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RC Sanwal
Department of Soil Science and Agriculture Chemistry, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Yogesh Sharma
Department of Soil Science and Agriculture Chemistry, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

ML Reager
Krishi Vigyan Kendra, Bikaner, Rajasthan, India

Dayanand
KVK, Abusar - Jhunjhunu, Rajasthan, India

Shri Rakesh
Department of Agronomy, College of Agriculture, Bikaner Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Corresponding Author:
RC Sanwal
Department of Soil Science and Agriculture Chemistry, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Effect of vermicompost, nitrogen and phosphorus on economics of coriander and soil health

RC Sanwal, Yogesh Sharma, ML Reager, Dayanand and Shri Rakesh

Abstract
The field experiment was conducted at the Agronomy Research Farm, College of Agriculture, S.K. Rajasthan Agricultural University, Bikaner during *rabi* seasons of 2009-10 and 2010-11 to study the effect of vermicompost, N and P levels on economics of coriander and soil heath. Twenty seven treatment combinations i.e. three levels of vermicompost (control, 2.5 and 5.0 t ha^{-1}), three levels of nitrogen (control, 40 and 80 kg ha^{-1}) as main plot treatment and three levels of phosphorus (control, 20 and 40 kg P_2O_5 ha^{-1}) as sub plot treatment were laid out in split plot design with three replications. From the results, among all the treatment combinations application of vermicompost @ 2.5 t ha^{-1} with N level @ 40 kg/ ha and P level 20 kg/ha significantly increased net returns and B:C ratio of coriander. Application of vermicompost @ 2.5 t ha^{-1} with N level @ 40 kg/ ha and P level 20 kg/ha also improve nutrient status of soil.

Keywords: Coriander, Net retuen, B:C ratio, Nitrogen, Phosphorus, Vermicompost

1. Introduction

Spices are grown in abundance in India, and many of them are indigenous to the country. India is sometimes known as the "Spice Kingdom." In addition to their usage in the culinary sector, spices have therapeutic characteristics and are consequently utilised in a variety of pharmaceutical treatments as well as the cosmetic industry. The Indian economy relies heavily on coriander. Coriander (*Coriandrum sativum* L.), often known as "Dhania," is one of the world's oldest seed spices. It holds a prominent position among the seed spices growing in Northern India, especially in Rajasthan.

In Rajasthan, it is mainly grown in the districts of Kota, Jhalawad, Baran, Bundi, Sikar, Jaipur, Tonk, Alwar, Nagour and Bikaner districts. It is the most widely used condiment throughout the worldIt is primarily grown for its aromatic and fragrant seed, which is a cremocarpic fruit in botanical terms. Coriander's fresh green stem leaves and fruits offer a lovely aromatic aroma. Coriander fruits have an aromatic odour and flavour that comes from an essential oil made composed of hydrocarbon and oxygenation molecules. The most of the soils are low in organic carbon and a major limiting factor for coriander sustainable crop production in Rajasthan. It is evident now a day that out of all the major plant nutrients found in various Indian soils, nitrogen (N) is the most deficient element especially in sandy loam soils of Rajasthan [Arakery *et al.* (1956)] [1]. Dhun (1983) [2] reported that coriander grows well on well drained sandy loam and light sandy soils and its cultivation should be avoided in heavy textured soils. Availability of N is of prime importance for growing plants as it is a major and indispensable constituent of protein and nucleic acid molecules. The unsustainable crop production call for substituting part of inorganic fertilizers with locally available, organic sources of nutrients *viz.* manures, green manures, crop residues, bio-fertilizers etc in a synergistic manner. However, due to paucity of organic sources of nutrients and their inability to meet out total nutrient requirement to sustain large scale productivity goals to meet the demands of increased population, their integrated use with chemical fertilizer is inevitable [Acharya (2002)] [3]. The vermicomposting is an eco-friendly and effective way to recycle organic wastes. Phosphorus (P) is one of the most important plant nutrients and due to its deficiency it restricts the growth and yield of crops. Phosphorus has been known to be associated with number of vital metabolic activities in the plant and its deficiency is manifested into marked reduction of plant growth and finally the crop yield. Application of P not only increases the crop yield but also improves the resistance to plant diseases. Phosphorus has also been associated with early maturity of the crop and is considered essential to seed formation and provide great strength to plants.

