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Yield attributes and yield of groundnut (*Arachis hypogaea* L.) as influenced by weed management practices in semi arid region

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ABSTRACT

Field experiment was conducted during three consecutive kharif seasons of 2008, 2009 and 2010 at the Research Farm of Rajasthan Agricultural Research Institute, Jaipur in search of an effective and economic weed control tactics in groundnut through integration of post emergence herbicides. Pre-emergence application of pendimethalin @1kg a.i. ha^{-1} + 1 hand weeding + post emergence application of imazethapyr @ 50g a.i. ha^{-1} at 20 days after sowing produced higher pod yield (4147 kg ha^{-1}) than other treatments. Haulm yield was highest in pendimethalin + 1 hand weeding at 45 days after sowing. Highest weed control efficiency (88.25%) was recorded with pendimethalin + one hand weeding at 45 DAS + imazethapyr @ 50g a.i. ha^{-1} at 20 DAS. The highest benefit:cost ratio (4.96) was obtained from the application of pendimethalin + one hand weeding at 45 DAS.

***Keywords*:** Groundnut, imazethapyr, pendimethalin, weed management and yield

Groundnut (*Arachis hypogaea* L.) is the major oilseed crop and widely grown allover India. Groundnut is also known as poor men's cashew nut and wonder nut. India produced 8.26 mt from 5.86 mh area, with an average yield of 1411 kg.ha^{-1} of Groundnut, while the contribution of Rajasthan in production was 0.68 mt from 0.35 mh area, with an average yield of 1943 kgha^{-1} during 2010-11 (Anon., 2012). It contains 45% oil, so it is one of the most important crops for producing edible oil. Groundnut is a rich source of protein (26%).

In our country, weeds are one of the important factors responsible for low yield of groundnut. Weeds reduce yields by competing with the groundnut plant for resources, such as sunlight, space, moisture, and nutrients (Upadhyay, 1984) not only throughout the growing season, but also create problem during digging and inverting procedures and reduce harvesting efficiency. Harvesting losses increases as the biomass of weeds slow down the field-drying of groundnut vines and pods and increases the possibility of exposure to rainfall. Weeds have allellopathic effect with groundnut (Bansal, 1993) and they act as host for causal organisms of various diseases and insect pests. In the initial growth of crop there is relatively shallow canopy and it slowly shades the inter-row area, which allows bumper weeds growth and thus groundnut crop becomes more susceptible to weed crop competition in the earlier growth period of the crop. Therefore, according to Wesley *et al*. (2008) the critical period of grass weed control was found to be from four to nine weeks after planting whereas, the critical period of broad leaved weeds control was from two to eight weeks. Zimdhal (2004) reported that Groundnut yield decreased with increasing time of weed interference with all type of weed species. According to Walia *et al*., (2007), there is an urgent need to explore the possibilities for increasing the productivity through better understanding of the constraints in production of oilseed crops especially in groundnut.

Since manual weeding requires manpower and it is time consuming, herbicides are the most effective and economic weed control measures. 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 with that of farmer's practice for augmenting the productivity of groundnut crop and harvesting higher yield.

MATERIALS AND METHODS

The present experiments were carried out at Research Farm of Rajasthan Agricultural Research Institute, Durgapura, Jaipur (Rajasthan) during three consecutive *Kharif* (Rainy) seasons in 2008, 2009 and 2010. Durgapura is situated in the eastern part of Rajasthan and lies between 26^{0}51' north latitude and 75^{0}47'east longitude with an elevation of 390m. It falls under semi arid climatic conditions, which is characterized by the features of hot dry summers and cool dry winters. The annual rainfall ranges from 500-600mm. The soil of the experimental field was loamy sand with sand (87.7 %), silt (5.6%), clay (7.7%), having pH 8.3, 0.24% organic carbon and 143.3, 33.0, and 223.6 kg ha^{-1} available N, P_2O_5 and K_2O respectively.

