

Assessment of different fertilizer levels on growth and yield returns of coriander crop. (*Coriandrum sativum* L.) cv- JD-1.

ABSTRACT

Using chemical fertilizers or organic manures alone as amendments may be detrimental to the soil health and crop quality and neither of these alone can sustain productivity. Hence the combination of nutrients from different sources together in optimum ratio is a way forward to achieve optimum returns and to protect soil health. In view of this a trial was conducted in coriander cv- JD-1 over winter 2012-13 at Horticulture research farm, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh to evaluate the effect of organic manures and chemical fertilizers with different levels on growth and yield parameters of coriander. The experiment consists of four levels of organic manures viz Vermicompost 5 t/h, Vermicompost 2.5 t/h, Farm yard manure 20 t/h and Farm yard manure 10 t/h with two fertilizer levels 100 % RDF and 50 % RDF laid out in a randomized block design replicated thrice. The study shows that among the organic manures vermicompost 5 t/h and among the fertilizer levels RDF 100% showed maximum values for growth and yield parameters comparison to other levels of manures and fertilizer. Results in relation to interaction effect shows that vermicompost 5 t/h + 100 % RDF was superior over other treatment combinations. Highest gross income were observed with vermicompost 5 t/h + 100 % RDF and highest benefit cost ratio with farm yard manure 20 t/h + 100 % RDF.

Key words: Coriander, seed yield, economic returns, organic manures and fertilizers.

INTRODUCTION

Coriander is an annual herb and a member of the family Apiaceae (Parsley) and genus *Coriandrum* (Sharma *et al.*, 2012; Khan, 2019). There are only two known species of this genus which includes the cultivated plant *C. sativum* L. and its wild relative *C. tordylium*. Coriander is originated from the Eastern Mediterranean

region and is widely cultivated in Asia, North Africa Central Europe, and Russia, (Singh *et al.*, 2006; Sriti *et al.*, 2009a, 2009b). Coriander is important and most commonly used spices (Leena *et al.*, 2012), occupying a prime position throughout the globe to add taste and flavor in various food items. Coriander can be refer to both herb and spice. Herbs are the fresh, leafy part of a plant (JSS, 2018) used in culinary to add flavour or as a medicine. Spices come from the bark, roots or seeds, of the plant or any edible part of the plant, besides the leaf, that can be used for seasoning; some plants have both. Therefore, most of the time cilantro refers to the leaves while coriander is to indicate the seeds. Cilantro leaves and coriander seeds have different taste and cannot be substituted for each other. (Bhat *et al.*, 2014, Filippone., 2018). Coriander is essential component in the preparation of ayurvedic medicines and traditional home therapies for different ailments (Emamghoreishi *et al.*, 2005). “Seeds contains high amount of minerals and essential oils which could be used for the preparation of medicinal combatants against several acute and chronic diseases” (Sharma *et al.*, 2012; Khan., 2019).

“Production of coriander continues to be limited by a number of factors that can reduce quality and yield like other crops” (Wang *et al.*, 2013). “Among those factors, nutrient management has significant practical importance. Fertility status of the soil can be reduced due to mineralization, exporting, leaching, immobilization or other means. Therefore, substantial fertilizer applications are required to meet the crop demand of nutrients to obtain good return” (Reetz, 2016). “However, continuous application of suboptimal doses of fertilizers may leads to depletion of nutrient reserves in the soil. In general, agro-environmental problems are not limited to the use of inorganic fertilizers only but also occur with organic fertilizers. Both organic and inorganic fertilizers have the potential of environmental pollution” (Reetz, 2016). “Chemical fertilizers accumulate salt

which require more energy to draw water from the soil and cause plants to appear wilted or dried out and if there is a rainfall shortly after applied, fertilizers wash away and can pollute streams, ponds and other water bodies. It can also leach away from the root zone of plants. It may enter the food chain through plants and they may get accumulated and harm human health” (Sharma and Chetani, 2017). “However organic fertilizers are environmentally eco-friendly when compared to inorganic fertilizers” (Chauhan *et al.*, 2012; Ahmad *et al.*, 2017). “But, intensive use of organic fertilizers alone can affect physico-chemical properties of the soil which results in decreased soil fertility status” (Chauhan *et al.*, 2012). “Continues application of organic fertilizers will increase levels of soil nutrients, could cause a build up of some nutrients, and results in loss of nutrients to the environment. In addition, decomposition of organic material is strongly affected by soil moisture and temperature thus nutrients may be released when plant does not need them and only a limited amount of organic material is available and it is generally difficult to meet crop nutrient demands through organic fertilizers alone. This implies that crops can suffer initial starvation from nutrient immobilization prior to mineralization” (Sharma and Chetani., 2017). “To meet the entire crop nutrient requirement, different fertilizer types have to be applied in an integrated manner, as applying of single dose of nutrient can’t fulfil the crop nutrient demands” (Mahajan and Gupta, 2009). “Rather, there is a need to be used in an integrated manner following a management technology which is practicable, economically viable, socially acceptable, and ecologically sound” (Mahajan and Gupta, 2009). Therefore, present study was taken to develop a suitable nutrient management practice for coriander crop adopting organic manures.

MATERIALS AND METHODS

An open field experiment was conducted during the winter seasons (Rabi) of year 2012-2013 at Horticulture research farm, Department of Horticulture, Jawaharlal Nehru krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh. The experimental site falls on 23.9⁰N latitude and 79.58⁰E longitudes with an altitude of 411.8 m above the mean sea level. Geographically, Jabalpur falls under “Kymore Plateau and Satpura Hills” agro climatic region of M.P. It is situated in the semi-arid region having sub-tropical climate with hot dry summer, and cold winter. The average rainfall of about 1375 mm, which is mainly distributed from mid June to September. The average temperature ranges between 46.6⁰C and 21⁰C. The mean relative humidity reaches up to 78% during winter (November- February) with occasional frost. The Design of experiment was Randomized complete block design (RCBD) with 3 replications. The experiment consisted of 8 treatments. Viz fertility levels 100% RDF (N50P30K60 kg /ha) and 50 % RDF (N25P15K30 kg/ha) in combinations with vermicompost (VC) 5 t/ha , vermicompost (VC) 2.5 t/ha, farmyard manure (FYM) 20 t/ ha and farmyard manure (FYM) 10 t/ha. Proper leveling was done in order to facilitate the irrigation. Layout of the experiment was done as per plan of the investigation and treatments were given. The well decomposed FYM and vermicompost was applied in required plots before sowing of seeds. It was mixed well in each plot by light ploughing. Half amount of nitrogen (N) with full amount of phosphorus (P) and potash (K) were given per plot as basal dose and rest amount of N was given as top dressing after 40 days of sowing (DAS). Prior to sowing coriander variety JD-1 seeds were split into two halves. Seed treatment with thiram @ 2 g/kg of seeds was done thoroughly against seed borne diseases. The sowing of seeds was done as per treatments in prepared plots. Seeds were sown at 30 cm row spacing apart. The first light irrigation was provided just after sowing and subsequent irrigations were

given at 15-20 days intervals to maintain the soil moisture till crop maturity. All the cultural operations were done as and when required for good crop stand. Other operations were done as per operation schedule. Since, all the plants have equal opportunity for their growth and development. Therefore, a technique of random sampling was adopted and a sample of five plants from each plot was drawn at random to record data on various parameters. The experimental data was analysed statistically by the method of analysis of variance as outlined by Panse and Sukhatme (1985). To find out the economic feasibility of various treatment combinations, economics of the various treatments were worked out by calculating parameters like cost of cultivation, gross returns, net returns and benefit cost ratio using the prevailing price of inputs and outputs in local market.