In this above backdrop, a study was carried out at Research Farm of SKRAU, Bikaner to test the hypothesis of keeping in view the above facts; the present investigation was carried out to study the effect of vermicompost, N and P levels on economics of coriander and soil heath.

2. Materials and Methods

2.1 Experimental site and location

The experiment was conducted at the Agronomy Research Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during the rabi 2009-10 and 2010-11. College of Agriculture is situated on Sriganganagar road at 28.01° N latitude and 73.22°E longitude at an altitude of 234.70 meters above mean sea level. According to "Agro-ecological region map" brought out by the National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Bikaner falls under Agro-ecological region No. 2 (M9 E1) under Arid ecosystem (Hot Arid Eco-region), which is characterized by deep, sandy and coarse loamy, desert soils with low water holding capacity, hot and arid climate. PET in this region ranges between 1500-2000 mm. As per NARP classification of agro climatic zones, Bikaner falls in Agroclimatic 684 R. C. Sanwal *et al*. zone Ic (Hyper Arid Partially Irrigated Western Plain Zone).

2.2 Climate and weather condition

The climate of this zone is typically arid characterized by aridity of the atmosphere with extremes of temperature both in summers and winters. The average annual rainfall of this tract is about 265 mm which is mostly received during rainy season from July to September. The mean maximum and minimum temperature shows a wide range of fluctuation during the summer and winter months. A maximum temperature is around 48°C during summer while in the winters it may fall as low as 0°C. Maximum and minimum relative humidity during the experimentation period varied from 35 to 97 and 9 to 62 per cent, respectively, during rabi 2009-10 while in 2010-11, the maximum and minimum relative humidity varied from 10 to 56 and 10 to 61 per cent, respectively.

2.3 Physico-chemical properties of experimental site

The soil of the experimental field was analyzed for physico-chemical properties before sowing of the crop. The values of different properties along with their methods used for analysis are given in Table 1. The soil of the experimental field was loamy sand in texture, low in organic carbon, N, P, medium in potash and alkaline in reaction.

Table 1: Physico-chemical properties of the experimental soil

Soil properties	Contents		Methods used and reference
	2009-10	2010-11	
A. Mechanical composition			
Sand (%)	87.58	87.73	Hydrometer method (Bouyoucos, 1962) [18]
Silt (%)	3.10	3.13	
Clay (%)	8.95	8.98	
Texture	Loamy sand	Loamy sand	Triangular method (Brady, 1983) [19]
B. Physical properties			
Field capacity (%) moisture content at (0.003 MPa)	7.65	7.61	Pressure membrane apparatus method (Richards, 1947) [23]
Permanent wilting point (%) moisture content at (0.15 MPa)	1.64	1.68	Pressure membrane apparatus method (Richards, 1947) [23]
Bulk density (Mg m^{-3})	1.58	1.60	Core sampler method (Kanwar and Chopra, 1959) [20]
C. Chemical properties			
Soil pH (1:2 soil water suspension)	8.42	8.46	Glass electrode pH meter USDA Hand Book No. 60 (Richards, 1954) [24]
EC (dS m^{-1} at 25^0C)	0.18	0.19	Method No.4 USDA Hand Book No. 60 (Richards, 1954) [24]
Organic carbon (%)	0.15	0.19	Walklay and Black's wet digestion method (Walklay and Black, 1934) [25]
Calcium carbonate (%)	0.13	0.15	Rapid tritaration method (Hitchinson and McLennan, 1914) [27]
Available nitrogen (kg ha^{-1})	125.40	124.20	Alkalion permagent method (Subbaiah and Asija, 1956) [26]
Available P_2O_5 (kg ha^{-1})	21.80	21.30	Olsen method Olsen *et al*., 1954 [22]
Available K_2O (kg ha^{-1})	234.6	231.1	Flame photometric method (Metson *et al*., 1956) [21]

2.4 Experimental details and layout

The experiment comprised of three levels of vermicompost, three levels of N and three levels of P. Thus, total were 27 treatment combinations that were laid out in split plot design and replicated three times. Vermicompost and N were assigned to main plots, whereas, P to sub plot. The levels of vermicompost were applied in the respective plots as per treatment and were thoroughly incorporated into the soil before sowing. The crop was grown in rabi (2009-10 and 2010-11) at SKRAU, Bikaner research farm with net plot size was 3.0 m × 1.8 m. The coriander variety RCr-436 used as a test crop with row to row spacing 30 cm and plant to plant 5 cm. Full doses of P and K and half dose of N were applied at the time of sowing and remaining in 2 split doses i.e. at 30 days after sowing and at flowering initiation. The crop was raised with the standard agronomic management practices.

