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Influence of different levels of nitrogen and phosphorus on seed yield and economics of coriander (*Coriandrum sativum* L.)

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Abstract
A field investigation was conducted at the Department of Horticulture, Dr. PDKV Akola Maharashtra during the *rabi* season of 2014-2015 to determine the requirement of nitrogen and phosphorus for coriander variety Hisar Anand for achieving maximum seed yield and benefit cost ratio. Four different levels of nitrogen (40, 50, 60 and 70 kg/ha) and three different levels of phosphorus (30, 40 and 50 k/ha) in different combination were distributed in the plots. The experiment was laid out in Factorial Randomized Block Design with 3 replications. Available N and P levels in soil after harvesting was non-significantly affected with different nitrogen and phosphorus combinations. There was a significant effect of application of these two nutrients on most of the seed yield attributes of coriander up to a certain limit. The results indicated that yield parameters were declined with very high rate of nitrogen. Therefore, significantly 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), was recorded with treatment T_{11} i.e. (N_{60} + P_{50} kg/ha) instead of highest dose of both nutrients. For two parameter *viz.,* umbellate per umbel and seeds per umbel interaction effect was found to be non-significant. The highest net return, highest gross return and highest benefit cost ratio was recorded with same treatment T_{11} i.e. (N_{60}+P_{50} kg/ha). Therefore, The treatment combination of (N_{60} + P_{50} kg/ha) was observed to be the best and most profitable dose for coriander cultivation on black cotton soil of Akola, Maharashtra.

Keywords: *Coriandrum sativum* L., Coriander, Yield attributes, Umbels, Umbellate, Economics

1. Introduction
Coriander (*Coriandrum sativum* L.) is an annual herb. It is one of the first seed spice to be used by mankind. Coriander (which belongs to the family *Apiaceae* (*Umbelliferae*) is mainly cultivated from its seeds throughout the year (Mhemdi *et al.* 2011) [7]. It is one of the most common and popular spice crop in India. It is also known as 'Dhaniya' in Hindi. Its leaves as well as fruits are commonly used raw or dried for culinary applications. Seeds are round to oval in shape, golden brown or brown in color with vertical ridges and have a distinct flavor. The seeds are important ingredient of curry powder (Ramadan *et al*. 2002) [14]. Dried coriander seeds are one of the common spice ingredients used worldwide. In India ground powder of coriander seeds is a common household spice powder that is used in pickling, chutney, stews curries, marinades as well as in sausages. The coriander seeds are used in sweet, breads, cakes and to flavor liquors. They are used medicinally for a number of purposes, particularly to relieve flatulence (Bhuiyan *et al*. 2009) [4]. The dried seeds contribute to pleasantly aromatic spice that is much used in stews, cuisine, sweet breads, sausages and cakes (Peter, 2004) [12]. Oil like oleoresin obtained from seeds, is used in scent perfumes, deodorants and soaps. Despite of culinary and industrial uses coriander seeds also have medicinal importance. Seeds are carminative and digestive, chewed as a remedy to prevent bad smell of breath. It contains cineole and linoleic acid, which possess anti rheumatic and anti anthritic properties. It helps in reducing blood cholesterol level. It acts as antiseptic, can cure diarrhea, assist digestion, promote proper functioning of liver. In contrary to leaves 100 g of coriander seed contains nearly 11.37 % water,11.49% crude protein,19.15% fat, 28.43% crude fiber, 10.53 % starch, 10.29 % pentosans, 1.92 % sugar, 4.98 % mineral constituents, and 0.84 percent essential oil. (Diederichsen, 1960) [6]. In India coriander occupies the pride of place among the seed spices. This spice crop is grown in an area of 447 '000ha, with an estimated production of 314'000Mt, and 0.7 Mt/ha productivity. Its commercial cultivation is limited to a few states, which include Rajasthan, Gujarat, Madhya Pradesh, Tamil Nadu and Andhra Pradesh. Rajasthan leads both in area and production followed by Gujarat. (Source: NHB 2014) [1].
Coriander is an underutilized seed spice crop, it is regularly consumed as a leaf spice by