RESULT AND DISCUSSION.

The results pertaining to the analysis of variance for the experimental design are reported in below tables (1-5) and graphs (1-5). The Anova revealed that there existed significant difference among the treatments for maximum characters studied when analysed statistically.

Effect of Organic manures on Growth and Yields of Coriander.

The study have shown (Tables 1-5) that the application of organic manures significantly improves the various growth and yield parameters. The maximum mean values for plant height (14.55cm, 70.97cm and 93.17cm) at 30, 60 and 90 DAS, primary branches per plant (9.07) and secondary branches per plant (21.86), days to first flowering (52.83) and days to 50 % flowering (61.50), umbels per plant (32.33), umbellets per umbel (6.82), seeds per umbel (32.52), weight of seeds per umbel (0.43g), seeds per plant (550.44), seed yield per plant (5.53g), seed yield per plot (1.82kg) and seed yield per hectare (17.07q) were recorded

from plants receiving vermicompost 5 t/ ha in comparison to other levels of organic manures i.e Vermicompost 2.5 t/ ha, Farmyard manure 20 t/ ha and Farmyard manure 10 t/ ha. However, the minimum mean values for plant height (11.18cm, 66.47cm and 87.31cm) at 30, 60 and 90 DAS, primary branches per plant (8.10) and secondary branches per plant (17.83), days to first flowering (49.67) and days to 50 % flowering (57.50), umbels per plant (30.57), umbellets per umbel (6.37), seeds per umbel (29.88), weight of seeds per umbel (0.37g), seeds per plant (488.54), seed yield per plant (4.25g), seed yield per plot (1.49kg) and seed yield per hectare (14.02q) with farmyard manure 10 t/ha. These growth responses were most probably due to the production of plant growth substances and other growth promoting substances. By the applications of vermicompost the metabolic process of the plant gets stimulated including increased uptake of nutrients through insoluble nutrient like P gets converted in to soluble nutrients by the activation of desirable enzymes. “It’s reported that vermicompost is rich in nutrients like O, C, N, P, K, Ca, Mg, Fe, Zn, Cu, Mn and Br when compared to farmyard manure. Utilization of vermicompost is the most excellent means of reducing soil degradation, environmental pollution and reduce in discriminate use of chemical fertilizers. Literature stated that organic fertilizer can influence different attributes of coriander crop. It can influence production through adding nitrogen to the soil (legumes), nitrogen conservation (by reducing leaching) and making nitrogen available to plant” (Rayns and Rosenfeld., 2010). Similarly Edwards and Burrows., (1988) and Atiyeh *et al.*, (2002) reported that vermicompost has a positive effect on biomass production which subsequently enhanced growth and yield parameters. Ravimycin., (2016) observed higher germination percentage (94%), root length (8.4cm), shoot length (24.8cm), plant fresh weight (16.7 g), plant dry weight (7.8g), total chlorophyll (6.8 mg.fr.wt), carotenoids (2.25 mg.fr.wt) and protein (23.32 mg.fr.wt) was recorded in

vermicompost application at 90 DAS of coriander plant. The minimum recorded in control at 90 DAS of coriander plants. Dash *et al.*, (2019) observed highest leaf yield in treatment with vermicompost (12.5 t/ha) (PP with organic methods) (4.53-4.60 kg/plot).The present findings are in conformity to Moslemi *et al.*, (2012), Darziet *et al.*, (2012) in anise, and Asgharipour (2012) in cumin, Ibrahim *et al.*, (2006) and El- Mekawey *et al.*, (2010) in coriander.

Effect of Fertilizer levels on Growth and Yields of Coriander.

In our study to standardize the rate of three major nutrients nitrogen, phosphorus and potash, results have shown (Tables 1-5) that the maximum mean values for plant height (13.73cm,70.15cm and 92.71cm respectively) at 30, 60 and 90 DAS, primary branches per plant (8.92) and secondary branches per plant (21.21), days to first flowering (52.92) and days to 50 % flowering (61.00), umbels per plant (32.74), umbellets per umbel (6.92), seeds per umbel (32.65), weight of seeds per umbel (0.45g), seeds per plant (567.28), seed yield per plant (6.01g), seed yield per plot (1.87 kg) and seed yield per hectare (17.23q) was found with 100 % RDF i.e N50P30K60 kg/ ha and the minimum mean values for plant height (11.75cm, 67.59cm and 87.98 cm respectively) at 30, 60 and 90 DAS, primary branches per plant (8.20) and secondary branches per plant (18.09), days to first flowering (50.08) and days to 50 % flowering (57.75), umbels per plant (30.02), umbellets per umbel (6.25), seeds per umbel (29.01), weight of seeds per umbel (0.34g), seeds per plant (464.82), seed yield per plant (4.25g), seed yield per plot (1.53 kg) and seed yield per hectare (14.04q) with 50 % RDF i.e N25P15K30 kg/ ha. 100 % RDF was found to be significant over 50 % RDF. The probable reason might be due to increased supply of major plant nutrients that are required in larger quantities and cumulative effects of nutrient on growth which ultimately led to more photosynthetic activities. “It’s that balanced fertilizer application improved

the availability of phosphorous, nitrogen and other nutrients, helped in increasing the yield attributing characters” (Mounika *et al.*, 2018). The present finding are in propinquity with the results of Manure *et al.*, (2000), Naghera *et al.*, (2000); Singh *et al.*, (2000); Singh and Jat., (2002); Channabasavanna *et al.*, (2002); Okut and Ydrm., (2005) ; Gujar *et al.*, (2005); Tripathi., (2006); Akbarinia *et al.*, (2006); Oliveira *et al.*, (2006); Kumar *et al.*, (2007); Kumar *et al.*, (2008) Nagar *et al.*, (2009)); Nayak *et al.*, (2009); Jan *et al.*, (2011) and Khalid., (2012.). Fikadu *et al.*, (2019) observed maximum number of umbels per plant (17.93), umbellate per umbel (6.69), seeds per umbel (18.34), seed yield per plant (4.01 g) seed yield per plot (341g) and seed yield per hectare (12.36 q) with treatment N (60kg/ ha) and P (50 kg/ha) instead of highest dose of both nutrients. Javiya *et al.*, (2017) experimental results revealed that “application of 60 kg N/ha promoted seed yield (1483 kg/ha) and stover yield (1760 kg/ha) with higher net return (65976/ ha) and benefit cost ratio (3.48) over untreated. Conversely, frequent application of nitrogen fertilizers is likely to increase the concentration of nitrate in ground water which is detrimental to human health” (Elasbah *et al.*, 2019). “Application of phosphorus enhanced significantly growth and yield attributes. For example, 40 kg P₂O₅/ ha increased seed yield (1388 kg/ha) and stover yield (1613 kg/ha) of coriander. The yield further increased with increasing level of P₂O₅ but could not reach up to level of significant. The maximum net realization of (61008/ ha) obtained with 60 kg P₂O₅/ ha, but benefit cost ratio maximum (3.26) was obtained with 40 kg P₂O₅/ ha. It also significantly increased content and uptake of NPK kg/ha at 60 kg N /ha and 60 kg P₂O₅/ ha in seed and stover” (Javiya *et al.*, 2017). “Maintaining and keeping soil health has paramount importance for sustainability of ecosystem. The effect of long-term application of inorganic fertilizers on soil biological properties is of topical importance for up keeping soil health. Nitrogen supplying fertilizers upon hydrolysis also produce ammonium, decrease soil pH

and affecting activities of those microbes” (Basak *et al.*, 2017). “Farming can be more profitable with higher crop yield through use of those inorganic NPK fertilizers. But, wide disparities in NPK ratio along with inability of integrated use of all sources of plant nutrients deteriorate soil health and thus nutrition of plants” (Reetz, 2016). “However, the continuous use or excess supply of inorganic fertilizers as source of nutrient in imbalanced proportion is also a problem, causing economic inefficiency, damage to the environment and in certain situations harm plants themselves and also to human being who consume them” (Dolker *et al.*, 2017).

