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Economics of groundnut production as influenced by different weed management practices

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Abstract
The field experiment was conducted at the Main Agricultural Research Station (MARS) (15° 29′ 45″ N | 74° 59′ 19″ E | 700 m MSL), University of Agricultural Sciences, Dharwad (Karnataka) on medium black clay during two consecutive years (2015-16 and 2016-17) in *kharif-rabi.* To study the economics of groundnut production as influenced by different weed management practices. The treatments comprised of five different pre-emergence herbicides (Alachlor 50 % EC @ 3.00 l ai/ha, Pendimethalin 30 % EC @ 1.00 kg ai/ha, Butachlor 50 % EC @ 1.00 kg ai kg/ha, Pendimethalin 38.7 CS @ 750 g ai/ha and Oxyfluorfen 23.5 % EC @ 100 g ai/ha) and four post-emergence herbicides (Propaquizafop 10 % EC @ 100 g ai/ha, Quizalofop ethyl 5 % EC @ 50 g ai/ha, Fenoxaprop-p-ethyl 9.3 % EC @ 100 g ai/ha and Imazethapyr 10 % SL @ 100 g ai/ha) weed free and weedy check. In the present investigation, it was observed that, pre-emergence application of herbicides and weed free control treatments produced higher net monetary returns and higher B:C ratio over post-emergence application of herbicides and weedy check treatment. Among the different post-emergence herbicides, post-emergence application of Imazethapyr 10 % SL @ 100 ai/ha recorded lower net monetary returns and lower B:C ratio.

Keywords: Groundnut, weed and management

Introduction
Oilseeds occupy an important position in the world agricultural economy next to food grains. Among the oilseed crops, groundnut (*Arachis hypogaea* L.) is the world's fourth most important source of edible oil and third most important source of vegetable protein. In the world, the groundnut crop is grown in an area of 26.62 million hectare by 84 countries with an annual production of 35.66 million tonne of nuts-in-shell (pods) with a productivity of 1348 kg/ha. In India, it is grown in 11 states in an area of 4.19 million hectare with a production of 5.62 million tonne of pods/year. The average productivity of groundnut in India is about 1341 kg/ha as against the world's average yields of 1348 kg/ha (Anon., 2016) [1]. Eighty per cent of the total groundnut area in India is confined to five states (Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra).
The age-old practices of controlling weeds in groundnut by cultural practices (manual weeding and inter-cultivation), which although more effective, are time consuming, expensive and tedious. In addition, continuous / incessant rains during the early crop growth stages of these crops hinder the cultural methods of weed control. Under such situations, integrated weed management practices involving pre-plant / pre-emergence / post-emergence herbicides and cultural practices offer economically suitable alternative to manual weeding and cultural practices. In point of view the present study was conducted to know the Economics of groundnut production as influenced by different weed management practices.

Material and methods
The experiment was conducted at Main Agricultural Research Station (MARS) (15° 29′ 45″ N | 74° 59′ 19″ E | 700 m MSL), University of Agricultural Sciences, Dharwad (Karnataka) on medium black clay soil [Neutral pH (7.40 to 7.50), medium in available nitrogen and phosphorus (290.64 to 301.56 kg N/ha and 27.63 to 28.23 kg P_2O_5/ha, respectively), high in available potassium (384.37 to 386.32 kg K_2O/ha), medium in organic matter content (7.55 to 7.60 g/kg) and normal in salt content (0.25 dS/m)] during two consecutive years (2015-16 and 2016-17) in *kharif-rabi*.

The experiment consist groundnut (cv. JL 24, early maturing, drought tolerant and high yielding) and eleven Weed management practices involving five pre-emergence herbicides (Alachlor 50 % EC @ 3.00 l ai/ha, Pendimethalin 30 % EC @ 1.00 kg ai/ha, Butachlor 50 % EC @ 1.00 kg ai/ha, Pendimethalin 38.7 CS @ 750 g ai/ha and Oxyfluorfen 23.5 % EC @ 100 g ai/ha), four post-emergence herbicides (Propaquizafop 10 % EC @ 100 g ai/ha, Quizalofop ethyl 5 % EC @ 50 g ai/ha, Fenoxaprop-p-ethyl 9.3 % EC @ 100 g ai/ha and Imazethapyr 10 % SL @ 100 g ai/ha), weed free control treatment and weedy check control treatment] and was laid out Randomized Complete Block Design (RCBD) with three replications. During both the years of experimentation (2015 and 2016), recommended rates of nitrogen, phosphorus and potassium fertilizers 25 kg N, 75 kg P_2O_5 and 25 kg K_2O were applied to groundnut during *kharif*.

