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Economic Analysis of Groundnut Based Cropping Systems

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A B S T R A C T

A field experiment was carried out during 2011-12 and 2012-13 at MPKV, Rahuri (M.S.), to evaluate the groundnut based cropping systems (groundnut-onion, groundnut-wheat and groundnut-chickpea) under different nutrient management treatments. The yield target of 25 q ha^{-1} was achieved in *kharif* groundnut by application of fertilizer as per STCR (23.08 and 24.49 q ha^{-1}) equation with less than 10 % variation during both years of experimentations. Among the cropping systems, groundnut–onion cropping system recorded significantly maximum total system productivity (67.21 and 89.17 q ha^{-1}), production efficiency (30.16 and 39.96 kg ha^{-1} day^{-1}) and economic efficiency (Rs. 620.66 and 1064.26 ha^{-1} day^{-1}) than rest of the cropping systems. Similarly, groundnut- onion cropping system obtained significantly maximum gross monetary returns (Rs. 2,31,903 and Rs. 3,34,409 ha^{-1}), net monetary returns (Rs. 1,38,207 and Rs. 2,37,982 ha^{-1}) and B:C ratio (2.84 and 3.47) than rest of cropping systems.

Introduction

In recent years, stagnation in system productivity due to continuous cultivation of cereal-cereal cropping system, reduction in profitability and decline in soil health has been experienced. Inclusion of legume in a crop sequence not only takes care of soil health but also gives higher yield and economic returns to the farmers. In India, groundnut is essential and mostly adopted oilseed crop. The studies on different nutrient management treatments in *kharif* crops and its residual effects on *rabi* crops is necessary to increase yield and profitability of groundnut based cropping system. The targeted yield concept has also proved to be superior to others whose theoretical basis and proof was demonstrated by Ramamoorthy *et al.*, (2009). For that purpose, study was undertaken two consecutive years with increase the production potential and economic analysis of groundnut based cropping systems.

Materials and Methods

A field experiment was carried out during 2011-12 and 2012-13 at MPKV, Rahuri (M.S.) on sandy clay loam soil with low in available nitrogen (172.11 kg ha^{-1}), medium in available phosphorus (18.02 kg ha^{-1}) and high in available potassium (427.0 kg ha^{-1}) and moderate in Fe (6.89 µg g^{-1} soil), Mn (9.51 µg g^{-1}soil), Zn (0.62 µg g^{-1} soil) and Cu (3.41 µg g^{-1} soil). The soil was moderately alkaline in reaction (pH 8.2). The electrical conductivity,

organic carbon and $CaCO_3$ were 0.29 dSm^{-1}, 0.54 and 4.50 %, respectively.

The treatment consist of three cropping systems *viz.,* C_1-groundnut-onion, C_2-groundnut-wheat and C_3- groundnut-chickpea with four nutrient management treatments *viz.,* T_1- recommended dose of fertilizer, T_1-fertilizer dose as per soil test, T_1- fertilizer dose as per STCR equations and control as main plot treatment whereas three fertilizer levels *viz.,* F_1-100 % RDF, F_2-75% RDF and F_3- 50 % RDF as sub plot treatments. The experiment was laid out in a strip plot design with three replications. Groundnut JL- 501, onion N 2-4-1, wheat- Trimbak and chickpea-Digvijay these cultivators were used during *kharif* and *rabi* seasons, respectively. Both the year's crop seasons were favourable to grow the *kharif* and *rabi* crops. For comparison between crop sequences, the yields of all crops were converted groundnut equivalent on price basis. The production efficiency value in terms of kg $ha^{-1}day^{-1}$ was calculated dividing the production of the sequence by total duration of sequence and economic efficiency in terms of Rs. $ha^{-1}day^{-1}$ was obtained by net return of sequence divided by total duration of sequence (Kumpawat, 2001). The recommended packages of practices were adopted to grow the crops and fertilizers were applied as per treatments.

