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EFFECT OF ORGANICS ON CONTENT AND UPTAKE OF NUTRIENTS BY LENTIL GENOTYPES

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ABSTRACT

A field experiment was conducted during winter seasons of 2009-10 and 2010-11 at Rewa to study the effect of triacontanol, vermicompost and biofertilizers on content and uptake of nutrients by lentil genotypes. The nutrient contents in grain and straw viz. N, P, K and S deviated significantly due to different genotypes and organics as well as their interactions. Among the genotypes, VL 508 and amongst the organics, vermicompost + biofertilizers applied alone or in their combination resulted in almost highest nutrient contents in grain and straw. Amongst the genotypes, nutrient uptake of N, P, K and S was significantly higher in grain and straw of VL-508. The nutrients uptake in grain and straw was significantly higher due to applied organics over control. The highest total uptake of N (63 kg ha^{-1}), P (7.6 kg ha^{-1}), K (31.9 kg ha^{-1}) and S (6.5 kg ha^{-1}) by lentil was noted with vermicompost plus biofertilizers.

Key words: Lentil genotypes, organic sources of nutrients, nutrient contents, uptake

INTRODUCTION

The continuous use of chemical fertilizers is known to degrade physico-chemical properties of soil. On the other hand, the use of organics improves soil properties; its health and fertilizer use efficiency, mitigates short supply of micronutrients, stimulates the proliferation of diverse group of soil micro-organisms and improves the ecological balance of rhizosphere. Vermicompost application to different field crops has been known to reduce the requirement of chemical fertilizers without any reduction in crop yield (Giraddi, 2000). Worm casts contain five times more N, seven times more P, and eleven times more K than ordinary soil, the main minerals needed for plant growth (Sharma and Agrawal, 2004). The content and uptake of nutrients was found to influence significantly due to genotypes (Patel *et al.*, 2012) and augment due to different organics (Vasanti and Subramanian, 2004; Tiwari *et al.*, 2005; Tiwari *et al.*, 2006; Singh and Ahmad, 2010). The uptake of nutrients by high yielding crop varieties is generally greater than their additions in the soil. It was essential to know as to how much newly developed lentil genotypes would remove N, P, K, and S nutrients from per hectare soil and how much yield response and economy in fertilizer use can be derived due to organics. The varietal interaction applied with the different organics would be important findings for the lentil growers of this region. Looking to the poor fertility conditions of the intensively cropped lands where lentil is generally grown, recycling of organics is important amongst the various technologies of higher production, particularly from high-yielding lentil cultivars. Since very little information was available on these aspects, the present research was taken up.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* seasons of 2009-10 and 2010-11 at the Private Agriculture-cum-Research Farm, Beenda-Semariya Road, Rewa (M.P.). The soil of the experimental field was clay-loam having pH 7.5 – 7.6, electrical conductivity 0.32 – 0.34 dS m^{-1}, organic carbon 8.6 – 8.8 g kg^{-1}, available N 230.2 – 237.8 kg ha^{-1}, available P_2O_5 13.8 – 14.3 kg ha^{-1}, available K_2O and 371.7 – 380.6 kg ha^{-1} and available S 20.5 – 24.3 kg ha^{-1}. The rainfall received during the winter months was 78.8 and 101.8 mm in both the years. The treatments comprised four lentil genotypes (H-1, JL-3, PL-7 and VL-508) in main plots and six fertility treatments (absolute control, triacontanol, biofertilizers *Rhizobium* + PSB, triac. + biof. vermicompost with and without biofertilizers) in sub-plots. The experiment was laid out in split-plot design with three replications. Lentil genotypes were sown on 2 November, 2009 and 4 November, 2010 @ 35 kg seed ha^{-1} at 30 cm row spacing. An uniform dose of 20 kg N and 50 kg P_2O_5 ha^{-1} was applied through diammonium phosphate and 20 kg S ha^{-1} through elemental sulphur as basal in all the treatments. Before sowing seeds were inoculated with Rhizobium biofertilizer @ 20 g kg^{-1} seed, and during sowing PSB (phosphate-solubilizing bacteria) was also applied in the same furrows @ 20 g kg^{-1} seed mixed with FYM as per treatments. The crop was grown as per recommended package of practices.