Indians but its use as seed spice is still to be enhanced. Production of coriander seed is very low because of less attention was given in past and present for its cultivation aspects, and nutrient management. Plant nutrition plays an important role in overall production of plant and determination of nutritional needs of any crop species. The soils of India are lack of essential plant nutrient. The nitrogen and phosphorus are two important influencing nutrients on the seed yield of plant. For improvement of seed yield the management practices of cultivation aspects needs to be standardized so that wastage of resources can be minimized and per unit area production can be increased. As the coriander seeds are gaining importance due to its commercial, medicinal and industrial value, it is very necessary to cope up increasing demand with increase production of coriander seeds and this can be achieved by using proper levels of nutrients. Therefore, the study was conducted to test the effects of two major nutrient Nitrogen and Phosphorus on seed yield and economics of coriander.

Materials and Methods

The experiment was carried out at main garden of Dr. PDKV Akola, Maharashtra on black cotton soil during November month of 2014-15. The gross plot size was 1.8×1.8 m^2 and the net plot size was 1.2 X 1.7 m^2.The experiment was set up in FRBD. There were 4 levels of nitrogen (40, 50, 60, 70 kg/ha) and three levels of phosphorus (30, 40, 50 kg/ha).

The experiment was laid out with 12 treatment combinations and replicated 3 times. Nitrogen and phosphorus was applied in each plot together in different combinations *viz.* N_1P_1 : 40 kg N+ 30 kg P/ha,N_1 P_2: 40kg N+40kg P/ha, N_1 P_3: 40kg N+ 50 kg P/ha, N_2P_1:50kg N +30 kg P/ha, N_2 P_2: 50kg N+ 40 kg P/ha, N_2 P_3:50kgN+ 50kg P/ha, N_3 P_1:60kg N+ 30 kg P/ha, N_3 P_2:60kg N+ 40 kg P/ha, N_3 P_3:60kg N+ 50kg P/ha, N_4 P_1: 70kgN+ 30 kg P/ha, N_4 P_2:70kgN + 40 kg P/ha, N_4P_3:70kg N+50 kg P/ha. Seeds of coriander variety Hisar Anand were showed during late November as it is a mid late season variety with medium to small, oval shaped seeds. Seed posses a light red to brown colour at the time of maturity. Urea (40 % N) and single super phosphate (16%) were the main fertilizers used as source of nitrogen and phosphorus respectively. Top dressing of fertilizers in each plot was done at the time of sowing. Light irrigation was given immediately after sowing and subsequent irrigation was given to the plots at an interval of 3-4 days during the period of experiment. The status of soil nutrients before sowing was determined by Alkaline permagnate method (Subbaiah and Asija, 1956) [17] and Olsen's method of nitrogen and phosphorus respectively. Initial level of soil nitrogen and phosphorus was recorded 231.67 kg/ha and 11.18 kg/ha respectively. Different yield parameters *viz.*, number of umbels /plant, umbellate/umbel, seeds/ umbel, seed yield /plant, seed yield/plot, seed yield/ha were recorded on five randomly selected plants. Observational plants were tagged from each plot. Boarder rows plants were avoided for recording observations. The average of different recorded observations was subjected to statistical analysis by Panse and Sukhatme, 1985 [11]

Results and Discussion

Nutrient Study of Soil after Harvesting Of Crop

The effect of nitrogen and phosphorus levels on soil nutrient status was found to be significant. The data presented in Table 1 showed that the plot which received 70 kg N/ha recorded significantly maximum available nitrogen (236.93g) after harvesting which was highest than other treatments. Similarly levels of phosphorus significantly influenced the nutrient status after harvesting. Significantly maximum phosphorus (13.11g) was recorded from plot receiving 50 kg P/ha. Effect of interaction factor on available N and P levels in soil after harvesting was non-significant. However, maximum soil nitrogen and phosphorus was noted from plot which received treatment T_{11} i.e.(70 kg N+ 50 kg P/ha). It was probably due to the fact that plants from the plot, where maximum nitrogen and phosphorus was applied, utilized nutrients up to a certain limit which resulted maximum content of these nutrient levels in soil after harvesting.

