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Weed Management in Groundnut (*Arachis hypogaea* L.) with Phosphorus in Southern Rajasthan

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ABSTRACT

Background: Agriculture sector is vital for food and nutritional security of the nation. Contrary to great stride in cereals and millets production during last few decades, desired rise in production of oilseeds has yet to be achieved though India has 14 and 9 per cent of global acreage and production.

Methods: The present investigation was conducted during kharif seasons of 2016 and 2017, at Instructional farm, MPUAT, Udaipur to access the effect of different pre - post herbicides for weed control in groundnut under phosphorus application. This experiment was operated with six weed management practices and four phosphorus levels thus, 30 treatment combinations; all were evaluated in split-plot design with three replications.

Result: Our investigations results revealed that herbicidal treatments as well as weed free check significantly control weed population and recorded the highest values of N, P, K concentration in weeds, kernel, biological yields and total chlorophyll content over weedy check while, significantly maximum N, P, K uptake and soil available phosphorus were noted under weedy check over rest of the treatments. Further, the results also showed that application of phosphorus exhibit significant increase in nutrient concentration and their uptake by weeds, kernel, biological yields, total chlorophyll content and soil available phosphorus over control during the course of investigation.

Key words: Chlorophyll, Groundnut, Phosphorus, Weed dynamic, Yield.

INTRODUCTION

Groundnut or peanut (*Arachis hypogaea* L.) adorned as king of oilseeds as well as wonder nut and poor men's cashew nut, is a unique valuable annual unpredictable legume cum ancient edible oilseed cash crop (Nataraja *et al*., 2013; Umesh *et al*., 2015). Rajasthan occupies 6.41 mha area, with 12.59 mt production but productivity is only 1935 kg/ha (Raj. Agril. Stat. at a glance, 2017-2018). The low yield of groundnut in Rajasthan as well as in the country can be attributed to several constraints. Among them, one of the major constraints to raise the productivity of groundnut crop is the weed menace and on other hand, shrinking soil fertility during post green revolution era.

Among various weed management practices, chemical method has become great importance cost effective and timely control of weeds in groundnut because of weed competition with the groundnut crop for resources, such as soil moisture, nutrient and light in the early stage as its naturally short structure with slow seedling emergence, initial growth and underground pod bearing habit as well as interfere with pegging, pod development and harvesting of it during different stages of crop growth besides competing for essential resources (Behera *et al*., 2017). Weeds have allellopathic effect on groundnut and act as alternative host for causal organisms of various diseases and insect pests resulted in reduce the yield up to 70% (Kar *et al*., 2015).

Due emphasis on nutrition part is very essential. In recent years intensive cropping with inadequate and imbalance fertilization has resulted in more removal of nutrients from the soil and severe strain on the soil system, flower drop, dry matter partition *etc*. occupy important place. Groundnut with an extensive root system explores a large volume of soil and responds well to applied phosphorus fertilizer from various sources due to its high phosphorus demand for optimum productivity (Chaudhary *et al*., 2015).

In view of the above facts, the present investigation was attempted on weed management practices to identify effective and economically viable weed control method through evaluating the performance of pre and post emergence herbicides in groundnut by comparing their relative effect and to study the effect of phosphorus for augmenting the productivity of groundnut crop and harvesting higher yield.

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MATERIALS AND METHODS

The present field experiment was carried out consecutively for two *kharif* seasons of 2016 and 2017, at Instructional Farm, MPUAT, Udaipur (24°35' N latitude and 73°44' E longitude at an altitude of 582.17 MAMSL) to determine effect of various weed management practices under different phosphorus levels on weed dynamic, NPK concentration and their uptake by weed and also on groundnut yield as well as phosphorus status of soil. The experimental site is falls under agro-climatic zone IVa (sub-humid southern plain and aravalli hills) of Rajasthan, associated with typically semi-arid and sub-tropical climate with receives an average annual rainfall of 654.3 mm with erratic distribution over time and space. The soil of experimental site was sandy loam in texture and slightly alkaline in reaction (pH 7.74), medium in available nitrogen (261.10 kg/ha), phosphorus (17.11 kg/ha) and high in available potassium (176.37 kg/ha). The experiments were laid out in split-plot design and replicated thrice below treatments.

