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Research Paper

Effect of organic and inorganic sources of nutrients on productivity, profitability and soil health in lentil (*Lens culinaris*) under *Vertisols*

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ABSTRACT

A field experiment was carried out during winter (*rabi*) seasons of 2005–06 to 2007–08 at Agricultural Research Station, Ummedganj, Kota to find out the best combination of inorganic and organic sources of nutrition and biofertilizers for increasing productivity, profitability and soil health in lentil *Lens culinaris* (L.) Medik. under *Vertisols* of south eastern Rajasthan. Maximum nodules/plant (27.0) and their dry weight (47.0 mg/plant) at 60 days after sowing was found 116 and 44.2% higher than absolute control. Combined application of inorganic N, P, K and S (20, 17, 16, 20 kg/ha) + vermicompost (VC) 2 t/ha significantly increased the growth, yield attributes, seed yield (1.63 t/ha) and net returns (15.1 × 10^3 ₹/ha) over absolute control. It registered higher to the magnitude of 0.93 t/ha in yield and 12.14 × 10^3 ₹/ha in net returns. Maximum uptake of nutrients (N, P, K and S) was recorded with N, P, K and S (20, 17, 20, 20 kg/ha) + vermicompost (VC) 2 t/ha to the tune of 138.3, 252.0, 149.1 and 196.3% over absolute control respectively. Similarly, it improved organic carbon (0.17 g/kg soil) and buildup of nutrients (N, P, K and S) to the tune of 4.7, 0.75, 11.5 and 2.9 kg/ha over initial soil fertility. The next best treatment was inorganic N, P, K and S (20-17-16-20 kg/ha) + organic FYM 5 t/ha.

Key words : Biofertilizers, Crop production, FYM, INM, Lentil, Nutrient balance, Vermicompost, Yield

Nutrient use for agricultural production is essential to increase food production but continuous use of chemical fertilizers has deleterious effects on physical, chemical and biological properties of soil, which in turn cause decline in productivity, low nutrient recovery efficiency and increase in cost of production and environmental pollution (Sarkar *et al*., 1997). Low productivity of lentil may be ascribed to many reasons, but inadequate and imbalanced fertilization and terminal heat are the major factors. In most of the lentil-growing areas, poor soil fertility is one of the severe constrains limiting expression of its potential productivity. Thus nutrient imbalance is one of the major abiotic constraints for limiting productivity of pulses. Soil degradation is occurring due to inadequate and imbalanced fertilization, leading to nutrient mining and other constraints are cultivation under rainfed condition, aberrant weather condition and temperature extremities caused second-generation problems in nutrient management. To enhance productivity of this crop, use of balanced fertilization by application of chemical fertilizers, organic sources along with biofertilifers, viz. *Rhizobium* and *phosphate-solubilising bacteria* (PSB) is of great importance. Organic materials have a major role to play in maintaining buffering capacity of soil and are important for maintaining soil physical and biological properties. Addition of farmyard manure (FYM) along with N, P and K may be better for long-term sustainability of the crops/cropping systems. The combined use of organic sources with N, P and K obtained maximum productivity under the fine textured Vertisols (Behara and Pandey, 2006). Lentil responded to applications of nutrients (Singh *et al.,* 2000), farmyard manure Singh *et al.* (2003) and *Rhizobium* inoculation (Singh *et al.,* 2000).

Microbial harbouring rhizosphere provides benefits to crops through better nutrient availability by way of atmospheric N_2 fixation or solubilizing fixed mineral forms of nutrients. Use of efficient strains of *Rhizobium* and phosphate-solubilizing bacteria may help not only in increasing nutrient-use efficiency and yield but also reducing the cost of cultivation. Nutrient requirement of the crop can be met by supplying nutrients through chemical fertilizers, organic manures (FYM or vermicompost) and use of

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biofertilizers (*Rhizobium* and phosphate-solubilizing bacteria). Keeping this in view, a field experiment was carried out to find out the best combination of organic and inorganic nutrition sources and biofertilizers for enhancing productivity, profitability and soil health in lentil under Vertisols.

