW at 30 DAS	8.19	11.52	6.05	6.74	9.04	9.08
T_7-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + Quizalofop-p-ethyl @ 0.05 kg a.i.ha^{-1} at 25 DAS.	9.12	10.87	8.22	9.47	11.21	12.64
T_8- Weed free check	11.93	7.15	5.50	6.56	7.91	8.20
S.E. ±	0.38	0.53	0.38	0.34	0.59	0.60
C.D.at 5%	1.16	1.60	1.16	1.04	1.80	2.43
General mean	9.90	11.09	10.37	12.76	14.81	16.26

Table 2: Weed intensity of dicot weeds in groundnut as influenced periodically by different treatments

Treatments	Weed intensity of dicot weeds (m^{-2})					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1 -Weedy check	13.23	27.67	38.42	45.73	62	63.23
T_2 -One hoeing at 15 DAS + 1HW at 30 DAS	12.55	7.88	7.54	8.15	9.78	9.52
T_3- One hoeing at 15 DAS + Quizalofop - p- ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS.	12.56	8.37	10.58	8.51	8.37	9.62
T_4-Pendimethalin @ 1 kg a.i. ha^{-1}(PE)	9.47	11.42	11.24	10.23	9.37	10.61
T_5- Pendimethalin @ 1 kg a.i.ha^{-1} (PE)+ 1 Hoeing at 30 DAS	8.67	10.61	6.57	7.30	7.98	8.36
T_6-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + 1 HW at 30 DAS	8.52	10.42	5.93	7.24	7.58	8.28

T_7-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + Quizalofop-p-ethyl @ 0.05 kg a.i.ha^{-1} at 25 DAS.	9.30	10.76	10.67	10.58	8.98	10.42
T_8- Weed free check	12.78	6.69	5.25	5.07	6.04	7.19
S.E. ±	0.42	0.70	0.48	0.96	0.73	0.45
C.D.at 5%	1.27	2.14	1.48	2.75	2.22	1.36
General mean	10.61	11.73	10.27	12.85	15.01	15.90

Dry matter of weeds

The data pertaining to the effect of different weed management treatments on dry matter of weeds at harvest is presented in Table 3.

Effect of treatments

The data presented regarding dry matter of weed was significantly influenced by different weed control treatments. However, the significantly lowest weed dry matter was recorded in weed free check treatment (9.62 g) as compared to rest of the treatments which was at par with the treatments pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS (11.45 g) and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS (11.64 g) but significantly superior over treatment weedy check. The significantly highest dry matter of weeds was recorded in weedy check (45.52 g) over rest of treatments.

The next best treatments were one hoeing at 15 DAS + one hand weeding at 30 DAS (13.36 g), one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS (13.82 g), pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS (14.31 g) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} (15.48 g) except weedy check (45.52 g). Similar results were reported by Gunri *et al.*, (2014) [7] and Murthy *et al.*, (1982) [13].

Table 3: Mean weed dry matter, weed control efficiency and weed index as influenced by different treatments at harvest of groundnut

Treatment	Weed dry matter (g)	Weed control efficiency (%)	Weed index (%)
T_1 -Weedy check	45.52	-	24.97
T_2 -One hoeing at 15 DAS + 1HW at 30 DAS	13.36	70.72	13.53
T_3- One hoeing at 15 DAS + Quizalofop - p- ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS.	13.82	69.78	15.55
T_4-Pendimethalin @ 1 kg a.i. ha^{-1}(PE)	15.48	65.95	20.43
T_5- Pendimethalin @ 1 kg a.i.ha^{-1} (PE)+ 1 Hoeing at 30 DAS	11.64	75.44	10.32
T_6-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + 1 HW at 30 DAS	11.45	77.23	9.72
T_7-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + Quizalofop-p-ethyl @ 0.05 kg a.i.ha^{-1} at 25 DAS.	14.31	68.67	18.09
T_8- Weed free check	9.62	80.81	-
S.E. ±	1.06	-	-
C.D.at 5%	3.23	-	-
General mean	18.70	71.30	16.09

Weed control efficiency

The data pertaining to the effect of different weed management treatments regarding weed control efficiency at harvest are presented in Table 3.

Effect of treatments

At harvest, the highest weed control efficiency was observed in weed free check (80.81%) over rest of the treatments. Followed by the treatments pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS (77.23%) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (75.44%), one hoeing at 15 DAS + one hand weeding at 30 DAS (70.72%), one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS (69.78%), pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS (68.67%) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} (65.95%) which were superior over weedy check.

The lowest weed control efficiency was recorded in weedy check over rest of the treatments whereas higher is the weed control efficiency better is the treatment. Similar trend of observation were reported by Sharma *et al.*, (2015) [19], Sagvekar *et al*., (2015) [17] and Patel *et al.*, (2006) [15].