Result and discussion

Weed flora of the experimental field

In general, the weed flora in crops varies with weather situation, type of soil, crop cultivars, growing region and growing season. At Dharwad, differential weed flora was observed both in groundnut. Major annual grass (monocot) weeds observed in the experimental field during *kharif* 2015and 2016 were *Digitaria marginata* Link var. *fimbriate* Stap f. *Dinebra retroflexa* (Vahl.) Panz. *Setaria* spp., *Eleusine indica* Gaertn., *Echinochloa colona* (L.) Link, *Pannicum* spp. and *Cynodon dactylon* (L.) Pers. Major annual (broad leaf) weeds observed in the experimental field during *kharif* 2015 and 2016 were *Commelina subulata* Roth., *Commelina benghalensis* L., *Euphorbia hirta* L., *Parthenium hysterophorus* L., *Sida acuta* Burm. f., *Convovulus arvensis* L., *Cyanotis cucullata* (Roth) Kunth, *Portulaca oleracea* L., *Mollugo pentaphylla, Corchorus olitorius, Phyllanthus niruri, Sonchus arvensis* L., *Lactuca serriola,* and *Alternanthera sessilis*. Among the sedges, *Cyperus rotundus* was observed in the experimental field. Further, it was observed that during both the years of experimentation, *P. hysterophorus* L. was dominated the weed flora of groundnut.

In the present investigation, it was observed that, among the treatments which received pre-emergence application of Alachlor 50 % EC @ 3.00 l ai/ha was more effective in reducing number of annual grassy and annual broad leaf weeds at 65 DAS. In general, all the pre-emergence herbicides were more effective in reducing annual grassy and annual broad leaf weeds right from the emergence of groundnut and provided relatively greater weed free environment throughout the season. Similar findings were reported earlier by Jain *et al.* (2000), Pandey and Padhiar (2000) [7] and Dutta *et al.* (2005) [3].

Among the weed management practices which received different post-emergence herbicides in groundnut, the application of Quizalofop-ethyl 5 % EC @ 50 g ai/ha, Propaquizafop 10 % EC @ 100 g ai/ha and Fenoxaprop-p-Ethyl 9.3 % @ 100 g ai/ha were more effective in reducing annual grassy weeds whereas, annual broad leaved weeds were unaffected by these treatments. On the contrary, post-emergence application of Quizalofop-ethyl 5 EC @ 50 g ai/ha, Propaquizafop 10 % EC @ 100 g ai/ha and Fenoxaprop-p-Ethyl 9.3 % @ 100 g ai/ha reduced the population of annual grassy weeds by killing them completely. However, the post-emergence application of Imazethapyr 10 % SL 100 g ai/ha significantly reduced the growth and development of both annual grassy and annual broad leaf weeds but did not kill completely instead snubbed them. Annual grassy weeds showed regeneration in treatment which received post-emergence application of Imazethapyr 10 % SL 100 g ai/ha. Post-emergence application of Imazethapyr 10 % SL 100 g ai/ha in groundnut. Among the different weed management practices, weedy check treatment recorded higher number of monocot weeds whereas, sedges were not affected by both pre and post-emergence herbicides. Malligawad *et al*. (2016) [6] also obtained similar results with the use of above post-emergence herbicides in groundnut.

Weed control efficiency at 65 DAS

Weed control efficiency at 65 DAS varied significantly due to different weed management practices. Among the treatments which received pre-emergence herbicides in groundnut, the application of Alachlor 50 % EC @ 3.00 l ai/ha recorded higher weed control efficiency (97.96 %). Weed control efficiency with pre-emergence application of Pendimethalin 30 % EC @ 1.00 kg ai/ha, Butachlor 50 % EC @ 1.00 kg ai/ha, Pendimethalin 38.7 % CS @ 750 g ai/ha, and Oxyfluorfen 23.5 % EC @ 100 g ai/ha was 96.22, 97.19, 96.47, 97.10 and 97.86 per cent in groundnut, respectively. Among the treatments which received post-emergence herbicides in groundnut, the application of Imazethapyr 10 % SL @ 100 g ai/ha recorded higher weed control efficiency (82.88 %,). Weed control efficiency in groundnut recorded with post-emergence application of Quizalofop-ethyl 5 % EC @ 50 g ai/ha, Propaquizafop 10 % EC @ 100 g ai/ha and Fenoxaprop-p-Ethyl 9.3 % EC @ 100 g ai/ha was 56.69, 49.48, 54.03 and 82.88 per cent in groundnut, respectively. Higher weed control efficiency in groundnut crops was observed with application of pre-emergence herbicides (96.22 to 97.93 %, respectively) as compared to post- emergence herbicides (49.48 to 82.88 %, respectively).