MATERIALS AND METHODS

A field experiment was conducted at same site during 3 consecutive *rabi* (winter) seasons of 2005–06 to 2007–08 at Agricultural Research Station, Maharana Pratap University of Agriculture and Technology, Ummedganj, Soybean–lentil was the cropping system at experimental site and soybean grown as a general crop without fertilization, hence as per treatments fertilization was given to lentil crop only. The soil was clay loam, slightly alkaline in reaction (pH 7.5), poor in organic carbon (4.1 g/kg), low in available nitrogen (278.5 kg/ha), phosphorus (8.95 kg/ha), sulphur (18.3 kg/ha) and medium in available potassium (243.6 kg/ha). The experiment was carried out in randomized block design, comprising 10 treatments, viz. T_1, control (no fertilization); T_2, recommended dose of fertilizer 20,17,16,20 kg N,P,K and S/ha (RDF); T_3, farmyard manure (FYM) 5 t/ha; T_4, vermicompost (VC) 2 t/ha; T_5, RDF + FYM 5 t/ha; T_6, RDF + VC 2 t/ha; T_7, *Rhizobium* + phosphate-solubilizing bacteria; T_8, RDF + *Rhizobium* + phosphate-solubilizing bacteria; T_9, FYM 5 t/ha + *Rhizobium* + phosphate-solubilizing bacteria; and T_{10}, VC 2 t/ha + *Rhizobium* + phosphate-solubilizing bacteria with 3 replications. Organic manure (farmyard manure) was applied 2 weeks before sowing, while vermicompost and chemical fertilizers were drilled into the soil at the time of sowing in earmarked plots. Seeds were treated with *Rhizobium* and phosphate solubilizing bacteria (PSB) @ 10 g/kg as per treatment. The N, P and K content of FYM and vermicompost on oven-dry weight basis mean of 3 years were 0.52, 0.26 and 0.55% and 1.56, 1.2 and 1.1%, respectively.

A pre-sowing irrigation was applied to all the plots 10 days before sowing. The seed of variety 'DPL 62' was drilled at 30 cm and 5 cm inter-and intra-row spacing, respectively, by adopting the seed rate of 60 kg/ha. Weeds were managed manually by hand-weeding at 30 and 60 days after sowing (DAS). The plant-protection measures were taken up as and when required for the control of black aphids. In each plot, 5 random plants were selected to record biometric observations on growth and yield attributes. Organic carbon, bulk density, pH, available N, P, K and S in soil and plant were estimated by standard methods. Nutrient uptake was estimated by multiplying the dry-matter accumulation at maturity in grain and straw of lentil by their respective percentages. Total uptake was calculated by adding uptake of grain and straw.

Data on number and dry weight of nodules/plant were recorded at 60 days after sowing by digging 5 plants from each plot. Nodules/plant were counted and then dried to get nodule weight/plant. At maturity, data on plant height, branches/plant, pods/plant, seeds/pod, 1,000-seed weight, biological yield and grain yield were recorded. Harvest index was calculated by dividing economical yield by total biomass production. Net returns as well as benefit: cost ratios were also worked out. All data were subjected to analysis of variance.

RESULTS AND DISCUSSION

Nodule count and biomass

All the treatments significantly enhanced the number and dry weight of nodules compared to the control where no organic manure, chemical fertilizer and biofertilizer was applied (Table 1). The treatment which had received *Rhizobium* and phosphate-solubilizing bacteria inoculation recorded significantly higher number and dry weight of nodules compared to alone application of organic and inorganic sources (except nodule number in vermicompost @ 2 t/ha). *Rhizobium* inoculation is known to improve nodulation in lentil (Chowdhary *et al.,* 1998) and phosphate-solubilizing bacteria is known to solubilize the native phosphorus (EL-Sayed, 1999) and enhance its availability to the plants. This increased availability of the phosphorus might have helped in better nodulation. Improvement in nodulation was also observed in treatments of chemical fertilizers, farmyard manure or vermicompost applied alone or in combination compared to the control. The organic manures decrease P adsorption/fixation and enhance P availability thus, resulting in better root growth and consequently exploited greater soil volume for nodulation. Similar trend was observed in nodule dry weight recorded at 60 days after sowing. Maximum and significantly higher nodule count (27.0) and their dry weight (47.0 mg/plant) was recorded in treatment vermicompost 2 t/ha + *Rhizobium* + phosphate-solubilizing bacteria, which remained on par with farmyard manure 5 t/ha + *Rhizobium* + phosphate-solubilizing bacteria and N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solubilizing bacteria over rest of the treatments. Increased nodule biomass was recorded when combination of chemical and organic fertilizers was used compared to control. More pronounced effects of *Rhizobium* and phosphate-solubilizing bacteria in the presence of added fertilizers were reported by El-Sayed (1999).

