

RESIDUAL EFFECT OF ORGANIC AND INORGANIC NUTRIENT SOURCES ON NUTRIENT UPTAKE AND YIELD OF RAINFED LENTIL

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Abstract: On farm experimental data was recorded during *rabi* season of 2008 to 2011 at Banaras Hindu University, Varanasi, India in a long term nutrient management experiment in a rainfed rice based system under All India Coordinated Research Project on Dry land Agriculture. The experiment was laid out with six treatments namely, control (no nutrient supplemented), 100% RDF (80-40-30 kg ha⁻¹ N: P: K), 100% N through FYM, 50% N through FYM, 50% RDF + 50% N through FYM and Farmer's Practice (only 20 kg N ha⁻¹) applied for *Kharif* direct seeded rainfed rice crop in an Inceptisol. The residual effect of these treatments on yield and nutrient uptake efficiency was studied on rainfed *rabi* lentil crop. The experimental findings indicated that crops grown under 100% N through FYM (T₃) treatment was significantly superior in increasing grain, stubble yield as well as protein yield of lentil. The conjunctive use of organic and inorganic source of fertilizer significantly induced to release higher concentration of N, P, K and S in the soil available pool thereby increased uptake by lentil plant at harvest. A significantly higher yield and economic return (B: C=0.72) was noted when the crop was grown under 100% N through FYM followed by T₅, 50% RDF + 50% N through FYM (B: C=0.62) and T₂, 100% RDF (B: C=0.54).

Keywords: Lentil, FYM, nutrient uptake, rainfed

INTRODUCTION

The '*rice fallows*' occupy nearly 12 million hectares (Singh, 2002) with more than half in the states of eastern India. The rice fallows represent an enormous under utilized resource (Musa et al., 2001; DFID 2009). The land is fertile enough to grow *kharif* rice, hence, potential enough to bring the livelihood security of millions of small and marginal rainfed farmers provided a second crop can be grown. Lentil (*Lens culinaris* Medik) is one of the important and most nutritious *rabi* pulses. It has the potential to cover the risk of rainfed farming. It is also used as a cover crop to check the soil erosion in problem areas. The plants if failed under rainfed condition can be ploughed back into the soil as green manure to improve the fertility of soil by biological nitrogen fixation. It is also rich in calcium (560 ppm), iron, and niacin. It has the lowest content of lectins and trypsin inhibitors among legumes. In *utera/paira* cropping system of rice-lentil in eastern Uttar Pradesh, Bihar, Orissa, Madhya Pradesh, seeds are sown in standing rice crop and therefore no tillage is done. The gap between average yield level of farmers and the potential yield level is still very wide in the rainfed ecosystem (Mahapatra et al., 1996) particularly with reference to *rabi* cropping. In general, rainfed *rabi* crop is grown as residual with almost zero input, thereby low in productivity. Intervention of proper technology coupled with the up scaling of package of practices for promotion of *rainfed rabi* crop in rice fallows of eastern India can

lead to a possible second crop more specifically chickpea and lentil after rice. Against this background, the present study was undertaken to quantify the residual effect of conjunctive use of organic and inorganic nutrient sources on nutrient uptake, yield and economics of rainfed lentil.

MATERIAL AND METHOD

The experiment was conducted during *rabi* season 2008-2011 at the research farm (25° 18' N, 83° 03' E, altitude 129 m above sea level) of Banaras Hindu University, Varanasi. This experiment has been under the supervision of the All India Coordinated Research Project on Dryland Agriculture (AICRP-DLA) of the Indian Council of Agricultural Research. The experiment site falls under sub-humid climate with average rainfall of 1081.4 mm and annual potential evapotranspiration of 1525.2 mm. About 87% of the total rainfall is generally received during monsoon season (June to September). The mean monthly minimum temperatures varies from 8.9° in January to 27.3°C in June and monthly mean maximum temperatures varies from 21.6 °C in January to 37.9 °C in June, with wide diurnal variations (Table 1). The mean minimum relative humidity (%) varies from 32.6 in March to 72.8 in August and monthly mean maximum relative humidity varies from 61.9 in March to 86.2 in August. The soil at the experimental site is classified as fine loamy mixed hyperthermic *Udic Ustochrept*. The plough layer (0.0–0.15 m) has 24.3% sand,