2.5 Statistical analysis

The experimental data were analyzed using analysis of variance (ANOVA) technique to split plot design. The critical difference (CD) at 5 per cent level was computed wherever 'F' test was significant [Snedecor and Cochran (1967)] [4].

3. Results and Discussion

3.1 Effect of vermicompost, nitrogen and phosphorus on net returns and B:C ratio

Data depicted in table 1 indicated that there was significant difference on net returns and B:C ratio due to vermicompost, nitrogen and phosphorus levels during both the years and on pooled results. Among vermicompost treatments, vermicompost were found to be effective in increasing net returns and B:C ratio of coriander. Application of vermicompost @ 2.5 t ha^{-1} increased the 43.69, 39.61 and 41.51 per cent net returns and B:C ratio by 8.74, 7.35 and 7.67 per cent during both the years as well as in pooled analysis over control. Further increase in vermicompost levels resulted in to non-significant decrease in net returns and B:C ratio at 5.0 t ha^{-1} during both the years as well as in pooled analysis. Higher net return were obtained on account of higher seed yield which resulted in higher net return because of less cost involved in application of optimum level of vermicompost compared to additional yield obtained Singh *et al.* (2010) [5].

Results further documented that application of nitrogen @ 40 kg ha^{-1} being at par with 80 kg N ha^{-1} increased the net returns and B:C ratio during 2009-10, 2010-11 and in pooled analysis. Further increase in nitrogen level resulted in to non-significant increase net returns and B:C ratio at 80 kg ha^{-1}. This was mainly due to the increased seed yield with comparatively lesser cost of nitrogen under this treatment.

The data apparently showed that application of phosphorus at 20 kg P_2O_5 ha^{-1} being statistically at par with 40 kg P_2O_5 ha^{-1}, significantly increased net returns by 38.11, 26.57 and 31.77 per cent and B:C ratio by 20.24, 15.09 and 17.91 per cent over control during both the years of experimentation as well as in pooled analysis. Significantly increased net returns and B:C ratio over control due to similar changes in seed yield with the application of phosphorus and prevailing market prices.

Table 2: Effect of vermicompost, nitrogen and phosphorus on net returns and B: C ratio of coriander

Treatments	Net returns (₹ /ha)			B:C ratio		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Vermicompost (t ha^{-1})						
V_0	36790	42269	39530	2.86	3.13	3.00
$V_{2.5}$	52864	59013	55938	3.11	3.36	3.23
$V_{5.0}$	50472	56943	53707	2.66	2.88	2.77
S.Em+	1517	1537	1080	0.06	0.07	0.05
CD (P=0.05)	4548	4608	3110	0.19	0.21	0.14
Nitrogen (Kg ha^{-1})						
N_0	22194	26146	24170	1.91	2.07	1.99
N_{40}	57844	64732	61288	3.32	3.61	3.47
N_{80}	60088	67347	63717	3.40	3.70	3.55
S.Em+	1517	1537	1080	0.06	0.07	0.05
CD (P=0.05)	4548	4608	3110	0.19	0.21	0.14
Phosphorus(kg ha^{-1})						
P_0	36525	44626	40575	2.52	2.85	2.68
P_{20}	50446	56485	53465	3.03	3.28	3.16
P_{40}	53155	57114	55135	3.08	3.24	3.16
S.Em+	1313	1296	898	0.06	0.06	0.04
CD (P=0.05)	3765	3718	2529	0.16	0.17	0.11

3.2 Interaction effect of vermicompost and nitrogen levels on net returns (pooled)

Table 2 showed that interaction effect of vermicompost and nitrogen levels was found to be significant on net returns on pooled basis. The net returns increased significantly, with increasing levels of vermicompost up to 2.5 t ha^{-1} with all levels of nitrogen. Further, increasing levels of nitrogen also increased the net returns significantly, up to 80 kg N ha^{-1} in control plot of vermicompost, whereas net returns increased up to only 40 kg N ha^{-1} with the application of vermicompost at 2.5 t ha^{-1}. The significantly increased net returns (₹ 70074 ha^{-1}) was recorded under vermicompost @ 2.5 t ha^{-1} in combination with 40 kg N ha^{-1} on pooled basis, which was remained at par with $V_{5.0}$ N_{40}, $V_{2.5}N_{80}$ and $V_{5.0}N_{80.}$ Minimum net returns (₹ 19496 ha^{-1}) was recorded when both vermicompost and nitrogen was not applied.

