International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 1698-1702

Received: 01-09-2017
Accepted: 02-10-2017

RC Sanwal
Department of Soil Science and Agricultural Chemistry, COA, Bikaner, Rajasthan, India

Yogesh Sharma
Department of Soil Science and Agricultural Chemistry, COA, Bikaner, Rajasthan, India

Ajeet Singh
Department of Soil Science, CSK HPKV, Palampur, Himachal Pradesh, India

ML Reager
Department of Agronomy, KVK, SKRAU, Bikaner, Rajasthan, India

Dayanand
Department of Agronomy, KVK, Jhunjhunu, SKRAU, Bikaner, Rajasthan, India

Correspondence
Ajeet Singh
Department of Soil Science, CSK HPKV, Palampur, Himachal Pradesh, India

Impact of vermicompost, nitrogen and phosphorus on yield, quality and uptake of coriander (*Coriandrum sativum* L.) under arid condition

RC Sanwal, Yogesh Sharma, Ajeet Singh, ML Reager and Dayanand

Abstract
The use of vermicompost, Nitrogen (N) and phosphorus (P) as organic and inorganic sources under arid condition was tested in this study. Accordingly, a field experiment was carried out and Coriander (*Coriandrum sativum* L.) was grown in the research farm of agronomy, College of Agriculture, SKRAU, Bikaner. The experiment was conducted based on split plot design using three replications. 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 was laid out. From the results, among all the treatment combined application of vermicompost @ 2.5 t ha^{-1} with N level @ 40 kg ha^{-1} and P level 20 kg ha^{-1} significantly increased all the yield, quality and uptake parameters *viz.*, seed, stover and biological yield, oil and protein content, total N, P and K uptake by coriander over the other treatments. However, fiber content of coriander not increased significantly with application of these treatments. Therefore, it appears more logical to recommend a more realistic dose of 2.5 t vermicompost ha^{-1}, 40 kg N ha^{-1} and 20 kg P ha^{-1} for coriander crop grown on loamy sand soil under irrigated conditions of north western Rajasthan to make the fertilizer use more gainful with considerable response

Keywords: Coriander, Yield, Quality and N, P and K uptake

Introduction

Coriander (*Coriandrum sativum* L.) is an important seed spice crop mainly grown in *rabi season* and belongs to family Apiaceae and it is native of Mediterranean regions (Purseglove *et al.*, 1981) [21]. It is the most widely used condiment throughout the world. India is the largest producer of coriander in all over world. It is prominently cultivated in Rajasthan, Andhra pradesh, Gujrat, Tamil Nadu, Odisha, Karnataka, Haryana, Uttar Pradesh and Bihar. In India, it occupies 516.1 thousand hectares area with annual production of 496.2 thousand tonnes. The average productivity of coriander seed is 961 kg ha^{-1} (Anonymous, 2014b) [5]. In Rajasthan, the crop was grown on 158.0 thousand hectares with a production of 232.4 thousand tonnes. The average productivity was 1468 kg ha^{-1} (Anonymous, 2014a) [4]. Rajasthan occupies the premiere position in production and acreage and contributes about 40 percent to the total production of coriander in India.

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 nutrient 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) [1]. The application of vermicompost not only add plant nutrients and growth regulators but also increase soil water retention, microbial population, humic substances of the soils, mineralization and release of nutrients. Besides, vermicompost also improves soil aeration, reduction of soil erosion, reduces evaporation losses of water, accelerates the process of hummification, stimulates, the microbial activity, deodourification of obnoxious smell, destruction of pathogen, detoxification of pollutant soils etc (Manna and Hazra, 1996) [18].

It is evident now a day that out of all the major plant nutrients found in various Indian soils, nitrogen is the most deficient element especially in sandy loam soils of Rajasthan (Arakery *et* *al*. 1956) [6]. Dhun (1983) [11] 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 nitrogen is of prime importance for growing plants as it is a major and indispensable constituent of protein and nucleic acid molecules. It is an integral part of chlorophyll molecules which are responsible for photosynthesis. An adequate supply of nitrogen is associated with vigorous vegetative growth and more efficient use of available inputs, finally leading to higher productivity.

Phosphorus 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 phosphorus 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 provid great strength to plants. Therefore, present investigation was conducted with the objective to study the response of vermicompost, nitrogen and phosphorus on yield, quality and uptake of coriander under arid condition crop grown in sandy loam soil.