22.0% silt and 53.7% clay. The pH, EC, bulk density and CEC values at the beginning of the experiment were 7.54, 0.21 dS m⁻¹, 1.37 Mg m⁻³ and 1.38 cmol (p+) kg⁻¹, respectively and the available N, P, K and S status was 182.8 kg ha⁻¹, 13.0 kg ha⁻¹, 236.0 kg ha⁻¹ and 25.8 kg ha⁻¹, respectively. Six treatments comprising combinations of organic and inorganic nutrient sources were tested in 10 m X 10 m plots arranged in a randomized block design with three replications. The treatments were: control (no nutrient supplemented)-T₁, 100% RDF (80-40-30 kg ha⁻¹ N:P:K)-T₂, 100% N through FYM-T₃, 50% N through FYM-T₄, 50% RDF + 50% N through FYM-T₅ and farmer's practice (20 kg N ha⁻¹)-T₆ which was applied for *Kharif* rice crop and residual effect of this treatment was studied on rainfed lentil crop. The lentil (cv. HUL-57) was sown in the *rabi* season. Ten randomly selected plants from each replication of all the treatments were sampled at harvest for chemical analysis by using the modified methods as outlined by Piper, 1950 and Jackson, 1967.

RESULT AND DISCUSSION

Growth and Yield Attributes

A significantly higher plant height, number of pods, primary branches /plant, and 1000-grain weight (test weight) of lentil cv. HUL-57 was recorded in the residual 100 % FYM (T₃) treated plots under rice. The minimum plant height was recorded in control plot where no nutrient supplemented followed by farmer's practices. In general, increase in doses of NPK and FYM supplementation increased the yield and yield attributes significantly over control, clearly indicating the level of nutrients in available pool as growth limiting factor.

Grain and Stubble yield of lentil

The statistical analysis revealed that all the treatments produced significantly higher grain yield of lentil over control. Higher grain yield (832.7 kg ha⁻¹) and stubble yield of lentil (23.81 q ha⁻¹) was recorded for T₃ (100% FYM) treatment which was significantly higher over other treatments (Table 3). Interaction effect of FYM and NPK was found to be significant. The increase in yield might be due to application of organic and inorganic nutrients. These organic and inorganic sources create maximum nutrient availability to plant. Similar results were also reported by Tomar and Khajanji (2009). The gross return (₹29145), net income (₹12195) and benefit cost ratio (0.72) were higher under T₃ (100% N through FYM) treatment followed by crops grown under T₅ (50% FYM +50% RDF) treatments.

Concentration and uptake of nitrogen

All the treatments significantly enhanced the N concentration in Lentil grain and stubble. Successive

increase in the rates of NPK input caused a remarkable effect on N concentration. Highest concentration of grain and stubble was 3.8 and 1.4 percent obtained at 50% N through FYM+50% RDF followed by 100% FYM (T₃) and 100% RDF (T₂) treatment (Table 4). The maximum N uptake of grain (10.4 kg ha⁻¹) and stubble (8.8 kg ha⁻¹) was recorded by 100% FYM (T₃) and this was significantly higher over all other treatments. Similarly maximum total N uptake was recorded under 100% FYM (19.1 kg ha⁻¹) treatment while minimum (8.2 kg ha⁻¹) N uptake was recorded under no external nutrient supplementation (control treatment).