Treatment details

Treatments	Symbols
A. Weed management practices (Main plot)	
Weedy check	W_0
Weed free (up to 60 DAS)	W_1
Pendimethalin 750 g/ha pre-emergence	W_2
Oxyfluorfen 125 g/ha pre-emergence	W_3
Imazethapyr 100 g/ha post-emergence (15 DAS)	W_4
Quizalofop-ethyl 50 g/ha post-emergence (15 DAS)	W_5
B. Phosphorus levels (P_2O_5 kg/ha) (Sub plot)	
0 (Control)	P_0
20	P_1
40	P_2
60	P_3
80	P_4

To get good tilth, the experimental field was given one summer ploughing and 2 cross harrowing followed by planking. Healthy sound groundnut kernel (TG 37 A) treated with Carbendazim 3 g/kg and *Rhizobium leguminoserum* 6 g/kg were sown at spacing of 30 cm × 10 cm by using recommended seed rate of 100 kg/ha. Pre and post-emergence herbicides were applied at 2 and 15 DAS, respectively by using battery operated knapsack sprayer fitted with flat-fan nozzle as well as in the designated plots the weeds were removed manually to keep weed free up to 60 DAS while, unweeded check plots were allowed to remain infested with weeds till harvesting of the crop. The recommended dose of nitrogen 30 kg/ha and phosphorus (as per treatments) was applied as basal application through urea and DAP, respectively in the furrows below the kernel to all the plots. The rest packages of practices were adopted as per recommended in Rajasthan. Weeds density were recorded at 30, 45 DAS and harvest then data transformed to square root transformation $\sqrt{X + 0.5}$ to normalize their distribution. The weed dry matter at harvest was oven dried at 65°C till a constant weight and grounded then analyzed for determining N, P and K concentration by using standard methods.

NPK uptake by both broad-leaved and narrow-leaved weeds at harvest were computed by following formula and expressed in kg/ha.

Nutrient uptake by weeds =

$$\frac{\text{Nutrient content in weed (\%)}}{\text{Weed dry matter (kg/ha)}} \times 100$$

Initial and final groundnut plant population was counted from two random places in each net plot at 40 DAS and just before harvesting, respectively. Kernel yield was obtained by multiply shelling (%) with dry pod yield. Before threshing, sun dry weight of properly labeled produce of each net plot was recorded as biological yield. The total chlorophyll content of groundnut fresh leaf sample from each experimental plot was estimated at 55 DAS following the procedure laid down by Arnon (1949) using 80% acetone.

Soil samples were drawn from each net plot up to 15 cm depth after harvest of groundnut crop then air dried, grounded and passed through 2 mm sieve in order to analyze for available soil phosphorous using Olsen method. The recorded data were analysed using analysis of variance (ANOVA) technique (Gomez and Gomez 1984). The least significance test was used to decipher the main effects of treatments at 5% level of significance (P<0.05).

RESULTS AND DISCUSSION

Effect on weed dynamic

Digera arvensis

A critical review (Table 1) clearly shows that among the herbicidal treatments, imazethapyr application (4.54, 6.01 and 7.87 m^{-2}) maintain their significant superiority over other herbicidal treatments. Application of imazethapyr (50.76, 58.72 and 54.77), oxyfluorfen (36.55, 42.51 and 45.98), pendimethalin (31.24, 48.66 and 37.93) and quizalofop-ethyl (12.69, 15.45 and 15.86) resulted in per cent reduction in the density of this weed over weedy check (9.22, 14.56 and 17.40 m^{-2}) at 30, 45 DAS and harvest, respectively.

Trianthema portulacastrum

The data indicate (Table 1) that application of imazethapyr significantly reduced the density by (66.41, 59.45 and 57.49%) followed by oxyfluorfen (30.39, 37.40 and 43.17%) and pendimethalin by (33.42, 35.58 and 39.75%) over weedy check (18.13, 24.17 and 26.82 m^{-2}), respectively. Further, pendimethalin and oxyfluorfen were found statistically at par with each other in this respect.

Other broad-leaved weeds

Weed control through all weed management practices significantly reduced the density of broad-leaved weeds other than *Amaranthus viridis*, *Commelina benghalensis*, *Digera arvensis* and *Trianthema portulacastrum* over weedy check (Table 1). Among, herbicides imazethapyr proved significantly effective in reducing the density of other broad-

Table 1: Effect of weed management practices and phosphorus levels on weed density (Pooled data of 2016 and 2017).