Effect of different nutrient combinations on Growth and Yields of Coriander.

Results of investigation had shown (Tables 1 to 5) and (Graphs 1 to 5) that application of integrated nutrient source had direct positive effect on soil fertility and crop yield of coriander. The use of integrated nutrients such as vermicompost 5 t/ ha , and RDF 100 % as inorganic sources recorded the best yield in coriander among the treatment combinations i.e T1- Vermicompost 5 t/ ha + 100 % RDF, T2- Vermicompost 5 t/ ha + 50 % RDF, T3- Vermicompost 2.5 t/ ha + 100 % RDF, T4- Vermicompost 2.5 t/ ha + 50 % RDF, T5- Farmyard manure 20 t /ha + 100 % RDF, T4- Farmyard manure 20 t /ha+ 50 % RDF, T7- Farmyard manure 10 t /ha + 100 % RDF and T8- Farmyard manure 10 t /ha + 50 % RDF. Results shows that the maximum mean values for plant height (15.98 cm, 72.23 cm and 95.69 cm) at 30, 60 and 90 DAS, the primary branches per plant (9.67) and secondary branches per plant (23.60), days to first flowering (52.83) and days to 50 % flowering (61.50) umbels per plant (34.13), umbellets per umbel (7.11), seeds per umbel (34.13), weight of seeds per umbel (0.48g), seeds per plant (598.34), seed yield per plant (6.72g), seed yield per plot (1.98 kg) and seed yield per hectare (18.53q) with treatment combination vermicompost 5 /ha + 100 % RDF and the

minimum mean values for plant height (10.45cm, 64.87cm and 85.4 cm) at 30, 60 and 90 DAS, primary branches per plant (7.87) and secondary branches per plant (16.13), days to first flowering (47.67) and days to 50 % flowering (57.50) umbels per plant (29.03), umbellets per umbel (5.97), seeds per umbel (28.33), weight of seeds per umbel (0.33g), seed yield per plant (3.62g), seed yield per plot (1.27kg) and seed yield per hectare (11.90q) with treatment combination, farmyard manure 10 t /ha + 50 % RDF. Higher seed yield might be due to more number of umbels per plant, umbellate per umbel, seeds per umbel and maximum seed weight of this fertilizer level treatment over the others. While, application of organic and inorganic enhance carbohydrate and nitrogen metabolism of pectic substances, as well as improve the water metabolism and water relation in the plants. Integrated nutrient management accelerates the growth, development reproductive phases and protein synthesis in plants, there by promoting higher yield as compared to other fertilizer level treatments. “Moreover, it might also be due to balanced C: N ratio, increased decomposition, mineralization, availability of native and applied macro and micro-nutrients, resulted in accelerated carbohydrates synthesis, led to better translocation from sink to source” (Singh., 2015). These findings were in consonance with the report of Verma *et al.*, (1991); Ram and Verma (2000) and Subramanian and Vijayakumar., (2001) and Choudary *et al.*, (2011) for number of pods per plant in fenugreek. Singh (2011) and Moslemi *et al.*, (2012) in coriander. Mohamed and Abdu (2004); Sadanandan and Hamza (2006) in black pepper. Aishwath *et al.*, (2010); Jan *et al.*, (2011) and Sahu *et al.*, (2013) in coriander. Tripathi *et al.*, (2013) reported that integrated nutrient management practice improved the growth and yield contributing characters in coriander. Similarly findings are in line with the Nabi *et al.*, (2018) observed maximum number of lateral branches/ plant (8.50) and minimum days taken for 50% germination (19.63) was recorded by treatment with 50% nitrogen through urea and 50%

nitrogen through vermicompost. Singh., (2011) reported that the solely application of vermicompost and inorganic fertilizers did not influence coriander crop rather integrated application of vermicompost (7.5 t/ha) with 25% recommended NPK (25: 12.5: 12.5 kg/ha) produced maximum biomass (28.2 q/ ha), seed (10.82 q ha) and oil yield (6.53 kg /ha) of coriander. Pooja *et al.*, (2017) reported that practicing of integrated nutrient management improved the nutrient uptake, photosynthesis activity and moreover resistant to pests and diseases, ultimately resulted in more seed yield in coriander. Similarly, A combined application of vermicompost (2.5 t/ha) with N level (40 kg /ha) and P level (20 kg/ha) significantly increased all the yield, quality and uptake parameters. This is 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 (Sanwal *et al.*, 2017). Several authors have been agreed up on integrated nutrient application as it is sustainable, ecofriendly and free of contamination. Applying any fertilizer lonely cannot fulfill crop nutrient demand. The highest seed yield of coriander is obtained when different fertilizers are combined together. Applying of inorganic fertilizers lonely have increased seed yield of coriander crop. However, the best profit is obtained when those nutrients are supplied with organic fertilizers. Like inorganic fertilizers, organic fertilizers are also more profitable if added with other sources of nutrients. In general, growth and yield of coriander is doing better when nutrient is applied in an integrated manner .

Table.1. Plant height at various growth stages of coriander with regard to various treatments of organic manures and fertilizer levels.

**ORGANIC
MANURES**

Plant height(cm) at 30 DAS

Plant height(cm) at 60 DAS

Plant height(cm) at 90 DAS

	100 % RDF	50 % RDF	MEAN	100% RDF	50% RDF	MEAN	100% RDF	50% RDF	MEAN
VC 5 t/ ha	15.98	13.12	14.55	72.23	69.72	70.97	95.69	90.64	93.17
VC 2.5 t/ ha	13.81	12.14	12.97	70.13	68.64	69.38	92.05	87.68	89.87
FYM 20 t/ ha	13.22	11.30	12.26	70.18	67.13	68.66	93.87	88.17	91.02
FYM 10 t/ ha	11.91	10.45	11.18	68.07	64.87	66.47	89.21	85.41	87.31
MEAN	13.73	11.75	12.74	70.15	67.59	68.87	92.71	87.98	90.34
	(OM)	(RDF)	(OM X RDF)	(OM)	(RDF)	(OM X RDF)	(OM)	(RDF)	(OM X RDF)
SEm±	0.60	0.42	0.85	0.65	0.46	0.92	0.21	0.15	0.29
CD @ 5%	1.82	1.29	-	1.97	1.39	4.13	0.63	0.44	1.31

FYM- Farmyard manure, VC- Vermicompost , OM- Organic manures, RDF- Recommended dose of fertilizers, DAS- Days after sowing.