Growth and yield attributes

Various nutrients through different sources either single or in combination have significant improvement in plant height, branches/plant, pods/plant and seeds/pod over the control (Table 1). Significantly taller plants, branches/ plant and pods/plant were observed in N, P, K and S (20,17,16,20 kg/ha) + vermicompost (VC) 2 t/ha, which remained on par with N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha over rest of the treatments except branches/ plant in vermicompost 2 t/ha + *Rhizobium* + phosphate-solubilizing bacteria. The application of N, P, K and S (20,17,16,20 kg/ha), FYM and vermicompost along with seed inoculation of *Rhizobium* + phosphate-solubilizing bacteria produced higher plant height and branches/plant than control. It seems that *Rhizobium* + with inorganic as well as organic nutrient sources enhanced the grain yield. However, seeds/pod were markedly influenced by application of various sources of nutrients. The maximum and significantly higher seeds/pod (1.9) were recorded with application of N, P, K and S (20,17,16,20 kg/ha) + vermicompost 2 t/ha, which remained statistically on par with N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha, VC 2 t/ha + *Rhizobium* + phosphate-solubilizing bacteria, FYM 5 t/ha + *Rhizobium* + phosphate-solubilizing bacteria and N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solubilizing bacteria over the control and alone application of nutrients. Inoculation of seed with *Rhizobium* + phosphate-solubilizing bacteria did not influence the seeds/pod significantly over the control, while application of N, P, K and S (20,17,16,20 kg/ha), FYM and VC alone had significant effect on seeds/pod over the control. Different sources of nutrients alone or in combination had non-significant influence on test weight in lentil compared to the control. These findings corroborate the findings of Chowdhary *et al.* (1998) and Singh *et al.* (2001).

Yield and economics

The results on grain yield thus confirmed the trend observed earlier for the yield-contributing characters and upheld the need of supplementing the 100% N, P, K and S with organic sources, viz. VC and FYM (Table 2). This emphasized the need for organic manuring along with chemical fertilizers. This could be attributed to a sustained availability of major as well as trace elements which are evident from higher accumulation of nutrients. Different sources of nutrients alone or in combination with nutrients and seed inoculation of lentil with *Rhizobium* + phosphate-solubilizing bacteria had significant influence on yield and economics of lentil. Application of N, P, K and S (20,17,16,20 kg/ha) + VC 2 t/ha recorded significantly higher grain yield, biological yield, gross returns (29.42 × 10^3 ₹/ha) and net returns (15.10 × 10^3 ₹/ha), which remained statistically on par with N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha over rest of the treatments. Application of VC 2 t/ha + *Rhizobium* + phosphate-solubilizing bacteria significantly increased grain yield to the tune of 97.29% closely followed by N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solubilizing bacteria (91.88%) and FYM 5 t/ha + *Rhizobium* + phosphate-solubilizing bacteria (64.25%) over the control, while maximum net returns were fetched under N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solubilizing bacteria to the tune of 10.91 × 10^3 ₹/ha followed by VC 2 t/ha + *Rhizobium* + phosphate-solubilizing bacteria (8.24 × 10^3 ₹/ha) and FYM 5 t/ha + *Rhizobium* + phosphate-solubilizing bacteria (5.57 × 10^3 ₹/ha) over the control.