Eight treatment combinations *viz.*, T_1 - unweeded control, T_2 - weed free check [hand weeding (HW) at 15,25,35 and 45DAS], T_3 – pre-

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emergence application of pendimethalin @ 1kg *a.i.* ha^{-1} + one hand weeding at 45DAS, T_4 - quizalofop ethyl @ 50g *a.i.* ha^{-1} at 20DAS, T_5 - imazethapyr @ 50g *a.i.* ha^{-1} at 20DAS, T_6 - T_3 +T_4, T_7 - T_3 +T_5 and T_8 – farmer's practice (two hand weeding at 20 and 35DAS) were tested in a Randomized Block Design with three replications. The crop was sown in 35cm ×15cm spacing in a plot measuring 10.8m^2. The variety Girnar-2 was sown on 15th June of every year and the recommended dose of fertilizers was 20kg N + 60kg P_2O_5 + 0.0kg K_2O ha^{-1}. Four irrigations were given during the crop growing period. At the time of sowing phorate 10G @ 25kg ha^{-1} and subsequently chloropyriphos 20EC @1125ml ha^{-1} with irrigation water was applied to mange white grub infestation. Seeds rate was 100 kg kernels ha^{-1} and seeds were treated with mancozeb 75WP @ 3g kg^{-1} of seed to avoid the possible occurrence of the seed and soil borne diseases. The crop was harvested on 8th November of every year.

Observations were taken at 30 days after sowing (DAS) and at maturity. The WCE, WI and benefit-cost ratio which give an indication of monetary gain over every rupee of expense under a particular treatment were worked out.

RESULTS AND DISCUSSION

Table-1 reveals that besides weed-free check highest plant population (205.33 thousand ha^{-1}) was observed in T_3 (pre-emergence application of pendimethalin @ 1kg *a.i.* ha^{-1} + 1HW at 45DAS). The number of pods $plant^{-1}$ (24.97), pod weight $plant^{-1}$ (41.70g) and 100 kernel weight (82.3g) were obtained maximum with T_7 (T_3 + imazethapyr @ 50g *a.i.* ha^{-1} at 20DAS), followed by T_6 (T_3 + quizalofop ethyl @ 50g *a.i.* ha^{-1} at 20 DAS). Similar findings were also reported by Meena and Chaudhary (2007). All the weed management practices significantly influenced the yield attributes and yield of groundnut over unweeded control (Table 1, 2). The lowest pod yield and haulm yield were obtained in unweeded control. Besides, weed-free check treatment, treatment T_7 (pendimethalin + 1HW + imazethapyr) produced significantly highest pod (4147 kg ha^{-1}) and kernel yield (2996 kg ha^{-1}), followed by treatment T_6 (pendimethalin + 1HW + quizalofop ethyl) over rest of the treatments under study.

Table 1: Effect of weed control treatments on growth, yield attributes of groundnut

Treatments	Plant population ('000 ha^{-1})				No. of pods $plant^{-1}$				Pod Weight $plant^{-1}$ (g)				100 Kernel Weight (g)			
	2008	2009	2010	Mean	2008	2009	2010	Mean	2008	2009	2010	Mean	2008	2009	2010	Mean
T_1	157	149	165	157	8	9	9	9	15.6	15.1	15.7	15.4	67.1	76.8	73.5	72.4
T_2	214	209	231	218	19	28	28	25	32.1	49.3	49.8	43.7	75.5	88.1	83.4	82.3
T_3	199	197	219	205	18	25	25	23	32.6	43.2	43.3	39.7	77.2	89.7	85.2	84.0
T_4	166	168	186	174	9	16	16	14	19.3	27.0	27.8	24.7	70.1	86.0	78.6	78.2
T_5	162	164	180	169	11	22	22	18	21.9	35.3	34.6	30.6	70.4	87.1	83.1	80.2
T_6	201	196	218	205	17	27	26	24	30.3	43.5	42.2	38.2	77.3	86.7	82.4	82.1
T_7	201	199	210	203	18	29	28	25	29.9	47.3	48.0	41.7	76.7	87.4	83.1	82.4
T_8	197	192	213	200	16	26	27	23	28.1	40.8	44.7	37.8	75.2	84.1	80.3	79.8
SEm (±)	**4.9**	**5.1**	**8.1**		**0.8**	**1.0**	**0.8**		**3.1**	**1.8**	**1.8**		**2.6**	**1.6**	**1.5**	
LSD(0.05)	**15.1**	**15.8**	**24.6**		**2.3**	**3.0**	**2.4**		**9.6**	**5.6**	**5.4**		**NS**	**5.0**	**4.5**	
CV (%)	**4.5**	**4.9**	**6.9**		**9.2**	**7.4**	**6.2**		**20.0**	**8.4**	**8.1**		**6.0**	**3.3**	**3.1**	