Weed index

The data regarding weed index at harvest is presented in Table 3.

Effect of treatments

At harvest the lowest weed index was recorded in weed free check and followed by the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (9.72%) and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS (10.32%), T_2, T_3, T_7 and T_4 and superior over weedy check. The highest weed index was recorded by the treatment weedy check (24.97%).

The treatment weed free check was recorded minimum weed index which reflected that the lowest weed index results in highest yield of groundnut due lower weed crop competition. The results were conformity with Gunri *et al.*, (2014) [7], Sharma *et al.*, (2015) [19] and Sagvekar *et al.*, (2015) [17].

Yield parameters

The data regarding pod, haulm yield, biological yield and harvest index are presented in Table 4.The mean pod yield, haulm yield, biological yield and harvesting index were 32.74 q ha^{-1}, 49.82 q ha^{-1}, 83.04 q ha^{-1} and 39.54%, respectively.

Pod and haulm yield

Pod yield

Effect of treatments

The data pertaining to the effect of different weed management treatments on pod yield revealed that highest pod yield was recorded from weed free check (37.10 q ha^{-1}) which was statistically at par with the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (36.45 q ha^{-1}) and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at

30 DAS (35.82 q ha^{-1}) but significantly superior over rest of the treatments. The next best treatments were one hoeing at 15 DAS + one hand weeding at 30 DAS, one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i ha^{-1} at 25 DAS, T_7 and T_4 which were significantly superior over weedy check (25.42 q ha^{-1}). The significantly lowest pod yield in weedy check was recorded due to higher weed crop competition for nutrients, space, sunlight, moisture and CO_2 which reduces the pod yield. The magnitude of increase in pod yield with weed free treatment was 1.78, 3.57, 9.56, 12.42 and 13.31 per cent over the treatments T_6, T_5,T_2, T_3, T_7, T_4 and T_1, respectively.

Thus, the effective weed control achieved in the earlier mentioned treatments resulted in enhancing various growth and yield contributing characters of groundnut and finally gave significantly higher pod yield over weedy check. Similar trend of observations were reported by Sagvekar *et al.,* (2015) [17], Gunri *et al*., (2014) [7] and Patel *et al.*, (2006) [15]

Haulm yield

Effect of treatments

The data pertaining to the effects of different weed management practices on haulm yield revealed that significantly highest haulm yield was recorded by weed free check (55.65 q ha^{-1}) which was statistically at par with the treatments pre-emergence application of pendimethalin @1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (54.67 q ha^{-1}) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1}+ one hoeing at 30 DAS (53.73 q ha^{-1}) over rest of the treatments. Next in order with treatments one hoeing at 15 DAS + one hand weeding at 30 DAS, one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS, T_7 and T_4 which were significantly superior over weedy check (38.13 q ha^{-1}). The significantly lowest haulm yield was recorded in weedy check might be due to higher weed crop competition for nutrients, space, sunlight, moisture and CO_2.

Thus, the effective weed control achieved in the earlier mentioned treatments resulted in enhancing various growth and yield contributing characters of groundnut and finally gave significantly higher pod yield over weedy check. Similar trend of observations were reported by Sheoran *et al*., (2015) [21], Sagvekar *et al.,* (2015) [17], Gunri *et al*., (2014) [7] and Patel *et al*., (2006) [15].

Table 4.11: Pod yield, haulm yield, biological yield and harvest index as influenced by different treatments at harvest of groundnut

Treatment	At harvest			
	Pod yield (q ha^{-1})	Haulm yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
T_1 -Weedy check	25.42	38.13	63.55	37.48
T_2 -One hoeing at 15 DAS + 1HW at 30 DAS	33.86	50.79	84.00	39.82
T_3- One hoeing at 15 DAS + Quizalofop - p- ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS.	33.00	49.50	82.50	39.67
T_4-Pendimethalin @ 1 kg a.i. ha^{-1}(PE)	31.32	46.98	78.30	39.33
T_5- Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + 1 Hoeing at 30 DAS	35.82	53.73	89.55	39.97
T_6-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + 1 HW at 30 DAS	36.45	54.67	91.12	40.05
T_7-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + Quizalofop-p-ethyl @ 0.05 kg a.i.ha^{-1} at 25 DAS.	32.74	49.11	81.85	39.63
T_8- Weed free check	37.10	55.65	92.75	40.36
S.E. ±	1.02	1.54	2.80	1.30
C.D.at 5%	3.12	4.68	8.48	NS
General mean	32.74	49.82	83.04	39.54

Biological yield

Effect of treatments

The data pertaining to the effect of different weed management treatments on biological yield revealed that significantly highest biological yield was obtained from weed free check (92.75 q ha^{-1}) except the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (91.12 q ha^{-1}) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (89.55 q ha^{-1}) which were at par with the treatment weed free check and significantly superior over rest of the treatments. Next in order with the treatments i.e. one hoeing at 15 DAS + one hand weeding at 30 DAS, one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS, T_7 and T_4 which were significantly superior over weedy check. The significantly lowest biological yield was recorded in weedy check (63.55 q ha^{-1}).