Material and Methods

The experiment was set up in *rabi season during* 2009-10 and 2010-11 at the research farm of Agronomy, College of Agriculture, SKRAU, Bikaner. 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. The climate at the experimental area is semi-arid. A maximum temperature is around 48 °C during summer while in the winters it may fall as low as 0 °C. The average annual rainfall of this tract is about 265 mm which is mostly received during rainy season from July to September. Soil of the study area was loamy sand in texture and alkaline in reaction, it containing soil pH 8.42, EC 0.15 dSm^{-1} and very low organic carbon 0.15% and available 125.4, 21.8 and 234.6 N, P and K kg ha^{-1}. The experiment established with 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}) that were laid out in split plot design and replicated three times. The levels of vermicompost were applied in the respective plots as per treatment and were thoroughly incorporated into the soil before sowing**.** A representative homogeneous sample of vermicompost was taken and analyzed for various properties and enlisted in Table 1.

Table 1: Nutrient composition of vermicompost.

Nutrients	Vermicompost
N (%)	1.60
P (%)	0.8
K (%)	1.05
Fe (ppm)	3800
Mn (ppm)	410
Zn (ppm)	95
Cu (ppm)	40
pH	6.62
EC (dS m^{-1})	5.66
OC (g kg^{-1})	310

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. The seed, stover and biological yield of coriander were recorded and oil, protein, fiber and nutrient uptake was computed by fallowing formula:

Oil content in seed (%)

Oil content (%) in coriander seed was determined by using Soxhelat extraction method (A.O.A.C., 1970).

$$\text{Oil content (\%)} = \frac{\text{Weight of flask with ether extract} - \text{Weight of empty flask}}{\text{Weight of material taken}} \times 100$$

Protein content in seed (%)

The protein content in seed was calculated by multiplying the nitrogen percentage in seed with a factor 6.25 (A.O.A.C., 1970).

Fiber content in seed (%)

Fiber content (%) was determined by the method of fiber determination in fat free material (A.O.A.C., 1970).

$$\text{Fiber content (\%)} = \frac{\text{Weight of residue - Weight of ash}}{\text{Weight of material taken}} \times 100$$

Nutrient uptake (kg ha^{-1})

The total uptake of nitrogen, phosphorus and potassium by the crop at harvest of each treatment was computed by multiplying the seed and stover yields with their respective contents and adding the same as per formula given below.

$$\text{Nutrient uptake (N, P \& K kg ha}^{-1}\text{)} = \frac{\text{Nutrient conc. in seed (\%)} \times \text{Seed yield (kg ha}^{-1}\text{)} + \text{Nutrient conc. in stover (\%)} \times \text{Stover yield (kgha}^{-1}\text{)}}{100}$$

Representative seed and plant samples of coriander were collected each plot after harvest crop and analyzed using standard methods. Nitrogen content in coriander was estimated by Nessler's reagent, spectrophotometrically (Snell and Snell, 1959) [27], phosphorus by Vanadomolybdate phosphoric acid yellow colour method (Jackson, 1967) [15] and potassium by Flame photometer method (Jackson, 1967) [15]. 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).