Note: T_1 - unweeded control, T_2 - weed free check [hand weeding (HW) at 15,25,35 and 45D], T_3 – pre-emergence application of pendimethalin @ 1kg a.i. ha^{-1} + one HW at 45DAS, T_4 - quizalofop ethyl @ 50g a.i. ha^{-1} at 20DAS, T_5 - imazethapyr @ 50g a.i. ha^{-1} at 20DAS, T_6 - T_3 +T_4, T_7 - T_3 +T_5 and T_8 – farmer's practice (two HW at 20 and 35DAS)

Every year the lowest haulm (2051 kg ha^{-1}), pod (1606 kg ha^{-1}) and kernel yield (1103 kg ha^{-1}) of groundnut were recorded in unweeded control. Presence of weeds in the groundnut field revealed the losses varied from 61 - 63 %. This was in agreement with the findings of Pandian and Nambi (2002) and Meena and Mehta (2009). The pre-emergent application of pendimethalin accompanied with one hand weeding at 45DAS and application of imazethapyr @ 50g *a.i.* ha^{-1} at 20DAS (T_7) helped in controlling weed which in turn might have reduced weed crop competition for space, light, nutrients and

soil moisture. The treatment, therefore, resulted in higher growth and yield parameters which ultimately led to higher pod, haulm and kernel yield of groundnut. Similar results were also reported by Senthilkumar (2009), Meena and Chaudhary (2007). In general, crop growth was found better in the plots having weed control treatments than in weedy check treatment (Table 1, 2). It might be due to severe groundnut weed competition occurred in unweeded control treatment compared to weed control treatments throughout the growing period. As per Jhala *et al*. (2005), the weedy conditions in the unweeded control treatment reduced pod yield by 30 to 36 per cent as compared to integrated weed control method. Manickam *et al*. (2000) and Bhondve *et al*. (2009) also preferred integrated weed management as an effective tool for controlling weeds in groundnut.

Table 2: Effect of weed control treatments on yields of kernel, pod and haulm of groundnut

Treatments	Kernel yield (kg ha^{-1})				Pod yield (kg ha^{-1})				Haulm yield (kg ha^{-1})			
	2008	2009	2010	Mean	2008	2009	2010	Mean	2008	2009	2010	Mean
T_1	761	1554	993	1103	1238	2104	1478	1606	2296	2037	1820	2051
T_2	1759	4427	2777	2988	2564	5867	4034	4155	4750	6728	4783	5420
T_3	1729	4256	2700	2895	2477	5762	4012	4083	4620	6636	4845	5367
T_4	850	2551	1632	1677	1357	3427	2407	2397	2537	3302	2777	2872
T_5	1049	3565	2268	2294	1611	4731	3302	3214	3000	4537	3919	3818
T_6	1760	4271	2706	2912	2462	5734	2981	3725	4583	6605	4753	5313
T_7	1890	4348	2749	2996	2607	5805	4029	4147	4685	6607	4753	5348
T_8	1324	3688	2340	2450	2014	4970	3518	3509	3560	4780	4166	4168
SEm (±)	**48**	**146**	**96**		**65**	**166**	**144**		**110**	**176**	**125**	
LSD(0.05)	**148**	**451**	**292**		**200**	**513**	**346**		**338**	**544**	**381**	
CV (%)	**6.0**	**7.1**	**7.3**		**5.5**	**6.0**	**6.0**		**5.0**	**5.9**	**5.5**	

All the weed management practices significantly influenced the shelling and SMK (sound mature kernels) percentage over unweeded control (Table 3). The lowest shelling % and SMK % were obtained in unweeded control. Treatment T_7 produced significantly highest shelling (72.09) and SMK % (95.08), followed by treatment T_6 (pendimethalin @1kg *a.i.* ha^{-1} + 1 HW at 45DAS + quizalofop ethyl @ 50g *a.i.*ha^{-1} at 20DAS).