Treatments	Weed density (No./m)								
	Digera arvensis			*Trianthema portulacastrum*			*Other broad-leaved weeds*		
	30 DAS	45 DAS	Harvest	30 DAS	45 DAS	Harvest	30 DAS	45 DAS	Harvest
Weed management practices									
Weedy check	3.11	3.87	4.22	4.29	4.95	5.21	3.99	5.08	5.58
	(9.22)	(14.56)	(17.40)	(18.13)	(24.17)	(26.82)	(15.51)	(25.37)	(30.83)
Weed free (Up to 60 DAS)	0.71	0.71	1.55	0.71	0.71	0.71	0.71	0.71	1.65
	(0.00)	(0.00)	(1.93)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(2.37)
Pendimethalin 750 g/ha PE	2.60	2.82	3.36	3.54	4.01	4.08	3.31	3.71	3.72
	(6.34)	(7.48)	(10.80)	(12.07)	(15.57)	(16.16)	(10.47)	(13.33)	(13.32)
Oxyfluorfen 125 g/ha PE	2.51	2.97	3.13	3.62	3.95	3.96	2.96	3.68	3.79
	(5.85)	(8.37)	(9.40)	(12.62)	(15.13)	(15.24)	(8.32)	(13.07)	(13.89)
Imazethapyr 100 g/ha PoE	2.24	2.54	2.89	2.56	3.21	3.45	2.65	3.21	3.40
	(4.54)	(6.01)	(7.87)	(6.09)	(9.80)	(11.40)	(6.55)	(9.84)	(11.17)
Quizalofop-ethyl 50 g/ha PoE	2.92	3.58	3.88	4.32	4.70	5.04	3.74	4.73	5.21
	(8.05)	(12.31)	(14.64)	(18.21)	(21.55)	(24.88)	(13.55)	(21.92)	(26.77)
SEm ±	0.02	0.02	0.02	0.06	0.04	0.05	0.02	0.01	0.02
CD at 5%	0.06	0.06	0.06	0.18	0.11	0.14	0.08	0.05	0.07
Phosphorus levels (P_2O_5 kg/ha)									
0 (Control)	2.34	2.74	3.17	3.15	3.57	3.73	2.89	3.51	3.88
	(5.60)	(8.05)	(10.32)	(11.05)	(14.24)	(15.66)	(9.01)	(13.86)	(16.38)
20	2.34	2.74	3.17	3.15	3.58	3.72	2.89	3.52	3.89
	(5.62)	(8.08)	(10.34)	(11.09)	(14.26)	(15.59)	(9.05)	(13.89)	(16.40)
40	2.35	2.74	3.18	3.17	3.59	3.75	2.90	3.52	3.89
	(5.67)	(8.10)	(10.37)	(11.18)	(14.38)	(15.82)	(9.07)	(13.92)	(16.46)
60	2.35	2.75	3.18	3.19	3.60	3.75	2.90	3.52	3.90
	(5.69)	(8.14)	(10.40)	(11.27)	(14.46)	(15.92)	(9.09)	(13.95)	(16.46)
80	2.36	2.77	3.17	3.20	3.60	3.74	2.90	3.53	3.89
	(5.74)	(8.25)	(10.28)	(11.34)	(14.51)	(15.76)	(9.12)	(13.98)	(16.27)
SEm ±	0.01	0.01	0.01	0.03	0.02	0.02	0.01	0.01	0.02
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

*Data subjected to $\sqrt{X+0.5}$ transformation and figures in parenthesis are original weed count m^{-2}

leaved weeds followed by oxyfluorfen and pendimethalin.

Non-significant effect on broad-leaved weeds count was observed due to varying phosphorous levels during the years of investigation.

The probable reasons for obtaining lowest weed population under herbicides tried might be due to pre and post emergence application of herbicides resulted in better weed management during initial and later growth stages of crop due to their differed ability to control weeds as well as smothering effect of crop as lesser weed competition faced by groundnut crop. Similar results were also reported by Adhikary *et al*. (2016) and Sahoo *et al*. (2017).

Nutrient concentration and uptake

All weed management practices significantly influenced N, P and K concentration in narrow-leaved and broad-leaved weeds and the lowest were noted under weedy check (Table 2). At harvest, the lowest total uptake of N, P and K by weeds was recorded with weed free up to 60 DAS closely followed by application of imazethapyr, pendimethalin, oxyfluorfen and quizalofop-ethyl. Uptake of N, P and K by weeds almost followed the footsteps of weed biomass in trend.