Results and Discussions

Yield Attributes

The combined application of organic and inorganic manure and fertilizer was improve soil fertility and crop yield. Application of vermicompost, nitrogen and phosphorus significantly increased the seed, stover and biological yield of coriander (Table 2). Results showed that the maximum seed yield (10.11q ha^{-1}), stover yield (16.71q ha^{-1}) and biological yield (26.81q ha^{-1}) were found with the application of 2.5 t ha^{-1} vermicompost which was significantly higher with no application of vermicompost and statistically at par with 5.0 t ha^{-1} vermicompost on the pooled basis. Vermicompost are the products of the degradation of organic matter through interactions between earthworms and microorganisms. They are finely divided peat-like materials with high porosity, aeration, drainage and water-holding capacity, and usually contain most nutrients in available forms such as nitrates, phosphates, exchange able calcium and soluble potassium (Atiyeh *et al.* 2002; Arancon *et al.* 2005) [8, 7]. Further, showed that significantly increased seed, stover and biological yield was recorded with application of nitrogen fertilization up to 40 kg ha^{-1} over the control during both the years of study. Application of nitrogen @ 80 kg ha^{-1} being at par with 40 kg ha^{-1} did not increase it significantly any further under the study. Application of nitrogen at 40 kg ha^{-1} increased the seed, stover and biological yield by 73.80, 37.98 and 50.89 per cent in pooled mean, respectively over control. This might due to improved overall growth and profuse branching due to nitrogen fertilization coupled with increased net photosynthesis on one hand and greater mobilization of photosynthates towards reproductive structures (Kumar *et al.* 2002) [17]. Similar results revealed that application of phosphorus @ 20 kg P_2O_5 ha^{-1} being statistically at par with 40 kg P_2O_5 ha^{-1} resulted in significant increase in seed, stover and biological yield during both the years of study. Application of phosphorus at 20 kg P_2O_5 ha^{-1} increased the seed, stove and biological yield by 20.98, 12.89 and 15.81 per cent on the pooled mean basis, respectively compared to control. This might due to application of phosphorus could be attributed to the increase in vegetative growth, possibly the result of effective uptake and utilization of other nutrients absorbed through its extensive root system development under phosphorus fertilization. Thus, application of phosphorus improved yield attributes including test weight and biological yield as discussed above and as a result increased the seed and stover yield significantly. These results are in conformity with findings of Singh and Jat (2002) [26], Tuncturk *et al.* (2006) and Gupta (2012) [14].

Quality Parameters

The application of vermicompost significantly improvement of oil and protein content in coriander seed during both the year of study (Table 3). The maximum improvement in oil and protein content was recorded with the application of 2.5 t ha^{-1} vermicompost which was significantly higher over the control and statistically at par with 5.0 t ha^{-1} vermicompost. However, fiber content of coriander recorded at harvest was not affected significantly due to vermicompost levels during both the years of study. The protein and oil content was influenced due to higher uptake of nitrogen with application of vermicompost, as it plays an important role in oil synthesis and protein metabolism. Sexena *et al.* (2001) [24] also reported that the absorbed nutrient (P) accumulation in seed, favored improvement in oil. Similar results have also been reported by Kachot *et al.* (2001) [16], Darzi and Hadi (2012) [10] and Milica *et al.* (2015) [19]. Similarly, application of nitrogen @ 40 kg ha^{-1} increased the oil and protein content in seed by 10.38 and 13.41 per cent in pooled mean over control. The decrease in the fiber content with the application of 80 kg N ha^{-1} was 3.35 and 4.43 per cent over 40 kg ha^{-1} and control, respectively on pooled mean basis. Further reveled of data that coriander crop responded significantly up to 20 kg P_2O_5 ha^{-1} in terms of oil and protein content in seed, further increasing phosphorus level up to 40 kg ha^{-1} did not show any significant effect on the pooled mean basis. While fiber content of coriander recorded at harvest was not affected significantly due to phosphorus levels during both the years of study. This might due to increasing supply of phosphorus might have encouraged the synthesis of fatty acids in plants through conversion of acetyl Co-A to malonyl Co-A in the presence of ATP and phosphate (Bonner and Varner, 1965) [9]. Secondly, the higher oil content could be attributed to formation of more lecithin due to application of phosphorus. These results are in conformity with those of Gupta (2012) [14].

Nutrients Uptake

The different level of vermicompost, nitrogen and phosphorus application was significantly influence total nitrogen phosphorus and potassium uptake by coriander plant (Table 4). Total Nitrogen phosphorus and potassium uptake by coriander increased significantly with application of vermicompost @ 2.5 t ha^{-1} over the control. Further increase in vermicompost levels resulted in to non-significant increase in total uptake of nitrogen phosphorus and potassium by plant at 5.0 t ha^{-1} during both the years as well as in pooled analysis. This might due to increased dry matter at different growth stages and biological yield of coriander at harvest coupled with higher nutrient contents due to application of vermicompost led to higher N and P content and uptake by coriander. The results obtained are in close conformity with those of Remtake *et al.* (2001), Rubapathi *et al.* (2002) [23] and Patel *et al.* (2013). Mean of total Nitrogen, phosphorus and potassium uptake by coriander increase at lower level of nitrogen @ 40 kg ha^{-1} over the control while, at par with 80 kg N ha^{-1} increased the total uptake of nitrogen phosphorus and potassium by coriander plant during 2009-10 and 2010-11. The role of nitrogen in increasing physiological activity of the plants is of great significance as it is known to influence the auxin concentration, chlorophyll formation, cell division, plant growth, nitrogen metabolism and protein synthesis. Findings of Amin and Patel (2001) [2] and Shivran and Jat (2015) [25] also provided support to the findings of present investigation. Similarly, 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 total nitrogen phosphorus and potassium uptake by coriander on the pooled basis. This might due to the phosphorus fertilization improved its availability in the root zone leading to increased availability of other nutrients and development of extensive root system of the crop which in turn increased the N, P and K contents and uptake. Similar type of results was also reported by Garg *et al.* (2004) [12] and Gupta (2012) [14].