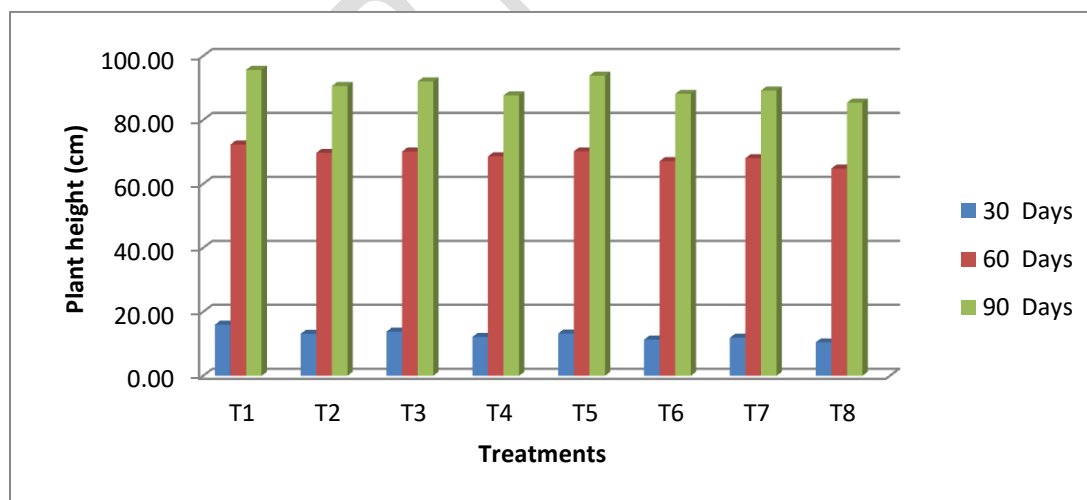


Fig 1. Graph representing variation in plant height at various growth stages due to various treatment interactions.

Table.2 Number of primary and secondary branches per plant of coriander with regard to various treatments of organic manures and fertilizer levels.

ORGANIC MANURES	Primary branches per plant			Secondary branches per plant		
	100 % RDF	50 % RDF	MEAN	100% RDF	50% RDF	MEAN
VC 5 t/ ha	9.67	8.47	9.07	23.60	20.13	21.86
VC 2.5 t/ ha	8.73	8.20	8.47	21.40	17.43	19.42
FYM 20 t/ ha	8.93	8.27	8.60	20.30	18.67	19.48
FYM 10 t/ ha	8.33	7.87	8.10	19.53	16.13	17.83
MEAN	8.92	8.20	8.56	21.21	18.09	19.65
	(OM)	(RDF)	(OM X RDF)	(OM)	(RDF)	(OM X RDF)
SEm±	0.06	0.04	0.09	0.25	0.18	0.36
CD @ 5%	0.18	0.13	0.38	0.76	0.54	1.6

FYM- Farmyard manure, VC- Vermicompost , OM- Organic manures, RDF- Recommended dose of fertilizers.

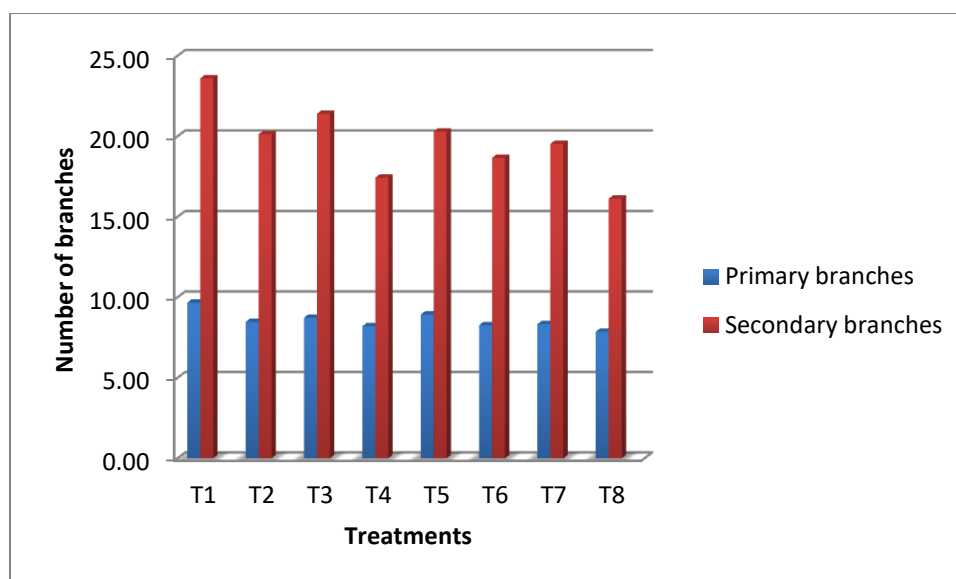


Fig 2. Graph representing variation in number of primary and secondary branches per plant due to various treatment interactions.

Table.3. Days taken to first and 50 % flowering in coriander with regard to various treatments of organic manures and fertilizer levels.

ORGANIC MANURES	Days to first flowering			Days to 50 % flowering		
	100 % RDF	50 % RDF	MEAN	100% RDF	50% RDF	MEAN
VC 5 t/ ha	54.33	51.33	52.83	63.67	59.33	61.50
VC 2.5 t/ ha	53.33	50.67	52.00	61.33	58.33	59.83
FYM 20 t/ ha	52.33	50.33	51.33	59.67	57.67	58.67
FYM 10 t/ ha	51.67	47.67	49.67	59.33	55.67	57.50
MEAN	52.92	50.08	51.45	61.00	57.75	59.38
	(OM)	(RDF)	(OM X RDF)	(OM)	(RDF)	(OM X RDF)
SEm±	0.23	0.16	0.32	0.25	0.18	0.36

CD @ 5% 0.69 0.49 1.45 0.76 0.54 1.6

FYM- Farmyard manure, VC- Vermicompost , OM- Organic manures, RDF- Recommended dose of fertilizers, DAS- Days after sowing.

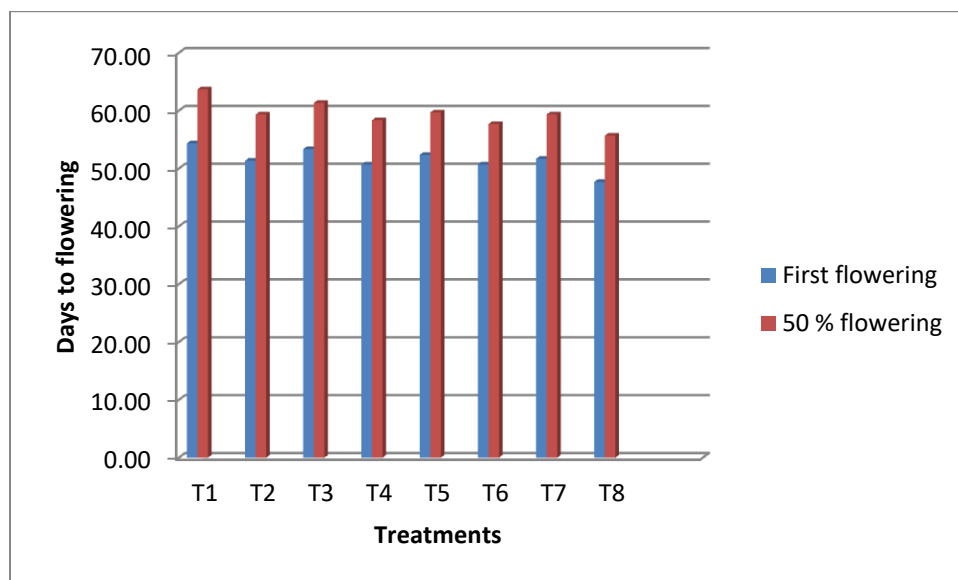


Fig: 3. Graph representing days taken to first and 50 % flowering in coriander due various treatment interactions.