Table 3: Interaction effect between vermicompost and nitrogen levels on net returns (₹ ha^{-1}) on pooled

Nitrogen levels (kg ha^{-1})	Vermicompost (t ha^{-1})		
	V_0	$V_{2.5}$	$V_{5.0}$
N_0	19496	26437	26577
N_{40}	46757	70074	67033
N_{80}	52336	71304	67511
S.Em±			1870
CD (P=0.05)			5387

3.3 Interaction effect of nitrogen and phosphorus levels on net returns

Combined effect of nitrogen and phosphorus levels on net returns was found to be significant (Table 2). The net returns increased significantly, with increasing levels of nitrogen up to 80 kg ha^{-1} without application of phosphorus. However, it increased significantly up to nitrogen at 40 kg ha^{-1} with the phosphorus @ 20 as well as 40 kg P_2O_5 ha^{-1}. Further, increasing level of phosphorus also increased the net returns significantly up to 20 kg P_2O_5 ha^{-1} with all the levels of nitrogen (*viz.* 0, 40 and 80 kg ha^{-1}). On pooled basis, the significantly increased net returns (₹ 66866 ha^{-1}) was recorded under nitrogen @ 40 kg ha^{-1} in combination with phosphorus @ 20 kg P_2O_5 ha^{-1}, which remained at par with $N_{80}P_{20}$, $N_{40}P_{40}$ and $N_{80}P_{40}$. Minimum net returns (₹ 17953 ha^{-1}) was recorded when both nitrogen and phosphorus was not applied. The net returns in general, significantly increased upto the optimum dose of vermicompost and nitrogen due to involvement of higher cost and lower returns on higher levels. A similar finding was also reported by Gupta (1976) [6] in dill, Rathore (1980) [9] in fenugreek, Patel *et al.* (2000) [8] in fennel and Garg *et al.* (2004) [7] in coriander.

Table 4: Interaction effect between nitrogen and phosphorus levels on net returns (Pooled)

Phosphorus levels (kg ha^{-1})	Nitrogen (kg ha^{-1})		
	N_0	N_{40}	N_{80}
P_0	17953	49091	54681
P_{20}	25166	66866	68364
P_{40}	29391	67907	68107
		S.Em±	CD (P=0.05)
N at same level of P		1870	5267
P at same level of N and at different levels		1720	4909

3.4 Effect of vermicompost, nitrogen and phosphorus on nutrient content in soil after harvest of crop

Data depicted in table 4 indicated that there was significant difference on nutrient content in soil after harvest of crop due to vermicompost, nitrogen and phosphorus levels during both the years and on pooled results. Results revealed that increasing levels of vermicopost up to 5.0 t ha^{-1} increased the organic carbon, available nitrogen, and available phosphorus significantly in soil during both the years as well as in pooled analysis. Application of vermicompost at 5.0 t ha^{-1} accumulate more organic carbon, available nitrogen and available phosphorus in soil as compared to over control, but it was at par with vermicompost at 2.5 t ha^{-1} during both the years as well as in pooled analysis. Vermicompost plays a vital role in improving soil conditions ideal for rhizosphere and microbial population. Vermicompost contributes a substantial amount of N in soil, which is released gradually over a long period. It is pertinent to point out that humic compounds resulting from vermicompost decomposition influence the availability of plant nutrients as it is rich in humus, phosphorus, potassium and in micronutrients (Zn, Cu, Fe, Mn), and has high microbiological potential (Darzi, 2012) [10]. Humic acid through its CEC and acid and base functional groups provides much of the pH buffering capacity in soils. In addition, the soil starved of N and P and due to continuous crop raising become available in the soil as constituents of organic matter due to addition of vermicompost and its slow mineralization. The findings of this investigation are in close conformity with those of Chauhan (2001) [11], Thomas and Lal (2004) [12] and Singh (2011) [13].