Concentration and uptake of phosphorus

Combined application of 50% FYM + 50% RDF (T₅) showed maximum P concentration in lentil grain (0.45%) and stubble (0.28 %) which was significantly higher than other treatments but 100% N through FYM showed statistically at par with 100% RDF and 50% N through FYM (Table 5). Except farmer's practices (T₆), all the fertilizer treatments showed significantly higher uptake of P by grain over control. The maximum withdrawal of phosphorus by lentil grain and stubble was recorded under 100% N through FYM (0.93 and 1.26 kg ha⁻¹) followed by 50% FYM + 50% RDF (0.74 and 1.25 kg ha⁻¹) treatment. All fertilizers treatments showed significant effect on P uptake by stubble over control. Increasing levels of NPK significantly enhanced the P removal by grain and stubble. Similarly total uptake of P by application of 100% N through FYM treatment led to significantly more utilization of P (2.19 kg ha⁻¹) in comparison to application of other treatment.

Concentration and uptake of potassium

The concentration of potassium in lentil grain and stubble grown under 50% FYM+ 50% RDF treatment was significantly higher over the control. At 50% FYM +50% RDF, K concentration in grain and stubble was 0.93 and 0.67 percent, respectively which was significantly higher than other treatments (Table 6). 100% N through FYM (T₃) recorded highest total K uptake compared to rest of the treatments followed by 50% FYM + 50% RDF (T₅) treatment.

Concentration and uptake of Sulphur

The highest S content in lentil grain and stubbles was recorded with 50% FYM +50% RDF followed by 100% N through FYM (T₃) treatment, which was significantly superior over rest of the treatments (Table 7). The lowest S concentration was recorded in control. Total uptake of S by lentil varied from 0.57 to 2.68 kg ha⁻¹ depending upon the level of nutrients supplemented during crop growth.

Maximum total S uptake by lentil crop was recorded when the crops was grown under 100% N through FYM followed by 50% FYM + 50% RDF treatment, while minimum under no nutrient supplementation (control) plots.

Protein Content and Yield

The protein content (%) and protein yield (kg ha⁻¹) of grain was influenced by different levels and sources of supplemented nutrients. The maximum protein content (23.69 %) and protein yield (119.5) was noticed when the crop was grown under organic nutrient sources *i.e.* T3 (100 % N through FYM) which was significantly higher over all other

treatments (Table 8). The protein content of seed increased with the increase in nitrogen levels from organic sources. This might be due to presence of more nutrients in labile pool to act as the building blocks of protein. Similar results were also recorded by Sonkamble *et al.* (2010) and Chaturvedi *et al.* (2010).

The study indicated that long term application of 100 % FYM and/ or integrated supply of nutrients through conjunctive use of organic and inorganic nutrient sources could be an effective practice of nutrient management for increasing nutrient-use efficiency and yield of rainfed lentil in alluvial soil of eastern U.P., India.

Table 1: Climatic pattern observed during the crop growing seasons of 2008–2011

Months	Rice growing season					Lentil growing season				
	June	July	August	September	October	November	December	January	February	March
Maximum temperature (°C)	37.9±2.4	33.6±1.3	32.8±0.3	32.4±0.7	31.8±0.6	29.0±0.7	24.2±2.4	21.6±1.4	25.8±1.5	32.2±1.5
Minimum temperature (°C)	27.3±1.2	26.5±0.9	26.2±0.6	25.3±0.4	20.9±1.1	14.7±1.4	10.3±0.9	8.9±1.4	12.1±1.0	16.3±1.0
Maximum RH (%)	65.4±4.3	83.6±4.7	86.2±2.6	85.8±2.7	83.6±4.2	83.6±2.5	85.9±3.7	86.8±4.5	82.4±4.5	61.9±6.8
Minimum RH (%)	46.5±5.8	67.6±5.6	72.8±2.5	70.0±3.3	55.0±5.5	41.0±2.86	44.4±6.7	50.2±5.8	48.0±5.5	33.6±5.2
Rainfall (mm)	11.2±4.1	14.2±4.0	15.1±5.22	26.0±4.8	11.4±3.8	4.5±2.5	3.0±1.0	6.2±4.1	7.1±4.8	6.5±4.6
Evaporation (mm day ⁻¹)	6.7±1.3	4.3±0.8	3.9±0.5	3.6±0.4	2.9±0.3	2.2±0.2	1.6±0.2	1.6±0.4	2.5±0.4	4.3±0.4
Sunshine (h)	7.1±1.4	4.7±0.8	5.4±0.7	5.8±1.9	7.8±0.8	7.7±0.7	6.3±0.9	5.9±1.5	7.7±1.4	8.9±0.6
Wind speed	6.5±1.2	6.6±0.6	5.4±0.9	4.3±0.7	2.4±0.7	1.8±0.6	2.0±0.4	3.0±0.7	3.3±0.7	3.5±0.7