The significantly lowest biological yield was recorded in weedy check due to higher weed crop competition for nutrients, space, sunlight, moisture and CO_2. Similar results were conformity with Chaudhary *et al*., (2017) [5], Sheoran *et al*., (2015) [21], Sagvekar *et al.,* (2015) [17], Gunri *et al*., (2014) [7] and Patel *et al*., (2006) [15].

Harvest index

Effect of treatments

The data pertaining to harvest index was not significantly affected by different weed management treatments. The treatment weed free check recorded highest harvest index.

(40.36%) followed by the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (40.05%) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (39.97%), one hoeing at 15 DAS + one hand weeding at 30 DAS, one hoeing at 15 DAS + post emergence application of quizalofop-p-ethyl @ 0.05 kg a.i ha^{-1} at 25 DAS, T_7 and T_4. The lowest harvest index was recorded by weedy check plot (37.48%). 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 CO_2 as compare to groundnut crop. This reduces pod yield and biological yield leading to minimum harvesting index. Similar trend of observations were reported by Sharma *et al*., (2015) [19], Patel *et al.*, (2006) [15] and Singh *et al.*, (2014) [20].

Mean nutrient content (NPK) in weeds after harvest

The data pertaining to the effect of different weed management practices on N, P and K content in weeds after

harvest of groundnut as affected by different weed control treatments are presented in Table 5.

Nitrogen content

Effect of treatments

The data regarding nitrogen content in weeds revealed that the treatment weed free check recorded significantly lowest nitrogen content in weeds (0.43%) except the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (0.45%) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (0.46%) which were at par with weed free check but significantly superior over rest of the treatments. The significantly highest nitrogen content of weeds was recorded in weedy check (0.72%). The minimum nitrogen content in weeds were recorded significantly lowest under weed free check. This might be due to the minimum weed crop competition for soil nutrients. Also because of lowest production of weed dry matter due to weed management practices.

Phosphorus content

Effect of treatments

The data regarding the phosphorus content in weeds revealed that the treatment weed free check recorded significantly lowest phosphorus content in weeds (0.22%) except the treatment pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (0.23%) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (0.24%) which were at par with weed free check but significantly superior over rest of the treatments. The phosphorus content in weeds were recorded significantly higher under weedy check (0.22%).

The minimum phosphorus content in weeds were recorded significantly lowest under weed free check. This might be due to the minimum weed crop competition for soil nutrient and also because of lowest production of weed dry matter due to weed management practices.

Potassium content

Effect of treatments

The data regarding potassium content in weeds revealed that weedy free check recorded significantly lowest potassium content in weeds (0.61%) except the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (0.62%) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (0.63%) which were at par with weed free check but significantly superior over rest of the treatments. The potassium content was recorded significantly higher under weedy check (0.81%).

The minimum potassium content in weeds were recorded significantly lowest under weed free check. This might be due to the minimum weed crop competition for soil nutrients. Also because of lowest production of weed dry matter due to weed management practices.

Nitrogen uptake

Effect of treatments

The data regarding nitrogen uptake by weeds revealed that treatment weed free check recorded significantly lowest nitrogen uptake by weeds (0.29 kg ha^{-1}) which was at par with the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (0.51 kg ha^{-1}) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (0.52 kg ha^{-1}) but significantly superior over rest of the treatments. The significantly highest nitrogen uptake by weeds were recorded in weedy check (3.30 kg ha^{-1}). The nitrogen uptake by weeds were recorded significantly lowest under weed free check this might be due to the minimum weed crop competition for soil nutrients and also because of lowest production of weed dry matter due to weed management practices. Similar observations were reported by Madhu *et al*., (2006) [10], Ambulkar *et al*., (1993) [1], Chaudhari *et al.*, (2017), Kumbar *et al.*, (2014) [9] and Reddy *et al*., (2016) [16].