Table 2: Effect of vermicompost, nitrogen and phosphorus on seed, stover and biological yield of coriander

Treatments	Seed Yield (q ha^{-1})			Stover Yield (q ha^{-1})			Biological Yield (q ha^{-1})		
	2009-10	**2010-11**	**Pooled**	**2009-10**	**2010-11**	**Pooled**	**2009-10**	**2010-11**	**Pooled**
Vermicompost (t ha^{-1})									
V_0	7.06	7.74	7.40	12.78	13.68	13.23	19.83	21.42	20.63
$V_{2.5}$	9.72	10.49	10.11	16.10	17.31	16.71	25.82	27.80	26.81
$V_{5.0}$	10.08	10.89	10.48	16.63	17.98	17.31	26.71	28.87	27.79
SEm±	0.19	0.19	0.14	0.31	0.29	0.21	0.48	0.47	0.34
CD (P=0.05)	0.57	0.58	0.39	0.92	0.87	0.61	1.44	1.40	0.97
Nitrogen (Kg ha^{-1})									
N_0	5.84	6.34	6.09	11.35	13.29	12.32	17.19	19.63	18.41
N_{40}	10.34	11.21	10.77	16.60	17.40	17.00	26.95	28.61	27.78
N_{80}	10.67	11.58	11.12	17.56	18.28	17.92	28.23	29.86	29.04
SEm±	0.19	0.19	0.14	0.31	0.29	0.21	0.48	0.47	0.34
CD (P=0.05)	0.57	0.58	0.39	0.92	0.87	0.61	1.44	1.40	0.97
Phosphorus(kg ha^{-1})									
P_0	7.59	8.60	8.10	13.77	14.92	14.35	21.37	23.53	22.45
P_{20}	9.42	10.17	9.80	15.60	16.81	16.20	25.02	26.98	26.00
P_{40}	9.85	10.34	10.09	16.13	17.25	16.69	25.98	27.59	26.78
SEm±	0.16	0.16	0.11	0.24	0.26	0.17	0.39	0.41	0.28
CD (P=0.05)	0.47	0.46	0.32	0.69	0.76	0.49	1.12	1.18	0.78

Table 3: Effect of vermicompost, nitrogen and phosphorus on oil, protein and fiber content of coriander seed

Treatments	Oil content (%)			Protein content (%)			Fiber content (%)		
	2009-10	**2010-11**	**Pooled**	**2009-10**	**2010-11**	**Pooled**	**2009-10**	**2010-11**	**Pooled**
Vermicompost (t ha^{-1})									
V_0	0.265	0.265	0.265	12.22	12.23	12.23	20.66	20.98	20.82
$V_{2.5}$	0.286	0.285	0.285	13.26	13.23	13.24	20.62	20.81	20.71
$V_{5.0}$	0.291	0.289	0.290	13.32	13.27	13.29	20.35	20.79	20.57
SEm±	0.003	0.003	0.002	0.11	0.12	0.08	0.12	0.13	0.09
CD (P=0.05)	0.008	0.008	0.006	0.32	0.37	0.23	NS	NS	NS
Nitrogen (Kg ha^{-1})									
N_0	0.261	0.259	0.260	11.79	11.77	11.78	21.00	21.12	21.06
N_{40}	0.288	0.287	0.287	13.33	13.39	13.36	20.80	20.95	20.87
N_{80}	0.292	0.292	0.292	13.67	13.56	13.62	19.83	20.51	20.17
SEm±	0.003	0.003	0.002	0.11	0.12	0.08	0.12	0.13	0.09
CD (P=0.05)	0.008	0.008	0.006	0.32	0.37	0.23	0.36	0.39	0.26
Phosphorus(kg ha^{-1})									
P_0	0.268	0.269	0.268	12.40	12.41	12.40	20.64	20.89	20.77
P_{20}	0.284	0.284	0.284	13.19	13.11	13.15	20.57	20.87	20.72
P_{40}	0.290	0.285	0.287	13.21	13.21	13.21	20.41	20.82	20.61
SEm±	0.002	0.002	0.002	0.08	0.11	0.07	0.12	0.13	0.08
CD (P=0.05)	0.007	0.006	0.004	0.24	0.31	0.19	NS	NS	NS