Table 2: Growth and yield parameters of lentil cv. HUL-57 as influenced by different nutrient management practices under rainfed condition of Varanasi.

Treatments	Plant height (cm)	Primary branches /plant	Pods per plant	Test weight 1000 grain weight (g)
T ₁	21.3± 0.5	6.93 ±0.7	51.9±0.2	17.06± 0.1
T ₂	28.1±0.3	7.73 ±0.4	78.4 ±0.3	18.20±0.4
T ₃	33.3±0.2	8.00±0.5	86.6± 0.8	18.93± 0.3
T ₄	28.9±0.1	7.06 ±0.3	76.2 ±0.4	18.13±0.2
T ₅	30.5±0.3	7.86 ±0.5	80.6 ±0.7	18.76±0.4
T ₆	21.8±0.8	7.40±0.6	56.8 ±0.4	17.13±0.2
C.D. (P=0.05)	1.908	0.440	5.289	1.050

Table 3: Productivity and economics of lentil cv. HUL-57 grown under conjunctive use of organic and inorganic nutrient management

Treatments	Grain Yield (kg ha ⁻¹)	Stubble yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross income (₹ ha ⁻¹)	Net Income (₹ ha ⁻¹)	B : C ratio
T ₁	370.3	13.01	16950	12961	-3990	-0.24
T ₂	745.3	21.57	16950	26086	9136	0.54
T ₃	832.7	23.81	16950	29145	12195	0.72
T ₄	546	19.90	16950	19110	2160	0.13
T ₅	786.7	22.46	16950	27535	10585	0.62

T ₆	373.5	17.53	16950	13073	-3878	-0.23
C.D. (P=0.05)	32.9	1.18				

Table 4: Effect of different treatments on nitrogen concentration and its uptake by lentil cv. HUL-57

Treatments	N concentration %		N uptake (kg ha ⁻¹)		
	Grain	Stubble	Grain	Stubble	Total
T ₁	3.64 ±0.03	1.28 ±0.02	4.56 ±0.05	3.61 ±0.04	8.17 ±0.09
T ₂	3.72 ±0.08	1.32 ±0.06	8.91 ±0.01	7.89 ±0.03	18.8 ±0.04
T ₃	3.79 ±0.01	1.38 ±0.03	10.36±0.7	8.75±0.5	19.12±0.12
T ₄	3.74 ±0.03	1.34 ±0.05	6.82 ±0.09	5.55 ±0.08	12.37 ±0.17
T ₅	3.81±0.03	1.4±0.04	9.4 ±0.07	8.77 ±0.09	18.16 ±0.16
T ₆	3.65 ±0.01	1.28 ±0.03	3.98 ±0.06	4.28 ±0.05	8.26 ±0.11
C.D. (P=0.05)	0.21	0.08	0.75	0.69	1.44

Table 5: Effect of different treatments on phosphorus concentration and its uptake by lentil cv. HUL-57