Among the treatments which received pre-emergence herbicides in groundnut \, the application of Butachlor 50 % EC @ 1.00 kg ai/ha in groundnut recorded lower weed index (4.97). Pre-emergence application of Pendimethalin 30 % EC @ 1.00 kg ai/ha, Butachlor 50 % EC @ 1.00 kg ai/ha, Pendimethalin 38.7 % CS @ 750 g ai/ha, and Oxyfluorfen 23.5 % EC @ 100 g ai/ha was 9.01, 5.46, 9.15 and 6.72, respectively. Such differences in the weed index due to the application of pre-and post-emergence herbicides similar resultes were earlier noticed by Dubey and Gangwar (2012) [2], Pratap *et al.* (2014) [8] and Malligawad *et al*. (2016) [6]. Among the treatments which received post-emergence herbicides in groundnut, the application of Imazethapyr 10 % SL @ 100 g ai/ha recorded higher weed index in groundnut (25.15 %) whereas, post-emergence application of Quizalofop-ethyl 5 % EC @ 50 g ai/ha, Propaquizafop 10 % EC @ 100 g ai/ha and Fenoxaprop-p-Ethyl 9.3 % EC @ 100 g ai/ha recorded 10.00 and 15.27, 10.71 and 8.61 and 11.24 and 15.08, respectively. Such differences in the weed index due to the application of pre-and post-emergence herbicides in groundnut reported earlier by Smita *et al.* (2015) [12] and Malligawad *et al*. (2016) [6].

Dry pod and kernel yield of groundnut was significantly influenced by different pre and post-emergence herbicides and other weed management practices. Significantly higher dry pod yield of groundnut and higher kernel yield of groundnut were noticed with weed free control treatment (4091 and 3118 kg/ha, respectively) as compared to weedy check (3245 and 2381 kg/ha, respectively). Pre-emergence application of Alachlor 50 % EC @ 3.00 l ai/ha, Pendimethalin 30 % EC @ 1.00 kg ai/ha, Butachlor 50 % EC @ 1.00 kg ai/ha, Pendimethalin 38.7 % CS 750 g ai/ha and

Oxyfluorfen 23.5 % EC 100 g ai/ha produced higher dry pod yield and higher kernel yield of groundnut (3889, 3723, 3862, 3718 and 3805 kg dry pod yield/ha, respectively and 2911, 2764, 2866, 2764 and 2845 kg kernel yield/ha, respectively) as compared to weed free check treatment (4091 and 3118 kg dry pod and kernel yield/ha, respectively). Post-emergence application of Quizalofop-ethyl 5 EC @ 50 g ai/ha, Propaquizafop 10 % EC 100 g ai/ha, Fenoxaprop-p-ethyl 9.3 % EC 100 g ai/ha and Imazethapyr 10 % SL 100 g ai/ha produced higher dry pod and higher kernel yield of groundnut (3684, 3649, 3630 and 3049 kg dry pod yield/ha, respectively and 2707, 2699, 2685 and 2206 kg kernel yield/ha, respectively) as compared to weedy check treatment (3245 and 2381 kg dry pod and kernel yield/ha, respectively) (Table 1).

Seed yield of soybean was also significantly influenced by different pre and post-emergence herbicides and other weed control treatments. Significantly higher seed yield of soybean was noticed with weed free control treatment (2842 kg/ha) as compared to weedy check (2172 kg/ha). Pre-emergence application of Alachlor 50 % EC @ 3.00 l ai/ha, Pendimethalin 30 % EC @ 1.00 kg ai/ha, Butachlor 50 % EC @ 1.00 kg ai/ha, Pendimethalin 38.7 % CS 750 g ai/ha and Oxyfluorfen 23.5 % EC 100 g ai/ha produced higher seed yield of soybean (2591, 2450, 2421, 2411 and 2412 kg/ha, respectively) as compared to weed free check treatment (2842 kg/ha). Post-emergence application of Quizalofop-ethyl 5 % EC @ 50 g ai/ha, Propaquizafop 10 % EC 100 g ai/ha, Fenoxaprop-p-ethyl 9.3 % EC 100 g ai/ha and Imazethapyr 10 % SL 100 g ai/ha produced higher seed yield of soybean (2399, 2607, 2401 and 2066 kg/ha, respectively) as compared to weedy check treatment (2172 kg/ha) (Table 1).