Table 3: Influence of weed control treatments on shelling and SMK percentage of groundnut

Treatments	Shelling (%)				SMK (%)			
	2008	2009	2010	Mean	2008	2009	2010	Mean
T_1	61.46	73.78	67.20	67.48	91.66	92.00	90.00	91.22
T_2	68.56	75.45	68.79	70.93	95.66	96.00	94.00	95.22
T_3	69.76	73.89	67.31	70.32	95.00	95.33	93.66	94.64
T_4	62.73	74.46	67.86	68.35	93.00	92.33	90.33	91.88
T_5	65.30	75.28	68.58	69.72	92.00	91.33	89.66	90.99
T_6	71.43	74.52	67.97	71.30	96.00	95.66	93.66	95.10
T_7	72.60	74.83	68.85	72.09	96.00	95.66	93.66	95.08
T_8	64.90	74.20	66.53	68.54	95.33	94.66	93.66	94.52
SEm (±)	**1.12**	**0.78**	**0.72**		**12**	**0.74**	**0.85**	
LSD(0.05)	**3.45**	**2.42**	**NS**		**NS**	**2.30**	**2.58**	
CV (%)	**2.88**	**1.82**	**1.84**		**5.19**	**1.37**	**1.59**	

Maximum weed dry matter accumulation of 5098 kg ha^{-1} was recorded in un-weeded control, which was significantly higher than other treatments (Table 4). Similar results were also reported by Meena and Mehta (2009), and Patel *et al.* (2007). Weed-free check plot recorded the lowest weed dry

matter accumulation at 30DAS and at harvest followed by T_7 (619 kg ha^{-1}). Quizalofop ethyl @ 50g a.i. ha^{-1} at 20 DAS was found less effective in reducing weed dry matter accumulation and weed control efficiency due to less control of weeds. The lowest weed density (number) was recorded in treatment T_7 being, 12.65 m^{-2} (Table 4). The highest weed control efficiency was observed in weed-free check (96.15% at 30 DAS and 94.90 % at harvest) due to continuous removal of weeds at 15, 25, 35 and 45 days after sowing (Table 5). Among all the weed management practices, maximum weed control efficiency of 88.25% was recorded in T_7. That was followed by weed control efficiency of 86.84% in T_6. The lowest weed control efficiency (49.95%) was recorded in T_4 (quizalofop ethyl @ 50g a.i. ha^{-1} at 20 DAS). Pendimethalin + one hand weeding + imazethapyr resulted in lowest weed index being, 0.19 (Table 5).

Table 4: Effect of treatments on weed density and weed dry matter accumulations of groundnut