Treatments	P concentration %		P uptake (kg ha ⁻¹)		
	Grain	Stubble	Grain	Stubble	Total
T ₁	0.33 ±0.08	0.19 ±0.03	0.23 ±0.01	0.28 ±0.04	0.52 ±0.05
T ₂	0.41 ±0.03	0.25 ±0.04	0.60 ±0.05	1.03 ±0.07	1.62 ±0.12
T ₃	0.42 ±0.05	0.25 ±0.01	0.93±0.03	1.26±0.09	2.19±0.12
T ₄	0.41 ±0.09	0.24 ±0.07	0.60 ±0.04	0.81 ±0.03	1.41 ±0.07
T ₅	0.45±0.02	0.28±0.04	0.74 ±0.07	1.25 ±0.08	1.99 ±0.15
T ₆	0.34 ±0.08	0.2 ±0.03	0.25 ±0.04	0.48 ±0.06	0.73 ±0.10
C.D. (P=0.05)	0.03	0.02	0.09	0.14	0.26

Table 6: Potassium concentration and its uptake by lentil cv. HUL-57 grown under different doses of organic and inorganic nutrients

Treatments	K concentration %		K uptake (kg ha ⁻¹)		
	Grain	Stubble	Grain	Stubble	Total
T ₁	0.80±0.08	0.49 ±0.06	0.56 ±0.05	0.73±0.04	1.29 ±0.09
T ₂	0.87 ±0.09	0.6 ±0.05	1.26 ±0.04	2.46 ±0.03	3.73 ±0.06
T ₃	0.91 ±0.08	0.65 ±0.07	2.01±0.05	3.28±0.04	5.29±0.09
T ₄	0.89 ±0.06	0.62 ±0.09	1.30 ±0.08	2.10 ±0.07	3.40 ±0.15
T ₅	0.93±0.05	0.67±0.07	1.52 ±0.09	3.00 ±0.06	4.52 ±0.03
T ₆	0.83 ±0.09	0.5 ±0.03	0.61 ±0.5	1.20 ±0.7	1.81 ±0.06
C.D. (P=0.05)	0.05	0.04	0.19	0.35	0.54

Table 7: Sulphur concentration and its uptake by lentil cv. HUL-57 grown under different doses of organic and inorganic nutrients

Treatments	S concentration %		S uptake (kg ha ⁻¹)		
	Grain	Stubble	Grain	Stubble	Total
T ₁	0.28 ±0.04	0.25 ±0.03	0.20 ±0.05	0.37 ±0.07	0.57 ±0.12
T ₂	0.36 ±0.02	0.34 ±0.03	0.52 ±0.08	1.39 ±0.05	1.92 ±0.13
T ₃	0.39 ±0.05	0.36 ±0.03	0.86±0.01	1.82±0.02	2.68±0.03
T ₄	0.37 ±0.09	0.35 ±0.07	0.54 ±0.02	1.19 ±0.01	1.73 ±0.03
T ₅	0.41±0.08	0.37±0.06	0.67 ±0.04	1.66 ±0.03	2.33 ±0.07
T ₆	0.3 ±0.04	0.26 ±0.02	0.22 ±0.07	0.62 ±0.06	0.84 ±0.13
C.D. (P=0.05)	0.026	0.024	0.087	0.200	0.287

Table 8: Effect of organic and inorganic sources of nutrient on nitrogen uptake (kg/ha) nitrogen content (%), protein content (%) and protein yield (kg/ha) in lentil cv. HUL-57

Treatment	N content in plant (%)	Yield (kg ha ⁻¹)	N uptake (kg ha ⁻¹)	Protein content (%)	Protein Yield (kg ha ⁻¹)
T ₁	3.64	548.9	8.17	22.75	51.1
T ₂	3.72	910.1	16.80	23.25	105.0
T ₃	3.79	1004.7	19.12	23.69	119.5
T ₄	3.74	839.8	12.37	23.38	77.3
T ₅	3.81	947.6	18.16	23.81	113.5
T ₆	3.65	739.8	8.26	22.81	51.6
C.D. (P=0.05)	0.07	61.8	0.45	0.42	5.8

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