Table 1: Dry pod yield and kernel yield of groundnut and seed yield of soybean at harvest as influenced by weed management treatments (*kharif* 2015, *kharif* 2016 and pooled)

Treatments		Dry pod yield (kg/ha)			kernel yield (kg/ha)			Seed yield (kg/ha)		
		2015	2016	POOLED	2015	2016	POOLED	2015	2016	POOLED
T 1	Pre-emergence application of Alachlor 50 % EC @ 3.00 l ai/ha	4144	3635	3889	3153	2669	2911	2450	2733	2591
T 2	Pre-emergence application of Pendimethalin 30 % EC @ 1.00 kg ai/ha	3931	3516	3723	2967	2561	2764	2119	2780	2450
T 3	Pre-emergence application of Butachlor 50 % EC @ 1.00 kg ai/ha	3971	3753	3862	2996	2736	2866	2164	2678	2421
T 4	Pre-emergence application of Pendimethalin 38.7 % CS @ 750 g ai/ha	3964	3473	3718	3007	2521	2764	2334	2488	2411
T 5	Pre-emergence application of Oxyfluorfen 23.5 % EC @ 100 g ai/ha	3822	3788	3805	2894	2796	2845	2205	2619	2412
T 6	Post-emergence application of Quizalofop ethyl 5 % EC @ 50 g ai/ha	3874	3493	3684	2901	2513	2707	2192	2607	2399
T 7	Post-emergence application of Propaquizafop 10 % EC @ 100 g ai/ha	3787	3512	3649	2845	2553	2699	2255	2960	2607
T 8	Post-emergence application of Fenoxaprop-p-ethyl 9.3 % EC @ 100 g ai/ha	3801	3459	3630	2841	2528	2685	2175	2628	2401
T 9	Post-emergence application of Imazethapyr 10 % SL @ 100 g ai/ha	2945	3152	3049	2172	2241	2206	1829	2303	2066
T 10	Weed free control (Situation based hand weeding and inter-cultivation)	4287	3896	4091	3283	2953	3118	2681	3002	2842
T 11	Weedy check (No weed control)	3637	2853	3245	2674	2088	2381	1967	2377	2172
Mean		3833	3503	3668	2885	2560	2722	2216	2652	2434
S.Em±		134.91	167.56	97.69	104.65	123.39	73.99	137.819	133.523	101.176
LSD (p=0.05)		398.00	494.30	288.17	308.71	364.00	218.28	406.57	393.	298.47

Table 2: Cost of cultivation and Gross monetary returns of groundnut as influenced by weed management practices (*kharif* 2015, *kharif* 2016 and pooled)

Treatment		Groundnut					
		Cost of cultivation(Rs/ha)			Gross monetary returns (Rs/ha)		
		2015	2016	Pooled	2015	2016	Pooled
T 1	Pre-emergence application of Alachlor 50 % EC @ 3.00 l ai/ha	38182	38182	38182	157457	138130	147793
T 2	Pre-emergence application of Pendimethalin 30 % EC @ 1.00 kg ai/ha	36880	36880	36880	149363	133621	141492
T 3	Pre-emergence application of Butachlor 50 % EC @ 1.00 kg ai/ha	36060	36060	36060	150890	142601	146746
T 4	Pre-emergence application of Pendimethalin 38.7 % CS @ 750 g ai/ha	37425	37425	37425	150617	131961	141289
T 5	Pre-emergence application of Oxyfluorfen 23.5 % EC @ 100 g ai/ha	36743	36743	36743	145225	143931	144578
T 6	Post-emergence application of Quizalofop ethyl 5 % EC @ 50 g ai/ha	37460	37460	37460	147208	132747	139977
T 7	Post-emergence application of Propaquizafop 10 % EC @ 100 g ai/ha	37390	37390	37390	143891	133443	138667
T 8	Post-emergence application of Fenoxaprop-p-ethyl 9.3 % EC @ 100 g ai/ha	37390	37390	37390	144438	131442	137940
T 9	Post-emergence application of Imazethapyr 10 % SL @ 100 g ai/ha	37540	37540	37540	111925	119763	115844
T 10	Weed free control (Situation based hand weeding and inter-cultivation)	42729	42729	42729	162912	148035	155474
T 11	Weedy check (No weed control)	35740	35740	35740	138202	108427	123314
Mean		-	-	-	145648	133100	139374
S.Em±		-	-	-	5126.763	6367.209	3712.041
LSD (p=0.05)		-	-	-	15123.94	18783.25	10950.51

Table 3: Net monetary returns (Rs /ha) and B:C ratio of groundnut as influenced by weed management practices (*kharif* 2015, *kharif* 2016 and pooled)