Plant growth regulator i.e. triacontanol (Vipul) was foliar sprayed (thrice) @ 250 ml/ha during 30, 40 and 50 days after sowing. The crop was harvested on 22 February, 2010 and 3 March, 2011. Nitrogen content in grain and straw was determined by Kjeldahl method (Jackson, 1973). Grain and straw were digested in diacid (HNO_3 and $HClO_4$) mixture for the estimation of P, K and S. Phosphorus was determined by molybdovomadate yellow colour method, K by flame photometer and S by turbidimeric method (Chesnin and Yien, 1951). The nutrients uptake per hectare was calculated by multiplying the seed or straw yield with the per cent nutrient content in seed or straw.

RESULTS AND DISCUSSION

The N and P contents in lentil genotypes were, in general, higher in grain than in straw whereas the reverse was true in case of K and S contents It ranged from 3.83 to 3.87 % N in grain and 0.87 to 0.90 % N in straw, 0.32 to 0.34 % P in grain and 0.15 to 0.18 % P in straw, 0.90 to 0.92 % K in grain and 1.00 to 1.06 % K in straw, 0.09 % S in grain and 0.29 to 0.31 % S in straw (Table 1). In fact, the grain acted as a sink for photosynthates, nitrogen and phosphorus. All the four nutrient contents in grain and straw were found to deviate significantly among the lentil genotypes except in case of N content in grain. Out of these, VL 508 showed higher nutrient contents over H-1, JL-3 and PL-7. This indicated that the genetically absorption capacity of applied nutrients to VL 508 genotype was almost significantly higher than the other genotypes.

Table 1: Nutrient contents (%) in grain and straw of lentil as influenced by genotypes and organics (Pooled for 2 years)

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur		Yield(q ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Genotypes										
H-1	3.86	0.87	0.32	0.15	0.91	1.04	0.09	0.29	9.72	13.90
JL-3	3.83	0.87	0.32	0.15	0.90	1.03	0.09	0.29	8.90	14.26
PL-7	3.86	0.88	0.33	0.17	0.91	1.00	0.09	0.29	9.80	13.51
VL-508	3.87	0.90	0.34	0.18	0.92	1.06	0.09	0.31	12.08	13.69
CD (P=0.05)	NS	0.011	0.003	0.007	0.011	0.015	0.001	0.007	0.77	0.12
Organics										
Control	3.80	0.82	0.29	0.13	0.85	0.92	0.08	0.22	7.84	10.38
Triacontanol	3.83	0.85	0.31	0.14	0.88	0.96	0.09	0.26	9.21	13.79
Biofertilizers	3.82	0.87	0.31	0.16	0.91	0.92	0.09	0.28	10.06	14.11
Triac. + Biof.	3.86	0.88	0.33	0.17	0.95	0.97	0.09	0.32	10.38	14.62
Vermicompost	3.91	0.93	0.35	0.17	0.93	1.14	0.09	0.32	10.90	14.91
Vermi. + Biof.	3.93	0.93	0.37	0.19	0.95	1.29	0.10	0.34	12.36	15.08
CD (P=0.05)	0.08	0.012	0.005	0.005	0.012	0.015	0.001	0.008	1.07	0.10