Results and Discussion

Production potential of *kharif* crop

Application of fertilizer as per STCR equation to *kharif* groundnut recorded maximum and significantly higher dry pod yield (23.08 and 24.49 q ha^{-1}) than rest of treatments during first year and second year. The yield target of 25 q ha^{-1} was achieved by STCR equation with less than 10 % variation. The fertilizer dose as per soil test was found second best treatment (18.91 and 19.59 q ha^{-1}) during both years experimentation (Table 1). This is because of the balanced nutrition through yield target approach increases the photosynthetic rate and translocation of photosynthates towards reproductive parts of groundnut (pods). Similarly, the groundnut being a legume crop having more nitrate reductase activities in root which is beneficial for peg formation and pod development stage. These results are in conformity with the results obtained by Dudhatra *et al.,* (2002) and Varalakshmi *et al.,* (2005).

Production potential of *Rabi* crops

Onion

Data presented in Table 1, indicated that application of fertilizer as per STCR equation to preceding crop *kharif* groundnut registered maximum and significantly higher yield of onion bulb (58.85 and 60.67 t ha^{-1}) and it was 10.26 and 8.90 % higher than recommended dose of fertilizer during first year and second year. Application of fertilizer as per soil test was found in second rank (54.86 and 56.52 t ha^{-1}).

Application of higher level of fertilizer (100 % RDF) to succeeding onion crop preceded by *kharif* groundnut registered significantly higher bulb yield (48.03 and 49.75 t ha^{-1}) and it was 4.52 and 4.38 per cent higher than 75 % recommended dose of fertilizer and it was 15.45 and 17.80 % higher than 50 % recommended dose of fertilizer during first year and second year (Table 2). This might be because of the residual effect of preceding crop maintaining soil organic matter, major and micronutrients, which increases the uptake of these nutrients and accelerating the physiological activities in crop for improving growth attributes. Similarly, it was also increases the translocation of photosynthates towards onion bulb resulted in increasing the size (polar and equatorial diameter) and

weight of bulb. These results are in conformity with those reported by Konde (2002), Reddy and Suresh (2009) and Jat *et al.,* (2011).

Wheat

Application of fertilizer as per STCR equation to preceding crop *kharif* groundnut recorded significantly higher grain yield (42.13 and 43.11 q ha^{-1}) of wheat and it was 7.91 and 8.64 % higher than recommended dose of fertilizer on 2011-12 and 2012-13 (Table1).

Application of 100 % recommended dose of fertilizer to wheat crop during *rabi* season recorded significantly maximum grain yield (35.98 and 36.82 q ha^{-1}) and it was 16.40 and 13.32 % higher in I^{st} and II^{nd} year than reduced level of fertilizer i.e. 50 % recommended dose of fertilizer but at par with 75 % recommended dose of fertilizer during both years. This indicate that growing of wheat crop after *kharif* groundnut saves 25 % recommended dose of fertilizer because of balance nutrition to *kharif* groundnut through STCR equation creates favourable environment in the root rhizosphere of wheat crop to absorb more nutrients and moisture by improving the nutrient use efficiency. These results are in corroborated with Verma *et al.,* (2005), Ramesh *et al.,* (2009) and Mubarak and Singh (2011).

Chickpea

Application of fertilizer as per STCR equation to preceding crop *kharif* groundnut recorded significantly maximum grain yield of chickpea (28.62 and 29.28 q ha^{-1}) than rest of treatments during the period of investigation, however it was at par with fertilizer dose as per soil test during second year of experimentation.

Application of 100 % recommended dose of fertilizer to chickpea during *rabi* season recorded significantly maximum grain yield (26.41 and 26.49 qha^{-1}) and it was 29.27 and 25.30 % higher grain yield than 50 % recommended dose of fertilizer during first year and second year, respectively. However, it was at par with 75 per cent recommended dose of fertilizer in respect of grain yield during both year of experiment (Table 1). This might be because of beneficial residual effect of *kharif* groundnut by fixing the atmospheric nitrogen through biological means and which may be available to mineralization of plant residues there by increases the yield of succeeding crop. These results are in accordance with Rao and Shakatwat (2002), Ramesh *et al.,* (2009) and Singh *et al.,* (2010).

Total system productivity

The total system productivity of cropping systems was assessed based on groundnut equivalent yield in groundnut–onion, groundnut-wheat and groundnut-chickpea cropping systems. Among the cropping systems, groundnut–onion cropping system recorded significantly maximum total system productivity of 67.21 and 89.17 q ha^{-1} and it was 115.48 and 160.12 % higher than groundnut-wheat and 68.19 and 116.43 per cent higher than groundnut-chickpea during first year and second year (Table 2 and Fig. 1).

