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Pande AD
M.Sc., Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Dr. Chirde PN
Subject Matter Specialist (Agronomy), Krishi Vigyan Kendra, Gadchiroli, Maharashtra, India

Dr. Shingrup PV
Assistant Professor, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Dr. Bhale VM
Ex. Vice-Chancellor, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
Pande AD
M.Sc., Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Effect of nitrogen source diversification in vertisols on the economics of soybean productivity

Pande AD, Chirde PN, Shingrup PV and Bhale VM

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Abstract
The current investigation examined the "Effect of Nitrogen Source Diversification in Vertisols on the economics of Soybean Productivity." in the year 2017-18 at Research Farm of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The soil was clayey in texture which as dominated by smectite clay minerals belongs to hyperthermic family of Typic Haplustert having swell shrink property of experimental plot. The soil exhibited a slightly alkaline reaction (pH 8.6), contained a medium level of organic carbon (0.52%), had low concentrations of nitrogen (216.5 kg ha^{-1}) and phosphate (16.86 kg ha^{-1}), but was very high in exchangeable potassium (367.22 kg ha^{-1}). During the cropping period, 378.8 mm of rainfall was recorded, which was below the normal level of 567.9 mm for that duration. The experiment was laid out in randomized block design with three replications. The other inter-cultivation practices were kept common as recommended, while the nutrients were provided as per the treatments of nutrient management. Different parameters were studied as Soybean growth characters, the yield contributing characters. It is concluded on economics the highest GMR, NMR and B:C ratio were recorded with application of RDF through chemical fertilizers over rest of treatments and found corresponding with 50% RDN + 50% RDN through vermicompost.

Keywords: Nitrogen source, economics, organic carbon content, B:C ratio

Introduction
Soybean (*Glycine max*. L.) is leguminous crop and also one of the important oilseed crops. Often referred to as the "Golden Bean" of the 21st century, soybean is known for its rich nutritional profile, contains approximately 40% protein and 20% oil. In India, it is predominantly cultivated as an oilseed crop. Soybean (*Glycine max* L.) is known as sojabean, soybean, Chinese pea and Manchurian bean which belongs to the origin Eastern Asian and Leguminaceae family. Soybean was cultivated in China from 3000 BC. It is a miracle crop which has witnessed phenomenal growth in the production. Trade and Processing of soybean in last few years in India has revolutionized the rural economy and improved socio-economic status of farmers. Soybean is generally processed for its oil, protein and lecithin as a whole bean or particularly/fully defatted cake meal. Soybean is extensively used for oil production in India, with approximately 85% of the total yield allocated for oil extraction, 10% for seed, and the remaining 5% for food consumption. However, its productivity is declining due to nutrient depletion, as soybean is a high-energy crop rich in protein and oil. Moreover, nutrition through chemical fertilizer may satisfy the need of crop and also invite incidence of pest and diseases. To ensure sustainable soybean production, it is essential to incorporate a combination of organic and inorganic nutrient sources to preserve soil fertility. The advantages of Integrated Nutrient Management (INM) in crops like soybean are well recognized, making it imperative to examine the impact of INM practices under the specific climatic conditions of the Vidarbha region. Hence, the present investigation was studied on the objective as," To evaluate the various nutrient management systems for maximizing the monetary returns".

Materials and Methodology
The study was carried out in the carried out in the Agronomy Research Farm (plot No. 66) of Department of Agronomy in Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *Kharif*

season of 2017- 2018. Akola lies in the subtropical zone, positioned at 22.42°N latitude and 77.02°E longitude, with an elevation of 307.42 meters above mean sea level. The region experiences a semi-arid climate marked by three distinct seasons: a hot and dry summer from March to May, a warm, humid, and rainy monsoon from June to October, and a mildly cold winter spanning November to February.

Soybean crop was sown on 28th June and the harvesting was done on 25th September. The rainfall during cropping season was 378.8 mm in 32 rainy days which were mainly concentrated in July and September compared to the average of 567.9 mm received over 30.2 rainy days.

Treatments	Details
T_1	RDF (30:75:30 NPK kgha^{-1})
T_2	50% RDN + 50% RDN through vermicompost
T_3	50% RDN + 50% RDN through FYM + Jivamrut @ 500 lit ha^{-1}
T_4	50% RDN + 50% RDN through FYM
T_5	50% RDN + 50% RDN through Compost
T_6	50% RDN + 50% RDN through soybean crop residue + *Trichoderma virride* @ 1 kg ha^{-1}
T_7	50% RDN + 50% RDN through Glyricidia leaf incorporation.

The field was laid out into 21 plots. The treatments were randomly assigned to various plots within each replication. The crop received the recommended fertilizer doses: nitrogen at 30 kg ha^{-1}, phosphorus at 75 kg ha^{-1}, and potassium at 30 kg ha^{-1}, applied in the form of urea, single superphosphate, and MOP, respectively. The full doses of phosphorus and potassium, along with nitrogen, were applied as basal fertilizers at the time of sowing. Nitrogen was supplied through urea, vermi-compost, Glyricidia leaves, compost, FYM and soybean straw. As per treatments, 50% nitrogen was applied through Urea and remaining 50% nitrogen through vermicompost, compost, FYM, Glyricidia leaves and soybean crop residue respectively. Vermicompost, compost, FYM, Glyricidia leaves and soybean straw were incorporated in soil.