Amongst the applied organics, vermicompost plus biofertilizers increased the nutrient contents almost significantly in grain and straw. It was 3.93 % N in grain and 0.93 % N in straw, 0.37 % P in grain and 0.19 % P in straw, 0.95 % K in grain and 1.29 % K in straw and 0.10 % S in grain and 0.34 % S in straw. The significant increase in nutrient contents might be due to the fact that plants absorbed proportionately higher amount of applied organic sources of nutrients as the pool of available nutrients was already increased in the soil by adding vermicompost along with dual biofertilizers. The increasing nutrient contents in plant parts had a close relationship with the symbiotic efficiency, specific rhizobial activity, increased nutrients availability in soil and other favourable edaphic conditions (Dwivedi *et al.*, 1996). The present results agree with those of Rajkhowa *et al.* (2003), Vasanthi and Subramaniam (2004), Kumawat *et al.* (2009), Singh and Ahmad (2010)) and Patel *et al.* (2012). The treatment interactions influenced the nutrient contents significantly. VL 508 applied with vermi. + biof. resulted in maximum uptake of nutrients. The N content in grain and straw was 3.94 and 0.95 %, P content 0.39 and 0.21 %, K content 0.97 and 1.38 % and S content 0.10 and 0.36 %, respectively (Table 3).

Table 2: Nutrients uptake (kg ha^{-1}) in grain and straw of lentil as influenced by genotypes and fertility levels (Pooled for 2 years)

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Genotypes								
H-1	37.6	12.6	3.2	2.1	8.9	15.1	0.9	4.3
JL-3	34.2	12.8	2.9	2.3	8.0	15.3	0.8	4.4
PL-7	37.9	12.4	3.2	2.4	9.0	14.1	0.9	4.1
VL-508	46.8	12.8	4.2	2.6	11.2	15.1	1.1	4.4
CD (P=0.05)	3.39	0.17	0.22	0.17	0.89	0.24	0.05	0.19
Organics								
Control	29.8	8.9	2.3	1.4	6.6	1.0	0.6	2.4
Triacontanol	33.3	12.1	2.9	2.0	8.1	13.7	0.8	3.7
Biofertilizers	38.5	12.8	3.1	2.3	9.2	13.5	0.9	4.3
Triac. + Biof.	40.0	13.3	3.5	2.6	9.9	14.6	1.0	4.9
Vermicompost	42.6	14.3	3.8	2.6	10.2	17.6	1.0	5.0
Vermi. + Biof.	48.5	14.6	4.6	3.0	11.8	20.1	1.2	5.4
CD (P=0.05)	3.27	0.16	0.14	0.16	0.82	0.23	0.04	0.16

Uptake of nutrients

The uptake of N and P by lentil genotypes was, in general, higher in grain than by straw, however, the reverse trend was true in case of K and S uptake. N uptake ranged from 34.2 to 46.8 kg ha^{-1} by grain and 12.4 to 12.8 kg ha^{-1} by straw, P uptake 2.9 to 4.2 kg ha^{-1} by grain and 2.1 to 2.6 kg ha^{-1} by straw, K uptake 8.0 to 11.2 kg ha^{-1} by grain and 14.1 to 15.3 kg ha^{-1} by straw and S uptake 0.8 to 1.1 kg ha^{-1} by grain and 4.1 to 4.4 kg ha^{-1} by straw (Table 2). There were significant variations in the quantum of N, P, K and S uptake by grain and straw. The nutrients uptake, in general, was higher in VL 508 compared to other genotypes. It was 46.8 kg N ha^{-1} in grain and 12.8 kg N ha^{-1} by straw, 4.2 kg P ha^{-1} by grain and 2.6 kg P ha^{-1} by straw, 11.2 kg K ha^{-1} by grain and 15.1 kg K ha^{-1} by straw and 1.1 kg S ha^{-1} by grain and 4.4 kg S ha^{-1} by straw. The lowest uptake of NPKS particularly by grain i.e. 34.2, 2.9, 8.0 and 0.8 kg ha^{-1}, respectively was found in case of JL-3. The significant influence of genotypes on the nutrient uptake was due to significantly higher nutrient contents as well as grain yield among the genotypes. This may be due to the fact that the larger part of these nutrients absorbed by the plant would have migrated into the seeds by the time of harvest (Tiwari *et al.*, 2006). The combined impact of vermicompost with dual biofertilizers increased the nutrients uptake by lentil significantly over the remaining treatments. However, the second best treatment was vermicompost applied alone. The organics (vermicompost plus biofertilizers) removed the highest amongst of N (63.0 kg), P (7.6 kg), K (31.9 kg) and S (6.55) kg ha^{-1}. Genotypes x organics interactions were found to be significant in case of all the four nutrients by grain and straw. The best interaction was VL 508 grown with vermicompost plus dual biofertilizers. The positive influence of such interaction on the nutrient uptake might be due to the conjoint use of vermicompost with dual biofertilizers enhanced the utilization of nutrients by the soil microbial process. Moreover, the beneficial effect of vermicompost on high yielding VL 508 might be the result of its usefulness as a store-house of plant nutrients, with improved soil aeration, root development and increased microbial-cum-biological activities in the rhizosphere (Edwards and Arancon, 2004; Hakeem *et al.*,2007 and Singh and Ahmad, 2010).