The significantly maximum N concentration in broad-leaved weeds was recorded by applying 60 kg P_2O_5/ha. Whereas, significantly higher P and K concentrations in broad-leaved weeds and N & P concentrations in narrow-leaved were recorded by applying 80 kg P_2O_5/ha. Application of 80 kg P_2O_5/ha resulted in significantly higher N and P uptake by narrow-leaved weeds and also P and K uptake by broad-leaved weeds. Whereas, N uptake by broad-leaved as well as K uptake by narrow-leaved weeds were found significantly up to 60 kg P_2O_5/ha over preceding phosphorus levels. Nutrient uptake by weeds is primarily a function of nutrient concentration and their biomass similar results has also been reported by Kumbar *et al*. (2014) and Samant and Mishra (2014).

Effect on crop

Plant population

All the weed management practices and phosphorus levels did not differ significantly in their effect on groundnut plant population at 40 DAS and at harvest.

Table 2: Effect of weed management practices and phosphorus levels on nutrients concentration and uptake by weeds at harvest.

Treatments	Concentration (%)						Uptake (kg/ha)					
	Broad-leaved weeds			Narrow-leaved weeds			Broad-leaved weeds			Narrow-leaved weeds		
	N	P	K	N	P	K	N	P	K	N	P	K
Weed management practices												
Weedy check	2.121	0.327	1.637	1.703	0.252	1.820	30.48	4.70	23.50	19.10	2.83	20.40
Weed free (Up to 60 DAS)	2.182	0.346	1.687	1.762	0.275	1.840	1.19	0.19	0.92	1.53	0.24	1.60
Pendimethalin 750 g/ha PE	2.174	0.343	1.664	1.739	0.265	1.827	17.02	2.68	13.04	9.90	1.51	10.39
Oxyfluorfen 125 g/ha PE	2.161	0.337	1.654	1.729	0.259	1.800	15.96	2.49	12.21	12.33	1.86	12.82
Imazethapyr 100 g/ha PoE	2.164	0.343	1.669	1.736	0.264	1.824	12.24	1.93	9.45	8.43	1.28	8.85
Quizalofop-ethyl 50 g/ha PoE	2.151	0.334	1.649	1.752	0.268	1.834	27.15	4.21	20.81	9.88	1.51	10.34
SEm ±	0.008	0.001	0.004	0.006	0.001	0.008	0.22	0.03	0.13	0.11	0.02	0.12
CD at 5%	0.026	0.004	0.013	0.018	0.004	0.025	0.66	0.10	0.39	0.35	0.07	0.37
Phosphorus levels (P_2O_5 kg/ha)												
0 (Control)	2.101	0.305	1.600	1.683	0.233	1.802	16.48	2.37	12.49	9.54	1.31	10.24
20	2.149	0.324	1.632	1.724	0.250	1.824	17.32	2.59	13.14	10.17	1.45	10.77
40	2.165	0.341	1.636	1.739	0.267	1.830	17.47	2.73	13.21	10.27	1.55	10.84
60	2.185	0.359	1.642	1.757	0.282	1.831	17.67	2.88	13.28	10.40	1.64	10.89
80	2.196	0.363	1.790	1.783	0.288	1.833	17.77	2.92	14.49	10.58	1.73	10.91
SEm ±	0.005	0.001	0.002	0.005	0.001	0.007	0.05	0.01	0.03	0.04	0.00	0.04
CD at 5%	0.013	0.002	0.005	0.014	0.002	0.019	0.16	0.02	0.10	0.11	0.01	0.12

Table 3: Effect of weed management practices and phosphorus levels on plant stand, chlorophyll and yields of groundnut.

Treatments	Plant stand (no./m)		Kernel yield	Biological yield	Total chlorophyll
	At 40 DAS	At harvest	(kg/ha)	(kg/ha)	(mg/g)
Weed management practices					
Weedy check	30.80	30.19	588	3200	1.229
Weed free (Up to 60 DAS*)	32.26	32.22	1185	4861	1.673
Pendimethalin 750 g/ha PE	30.66	30.36	1113	4715	1.569
Oxyfluorfen 125 g/ha PE	30.40	30.10	945	4364	1.411
Imazethapyr 100 g/ha PoE	31.98	31.82	1134	4743	1.499
Quizalofop-ethyl 50 g/ha PoE	31.81	31.54	937	4316	1.488
SEm ±	0.49	0.52	22	40	0.009
CD at 5%	NS	NS	67	125	0.026
Phosphorus levels (P_2O_5 kg/ha)					
0 (Control)	31.09	30.37	599	3041	1.411
20	31.20	30.79	897	4306	1.456
40	31.18	31.01	1082	4729	1.483
60	31.56	31.36	1160	4862	1.506
80	31.55	31.65	1179	4894	1.535
SEm ±	0.18	0.21	7	14	0.003
CD at 5%	NS	NS	21	39	0.010