Table.4. Number of umbels per plant, number of umbellets per umbel, , number of seed per umbel and weight of seed per umbelwith regard to various treatments of organic manures and fertilizer levels.

ORGANIC MANURES	NUMBER OF UMBELS PER PLANT			NUMBER OF UMBELLETS PER UMBEL			SEEDS PER UMBEL			WEIGHT OF SEED PER UMBEL (G)		
	100% RDF	50% RDF	Mean	100% RDF	50% RDF	Mean	100% RDF	50% RDF	Mean	100% RDF	50% RDF	Mean
VC	34.13	30.53	32.33	7.11	6.54	6.82	34.13	30.90	32.52	0.48	0.38	0.43

5 t/ ha												
VC												
2.5 t/ ha	32.07	29.77	30.92	6.81	6.20	6.51	31.97	27.73	29.85	0.42	0.32	0.38
FYM												
20 t/ ha	32.67	30.73	31.70	6.99	6.29	6.64	33.07	29.07	31.07	0.47	0.34	0.41
FYM												
10 t/ ha	32.10	29.03	30.57	6.78	5.97	6.37	31.43	28.33	29.88	0.42	0.33	0.37
MEAN	32.74	30.02	31.38	6.92	6.25	6.59	32.65	29.01	30.83	0.45	0.34	0.40
	(OM)	(RDF)	(OM) x (RDF)	(OM)	(RDF)	(OM) x (RDF)	(OM)	(RDF)	(OM) x (RDF)	(OM)	(RDF)	(OM) x (RDF)
SEm±	0.19	0.13	0.27	NS	0.20	NS	0.35	0.25	0.49	0.07	0.05	NS
CD @ 5%	0.58	0.41	1.21	-	0.62	-	1.05	0.75	2.21	0.03	0.02	-

FYM- Farmyard manure, VC- Vermicompost , OM- Organic manures, RDF- Recommended dose of fertilizers, DAS- Days after sowing.

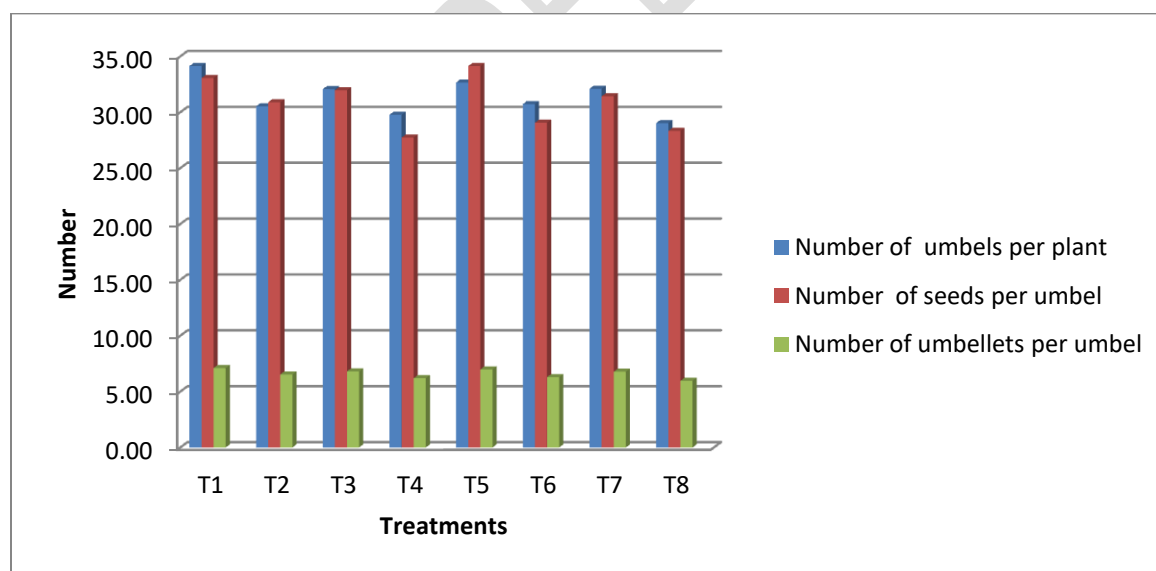


Fig 4. Graph representing variation in number of umbels per plant, number of seed per umbel and number of umbellets per umbel due to various treatment interactions.

Table.5. Number of seeds per plant, seed yield per plant (g), seed yield per plot (kg) and seed yield per hectare (q) with regard to various treatments of organic manures and fertilizer levels.

ORGANIC MANURES	NUMBER OF SEEDS PER PLANT			SEED YIELD PER PLANT (G)			SEED YIELD PER PLOT (KG)			SEED YIELD PER HECTARE (Q)		
	100% RDF	50% RDF	Mean	100% RDF	50% RDF	Mean	100% RDF	50% RDF	Mean	100% RDF	50% RDF	Mean
VC 5 t/ ha	598.34	502.54	550.44	6.72	4.34	5.53	1.98	1.67	1.82	18.53	15.61	17.07
VC 2.5 t/ ha	542.92	440.51	491.72	5.23	3.88	4.56	1.75	1.47	1.61	16.43	13.77	15.10
FYM 20 t/ ha	591.37	475.65	533.51	5.78	4.50	5.14	1.90	1.59	1.74	17.81	14.89	16.35
FYM 10 t/ ha	536.49	440.59	488.54	4.89	3.62	4.25	1.72	1.27	1.49	16.14	11.90	14.02
MEAN	567.28	464.82	516.05	6.01	4.25	5.13	1.87	1.53	1.70	17.53	14.30	15.91
	(OM)	(RDF)	(OM) x (RDF)	(OM)	(RDF)	(OM) x (RDF)	(OM)	(RDF)	(OM) x (RDF)	(OM)	(RDF)	(OM) x (RDF)
SEm±	2.2	1.6	3.1	0.11	0.075	0.15	0.02	0.01	0.03	0.17	0.12	0.25
CD @ 5%	6.71	4.74	14.1	0.32	0.29	0.68	0.05	0.04	0.11	0.53	0.38	1.12

FYM- Farmyard manure, VC- Vermicompost , OM- Organic manures, RDF- Recommended dose of fertilizers.