The nutrient management as per STCR equation proved it's superiority by recording maximum total system productivity of 60.91 and 72.86 q ha^{-1} and it was followed by nutrient management as per soil test during both years.

The total system productivity was significantly higher with 100 % recommended dose of fertilizer to succeeding crop during *rabi* season and at par with 75 % recommended dose of fertilizer during both the years. These results are in accordance with Ramesh *et al.,* (2009), Jat *et al.,* (2011), and Mukundam *et al.,* (2012).

Table.1 Yield of component crops in different cropping systems as influenced by different treatments

Treatment	Groundnut pod yield (q ha^{-1})		Onion bulb yield (t ha^{-1})		Wheat grain yield (q ha^{-1})		Chickpea grain yield (q ha^{-1})	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Nutrient management (T)								
T_1 – Recommended dose of fertilizer	16.43	17.61	53.37	55.71	39.04	39.68	25.64	26.34
T_2 –Fertilizer dose as per soil test	18.91	19.59	54.86	56.52	40.15	41.49	26.37	27.43
T_3- Fertilizer dose as per STCR eq^{n} (25 qha^{-1})	23.08	24.49	58.85	60.67	42.13	43.11	28.62	29.28
T_4-Control (No fertilizer)	7.96	6.63	13.68	13.28	13.47	12.66	14.01	13.06
SEm ±	0.59	0.52	0.76	0.82	0.26	0.38	0.27	0.59
C.D. (0.05)	1.71	1.54	2.64	2.83	0.91	1.33	0.95	2.05
B. Fertilizer levels (F)								
F_1-100% of RDF	--	--	48.03	49.75	35.98	36.82	26.41	26.49
F_2-75% of RDF	--	--	45.95	47.66	34.21	35.41	24.15	24.46
F_3-50% of RDF	--	--	41.60	42.23	30.91	32.49	20.43	21.14
SEm ±	--	--	0.52	0.68	0.39	0.46	0.37	0.36
C.D. (0.05)	--	--	2.05	2.65	1.54	1.79	1.46	1.42

Table.2 The productivity of different cropping systems as influenced by different treatments

Treatment	Total system productivity (q ha^{-1})		Production efficiency (kg ha^{-1} day^{-1})		Economic efficiency (Rs. ha^{-1} day^{-1})	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
A. Cropping system (C)						
C_1- Groundnut-onion	67.21	89.17	30.16	39.96	620.66	1064.26
C_2- Groundnut-wheat	31.19	34.28	14.34	15.67	166.09	252.63
C_3- Groundnut-chickpea	39.96	41.20	18.94	19.61	327.32	399.66
SEm ±	0.39	0.56	0.18	0.26	6.68	9.66
CD (0.05)	1.14	1.66	0.53	0.75	20.13	28.35
B. Nutrient management (T)						
T_1 – Recommended dose of fertilizer	50.32	61.85	23.17	28.45	422.98	681.73
T_2 –Fertilizer dose as per soil test	53.74	64.92	24.60	29.56	474.61	721.74
T_3- Fertilizer dose as per STCR eq^{n} (25 q ha^{-1})	60.91	72.86	27.63	32.87	578.11	848.56
T_4-Control (No Fertilizers)	19.53	19.91	9.18	9.44	9.74	36.72
SEm ±	0.45	0.65	0.21	0.29	7.92	11.15
C.D. (0.05)	1.32	1.92	0.61	0.87	23.25	32.73
C. Fertilizer levels (F)						
F_1- 100% of RDF	47.68	57.18	21.84	26.40	391.75	607.80
F_2- 75% of RDF	47.12	56.40	21.61	25.49	386.92	597.72
F_3- 50% of RDF	43.58	51.07	19.99	23.34	335.41	511.04
SEm ±	0.44	0.33	0.20	0.32	6.94	5.65
C.D. (0.05)	1.25	0.94	0.57	0.95	19.76	16.08

Table.3 Economics of different cropping systems as influenced by different treatments