Highest benefit: cost ratio was observed under N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solu-

Table 1. Effect of integrated nutrient management on nodule, growth parameters and yield attributes of lentil (pooled data of 3 years)

Treatment	Nodules/ plant at 60 DAS	Nodule dry-weight (mg/plant) at 60 DAS	Plant height (cm)	Branches/ plant	Pods/ plant	Seeds/ pod	Test weight (g)
Control	12.5	32.6	37.5	4.8	73.6	1.6	28.0
N, P, K and S (20, 17, 16, 20 kg/ha)	15.8	36.6	43.1	6.1	104.8	1.8	28.1
FYM @ 5 t/ha	16.0	38.6	43.0	5.8	96.5	1.7	28.4
VC @ 2 t/ha	20.0	39.4	44.8	6.1	105.7	1.8	28.5
N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha	19.6	40.1	48.1	6.7	128.9	1.9	28.5
N, P, K and S (20,17,16,20 kg/ha) + VC 2 t/ha	21.6	41.5	50.1	7.1	140.9	1.9	28.6
Rhizobium + phosphate-solubilizing bacteria	18.0	43.3	40.7	5.3	82.5	1.6	28.3
N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solubilizing bacteria	23.0	44.9	45.6	6.4	115.8	1.8	28.5
FYM @ 5t/ha + *Rhizobium* + phosphate-solubilizing bacteria	24.6	45.5	44.4	6.2	107.3	1.8	28.4
VC @ 2t/ha + *Rhizobium* + phosphate-solubilizing bacteria	27.0	47.0	46.3	6.6	124.9	1.8	28.6
SEm ±	0.45	0.55	1.18	0.18	4.95	0.04	0.13
CD (P=0.05)	1.25	1.53	3.28	0.50	13.73	0.11	NS

bilizing bacteria, which was significantly superior to rest of the treatments. The next best treatment was N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha and N, P, K and S + VC 2 t/ha. This might be due to that cost of cultivation is less in RDF and synergistic effect of *Rhizobium* + phosphate-solubilizing bacteria with organic sources of nutrition. These results are in agreement with the findings of Singh *et al.* (2000), Singh *et al.* (2001) and Singh *et al.* (2003).

Nutrient uptake

The uptake of N, P, K and S differed significantly due to different treatments during 3 years (Table 2). Recommended dose of fertilizers (20,17,16,20 kg N, P, K and S/ha) when applied with VC 2 t/ha and FYM 5t/ha recorded significantly higher total uptake of N, P, K and S over the control. This might be probably due to higher availability of these nutrients and higher grain and straw yields. Pandey *et al.* (2009) reported similar results. Integration of VC and FYM in INM resulted in the higher uptake of N, P, K and S over rest of the treatments. This may probably be due to enhanced nutrient retention and reduced fixation capacity of soil. Maximum and significantly higher uptake of nutrients (N, P, K and S) was recorded with application of N, P, K and S (20,17,16,20 kg/ha) + VC 2 t/ha, which remained statistically at par with N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha compared to the control, which were increased to the tune of 149.2, 252.0, 161.4 and 238.2% over the control respectively. However, application of N, P, K and S (20,17,16,20 kg/ha) + VC 2 t/ha was also found statistically at par in total N uptake with N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha, N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + *phosphate-solubilizing bacteria* and VC 2 t/ha + *Rhizobium* + phosphate-solubilizing bacteria over rest of the treatments and per cent increase of 149.2, 116.7, 105.9 and 99.1 over control respectively. Sole application of inorganic and organic sources of nutrients showed higher uptake of nitrogen compared to absolute control. While, total P uptake was maximum and significantly higher in N, P, K and S + VC 2 t/ha closely followed by N, P, K and S + FYM 5 t/ha over rest of the treatments. The total K uptake was maximum in N, P, K and S + VC 2 t/ha (29.28 kg/ha), which was at par with N, P, K and S + FYM 5 t/ha. Similarly, maximum and significantly higher sulphur was recorded in N, P, K and S + VC 2 t/ha remained on par with N, P, K and S + FYM 5 t/ha as compared to rest of the treatments, which was 238.2% higher over the control. Combined use of organic, inorganic sources along with biofertilizers were found statistically at par with each other, whereas application of VC 2 t/ha was also found significantly superior as compared to sole application of N, P, K and S, FYM and *Rhizobium* + phosphate-solubilizing bacteria. Similar results were reported by Singh *et al.* (2003), Davari and Mirzakhani (2009) and Singh and Ahmad (2010).