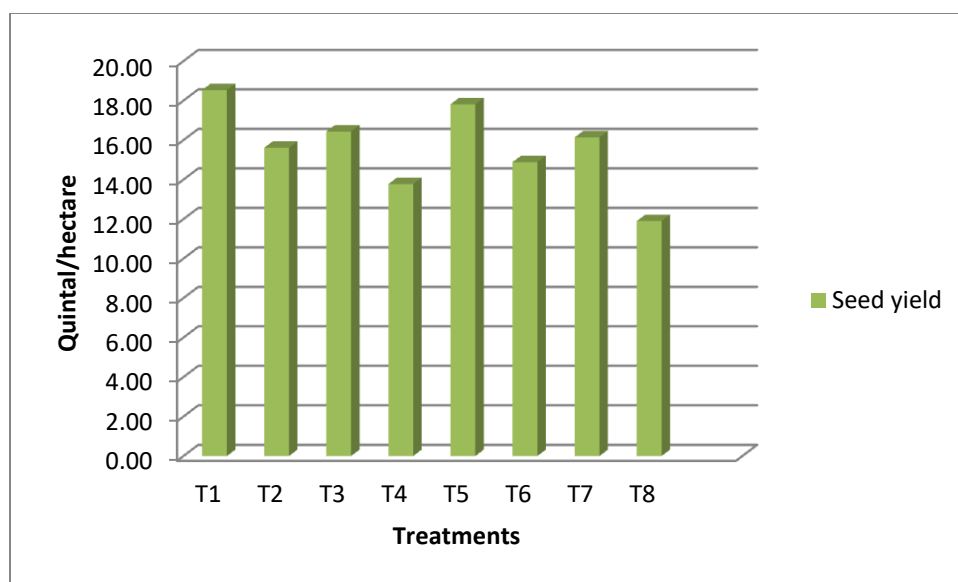


Fig 5. Graph representing variation in seed yield due to various treatment interactions.

ECONOMICS OF VARIOUS TREATMENTS.

The economics regarding the cultivation of the crop is calculated separately for different treatment on hectare basis. The fixed cost of cultivation of crops, fertilizers used in different treatments, cost of seeds etc. were calculated separately to determine the economics of cultivation. The revenue generated from seed yield was also calculated to determine the gross income under organic and fertilizer combinations.

Cost of cultivation (Rs./ha):

The cost of cultivation was directly associated with various inputs *viz.* cost of chemical fertilizers, FYM and vermicompost. The highest cost of cultivation (Rs 57650.6 ha.) was calculated under vermicompost 5 t/ha+ 100 % RDF followed by vermicompost 2.5 t/ha + 50 % RDF (Rs 56825.3 /ha.). While the minimum cost of cultivation (Rs 43125.3/ha.) was recorded by the use of FYM 10 t/ha + 50 % RDF. The high cost of cultivation is due to higher price of vermicompost compared to FYM.

Gross income (Rs./ha):

The maximum gross income (Rs 129710.00/ha.) was calculated in the treatment vermicompost 5 t/ha+ 100 % RDF with followed by FYM 20 t/ha + 100 % RDF (Rs 124670.00/ha.). While the minimum (Rs 89810.00 /ha.) was found in the treatment FYM 10 t/ha+ 50 % RDF).

Net profit (Rs. /ha):

The maximum net profit (Rs 79419.4 /ha.) was obtained in FYM 20 t/ha+ 100 % RDF) which is the best as compared to other treatments followed by vermicompost 5 t/ ha+ 100 % RDF) (Rs 72059.4/ha), however the minimum net income (Rs 46684.7/ha) was obtained in treatment FYM 10 t/ ha+ 50 % RDF.

Cost: Benefit ratio:

The maximum cost: benefit ratio (1: 2.76) was noted under the treatment FYM 20 t/ha + 100 % RDF . However, the minimum cost: benefit ratio (1: 1.92) was recorded from vermicompost 5 t/ha +50 % RDF). The reason is due to high cost of vermicompost raised the cost of cultivation resulting reduce in net profit and cost benefit ratio compared to FYM. Fikadu *et al.*, (2019) found that the use of RDF (100%) through fertilizers and combinations of different organic and inorganic sources produces the maximum grain yield (1024 kg/ha), net return (Rs. 59556 /ha) and benefit cost ratio (3.66) in coriander production. Jhankar *et al.*, (2017) observed, the maximum net profit (Rs. 107689/ha) and benefit: cost (2.09) in the treatment of inorganic fertilizer (100% of RDF), bio-fertilizers; azotobacter, azospirillum and PSB (2.5 kg/ha and farmyard manure (5 t/ ha). Similarly, it's also reported that 60 kg N ha⁻¹ (half dose of nitrogen as basal and remaining half dose at 30 days after sowing) and 60 kg P₂O₅ ha⁻¹ (full doses of phosphorus as basal) is optimum for higher production & net returns from coriander (Javiya *et al.*, 2017).

Therefore, integrated nutrient application is very important in improving the physicochemical and biological conditions of the soils and finally helped in increasing the net profit by maximizing benefit cost ratio (Tripathi *et al.*, 2013; Jhankar *et al.*, 2017; Pooja *et al.*, 2017).

Table .6. Economics of crop in relation to different treatments.

Symbol	Treatments	Yield (q/ha.)	Cost of cultivation (Rs. /ha.)	Gross income (Rs. /ha.)	Net income (Rs./ha.)	Cost : Benefit Ratio
T ₁	Vermicompost 5 t/ ha + 100 % RDF	18.53	57650.6	129710	72059.4	1:2.25
T ₂	Vermicompost 5 t/ ha + 50 % RDF	15.61	56825.3	109270	52444.7	1:1.92
T ₃	Vermicompost 2.5 t/ ha +100 % RDF	16.43	50150.6	115010	64859.4	1:2.29
T ₄	Vermicompost 2.5 t/ ha +50 % RDF	13.77	49325.3	96390	47064.7	1:1.95
T ₅	FYM 20 t/ ha + 100 % RDF	17.81	45250.6	124670	79419.4	1:2.76
T ₆	FYM 20 t/ ha + 50 % RDF	14.92	44425.3	104440	60014.7	1:2.35
T ₇	FYM 10 t/ ha + 100 % RDF	16.14	43950.6	112980	69029.4	1:2.57
T ₈	FYM 10 t/ ha + 50 % RDF	12.83	43125.3	89810	46684.7	1:2.08

FYM- Farmyard manure, RDF- recommended dose of fertilizers.

CONCLUSION.

The study shows that both the nutrient sources i.e. organic manures and inorganic fertilizers responded well in terms of yield and yield parameters. The interaction of both the nutrient sources showed significant effect on yield and economics. It is concluded that the application of vermicompost 5 t/ha+ 100 % RDF (50:30:60 kg NPK/ ha) recorded the maximum seed yield of coriander variety JD-1 along with gross income followed by FYM 20 t/ha + 100% RDF. However highest net profit and cost benefit ratio 1:2.76 was observed in FYM 20 t/ha + 100% RDF. Hence present findings have practical utility in successful cultivation of coriander for Kymore plateau and Satpura hills of Madhya Pradesh.

REFERENCES.

- Ahmad, T., Shah, S., Ullah, F., Ghafoor, F. and Anwar, U. (2017). Effect of organic fertilizer on growth and yield of coriander. *Int. J. Agri. and Env. Res.*, 3(1): 116-120.
- Aishwath, O. P., Mehta, R. S. and Anwer, M. M. (2010). Integrated nutrient management in seed spice crops. *Indian Journal of Fertilisers*. 6 (11): 132-139.
- Akbarinia, A., Daneshian, J. and Mohammadbegi, F. (2006). Effect of nitrogen fertilizer and plant density on seed yield, essential oil and oil content of *Coriandrum sativum* L. [Persian]*Iranian Journal of Medicinal and Aromatic Plants*. 22 (4): Pe410-Pe419.
- Atiyeh, R. M., Edwards, C. A., Metzger, J. D., Lee, S., Arancon, N. Q. (2002) The influence of humic acids derived from earthworm-processed organic wastes on plant growth. *Bioresource Technology* . 84, 7–14.
- Asgharipour, M. R. (2012). Effect of vermicompost produced from municipalsolidwaste on growth and yield of isabgol (*Plantago ovata* Forsk) and cumin (*Cuminum cyminum*). *Journal of Medicinal Plants Research*. 6(9) :1612-1618.