Treatment	Gross monetary returns (Rs. ha^{-1})		Cost of cultivation (Rs. ha^{-1})		Net monetary returns (Rs. ha^{-1})		B:C ratio	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
A. Cropping system (C)								
C_1- Groundnut-onion	231903	334409	93696	96426	138207	237982	2.48	3.47
C_2- Groundnut-wheat	107622	128550	71156	72993	36465	55557	1.51	1.76
C_3- Groundnut-chickpea	137887	154535	67769	70252	70118	84282	2.05	2.16
SE m ±	1349	2130	----	---	1349	2129	---	---
CD (0.05)	3960	6248	----	---	3958	6247	---	---
B. Nutrient management (T)								
T_1 – Recommended dose of fertilizer	173601	231969	81112	83369	92490	148599	2.14	2.78
T_2 –Fertilizer dose as per soil test	185431	243449	81223	84489	104208	158959	2.29	2.88
T_3- Fertilizer dose as per STCR eq^n (25 q ha^{-1})	210156	273232	82491	84754	127665	188477	2.58	3.22
T_4-Control (No fertilizers)	67361	74675	65337	66948	2024	7727	1.03	1.11
SE m ±	1558	2459	----	----	1558	2458	----	----
C.D. (0.05)	4573	7215	----	----	4570	7213	----	----
C. Fertilizer levels (F)								
F_1- 100% of RDF	164493	214458	78401	80769	86092	133688	2.10	2.65
F_2- 75% of RDF	162564	211504	77540	79890	85023	131614	2.09	2.64
F_3- 50% of RDF	150355	191531	76680	79011	73674	112519	1.96	2.42
SE m ±	1519	1241	---	----	1519	2198	----	----
C.D. (0.05)	4322	3530	---	---	4322	6594	---	----

Table.4 Details of prices used for economic evaluation

Sr. No.	Particulars	Prices	
		2011-12	**2012-13**
1	Ploughing (Rs. $ha^{-1)}$	2500.00	2500.00
2	Rotavator (Rs. ha^{-1})	2250.00	2250.00
3	Labour charges (Rs. ha^{-1} $head^{-1}$)	146.00	149.00
4	Cost of seed (Rs. $kg^{-1)}$		
i	Groundnut	87.00	88.00
ii	Onion	1000.00	1000.00
iii	Wheat	22.00	25.75
IV	Chickpea	22.50	51.00
5	Cost of chemical fertilizers ($Rs.kg^{-1)}$		
i	Urea	5.62	5.62
ii	Single super phosphate	7.40	7.40
Iii	Muriate of potash	17.80	17.80
iv	Di ammonium phosphate	16.80	23.66
6	Cost of biofertilizer and biopesticide (Rs. $kg^{-1)}$		
i	Azatobacter	40.00	40.00
ii	PSB	60.00	60.00
iii	Rhizobium	40.00	40.00
iv	Trichoderma	150.00	150.00
7	Farm yard manure (Rs. $t^{-1)}$	1200.00	1200.00
8	Insecticide and pesticides (Rs. $L^{-1,}$ kg^{-1})		
i	50 % WP *Carbendezium* (Bavistin)	1160.00	1160.00
ii	*Tebuconozole* 25.9 % EC (Folicur)	1700.00	1700.00
iii	50 % EC *Prophenophos* (Curacron)	430.00	430.00
iv	*Chloropyriphos* 20 % EC	330.00	400.00
v	*Imidachloprid* @17.8% (Confidor)	1500.00	1944.00
9	Irrigation Charges (Rs. ha^{-1} $turn^{-1)}$	400.00	400.00
10	Land rent($Rs.ha^{-1}$ $year^{-1}$)	225.00	225.00
11	Selling rate of Main produce ($Rs.q^{-1)}$		
i	Groundnut	3450.00	3750.00
ii	Wheat	1400.00	1800.00
iii	Chickpea	3300.00	3600.00
iv	Onion	360.00	600.00
12	By produce (Rs. q^{-1})		
i	Groundnut haulm	55.00	100.00
ii	Wheat straw	20.00	30.00
iii	Chickpea straw	60.00	100.00

Production efficiency

Among the cropping systems, groundnut–onion cropping system registered significantly higher production efficiency (30.16 and 39.96 kg ha^{-1} day^{-1}) than groundnut-wheat and groundnut-chickpea cropping systems during both the years of experimentation. The groundnut-wheat cropping system registered significantly lowest on production efficiency (14.34 and 15.67 kg ha^{-1} day^{-1}) during both the years.