Gross monetary returns: The cost of cultivation per hectare was determined for each treatment based on the inputs which were utilized and the current market prices of the product. Gross monetary returns were calculated by multiplying the economic yield with the prevalent market rate of soybean seed.

Net monetary returns: Net monetary returns were calculated by deducting cost of cultivation from gross monetary returns for each treatment.

Benefit-Cost (B: C) ratio: calculated by using the formula as below

$$\text{Benefit to cost ratio} = \frac{\text{Net returns (Rs ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs ha}^{-1}\text{)}}$$

Statistical method for analysis

Observations taken before and after harvest across various time-frames covering growth traits, yield metrics, and lab analyses were analyzed statistically using a Randomized Block Design, following the methodology drafted by Gomez and Gomez (1984) [3].

Results and Discussion

Agricultural sustainability is secured when the secondary goal of economic stability is fulfilled, alongside the preservation of environmental integrity. Indeed, for agriculture to function as a viable enterprise, it must yield sustained profitability over time. Accordingly, its financial evaluation serves as the benchmark for location-specific scalability. Therefore, to assess the practicality of the various nutrient management strategies under investigation, a cost-benefit analysis was conducted following the completion of all farming activities and subsequent marketing. Here the estimated values for cultivation expenses, total financial gains, net profits, and the benefit-to-cost ratio, which are detailed in the Table -1, and visually illustrated by Figure 1.

Cost of cultivation (₹/ha^{-1})

The ultimate intention in agricultural or any business management system is targeted towards minimizing the input cost to heighten the margin of profit. However, some cultivation aspects could not be counted merely in terms of profit, as indirect improvement resultant from such operations override the economic profitability. In this current investigation, the input costs associated with soybean cultivation under various nutrient management treatments were analyzed, and the corresponding data are presented in Table-1.

Lowest cost of cultivation (28073 ₹ ha^{-1}) was registered with treatment (T_1) i.e. RDF and substitution of RDN inorganic forms resulted in variation in cost of cultivation. However, with every substitution of RDN by both organic and inorganic, caused an increase in cost of cultivation and get to maximum with (T_3) i.e. 50% RDN + 50% RDN through FYM + Jivamrut @ 500 litre/ha (35723 ₹ha^{-1}). At a given level of substitution, cost of cultivation with FYM + Jivamrut @ 500 lit/ha was higher when compared to other organic sources. This might be due to large quantity of FYM required for substitution of 50% of nitrogen and also addition of 500 lit Jivamrut per hectare which was quite costly. Similarly every addition of an input caused further increase in cost of cultivation.

Table 1: Economics of soybean production as influenced by different treatments

Treatments	COC (₹)	GMR (₹)	NMR (₹)	B:C ratio
T_1-RDF (30:75:30 NPK Kg ha^{-1})	28073	83094	55021	2.96
T_2-50% RDN+50% RDN through Vermicompost	32714	81329	48615	2.49
T_3-50% RDN+50% RDN through FYM + Jivamrut @500 litre/ha.	35723	73284	37561	2.05
T_4-50% RDN+50% RDN through FYM	34723	68275	33552	1.97
T_5-50% RDN+50% RDN through Compost	33131	75755	42624	2.29
T_6-50% RDN+50% RDN through soybean crop residue + *Trichoderma virride* @ 1kg/ha.	32202	63847	31645	1.98
T_7-50% RDN+50% RDN through Glyricidia leafs incorporation	31693	65377	33684	2.06
SE(m)±	-	1862	1862	-
CDaT$_5$%	-	5736	5736	-
GM	32609	72994	40386	2.26

Where (GMR= Gross monetary returns, NMR=Net monetary returns and B: C=Benefit to Cost ratio

Gross monetary returns (₹ ha^{-1})

System productivity as influenced by management practices along with prevailing market prices are the factors influencing the economics return in agricultural business. As in present investigation the management practices are altered to a great extent, hence their economic sustenance would largely depend upon the quantum of GMR. Average gross monetary return (GMR) obtained from the present investigation was that of 72994 ₹ha^{-1}. Data presented in Table. 20. Indicate the pronounced treatment differences due to various nutrient management practices.

Significantly highest GMR (83094 ₹ha^{-1}) was recorded with treatment T_1 (RDF alone) and found statistically similar with treatment (T_2) 50% RDN + 50% RDN through Vermicompost (82329 ₹ha^{-1}). It was followed by other nitrogen substitution treatments in the decreasing order of treatments $T_5>T_3>T_4>T_7>T_6$, with respective GMR values of 75755, 73284, 68275, 65377 and 63847 ₹ha^{-1}. Similar results were reported by Narayana (2003) [6] and Kolpe and Bodake (2017) [5]. The resultant increase in GMR with treatment was due to increased production of soybean with it.