Basak, N., Biswas, S., Tamang, A., Basak, P., Murmu, S., Hazra, C. and Mandal, B. (2017). Impact of inorganic fertilizers on soil biological health, 3(2). Edited by Sen, H., Mandal, B., Ghorai, D., Rahman, F. and Sarkar, D. Society for Fertilizers and Environment, West Bengal, India.

Bhat S, Kaushal P, Kaur M, and Sharma H. (2014). Coriander (*Coriandrum sativum*) Processing, nutritional and functional aspects. *African Journal of Plant Science*. 8 (1) :25–33.

Channabasavanna, A. S., Yalamali S. G. and Biradar, D. P. (2002). Nutrient requirement of coriander in Tungabhadra project area of Karnataka . *Journal of Maharashtra Agricultural Universities*. 27(1): 38-39.

Choudhary, B.R., Gupta A.K., Parihar C.M., Jat S.L. and Singh D.K. (2011). Effect of integrated nutrient management on fenugreek (*Trigonella foenumgraecum*) and its residual effect on fodder pearl millet (*Pennisetum glaucum*). Online published on 3 December.

Chauhan, P., Singh, A., Singh, R., and Ibrahim, M. (2012). Environmental impacts of organic fertilizers usage in agriculture. National botanical research institute, India.

Darzi, M., Shirkhodaei, M. and Hadi, M. (2014). Influence of vermicompost and biostimulant on the growth and biomass of coriander (*Coriandrum sativum* L.). *Int J Adv. Biol. Biom. Res.* 2(3):706- 714.

Dash, S., Pathak, M., Tripathy, L. and Barik, S. (2019). Studies on effect of integrated nutrient management on growth and yield attributes in radish (*Raphanus sativus* L.) and its residual effect in radish - coriander cropping sequence. *Journal of Pharmacognosy and Phytochemistry* . 8(1): 319-322.

Dolker D., Bakshi P., Wali V.K., Dorje S., Kour K. and Jasrotia A. (2017). Integrated Nutrient Management in Fruit Production. *Int. J. Curr. Microbiol. App. Sci.* 6(7): 32-40.

Edwards, C.A. and Burrows, I., (1988). The potential of earthworm composts as plant growth media. In: Edwards, C.A., Neuhauser, E.F. (Eds.), *Earthworms in*

Environmental and Waste Management. SPB Academic Publ. b.v., The Netherlands, pp. 211–220.

Elasbah, R., Selim, T., Mirdan, A. and Berndtsson, R. (2019). Modeling of fertilizer transport for various fertigation scenarios under drip irrigation. *J. of Water*, 11:893; doi:10.3390/w11050893.

El- Mekawey, M.A.M., Ali, M.A.M., Awad, A.E. and Hassan, H.M.S. (2010) . Effect of fertilization and growth regulators on *coriandrum sativum* L. plants productivity under north sinai conditions. *J. Agric. Res.* 36 :314 -339.

Emamghoreishi, M., Khasaki, M., Aazam, M. F. (2005). *C. sativum*. Evaluation of its anxiolytic effect in the elevated plus-maze. *J Ethnopharmacol.* 96:365–70.

Fikadu, L. W., Diriba, S. G. and Muluaalem, A. M. (2019). The need of integrated nutrient management for coriander (*Coriandrum sativum* L.) production. *International Journal of Food & Nutrition* .4 (1): 1 – 13.

Filippone, P.(2018).What is Coriander? Retrieved from:[https://www.thespruceeats.com/ what- is coriander- 1807009](https://www.thespruceeats.com/what-is-coriander-1807009).

Gujar, S. M., Warade, A. D., Mohariya, A. and Paithankar, D. H. (2005). Effect of dates of sowing and nitrogen levels on growth, seed yield and quality of coriander. *Crop Research* (Hisar). 29 (2): 288-291.

Ibrahim, S. M., El-Labban, H. M., Mohamed. F. I. and Naga, N. M. (2006). Effect of Organic manures and chemical Fertilizers on *Foeniculum vulgare*, Mill and *Carum Carvi*, L. *Bull. Pharm. Sci., Assiut University*. 29 (1):187-201.

Jan, I., Sajid, M., Shah, A. H., A. Rab, Khan, N. H., Wahid, I. F., Rahman, A., Alam. R and H. Alam. (2011). Response of seed yield of coriander to phosphorus and row spacing. *Sarhad. J. Agric.* 27(4): 549-552.

Javiya, P.P., Solanki, J.N., Kaneria, S.C. and Rupareliya, V.V. (2017). Response of Coriander (*Coriandrum sativum* L.) to Nitrogen and Phosphorus in South Saurashtra Condition. *Int. J. Pure App. Biosci.* 5(4): 860-866.

Jhankar, P., Panda, C. and Sethi, D. (2017). Effect of INM practices on yield, yield attributes and economics of coriander (*Coriandrum sativum* L.). *Int. J. Curr. Microbiol. App. Sci.* 6(5): 1306- 1312.

JSS, Johnny's Selected Seeds. (2018). Cilantro and coriander production. 955, Benton Ave., Winslow, ME 04901. Available at: <https://www.johnnyseeds.com/on/demandware.static/-/Library-ites-JSSSharedLibrary/default/dw49416348/assets/information/8306-cilantro-production.pdf>. Accessed on May 26, 2019.

Khalid, K. A. (2012). Effect of NP and foliar spray on growth and chemical compositions of some medicinal Apiaceae plants grow in arid regions in Egypt. *Journal of Soil Science and Plant Nutrition*.12 (3): 617-632.

Khan, M., Habib, A., Abdullah, A., Tahir, A., Zahid, K., Asghar, J., Latif, S. and Mushtaq, M. (2019). Seed associated mycoflora of coriander (*Coriandrum sativum* L.) its effect on seed germination and management through seed treatment chemical. *The Int. J. Biol. Res.* 2: 101-117.

Kumar, A., Singh, R. and Chhillar, R. K. (2008). Influence of omitting irrigation and nitrogen levels on growth, yield and water use efficiency of coriander (*Coriandrum sativum* L.). *Acta Agronomica Hungarica*.56 (1): 69-74.

Kumar, K., Singh, G. P., Singh, N., Bhatia, A. K. and Nehra, B. K. (2007). Performance of seed crop of coriander under different levels of row spacing, nitrogen and cycocel. *Haryana Journal of Horticultural Sciences*. 36 (1/2): 127-128.

Leena K, Sharma A, Lodi S (2012). Potential health benefits of coriander (*Coriandrum sativum*) . *Int. J. Pharm. Res. Dev.* 4(2):10-20.

Mahajan, A., and Gupta, R. (2009). Need of INM System in modern agriculture. Integrated Nutrient Management (INM) in a Sustainable Rice-Wheat Cropping System. Springer, Dordrecht. DOI: https://doi.org/10.1007/978-1-4020-9875-8_3.

Mohamed M. A-H. and Abdu.M. (2004). Growth and Oil Production of Fennel (*Foeniculum vulgare* Mill): Effect of Irrigation and Organic Fertilization. *Biological Agriculture and Horticulture*. 22:31-39.

Manure, G. R., Shivaraj, B., Farooqui, A. A. and Surendra, H. S. (2000). Yield attributes, seed, essential oil yield and oil content of coriander (*Coriandrum sativum* L.) as influenced by the graded levels of nitrogen, sulphur and zinc nutrition in red sandy loam soils. challenges and opportunities in the new century. Contributory papers. *Centennial conference on spices and aromatic plants*. 139-144.

