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Direct and residual effects of nutrient management on economics of soybean based cropping systems

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Abstract
The present experiment entitled "Response of nutrient management on productivity and profitability of soybean-based cropping systems" was conducted during 2014-15 and 2015-16 at Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (MS). The soybean-based crop sequences were assessed on the basis of gross, net returns and B: C ratio.

Keywords: nutrient management, economics, soybean-based cropping systems

Introduction
Intensive cropping systems with high yielding improved crop varieties require a higher amount of nutrients as the system removes large amount of nutrients from the soil pool. Intensive cultivation and growing of exhaustive crops have made the soil deficient in macro as well as in micro nutrients. The success of any cropping system depends upon the appropriate management of resources including balanced use of manures and fertilizers. Chemical fertilizer increases the quantity of food produced but decreases its nutritional quality and also soil fertility over the years if used in imbalanced form (Sinha *et al.* 2010) [3].

The mineral fertilizers alone cannot meet the requirement of crops and cropping system, because of their high cost and residual effect of chemicals. Fertilizer is, by and large, the most important resource affecting the production and productivity of any cropping sequence. The imbalanced and indiscriminate use of chemical fertilizers in intensive cropping systems has resulted in deterioration of soil health and decline in factor productivity. Hence, there is increasing trends towards use of GRDF. Incorporation of organic matter is vital for supplement plant nutrients and maintenance of soil fertility. Continuous cropping of these crops without adequate restorative practices may pose threats to sustainability of system as high yielding varieties draw heavy amount of plant nutrients from soil and nutrient uptake often exceeds replenishment through fertilizers causing soil fertility deterioration.

The crops in intensive cropping system are grown in a definite sequence where each crop needs to be fortified to its optimum requirement to realize its production potential. Soybean followed by onion and potato are most commonly adopted cropping sequence in most parts of Maharashtra. The existing system of fertilizer application is based on the nutrient requirement of the individual crop ignoring the carry over effect of the manures or fertilizer application to the succeeding crop to a great extent.

However, the information about the manner in which these two crops would behave after soybean if they are grown in sequence is lacking. Hence, the nutrient management on a cropping system basis is the need of the hour to know the residual effect of kharif season GRDF to the succeeding crops. The nutrient management practices for soybean based cropping system of onion and potato is important to the farmers and community at large. The existing system of fertilizer application is based on nutrient requirement of the individual crop ignoring the carryover effect of the manure and fertilizer applied to preceding crop.

Materials and Methods
Treatments under the present investigation were tested in soybean based cropping system during 2014-15 and 2015-16. The experiment was laid out in split plot design with three replications. Six combinations of two crop sequences (soybean-onion and soybean-potato) and three levels of GRDF viz. 75, 100 and 125% were the main plot treatments in *kharif* season replicated three times in randomized block design. During *rabi* season each main plot treatments of residual effect of GRDF levels was split into three sub plot treatments with three

levels of recommended dose of fertilizer viz. 75, 100 and 125% to *rabi* season crops resulting in eighteen treatment combinations replicated three times in split plot design. The gross plot size for soybean and onion was 3.60 m x 3.00 m; net plot size for soybean was 3.20 m x 2.40 m, for onion 3.00 m x 2.40 m and for potato 2.80 m x 1.80 m, respectively.

Results and Discussion

The economics in forms of gross and net monetary returns cost of production and benefit cost ratio realized during 2014-15, 2015-16 and pooled from soybean based cropping system under the influence of different treatments are presented in Table 50 and graphically depicted in Fig. 10. The treatment wise cost of production of soybean, onion and potato are presented in Appendix I to X.

Cropping systems

Among the cropping systems, significantly maximum gross monetary returns (`lakh ha$^{-1}$ 4.46, 4.63 and 4.54), net monetary returns (`lakh ha^{-1} 3.65, 3.78 and 3.72) and B: C ratio (5.53, 5.46 and 5.50) were realized from soybean-onion cropping system than soybean-potato cropping system during first year, second year and pooled mean, respectively.

Residual effect of GRDF levels

The significantly higher gross monetary returns (`lakh ha$^{-1}$ 3.87, 4.02 and 3.94), net monetary returns (`lakh ha^{-1} 2.93, 3.00 and 2.96) were realized by residual effect of 125% GRDF than the residual effect of 75% GRDF level and it was at par with 100% GRDF level during first year, second year and on pooled mean, respectively. B: C ratio (4.26, 4.19 and 4.23) recorded maximum in 100% GRDF during both the years and on pooled mean. This might be because of in soybean-onion cropping system, onion produced maximum bulb yield as compared to potato, though the selling price of onion was less (`7.50 kg$^{-1}$ for the both years ) than potato (`11.00 kg $^{-1}$ for the both years) but yield of onion was more which influences on maximum monetary benefit during both years. Results corroborates finding of Kumarsen *et al.*

Direct effect of RDF levels

The significantly maximum gross monetary returns (`lakh ha$^{-1}$ 3.82, 3.95 and 3.89), net monetary returns (`lakh ha^{-1} 2.90, 2.95 and 2.92) obtained by application of 125% RDF to *rabi* season crop than 75% RDF levels. However, it was at par with 100% RDF levels during 2014-15, 2015-16 and pooled mean, respectively. The B: C ratio (4.30, 4.16 and 4.23) was obtained maximum in 100% RDF level during both the years. The significantly maximum gross monetary return (`lakh ha$^{-1}$ 3.82, 3.95 and 3.89), net monetary return (`lakh ha^{-1} 2.90, 2.95 and 2.92) obtained by application of 125% RDF to *rabi* season crop than 75% RDF levels. However, it was at par with 100% RDF levels during 2014-15, 2015-16 and pooled mean, respectively. B: C ratio (4.30, 4.16 and 4.23) was obtained maximum in 100% RDF level during both the years and on pooled mean. Similar result postulated by Gudhade (2008) [1].