Treatment		Groundnut					
		Net monetary returns (Rs /ha)			B:C		
		2015	2016	Pooled	2015	2016	Pooled
T 1	Pre-emergence application of Alachlor 50 % EC @ 3.00 l ai/ha	119275	99948	109611	4.12	3.62	3.87
T 2	Pre-emergence application of Pendimethalin 30 % EC @ 1.00 kg ai/ha	112483	96741	104612	4.05	3.62	3.84
T 3	Pre-emergence application of Butachlor 50 % EC @ 1.00 kg ai/ha	114830	106541	110686	4.18	3.95	4.07
T 4	Pre-emergence application of Pendimethalin 38.7 % CS @ 750 g ai/ha	113192	94536	103864	4.02	3.53	3.78

T 5	Pre-emergence application of Oxyfluorfen 23.5 % EC @ 100 g ai/ha	108482	107188	107835	3.95	3.92	3.93
T 6	Post-emergence application of Quizalofop ethyl 5 % EC @ 50 g ai/ha	109748	95287	102517	3.93	3.54	3.74
T 7	Post-emergence application of Propaquizafop 10 % EC @ 100 g ai/ha	106501	96053	101277	3.85	3.57	3.71
T 8	Post-emergence application of Fenoxaprop-p-ethyl 9.3 % EC @ 100 g ai/ha	107048	94052	100550	3.86	3.52	3.69
T 9	Post-emergence application of Imazethapyr 10 % SL @ 100 g ai/ha	74385	82223	78304	2.98	3.19	3.09
T 10	Weed free control (Situation based hand weeding and inter-cultivation)	120183	105306	112745	3.81	3.46	3.64
T 11	Weedy check (No weed control)	102462	72687	87574	3.87	3.03	3.45
Mean		108054	95506	101780	3.88	3.54	3.71
S.Em±		5126.76	6367.21	3712.04	0.137	0.171	0.099
LSD (p=0.05)		15123.94	18783.25	10950.51	0.40	0.51	0.29

Pooled: Mean of kharif 2015 and kharif 2016
DAS: Days after sowing

Economics

Among all the treatments, weed free check produced significantly higher gross monetary returns in groundnut (₹ 1,55,474) as compared to weedy check treatment (₹ 1,23,314), weed management practice involving pre-emergence application of herbicides (₹ 1,41,289 to 1,47,793,) and weed management practice involving post-emergence application of herbicides (₹ 1,15,844 to 1,39,977). Among the weed management practices involving either pre-emergence herbicide application or post-emergence herbicide application in groundnut, post-emergence application of Imazethapyr 10 % SL @ 100 ai/ha produced lowest gross monetary return (₹ 1,15,844). Similar results also reported by Singh *et al.* (1994). Similarly, weed free check treatment produced significantly higher net monetary returns in groundnut (₹ 1,12,745) as compared to weedy check treatment (₹ 87,574), weed management practice involving pre-emergence application of herbicides (₹ 1,03,864 to 1,09,611) and weed management practice involving post-emergence application of herbicides (₹ 78,304 to 1,02,517). Among the weed management practices involving either pre-emergence herbicide application or post-emergence herbicide application in groundnut post-emergence application of Imazethapyr 10 % SL @ 100 ai/ha produced lowest net monetary returns (₹ 78,304). These results conformity with the results obtained earlier by Malligawad *et al.*, (2000) [5], Sardana *et al.*, (2006) [9], Chaitanya *et al.* (2010) and Sudha *et al.* (2016). Weed free check treatment produced significantly higher B: C ratio in groundnut production (3.64) as compared to weedy check treatment (3.45), weed management practice involving pre-emergence application of herbicides (3.78 to 4.07) and weed management practice involving post-emergence application of herbicides (3.09 to 3.74). Post-emergence application of Imazethapyr 10 % SL @ 100 ai/ha produced lowest B:C ratio (3.09). Thus, it can be concluded that weed management practices involving pre-emergence application of herbicides produced higher net monetary returns and higher B:C ratio over post-emergence application of herbicides and weedy check treatment the results in line with Gnanmurthy and Balasubramaniyan (1998) [4], Malligawad *et al.* (2000) [5] and Sardana *et al*. (2006) [9]. Weed free control treatment with manual weeding and inter-cultivation produced higher net monetary returns and lower B:C ratio. Among the different weed management practices involving in groundnut, post-emergence application of Imazethapyr 10 % SL @ 100 ai/ha in produced lower net monetary returns and lower B:C ratio.

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