The nutrient management treatments as per STCR equation registered significantly higher production efficiency of 27.63 and 32.87 kg ha^{-1} day^{-1} and it was 19.24 and 15.53 % higher than recommended dose of fertilizer during first year and second year.

Application of 100 % recommended dose of fertilizer to succeeding crop during *rabi* season registered significantly higher production efficiency (21.84, 26.40 and 24.12 kg ha^{-1} day^{-1}) than 50 % recommended dose of fertilizer and at pat with 75 % recommended dose of fertilizer during both the years (Table 2 and Fig. 2).

Similar findings were postulated by Srinivas and Srinivasa Raju (2000), Walia *et al.*, (2009) and Jat (2011).

Economic efficiency

The groundnut-onion cropping system recorded significantly higher economic efficiency (Rs. 620.66 and 1064.26 ha^{-1} day^{-1}) than groundnut-wheat (Rs.166.09 and 252.63 ha^{-1} day^{-1}) and groundnut-chickpea (Rs. 327.32 and 399.66 ha^{-1} day^{-1}) cropping systems during both the years.

Application of fertilizer as per STCR equation to *kharif* groundnut recorded significantly higher economic efficiency (Rs.578.11 and 848.56 ha^{-1} day^{-1}) than rest of the nutrient management and control treatment during both the years. The control treatment registered significantly lowest economic efficiency (Rs. 9.74 and 36.72 ha^{-1} day^{-1}) during both the years.

The economic efficiency of different cropping systems was also influenced by different fertilizer levels. Application of 100 % recommended dose of fertilizer to succeeding crop during *rabi* season recorded significantly higher economic efficiency (Rs. 391.75 and 607.80 ha^{-1} day^{-1}) than 50 % recommended dose of fertilizer level (Rs. 335.41 and 511.04 ha^{-1} day^{-1}) and it was as par with 75 % recommended dose of fertilizer (Rs. 386.92 and 597.72 ha^{-1} day^{-1}) during both years (Table 2 and Fig. 3). This is because of higher yield and biomass production with higher level of fertilizer. These results are in agreement with Walia *et al.,* (2009), Jat *et al.,* (2011) and Singh *et al.,* (2012).

Economic analysis

Among the cropping systems, groundnut-onion cropping system obtained significantly maximum gross monetary returns (Rs. 2,31,903 and Rs. 3,34,409 ha^{-1}), net monetary returns (Rs. 1,38,207 and Rs. 2,37,982 ha^{-1}) and B:C ratio (2.48 and 3.47) than groundnut-wheat and groundnut-chickpea cropping systems during both the years.

The groundnut-chickpea cropping system was found second rank in respect of gross and net monetary returns during both the years. Application of fertilizer as per STCR equation to *kharif* groundnut obtained significantly maximum gross monetary returns (Rs. 2,10,156 and Rs. 2,73,232 ha^{-1}), net monetary returns (Rs. 1,27,665 and Rs. 1,88,477 ha^{-1}) and B:C ratio (2.58 and 3.22) than rest of the nutrient management treatments during both the years.

Application of 100 per cent recommended dose of fertilizer to succeeding crop during *rabi* season obtained significantly maximum gross monetary returns (Rs.1,64,493, and Rs. 2,14,458 ha^{-1}), net monetary returns (Rs. 86,092 and Rs. 1,33,688 ha^{-1}) and B:C ratio (2.10 and 2.65) than 50 % recommended dose of fertilizer. However, it was at par with 75 % recommended dose of fertilizer in respect of gross monetary returns, net monetary returns and B: C ratio during both the years (Table 3 and 4). These results are in conformity with those reported by Walia *et al.,* (2009), Jat *et al.,* (2011) and Mukundam *et al.,* (2012)

On the basis of two years of experiment, it could be concluded that, application of fertilizer as per soil test crop response equation to *kharif* groundnut followed by 75 % recommended dose of fertilizer (75:37.5:37.5 N, P_2O_5, K_2O kg ha^{-1}) to onion during *rabi* season found most beneficial to achieve maximum yield and monetary returns in groundnut– onion cropping system.

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