Moslemi, M., Aboutalebi, A., Hasanzade, H. and Farahi, M. H. (2012). Evaluation the effects of different levels of vermicompost on yield and yield components of Coriander (*Coriandrum sativum* L.). *Annals of Biological Research*.3 (10) : 4852-4853.

Mounika, Y., Sivaram, G., Reddy, P. and Ramaiah, M. (2018). Influence of biofertilizers and micronutrients on seed yield, essential oil and oleoresins of coriander (*Coriandrum sativum* L.) cv. Sadhana. *Bull. Env. Pharmacol. Life Sci.*, (7):36-39.

Nabi, J., Mushtaq, F., Mushtaq, N., Riyaz, L. and Jabeen, N. (2018). Influence of different levels of nitrogen fertilization on initiation of germination and branching number in coriander (*Coriandrum sativum* L.) var. Shalimar Dhanial-1. *The Pharma Innovation Journal*. 7(8): 102-104.

Nagar, R. K., Meena, B. S., and Dadheech, R. C. (2009).Effect of integrated weed and nutrientmanagement on weed density, productivity and economics of coriander (*Coriandrum sativum*). *Indian Journal of Weed Science*.41 (1/2): 71-75.

Naghera, R. P., Sukhadia, N. M. and Ramani, B. B. (2000). Effect of sowing dates and varying levels of nitrogen and phosphorus on Coriander (*Coriandrum sativum* L.). *Gujarat Agricultural University Research Journal*.26 (1): 52-54.

Nayak, B. R., Saini, S. S. and Sahu, G. S. (2009). Effect of farm yard manure, nitrogen and plant spacings on yield and attributing character of coriander (*Coriandrum sativum* L.). *Environment and Ecology*. 27 (3A): 1374-1377.

Okut, N. and Ydrm, B. (2005). Effects of different row spacing and nitrogen doses on certain agronomic characteristics of coriander (*Coriandrum sativum* L.). *Pakistan Journal of Biological Sciences*. 8 (6): 901-904.

Oliveira, A. P., de Alves, E. U., Bruno, R. de L. A., Sader, R. and Alves, A. U. (2006). Yield and quality of coriander seeds in function of nitrogen levels. [Portuguese]. *Revista Brasileira de Sementes*. 28 (1): 193-198.

Panse, V. G. and Sukhatme, P. V., (1985). Statistical Methods for Agricultural Workers, ICAR, New Delhi, PP: 381

Pooja., Nagre, P. and Yadav, H. (2017). Influence of different levels of nitrogen and phosphorus on seed yield and economics of coriander (*Coriandrum sativum* L.). *Journal of Pharmacognosy and Phytochemistry*. 6(5): 157-160.

Ram, D. and Verma, J. P. (2000). Effect of level of phosphorus and potash on the performance of seed yield of 'Pusa Early Bunching' fenugreek (*Trigonella foenum-graecum*). *Ind. J. of Agril. Sci.* 70 (12): 866-868.

Rayns, F. and Rosenfeld, A. (2010). Green manures- Effects on soil nutrient management and soil physical and biological properties.

Ravimycin, T. (2016). Effects of vermicompost (VC) and farmyard manure (FYM) on the germination percentage growth biochemical and nutrient content of Coriander (*Coriandrum sativum* L.). *Int. J. Adv. Res. Biol. Sci.* 3(6): 91-98.

Reetz, H. (2016). Fertilizers and their efficient use. International fertilizer industry association. 1st ed., Paris, France.

Sadanandan, A. K. and Hamza, S. (2006). Effect of Organic Farming on Soil Quality, Nutrient Uptake, Yield and Quality of Indian Spice. Scientific registration n^o:2445. Symposium n^o:40.

Sahu, R., Sahu, H. and Kashyap, P. (2013). Effects of biofertilizer on the growth characters, yield attributes and quality of coriander (*Coriandrum sativum*). *Asian J. Soil Sci.*, 8(2):330-333.

Sanwal, R., Sharma, Y., Singh A., Reager, M. and Dayanand. (2017). Impact of vermicompost, nitrogen and phosphorus on yield, quality and uptake of coriander (*Coriandrum sativum* L.) under arid condition. *International Journal of Chemical Studies*. 5(6): 1698-1702.

Sharma, A. and Chetani, R. (2017). A review on the effect of organic and chemical fertilizers on plants.

Sharma, M.M. and Sharma, R.K. (2012). Handbook of Herbs and Spices (Second Edition), Volume 1.

Singh G, Maurya S. De., Lampasona M. P. and Catalan C. A. N. (2006). Studies on the essential oils, part 41: chemical composition, antifungal, antioxidant and sprout suppressant activities of Coriander (*Coriandrum sativum*) essential oil and its oleoresin. *Flav Frag J* 21: 472–479.

Singh, J., Malik, Y. S., Thakral, K. K. and Mehla, C. P. (2000). Effect of sowing time, nitrogen levels and leaf cuttings on green and seed yield of Coriander. *Haryana Journal of Horticultural Sciences*. 29 (3/4): 225-228.

Singh M. (2011). Effect of vermicompost and chemical fertilizers on growth, yield and quality of coriander (*Coriandrum sativum* L.) in a semi-arid tropical climate. *Journal of Spices and Aromatic Crops*. 20 (1) : 30-33.

Singh, S. and Jat, N. L. (2002). Effect of phosphorus and zinc fertilization on growth and yield of coriander (*Coriandrum sativum* L.). *Annals of Agricultural Research*. 23 (4): 734-736 .

Singh S.P. (2015). Effect of organic manures on growth, yield and economics of coriander (*Coriandrum sativum* L.). *Journal of Eco-friendly Agriculture*. 10(2):124-127.

Sriti J, Talou T, Wannes WA, Cerny M and Marzouk B. (2009a). Essential oil, fatty acid and sterol composition of Tunisian coriander fruit different parts. *J Sci Food Agri* .89: 1659–1664.

Sriti J, Wannes WA, Talou T, Mhamdi B, Cerny M, and Marzouk B. (2009b). Lipid profile of Tunisian coriander (*Coriandrum sativum*) seed. *J Am Oil Chems Soc* .87: 395–400.

Subramanian, S. and Vijayakumar, M. (2001). Effect of various levels of nitrogen and Azospirillum on growth and yield of CO 3 coriander (*Coriandrum sativum* L.). *South Indian Horticulture*. 49: Special, 191-194.

Tripathi, M. L. (2006). Response of coriander varieties to fertility levels. *Research on Crops*. 7 (3): 885-886.

Tripathi, M., Singh, H. and Chouhan, S. (2013). Response of coriander (*Coriandrum Sativum L.*) to integrated nutrient management. *A Journal of Multidisciplinary Advance Research*. 2(2): 43- 46.

Verma, J. P., Thakur, R. N., Sharma, B. N., Katiyar, D. S. and Singh, V. (1991). Response of fenugreek (*Trigonella foenum graecum L.*) to N and P. *Ind. J. of Agron.* 36 (1): 116-118.

Wang, M., Zheng, Q., Shen, Q. and Guo, Sh. (2013). The critical role of potassium in plant stress response (a Review). *Int. J. Mol. Sci.* 14: 7370-7390. doi: 10.3390/ijms14047370.