Soil fertility

The application of different sources of nutrients had significant effect on buildup in soil organic carbon com-

Table 2. Effect of integrated nutrient management on yield, economics and uptake of nutrients by lentil (Pooled data of 3 years)

Treatment	Yield (t/ha) Grain	Yield (t/ha) Biological	Total cost of cultivation (×10^3 ₹/ha)	Gross returns (× 10^3 ₹/ha)	Net returns (× 10^3 ₹/ha)	Benefit: cost ratio	Total uptake of nutrients (kg/ha) N	P	K	S
Control	0.70	1.72	9.67	12.63	2.96	0.31	12.5	1.5	11.2	3.6
N, P, K and S (20, 17, 16-20 kg/ha)	1.05	2.55	10.3	18.91	8.59	0.83	20.1	2.8	18.5	6.5
FYM @ 5 t/ha	0.99	2.44	12.2	17.87	5.69	0.47	18.2	2.7	17.1	6.0
VC @ 2 t/ha	1.14	2.78	13.7	20.43	6.75	0.49	22.2	3.2	20.6	7.5
N, P, K and S (20, 17, 16, 20 kg/ha) + FYM 5 t/ha	1.53	3.72	12.8	27.50	14.68	1.15	27.0	4.4	25.4	10.5
N, P, K and S (20, 17, 16, 20 kg/ha) + VC 2 t/ha	1.63	4.01	14.3	29.42	15.10	1.05	31.1	5.2	29.3	12.1
Rhizobium + phosphate-solubilizing bacteria	0.87	2.14	9.73	15.66	5.93	0.61	16.0	2.1	14.4	5.0
N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solubilizing bacteria	1.35	3.26	10.37	24.24	13.87	1.34	25.7	3.7	23.0	9.0
FYM @ 5 t/ha + *Rhizobium* + phosphate-solubilizing bacteria	1.15	2.81	12.23	20.76	8.53	0.70	22.0	3.2	20.7	7.8
VC @ 2t/ha + *Rhizobium* + phosphate-solubilizing bacteria	1.39	3.38	13.73	24.92	11.20	0.82	24.8	3.7	22.5	9.1
SEm ±	0.45	1.06	-	0.81	0.81	0.07	2.4	0.3	2.0	0.5
CD (P=0.05)	1.24	2.95	-	2.23	2.23	0.18	7.1	0.8	5.9	2.8

DAS, days after sowing; FYM, farmyard manure; VC, vermicompost pared to control (Table 3). Maximum and significant buildup of organic carbon was recorded with application of N, P, K and S + VC 2 t/ha, which remained on par with N, P, K and S + FYM 5 t/ha. However, application of different sources of nutrients either chemical or organic sources, i.e. FYM and VC along with seeds inoculated with *Rhizobium* + phosphate-solubilizing bacteria had significant improvement in soil organic carbon over the control and *Rhizobium* + phosphate-solubilizing bacteria, but these treatments were statistically at par with each other. Seed inoculation with *Rhizobium* + phosphate-solubilizing bacteria also had significant and positive effect on buildup of soil organic carbon. Application of N, P, K and S + VC 2 t/ha recorded the maximum and significantly positive gain in available nutrients (N, P, K and S) in the soil which was statistically on a par with N, P, K and S + FYM 5 t/ha. However, seed inoculation with *Rhizobium* + phosphate-solubilizing bacteria along with application of chemical as well as organic sources of nutrients had significant impact on available N, P, K and S nutrients in the soil, while application of only inorganic or organic sources of nutrients led to marginally increased the available N, P, K and S in the soil. The recommended level of fertilizer to lentil showed only slight improvement in nutrient status after completion of 3 years crop cycles of lentil compared to initial values which might be due to the fact that legume improved the nutrient status of soil.