Table 5: Nutrient content (NPK) and uptake in weeds as influenced by different treatments at harvest of groundnut

Treatment	Nutrient content in weeds (%)			Nutrient uptake by weeds (kg ha^{-1})		
T_1 -Weedy check	**N**	**P**	**K**	**N**	**P**	**K**
T_2 -One hoeing at 15 DAS + 1HW at 30 DAS	0.72	0.34	0.81	3.30	1.55	3.7
T_3- One hoeing at 15 DAS + Quizalofop - p- ethyl @ 0.05 kg a.i. ha^{-1} at 25 DAS.	0.51	0.26	0.67	0.71	0.37	0.94
T_4-Pendimethalin @ 1 kg a.i. ha^{-1}(PE)	0.55	0.27	0.69	0.79	0.41	0.97
T_5- Pendimethalin @ 1 kg a.i.ha^{-1} (PE)+ 1 Hoeing at 30 DAS	0.64	0.30	0.74	1.00	0.50	1.15
T_6-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + 1 HW at 30 DAS	0.46	0.24	0.63	0.52	0.27	0.73
T_7-Pendimethalin @ 1 kg a.i.ha^{-1} (PE) + Quizalofop-p-ethyl @ 0.05 kg a.i.ha^{-1} at 25 DAS.	0.45	0.23	0.62	0.51	0.26	0.70
T_8- Weed free check	0.58	0.28	0.72	0.80	0.40	1.00
S.E. ±	0.43	0.22	0.61	0.29	0.21	0.59
C.D.at 5%	0.017	0.009	0.120	0.07	0.02	0.05
General mean	0.05	0.02	0.03	0.24	0.09	0.18
	0.54	0.27	0.70	0.88	0.49	1.09

Phosphorus uptake

Effect of treatments

The data regarding phosphorus uptake by weeds revealed that the treatment weed free check was recorded significantly lowest phosphorus uptake by weeds (0.21 kg ha^{-1}) which was at par with the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (0.26 kg ha^{-1}) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (0.27 kg ha^{-1}), but significantly superior over rest of the treatments. The significantly highest phosphorus uptake by weeds were recorded in weedy check (1.55 kg ha^{-1}) The phosphorus uptake by weeds were recorded significantly lowest under weed free check. This might be due to the minimum weed crop competition for soil nutrients and also because of lowest production of weed dry matter due to weed management practices. Similar observations were reported by Madhu *et al*., (2006) [10], Ambulkar *et al*., (1993) [1], Chaudhari *et al.*, (2007) [4], Kumbar *et al.*, (2014) [9] and Reddy *et al*., (2016) [16]

Potassium uptake

Effect of treatments

The data regarding potassium uptake by weeds revealed that the treatment weed free check recorded significantly lowest potassium uptake by weeds (0.59 kg ha^{-1}) which was at par with the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (0.70 kg ha^{-1}) and pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hoeing at 30 DAS (0.73 kg ha^{-1}), but significantly superior over rest of the treatments. The significantly highest potassium uptake by weeds was recorded in weedy check (3.70 kg ha^{-1}). The potassium uptake by weeds was recorded significantly lowest under weed free check. This might be due to the minimum weed crop competition for soil nutrients and also because of lowest production of weed dry matter due to weed management practices. Similar observations were reported by Madhu *et al*., (2006) [10], Ambulkar *et al*., (1993) [1], Chaudhari *et al.*, (2017), Kumbar *et al.*, (2014) [9] and Reddy *et al*., (2016) [16]

Conclusion

The weed intensity for monocot and dicot weeds was significantly minimum in weed free check as compare to rest of the treatments except treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS which were comparable with weed free check. The treatment weed free check recorded lowest dicot and monocot weed intensity. Dry matter of weeds at harvest was significantly lowest in weed free check (9.62 g). Among the integrated weed management treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS (11.45 g) and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS (11.64 g) which were comparable with weed free check. The significantly highest weed intensity and dry matter (45.52 g) was recorded by treatment weedy check.

The mean pod yield (37.10 q ha^{-1}), haulm yield (55.65 q ha^{-1}), biological yield (92.75 q ha^{-1}) and harvest index (40.36%) was significantly highest in weed free check treatment. However weedy check recorded significantly lowest mean pod yield (25.42 q ha^{-1}), haulm yield (38.13 q ha^{-1}), biological yield (63.55 q ha^{-1}) and harvest index (37.48%). Among the integrated weed management, the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS were comparable with weed free check treatment and superior over rest of the treatments.

The total nitrogen, phosphorus and potash content in weeds after harvest of groundnut was recorded significantly lowest in the treatment weed free check except the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS which were comparable with the treatment weed free check and significantly superior over treatment weedy check. The significantly highest NPK content in weeds were recorded in treatment weedy check.

The total nitrogen (0.29 kg ha^{-1}), phosphorus (0.21 kg ha^{-1}) and potash (0.59 kg ha^{-1}) uptake by weeds after harvest of groundnut was recorded significantly lowest in the weed free check treatments except the treatments pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at 30 DAS and pre-emergence application of pendimethalin @ 1 kg a.i ha^{-1} + one hoeing at 30 DAS which were comparable with weed free check treatment and significantly superior over the treatment weedy check. The significantly highest NPK content in weeds were recorded in treatment weedy check.

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