Among the cropping systems, soybean-onion cropping system recorded significantly higher economic with application of 100% GRDF in *kharif* season and 100% RDF to *rabi* onion crop.

Economics of soybean-based cropping systems as influenced by different treatments

Treatments	Gross monetary returns (`lakh ha^{-1})			Cost of production (`lakh ha^{-1})			Net monetary returns (`lakh ha^{-1})			B:C ratio		
	2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean
A. Cropping system												
S_1: Soybean-Onion	4.46	4.63	4.54	0.81	0.85	0.83	3.65	3.78	3.72	5.53	5.46	5.50
S_2: Soybean-Potato	2.96	3.10	3.03	1.01	1.14	1.08	1.94	1.97	1.96	2.91	2.73	2.82
SEm±	0.01	0.02	0.02	--	--	--	0.01	0.02	0.02	--	--	--
CD at 5%	0.08	0.10	0.07	--	--	--	0.07	0.10	0.09	--	--	--
B. Residual effect of GRDF levels (*kharif* soybean)												
G_1: 75%	3.51	3.61	3.56	0.88	0.96	0.92	2.63	2.65	2.64	4.15	3.96	4.05
G_2: 100%	3.75	3.97	3.86	0.91	1.00	0.95	2.84	2.97	2.91	4.26	4.19	4.23
G_3: 125%	3.87	4.02	3.94	0.94	1.02	0.98	2.93	3.00	2.96	4.26	4.12	4.19
S Em ±	0.10	0.11	0.07	--	--	--	0.09	0.10	0.07	--	--	--
CD at 5%	0.33	0.35	0.22	--	--	--	0.27	0.30	0.22	--	--	--
C. Direct effect of RDF levels (*rabi* crops)												
F_1: 75%	3.52	3.71	3.62	0.89	0.97	0.93	2.63	2.74	2.68	4.09	4.00	4.05
F_2: 100%	3.78	3.94	3.86	0.91	0.99	0.95	2.87	2.94	2.90	4.30	4.16	4.23
F_3: 125%	3.82	3.95	3.89	0.93	1.01	0.97	2.90	2.95	2.92	4.28	4.11	4.20
SEm±	0.02	0.02	0.02	--	--	--	0.02	0.02	0.01	--	--	--
CD at 5%	0.06	0.07	0.06	--	--	--	0.06	0.07	0.04	--	--	--
Interaction												
A x B	--	--	--	--	--	--	--	--	--	--	--	--
A x C	--	--	--	--	--	--	--	--	--	--	--	--
B x C	Sig	Sig	Sig	--	--	--	Sig	Sig	Sig	--	--	--
A x B x C	--	--	--	--	--	--	--	--	--	--	--	--
Mean	3.69	3.86	3.77	0.92	1.00	0.96	2.77	2.85	2.81	4.16	4.04	4.10

Economics of soybean-based cropping systems as influenced by different treatments

Treatments	Gross monetary returns (`lakh ha^{-1})			Net monetary returns (`lakh ha^{-1})			B: C ratio		
	2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean
A.Cropping systems									
S_1: Soybean-Onion	4.46	4.63	4.54	3.65	3.78	3.72	5.53	5.46	5.50
S_2: Soybean-Potato	2.96	3.10	3.03	1.94	1.97	1.96	2.91	2.73	2.82
SEm ±	0.01	0.02	0.02	0.01	0.02	0.02	--	--	--
CD at 5%	0.08	0.10	0.07	0.07	0.10	0.09	--	--	--

B. Residual effect of GRDF levels (*kharif* soybean)									
G_1: 75%	3.51	3.61	3.56	2.63	2.65	2.64	4.15	3.96	4.05
G_2: 100%	3.75	3.97	3.86	2.84	2.97	2.91	4.26	4.19	4.23
G_3: 125%	3.87	4.02	3.94	2.93	3.00	2.96	4.26	4.12	4.19
SEm ±	0.10	0.11	0.07	0.09	0.10	0.07	--	--	--
CD at 5%	0.33	0.35	0.22	0.27	0.30	0.22	--	--	--
C. Direct effect of RDF levels (*rabi* crops)									
F_1: 75%	3.52	3.71	3.62	2.63	2.74	2.68	4.09	4.00	4.05
F_2: 100%	3.78	3.94	3.86	2.87	2.94	2.90	4.30	4.16	4.23
F_3: 125%	3.82	3.95	3.89	2.90	2.95	2.92	4.28	4.11	4.20
SEm ±	0.02	0.02	0.02	0.02	0.02	0.01	--	--	--
CD at 5%	0.06	0.07	0.06	0.06	0.07	0.04	--	--	--
Interaction									
A x B	--	--	--	--	--	--	--	--	--
A x C	--	--	--	--	--	--	--	--	--
B x C	Sig	Sig	Sig	Sig	Sig	Sig	--	--	--
A x B x C	--	--	--	--	--	--	--	--	--
Mean	3.69	3.86	3.77	2.77	2.85	2.81	4.16	4.04	4.10

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