Treatments	Weed density (No. m^{-2})								Weed dry matter accumulations (kg ha^{-1})							
	30 DAS				At harvest				30 DAS				At harvest			
	2008	2009	2010	Mean	2008	2009	2010	Mean	2008	2009	2010	Mean	2008	2009	2010	Mean
T_1	32.6	31.4	35.6	32.2	67.6	64.4	69.6	67.2	717	630	648	665	5322	4785	5186	5098
T_2	2.3	2.1	3.1	2.5	6.3	6.0	7.0	6.4	26	21	29	25	264	245	269	259
T_3	10. 8	11.1	13.8	11.9	20.2	22.2	24.0	22.2	37	25	27	30	2050	1870	1987	1969
T_4	31.1	33.0	39.0	34.4	35.1	34.5	37.3	35.6	233	233	264	243	2517	2460	2727	2568
T_5	30.4	26.3	32.2	29.6	32.0	27.3	29.6	29.6	174	166	179	173	1607	1570	1617	1598
T_6	11.5	9.8	11.6	11.0	15.5	15.1	16.4	15.7	41	37	44	41	743	610	691	681
T_7	10.5	11.1	14.0	11.9	13.8	11.6	12.5	12.7	46	34	40	40	637	557	663	619
T_8	12.6	10.9	12.9	12.1	15.6	13.6	14.7	14.6	50	40	46	45	735	750	863	783
SEm (±)	**0.6**	**0.5**	**2.1**		**0.8**	**2.5**	**2.5**		**10.99**	**11.67**	**1086**		**117**	**122**	**108**	
LSD(0.05)	**1.9**	**1.6**	**6.3**		**2.4**	**7.7**	**7.7**		**34**	**36**	**33**		**356**	**375**	**329**	
CV (%)	**5.7**	**5.0**	**17.7**		**5.0**	**16.6**	**16.6**		**11**	**12**	**12**		**12**	**12**	**11**	

Table 5: Effect of treatments on weed control efficiency and weed index of groundnut

Treatments	Weed control efficiency								Weed index			
	At 30DAS				At harvest							
	2008	2009	2010	Mean	2008	2009	2010	Mean	2008	2009	2010	Mean
T_1	-	-	-	-	-	-	-	-	51.7	64.1	63.4	61.3
T_2	96.4	96.6	95.2	96.2	95.0	94.9	94.8	94.9	-	-	-	-
T_3	94.8	95.4	95.8	95.4	61.5	90.9	61.7	61.4	3.4	1.8	0.5	1.7
T_4	67.5	65.4	59.3	64.0	52.7	48.6	48.6	50.0	47.1	41.6	40.3	42.3
T_5	75.7	74.7	72.4	74.3	69.8	67.2	67.2	68.1	37.2	19.4	18.1	22.6
T_6	94.3	94.2	93.2	93.9	86.0	87.3	87.3	86.8	4.0	2.3	26.1	10.3
T_7	93.6	94.1	93.8	93.8	88.0	88.4	88.4	88.3	-1.7	1.1	0.1	0.2
T_8	93.0	93.7	92.9	93.2	86.2	84.3	83.4	84.6	20.4	13.7	12.8	15.6

The cost of cultivation was maximum of ` 27895 $ha^{-1}$ in $T_7$. The gross return was also found maximum in this treatment. The higher gross return was due to higher pod and haulm yields. Treatment, $T_1$ (un-weeded control) led to record significantly minimum gross return of ` 48561 ha^{-1} in totality as it recorded less pod and haulm yield. The maximum net return (` 100417 ha^{-1}) and benefit:cost ratio (4.96:1) were obtained in T_3 (pendimethalin + 1 HW at 45DAS), and that was followed by T_7 (Table 6). The maximum B:C ratio under in T_3 was due to the maximum gross return with the lowest cost of cultivation associated with it. The un-weeded control treatment had the minimum B:C ratio (2.40:1). Similar result was also reported by Sardana *et al*. (2006).

Table 6: Effect of weed control treatments on economics of groundnut production
(Mean of 3 years)

Treatments	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1	48561	22123	26438	2.40
T_2	127718	27787	99931	4.59
T_3	125764	25347	100417	4.96
T_4	73314	24587	48727	2.98
T_5	98762	24587	74175	4.01
T_6	114287	27895	86392	4.09
T_7	127298	27895	99403	4.56
T_8	107323	24576	82747	4.36

Note: T_1 - unweeded control, T_2 - weed free check [hand weeding (HW) at 15,25,35 and 45DAS], T_3 – pre-emergence application of pendimethalin @ 1kg a.i. ha^{-1} + one HW at 45DAS, T_4 - quizalofop ethyl @ 50g a.i. ha^{-1} at 20DAS, T_5 - imazethapyr @ 50g a.i. ha^{-1} at 20DAS, T_6 - T_3 +T_4, T_7 - T_3 +T_5 and T_8 – farmer's practice (two HW at 20 and 35DAS)

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