Table 3: Effect of organics and genotypes on nutrient contents in grain and straw

Organics	Genotypes				Genotypes			
	H-1	JL-3	PL-7	VL-508	H-1	JL-3	PL-7	VL-508
	Nitrogen in grain (%)				Nitrogen in straw (%)			
Absolute control	3.79	3.78	3.81	3.82	0.81	0.83	0.81	0.83
Triacontanol	3.82	3.82	3.85	3.85	0.83	0.84	0.85	0.87
Biofertilizers	3.85	3.81	3.82	3.83	0.87	0.84	0.87	0.87
Triac.+ Biof.	3.88	3.85	3.86	3.85	0.87	0.86	0.90	0.90
Vermicompost	3.92	3.89	3.92	3.92	0.93	0.92	0.92	0.95
Vermi. + Biof.	3.95	3.89	3.92	3.94	0.94	0.91	0.95	0.95
CD (P=0.05)		0.015				0.024		
	Phosphorus in grain (%)				Phosphorus in straw (%)			
Absolute control	0.29	0.29	0.29	0.31	0.12	0.12	0.14	0.14
Triacontanol	0.29	0.31	0.31	0.33	0.13	0.13	0.15	0.16
Biofertilizers	0.31	0.29	0.32	0.32	0.14	0.15	0.17	0.19
Triac.+ Biof.	0.35	0.31	0.32	0.35	0.15	0.17	0.18	0.20
Vermicompost	0.33	0.34	0.35	0.38	0.16	0.18	0.17	0.19
Vermi. + Biof.	0.37	0.37	0.37	0.39	0.19	0.19	0.19	0.21
CD (P=0.05)		0.005				0.010		
	Potassium in grain (%)				Potassium in straw (%)			
Absolute control	0.86	0.84	0.84	0.84	0.91	0.91	0.93	0.93
Triacontanol	0.89	0.86	0.88	0.88	0.94	0.96	0.97	0.97
Biofertilizers	0.91	0.90	0.92	0.93	0.92	0.93	0.91	0.91
Triac.+ Biof.	0.95	0.93	0.95	0.96	0.95	0.96	0.98	0.98
Vermicompost	0.92	0.90	0.93	0.96	1.18	1.17	1.06	1.17
Vermi. + Biof.	0.96	0.94	0.95	0.97	1.37	1.24	1.17	1.38
CD (P=0.05)		0.022				0.030		
	Sulphur in grain (%)				Sulphur in straw (%)			
Absolute control	0.08	0.08	0.08	0.08	0.21	0.23	0.21	0.25
Triacontanol	0.09	0.09	0.09	0.09	0.26	0.27	0.26	0.27
Biofertilizers	0.09	0.08	0.09	0.09	0.29	0.30	0.28	0.29
Triac.+ Biof.	0.10	0.09	0.09	0.10	0.34	0.32	0.31	0.33
Vermicompost	0.10	0.08	0.09	0.09	0.31	0.31	0.33	0.35
Vermi. + Biof.	0.10	0.10	0.09	0.10	0.35	0.33	0.34	0.36
CD (P=0.05)		0.022				0.015		