* Days after sowing

Kernel yield

Enforcing weed management through weed free and herbicides resulted in significant increase in kernel yield over weedy check. The maximum benefit of weed control in term of kernel yield enhancement was achieved by weed free followed by imazethapyr and pendimethalin by 101.53, 92.86 and 89.29 per cent over weedy check (588 kg/ha), respectively. All the weed management practices significantly influenced all the growth and related parameters compared to weedy check, which in turn increased the entire yield attributes *viz*., weight of mature pods/plant, shelling (%) and 100 kernels weight which ultimately reflected into significantly higher kernel yield Patel *et al*. (2017) and Singh *et al*. (2018).

Data (Table 3) reveal that progressively increased phosphorus application up to 80 kg P_2O_5/ha significantly increased kernel yield over control. The data further reveal that 29.31 and 7.21 per cent enhancement in kernel yield achieved by raising the phosphorus application from 20 and 40 to 60 kg/ha, respectively. Phosphorus is a constituent of phytin and phospholipids which accumulate in kernel, Hence with the application of phosphorus good kernel formation occurs and the weight of the kernel also increases this could be possible reason increasing the 100 kernels weight and also greater partisaning of metabolites and adequate translocation of nutrients to the developing reproductive pods. These positive influenced might have led to better development of individual kernel as evidenced by 100-kernel weight expressed as kernel yield kg/ha Datta *et al*. (2014) and Sibhatu *et al.* (2016).

Biological yield

Weed management through quizalofop-ethyl, oxyfluorfen, pendimethalin, imazethapyr and weed free tended to increase biological yield by 34.87, 36.37, 47.34, 48.22 and 51.91 per cent over weedy check (3200 kg/ha), respectively. The increased biological yield were obviously the results of better weed management which rendered favorable condition like increased availability of nutrient, moisture, light and other factors to the crop plant, which resulted in better growth and higher dry matter production of plants. Enhanced values of yield attributing characters were the outcome of these effects are in close accordance with the finding of Dixit *et al*. (2016) and Singh *et al*. (2018).

The result indicate that 41.60, 55.50, 59.88 and 60.93 per cent increased biological yield by application 20, 40, 60 and 80 kg P_2O_5/ha over control, respectively. Improvement in biological yield with each increment in P application levels appear to be on account of significant improvement in plant height and biomass accumulation by component characters at harvest of the crop. The increase in dry matter production with P might also be due to better nodulation of crop owing to better availability of P. The improvement in nodulation might have resulted in higher nitrogen fixation and thereby better vegetative growth and dry matter production Kar and Ram (2015).

Total chlorophyll content

Weed free resulted in significantly highest chlorophyll content (1.673 mg/g), whereas oxyfluorfen, quizalofop-ethyl, imazethapyr and pendimethalin increased the chlorophyll content by 14.81, 21.07, 21.97 and 27.66 per cent over weedy check (1.229 mg/g), respectively.

Application of 80 kg P_2O_5/ha associated with its 8.79, 5.43, 3.51 and 1.93 per cent increase over control, 20, 40 and 60 kg P_2O_5/ha, respectively. Chlorophyll content of groundnut leaves is decided by the proportion of various nutrients accumulated and/or development into an essential molecule. This property once again is a function of various complex bio-physico-chemical properties of the soil-plant-environment continuum.

Available soil phosphorus after crop harvest

Maximum available soil phosphorus was registered under weedy check (16.74 kg/ha). Among weed management practices, oxyfluorfen recorded significantly higher available soil phosphorus by 2.96, 4.34 and 4.47 per cent as compared to quizalofop-ethyl, pendimethalin and imazethapyr, respectively.

Application of 80 kg P_2O_5/ha recorded significantly higher available soil phosphorus by 1.87, 7.51, 9.26 and 28.48 per cent over 20, 40, 60 kg P_2O_5/ha and control, respectively. Phosphorus availability depends on microbial activity to break down the organic matter and release this phosphorus into available forms. Hadwani and Gundalia (2005) also reported that phosphatic fertilizer was found beneficial for increasing available phosphorus content soil.

CONCLUSION

It may be concluded from this study that either weed free up to 60 DAS or post-emergence application of imazethapyr @ 100 g a.i./ha (15 DAS) could be adopted for effective management of weeds and soil should be enrichment with 60 kg P_2O_5/ha for higher production of groundnut in the region.

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