Integrated use of inorganic and organic sources of nutrient to lentil crop influenced chemical properties of the soil (Table 3). Application of N, P, K and S + VC 2 t/ha recorded maximum values of available N, P, K and S and it was registered per cent increase of 1.69, 8.38, 4.72 and 15.93 over initial status of the soil, respectively. The improvement in the available N, P, K and S in the soil over no fertilization (control) was to the tune of 7.80, 44.78, 14.19 and 70.97%, respectively. Similarly, application of N, P, K and S + FYM 5 t/ha also recorded per cent higher values of nutrients (N, P, K and S) in the magnitude of 1.44, 5.03, 4.27 and 13.66 over initial status of the soil and 7.53, 40.29, 13.70 and 67.74 over no fertilization (control), respectively. It might be due to direct addition of partial N, P, K and S through organic sources of vermicompost and FYM and greater multiplication of soil microbes, which convert organically bound nutrients to inorganic forms as well as its capacity to form a cover on sesquioxide which reduces the phosphate fixation. These results corroborate the findings of Panwar (2008).

The actual gain of nitrogen 4.7 and 4.0 kg/ha owing to integrated nutrient management through N, P, K and S + VC 2 t/ha and N, P, K and S + FYM 5 t/ha over the control, respectively, indicating the benefits from the integrated use of fertilizers and manures which is also evident from the yield data (Table 3). Similarly, the maximum actual gain of phosphorus 0.7 and 0.4, potash 11.5 and 10.4 and sulphur 2.9 and 2.5 kg/ha was recorded with application of N, P, K and S + VC 2 t/ha and N, P, K and S + FYM 5 t/ha as compared to initial status of soil, respectively. However, integrated application of inorganic and organic sources of nutrients along with seed inoculation of biofertilizers (*Rhizobium* and phosphate-solubilizing bacteria) had positive impact on soil health especially phosphorus and sulphur gain was recorded as compared to sole

Table 3. Effect of integrated nutrient management on available nutrients and changes in soil fertility in lentil (pooled data of 3 years)

Treatment	Organic carbon (g/kg soil)	Available nutrients (kg/ha)				Changes in soil fertility (kg/ha)			
		N	P	K	S	N	P	K	S
Control	3.49	262.7	6.73	223.4	12.4	-15.8	-2.2	-20.2	-5.9
N, P, K and S (20,17,16,20 kg/ha)	4.02	274.4	8.63	234.4	17.5	-4.1	-0.3	-9.2	-0.8
FYM @ 5t/ha	4.09	269.8	8.44	233.1	18.4	-8.7	-0.5	-10.5	0.1
VC @ 2t/ha	4.03	271.3	8.61	233.1	18.6	-7.2	-0.3	-10.5	0.3
N, P, K and S (20,17,16,20 kg/ha) + FYM 5 t/ha	4.24	282.5	9.37	254.0	20.8	4.0	0.4	10.4	2.5
N, P, K and S (20,17,16,20 kg/ha) + VC 2 t/ha	4.27	283.2	9.70	255.1	21.2	4.7	0.7	11.5	2.9
Rhizobium + phosphate-solubilizing bacteria	3.96	267.6	7.37	229.1	15.6	-10.9	-1.6	-14.5	-2.7
N, P, K and S (20,17,16,20 kg/ha) + *Rhizobium* + phosphate-solubilizing bacteria	4.10	278.1	9.25	239.7	19.5	-0.4	0.3	-3.9	1.2
FYM @ 5t/ha + *Rhizobium* + phosphate-solubilizing bacteria	4.08	274.0	9.31	240.5	19.5	-4.5	0.4	-3.1	1.2
VC @ 2t/ha + *Rhizobium* + phosphate-solubilizing bacteria	4.10	275.4	9.35	239.5	19.7	-3.1	0.4	-4.1	1.4
SEm ±	0.04	1.45	0.14	1.19	0.27	-	-	-	-
CD (P=0.05)	0.10	4.01	0.38	3.30	0.75	-	-	-	-
Initial status	4.1	278.5	8.95	243.6	18.3	-	-	-	-

DAS, days after sowing; FYM, farmyard manure; VC, vermicompost application of nutrients. The beneficial effect of VC and FYM on available nutrients may be ascribed to release of nutrients due to decomposition of organic matter.

Thus, study indicates that integrated use of inorganic and organic sources of nutrients, i.e. N, P, K and S + VC 2 t/ha or N, P, K and S + FYM 5 t/ha harvest maximum productivity, profitability and positive gain of nutrients (N, P, K and S) in soil at the end of 3 years lentil crop cycle.

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