The higher uptake of nutrients under different treatments and their interactions might be owing to increased total biomass and per cent nutrient contents in those treatments. These results corroborate with those of Sharma and Namdeo (1999), Kumawat *et al.* (2009), Singh and Ahmad (2010) and Patel *et al.* (2012). The uptake of nutrients was influenced significantly due to genotypes x organics interactions. VL 508 applied with vermi. + biof. further encouraged the nutrients uptake. The maximum N uptake by grain and straw was 54.7 and 15.3 kg ha^{-1}, P uptake 5.4 and 3.4 kg ha^{-1}, K uptake 13.5 and 22.3 kg ha^{-1} and S uptake was 1.4 and 5.8 kg ha^{-1}, respectively (Table 4). The findings allude that amongst the genotypes, VL 508, and amongst the organics, vermicompost + biofertilizers produced the maximum crop biomass (grain + straw) per hectare and thereby drawn maximum N, P, K and S nutrients from the soil. This may be a guide line for proper nutrition to the HY varieties of lentil.

Table 4: Effect of organics and genotypes on uptake of nutrients in grain and straw

Organics	Genotypes				Genotypes			
	H-1	JL-3	PL-7	VL-508	H-1	JL-3	PL-7	VL-508
	Nitrogen in grain (kg ha^{-1})				Nitrogen in straw (kg ha^{-1})			
Absolute control	27.6	26.6	29.2	30.9	8.9	8.8	8.2	9.7
Triacontanol	31.7	29.5	35.0	45.0	11.3	13.0	12.2	11.9
Biofertilizers	36.9	33.3	37.5	46.1	12.9	13.4	12.4	12.4
Triac.+ Biof.	38.0	35.5	38.7	47.7	13.4	13.6	13.3	13.2
Vermicompost	41.6	36.6	41.1	51.1	14.6	14.3	14.0	14.2
Vermi. + Biof.	50.0	43.7	45.7	54.7	14.6	14.1	14.4	15.3
CD (P=0.05)		6.54				0.33		
	Phosphorus in grain (kg ha^{-1})				Phosphorus in straw (kg ha^{-1})			
Absolute control	2.1	2.1	2.3	2.9	1.3	1.2	1.5	1.6
Triacontanol	2.4	2.4	2.8	3.9	1.8	1.9	2.2	2.2
Biofertilizers	2.9	2.5	3.1	3.9	2.0	2.3	2.5	2.6
Triac.+ Biof.	3.4	2.9	3.2	4.3	2.3	2.6	2.7	2.8
Vermicompost	3.5	3.2	3.7	4.9	2.5	2.7	2.6	2.8
Vermi. + Biof.	4.6	4.2	4.3	5.4	2.9	2.9	2.9	3.4
CD (P=0.05)		0.28				0.33		
	Potassium in grain (kg ha^{-1})				Potassium in straw (kg ha^{-1})			
Absolute control	6.3	5.9	6.5	7.8	9.9	9.7	9.4	10.8
Triacontanol	7.4	6.7	8.0	10.3	12.8	14.7	13.8	13.4
Biofertilizers	8.7	7.8	9.0	11.2	13.7	14.7	12.8	12.7
Triac.+ Biof.	9.4	8.6	9.5	11.9	14.5	15.0	14.5	14.2
Vermicompost	9.8	8.5	9.8	12.5	18.5	18.3	16.1	17.4
Vermi. + Biof.	12.1	10.6	11.1	13.5	21.3	19.2	17.8	22.3
CD (P=0.05)		1.64				0.47		
	Sulphur in grain (kg ha^{-1})				Sulphur in straw (kg ha^{-1})			
Absolute control	0.6	0.6	0.6	0.8	2.3	2.5	2.1	2.8
Triacontanol	0.7	0.7	0.8	1.0	3.5	4.1	3.7	3.8
Biofertilizers	0.9	0.8	0.9	1.1	4.4	4.7	3.9	4.0
Triac.+ Biof.	1.0	0.8	0.9	1.2	5.2	5.0	4.7	4.7
Vermicompost	1.0	0.8	0.9	1.2	4.9	4.9	5.0	5.2
Vermi. + Biof.	1.2	1.1	1.1	1.4	5.4	5.1	5.1	5.8
CD (P=0.05)		0.086				0.322		

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