Table 4: Effect of vermicompost, nitrogen and phosphorus on total NPK uptake by plant at harvest

Treatments	Total NPK uptake by plant at harvest (kg ha^{-1})								
	Nitrogen			**Phosphorus**			**Potassium**		
	2009-10	**2010-11**	**Pooled**	**2009-10**	**2010-11**	**Pooled**	**2009-10**	**2010-11**	**Pooled**
Vermicompost (t ha^{-1})									
V_0	19.41	21.92	20.66	6.34	7.11	6.72	10.90	12.80	11.85
$V_{2.5}$	30.12	32.21	31.16	8.69	9.61	9.15	18.12	19.66	18.89
$V_{5.0}$	31.21	33.79	32.50	9.02	10.05	9.54	18.66	20.55	19.60
SEm±	0.72	0.71	0.51	0.19	0.19	0.14	0.50	0.51	0.36
CD (P=0.05)	2.16	2.14	1.46	0.57	0.58	0.39	1.50	1.54	1.03
Nitrogen (Kg ha^{-1})									
N_0	15.68	17.22	16.45	5.43	6.32	5.88	8.96	10.05	9.50
N_{40}	31.62	34.40	33.01	9.12	10.01	9.56	18.89	21.01	19.95
N_{80}	33.45	36.29	34.87	9.50	10.43	9.97	19.83	21.95	20.89
SEm±	0.72	0.71	0.51	0.19	0.19	0.14	0.50	0.51	0.36
CD (P=0.05)	2.16	2.14	1.46	0.57	0.58	0.39	1.50	1.54	1.03
Phosphorus(kg ha^{-1})									
P_0	22.13	25.13	23.63	6.41	7.36	6.89	12.05	14.03	13.04
P_{20}	28.70	31.03	29.86	8.58	9.48	9.03	17.47	19.33	18.40
P_{40}	29.92	31.75	30.83	9.06	9.93	9.49	18.16	19.65	18.91
SEm±	0.52	0.54	0.37	0.14	0.15	0.10	0.32	0.36	0.24
CD (P=0.05)	1.49	1.55	1.03	0.41	0.44	0.29	0.93	1.03	0.66

Conclusion

On the basis of the results of the present study, it can be concluded that application of vermicompost, nitrogen and phosphorus resulted in higher yield of coriander. Among the different level vermicompost (2.5 t ha^{-1}), nitrogen (40 kg N ha^{-1}) and phosphorus (20 kg P_2O_5 ha^{-1}) were observed best not only in enhancing seed, stover and biological yield, oil, protien and fiber content but also increase of nutrients uptake. These results are only indicated and required to arrive and more consistent and definite conclusion for recommendation to the formers for maintain soil fertility and increased production as well as saving fertilizer.