Data further indicated that application of nitrogen @ 40 kg ha^{-1} being at par with 80 kg N ha^{-1} increased the organic carbon and available nitrogen in soil during 2009-10, 2010-11 and in pooled analysis. Available phosphorus and available potassium did not influenced with nitrogen application. The nitrogen availability in soil after harvest of coriander significantly due to increased addition of nitrogen as only a part of it was utilized by the crop and a part of the remaining nitrogen contributed to its available pool of the soil. The application of nitrogen was not expected to influence status of other nutrient namely P and K as these were uniformly applied over all nitrogen levels. Application of higher levels of nitrogen is significantly increased organic carbon and available nitrogen. These findings corroborate the reports of Kumar *et al.* (2002) [14], Singh *et al.* (2011) [13], Hnamate *et al.* (2014) [15].

The data (Table 4) apparently showed that application of phosphorus at 20 kg P_2O_5 ha^{-1} being statistically at par with 40 kg P_2O_5 ha^{-1}, significantly increased organic carbon and available phosphorus in soil over control during both the years of experimentation as well as in pooled analysis. Available nitrogen and available potassium did not influenced with phosphorus application. As expected, the phosphorus availability in soil after harvest of coriander significantly increased due to increased addition of phosphorus as only a part of it was utilized by the crop and a part of the remaining phosphorus contributed to its available pool of the soil. The application of phosphorus was not expected to influence status of other nutrients namely N and K as these were uniformly applied over all phosphorus levels. Application of phosphorus could not disturb the buffering capacity of soil in permitting transformation to various forms of these nutrients. A similar finding was also reported by Balai (2002) [16], Singh and Ahlawat (2007) [17] and Gupta (2012).

Table 5: Effect of vermicompost, nitrogen and phosphorus on organic carbon, available nitrogen, phosphorus and potassium in soil after harvest of coriander

Treatments	Organic Carbon (%)			Available Nitrogen (kg/ha)			Available Phosphorus (kg/ha)			Available Potassium (kg/ha)		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Vermicompost (t ha^{-1})												
V_0	0.129	0.132	0.131	124.26	123.10	123.68	21.38	21.15	21.27	234.00	231.66	232.83
$V_{2.5}$	0.138	0.139	0.138	128.63	129.28	128.96	22.26	22.39	22.32	239.37	240.72	240.05
$V_{5.0}$	0.142	0.143	0.143	130.87	131.97	131.42	22.71	22.93	22.82	242.19	241.72	241.95
S.Em+	0.001	0.001	0.001	1.69	1.82	1.24	0.25	0.30	0.20	3.28	3.89	2.55
CD (P=0.05)	0.004	0.003	0.003	5.06	5.45	3.57	0.76	0.90	0.56	NS	NS	NS
Nitrogen (Kg ha^{-1})												
N_0	0.133	0.134	0.134	125.16	124.04	124.60	21.96	21.74	21.85	236.54	232.63	234.59
N_{40}	0.137	0.139	0.138	127.75	128.14	127.95	22.00	22.07	22.03	236.95	236.96	236.95
N_{80}	0.139	0.141	0.140	130.85	132.18	131.52	22.39	22.65	22.52	242.07	244.51	243.29
S.Em+	0.001	0.001	0.001	1.69	1.82	1.24	0.25	0.30	0.20	3.28	3.89	2.55
CD (P=0.05)	0.004	0.003	0.003	5.06	5.45	3.57	NS	NS	NS	NS	NS	NS
Phosphorus(kg ha^{-1})												
P_0	0.134	0.136	0.135	127.03	126.86	126.94	20.81	20.77	20.79	235.97	233.86	234.91

P_{20}	0.137	0.138	0.137	127.96	128.05	128.01	22.19	22.21	22.20	239.49	239.06	239.27
P_{40}	0.139	0.140	0.139	128.77	129.45	129.11	23.35	23.49	23.42	240.11	241.19	240.65
S.Em+	0.001	0.001	0.001	1.32	1.34	0.91	0.21	0.22	0.15	2.71	2.83	1.91
CD (P=0.05)	0.003	0.003	0.002	NS	NS	NS	0.60	0.62	0.41	NS	NS	NS

NS: Non significant

4. Conclusion

Application of vermicompost along with inorganic fertilizers i.e., N and P significantly increased net return and B:C ratio of coriander. Among all the treatment combination application of vermicompost @ 2.5 t ha^{-1} with N level @ 40 kg/ha and P level 20 kg/ha significantly increased net return and B:C ratio of coriander.

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