(NMR) Net Monetary Returns (Rs/ha^{-1})

The data presented in Table-1, indicate that net monetary returns were significantly influenced by the use of different nutrient management treatments. The average net monetary return (NMR) obtained from the present investigation was that of 40386 ₹ha^{-1}.

Treatment T_1 (RDF alone) recorded significantly highest NMR of 55021 ₹ha^{-1}. It was followed by remaining treatments.

In the nitrogen substitution treatments, treatment (T_2) 50% RDN + 50% RDN through vermin-compost (48615 ₹ha^{-1}) noted maximum NMR because of higher yield and comparative low cost of cultivation than maximum treatments. It was followed by treatments, T_5, T_3, T_7, T_4 and T_6, with respective NMR values of 42624, 37561, 33684, 33552 and 31645, respectively.

The notable increase in net monetary returns (NMR) observed under treatment T_1 (Recommended Dose of Fertilizers alone) can be attributed to higher productivity combined with lower cultivation costs. Treatment T_2, which involved substituting 50% of the recommended nitrogen dose with vermin-compost, also demonstrated good remarkable performance. Due to enhanced mineralization of nitrogen and other nutrients, T_2 produced a yield that was statistically comparable to the superior T_1 treatment, despite relying partially on organic inputs. The Similar views were expressed by Halvankar *et al.* (1994) [4], Singh *et al.* (1994) [9], Dube *et al.* (1995) [2], Malik (1996) [7], Sunderiya (2014) [10], Chaudhary *et al.* (2014) [1], Shivran *et al.* (2015) [8] and Kolpe and Bodake (2017) [5].

Benefit-cost ratio

The benefit-to-cost ratio serves as a reliable indicator of the net return on each rupee invested, effectively reflecting the economic viability of changes in crop management practices. In this study, the benefit-to-cost ratio was calculated through statistical analysis of the economic data corresponding to each treatment and is presented in Table 1. The results clearly demonstrate that, relative to the cost of soybean cultivation, the various nutrient management treatments yielded returns that were approximately one and a half times or even higher than the investment made.

Various treatments with nutrient management differed markedly in the benefit obtained from each treatment. Higher benefit-cost ratio as 2.96 was obtained in treatment where Recommended Dose of Fertilizer was applied through chemical fertilizers (T_1). Then best treatment with this respect was T_2 in which 50% N was replaced through application of vermin-compost, by providing the benefit-cost ratio of 2.49. Treatment T_5 with 50% N was given with compost also responded resulted well in providing B: C ratio of 2.29. The nutrient management treatments *viz*. T_7, T_3, T_6 and T_4 were not perform to the level of significance with B:C ratio of 2.06, 2.05, 1.98 and 1.97, respectively. Similar views were given by Singh *et al*. (1994) [9], Malik (1996) [7], Chaudhary *et al.* (2014) [1] and Kolpe and Bodake (2017) [5]. Hence, in a nutshell, economic results which are discussed above indicates practicality of substituting a minimum of 50% of nitrogen through the field application of vermin-compost.

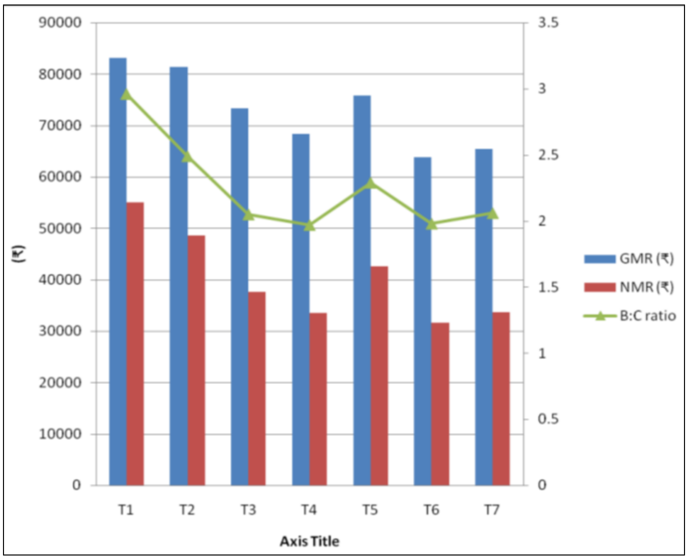

Fig 1: (GMR) Gross Monetary Returns, (NMR) Net monetary returns, and (B: C) Benefit: Cost ratio of soybean production influenced by different treatments

Treatment T_1 recorded the highest benefit-to-cost ratio as 2.96 in which RDF was given through chemical fertilizers. Then most effective treatment was the one in which 50% of the nitrogen was substituted with vermin-compost, yielding a benefit-to-cost ratio of 2.49.

Conclusion

The highest GMR, NMR and Benefit: Cost ratio were recorded with application of RDF through chemical fertilizers over rest of treatments and found comparable with 50% RDN + 50% RDN through vermi-compost. In conclusion, it can be inferred that substituting 50% of the recommended nitrogen dose with vermi-compost is a viable practice, as it does not decrease crop yield, quality, or economic returns.

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