References

1. Acharya CL. Integrated nutrient management for sustainable crop production in rainfed agro-ecosystem. J. Indian Soc. Soil Sci. 2002; 50:409-415.
2. Amin AU, Patel IS. Influence of irrigation and fertility levels on the yield, quality and economics of *rabi* fennel. Gujarat Agri. Uni. Res. J. 2001; 26:1-4
3. Amin AU, Patel IS, Patel JC, Patel JK. Response of *rabi* fennel (*Foeniculum vulgare* Mill) to irrigation under varying levels of nitrogen and phosphorus. J Gujarat Soc. Agro. Soil Sci. 2005; 3:26-30.
4. Anonymous. Agricultural Statistics at a Glance. Published by Government of India, New Delhi, 2014a, 193.
5. Anonymous. Rajasthan Agricultural Statistics at a Glance. Commissionerate of Agriculture, Rajasthan, Jaipur, 2014b, 101.
6. Arakery HR, Chalan GV, Satynarayan P, Donahue RI. Soil management in India, Asia Pub-Hou, Bombay, 1956.
7. Arancon NQ, Edwards CA, Bierman P, Metzger JD, Lucht C. Effects of vermicomposts produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. Pedobiol. 2005; 49:297-306.
8. Atiyeh RM, Arancon N, Edwards CA, Metzger JD. The influence of earthwormprocessed pig manure on the growth and productivity of marigolds. Biores. Tech. 2002; 81:103-108.
9. Bonner J, Varner JE. Plant Biochemistry. Academic Press, New York. 1965, 925.
10. Darzi MT, Hadi MHS. Effects of the application of organic manure and biofertilizer on the fruit yield and yield component in Dill (*Anethum graveolens*). J. Medical Plants Res. 2012; 6(16):3266-3271.
11. Dhun SPS. European dill ((*Anethum graveolens* L.). A crop of pharmaceutical value. Indian Farmer Dig. 1983; 16(2):21-22.
12. Garg VK, Singh PK, Katiyar RS. Yield, mineral composition and quality of coriander (*Coriandrum sativum*) and fennel (*Foeniculum vulgare*) grown in sodic soil. Indian J. Agri. Sci. 2004; 74(4):221-223.
13. Godara AS, Gupta US, Lal G, Singh R. Influence of organic and inorganic source of fertilizer on growth, yield and economics of coriander (*Coriandrum sativum* L.). Int. J. Seed Spi. 2014; 4(2):77-80.
14. Gupta K. Role of phosphorus and zinc in enhancing growth, yield and quality of fennel crop (*Foeniculum vulgare* Mill.) in irrigation conditions of North-West Rajasthan. Ph.D. (Soil Science) Thesis, submitted to Swami Keshwanand Rajasthan Agricultural University, Bikaner, 2012.
15. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi. 1967, 38-226.
16. Kachot NA, Malavia, DD, Solanki RM, Sagarka BK. Integrated nutrient management in riny season groundnut (*Arachis hypogaea*). Indian J Agro. 2001; 46:516-527.
17. Kumar S, Choudhary GR, Choudhary AC. Effect of nitrogen biofertilizers on the yield and quality of Coriander (*Coriandrum sativum* L.) Ann. Agri. Res. 2002; 23:634-637.
18. Manna MC, Hazra JN. Comparative performance of cowdung slurry, microbial inoculums and inorganic fertilizers on maize. J Indian Soc. Soil Sci. 1996; 44:526-528.
19. Milica GA, Zeljko KD, Snezana IO, Dusan DK, Mico VO. Effect of organic and mineral fertilizers on essential oil content in caraway, anise and coriander fruits. Act. Sci. Pol. Hort. Cult. 2015; 14(1):95-103.
20. Patel CB, Amin AU, Patel AL. Effect of varying levels of nitrogen and sulphur on growth and yield of coriander (*Coriandrum sativum* L.). An Int. Qua. J Life Sci. 2013; 8(4):1285-1289.
21. Purseglove JW, Brown EG, Green CL, Robbins SRJ. Spices, Longman, New York. 1981, 2.
22. Remtake JR, Patil RA, Bal AS, Kamde VM. Judicious use of organic and inorganic source of nutrients for sustaining productivity of rice-chilli cropping system. In: International Conference Of Nature Forming And Ecological Balance (ICNFBF), held between March, 7-10, Hissar. 2011, 13-114.
23. Rubapathi K, Raangaswami A, Chinnuswami C. Performance of sorghum based intercropping systems in rainfed vertisols of western zone. J Eco. 2002; 12(4):293-299.
24. Saxena SC, Manral NS, Chandel AS. Effect of inorganic and organic sources of nutrients on soybean (*Glycine max*). Indian J Agro. 2001; 46(1):135-140.
25. Shivran AC, Jat NL. Integrated nutrient management influenced growth, yield and economics of fennel (*Foeniculum Vulgare*) under semi-arid conditions. Indian J Agro. 2015; 60(2):318-323.
26. Singh S, Jat NL. Effect of phosphorus and zinc fertilization on growth and yield of coriander (*Coriandrum sativum* L.). Ann. Agri. Res. 2002; 23(4):734-736.
27. Snell FD, Snell CT. Colorimetric method of analysis. 3rd Edition Volume IID. Van Nostrand Co. Inc. Priencenton, New Jersey. 1959, 814-819.