Yield Parameters

1. Number of umbels per plant

The inflorescence of coriander is called umbel. Umbel contain umbellate where seed setting takes place. The numbers of umbel were directly responsible for a good yield. More umbel per plant ensures more seed yield. The results of experiment conducted, are presented in Table 2 and it indicates that nitrogen and phosphorus levels significantly affected the number of umbels per plant. Significantly maximum umbels per plant (17.93 and 16.00) were observed at 60 kg N and 50 kg P/ha respectively, which was superior to other doses of these two nutrients. This was probably due to availability of more nutrients to plant at which plant could develop more branches, due to profuse branching maximum number of umbels produced. However, higher dose of nitrogen up to 70 kg /ha causes profuse vegetative growth due to which flowering was delayed and less numbers of umbels produced with 70 N kg/ha. It also proves the finding of Azizi *et al.* (2008) [2], Nath *et al*. (2008) [10] in ajowain and Raj *et al.* (2008) [13] in coriander.

2. Number of umbellate per umbel

As the number of umbellate per umbel depends on number of umbels per plant so maximum number of umbellate per umbel (6.69 and 5.52) was recorded with treatment application of 60 kg N and 50 kg P/ha respectively. This was significantly maximum to other applications.

3. Seeds per umbel

High nitrogen and phosphorus levels have positively affected seeds per umbel up to the moderate dose of application. Significantly maximum seeds per umbel (18.34) were recorded with 60 kg N/ha which was found to be at par with 70 kg N/ha (17.88).Similarly, maximum number of seeds per umbel were recorded with application of 50 kg P/ha which was superior to other phosphorus doses. More number of seeds per umbel depends on number of umbels per plant and number of umbellate per umbel that is why maximum seeds were recorded with the dose which gave highest number of umbels per plant. Similar results were observed by Salarajai *et al.* 2005 [16] *and* Mohammad *et al.* 2011 [9] in fennel and Meena *et al*. 2015 [8] in anise.

4. Seed yield per plant

Total Seed yield per plant is very much important than the biological yield which is a result of different physiological and biochemical process. Nitrogen and phosphorus improves nutritional condition of plant which has the positive effects on yield. Seed yield per plant was significantly affected by different application of nitrogen and phosphorus. Data presented in Table 2 showed that significantly maximum seed yield per plant (4.01 g) was obtained from plot receiving 60 kg N/ha. Similarly, highest seed yield per plant (4.16 g) was

recorded with application of 50 kg P/ha. Increase in seed yield with the higher uptake of N and P during seed formation might have increased number of seeds per plant. Similar results were also recorded by Bhuvneshwari *et al*. (2002) [5] in fenugreek crop.

5. Seed yield per plot

The plot having highest yielding plants will subsequently posses highest yield per plot. The data presented in Table 2 showed that seed yield per plot was significantly influenced by nitrogen and phosphorus levels. Maximum seed yield per plot (341 g) was recorded with 60 kg N application which was superior to all other doses of nitrogen. At the same time, maximum seed yield per plot (353 g) was recorded with 50 kg P/ha and it was superior to other doses of phosphorus.

6. Seed yield per hectare

Seed yield per hectare area that means, productivity enhances due to increase nitrogen and phosphorus levels. The results of this investigation showed that seed yield was significantly influenced with nitrogen and phosphorus levels. Maximum seed yield per hectare (9.46 q) was observed with the application of 60 kg N/ha, which was found to be significantly superior of other treatments. Similarly, maximum seed yield per unit area (9.82 q) was recorded with application of 50 kg p/ha. This was probably due to the fact that both these nutrients play an important role in plant nutrient uptake and affects various physiological functions such as photosynthesis, cholorophyll synthesis and reduced attack of diseases and pests etc. and ultimately leads to the improvement of growth and seed yield. The results of this investigation support the findings of Bhat and Sulkieri 1992 [3] in coriander and Tehlan *et al*. 2008 [18] in coriander crop.

Benefit Cost Ratio

The data presented in Table 3 indicates that highest Net return (53140.07 Rs/kg), highest Gross return (105060 Rs/kg) and highest Benefit cost ratio (2.02) was recorded with the treatment N_3P_3 i.e. 60 Kg N and 50 kg P/ha. The results obtained in this study were in a range of those given by Rana *et al*. (2012) [15] in black cumin.

Table 1: Nutrient status of soil after harvesting as influenced by different nitrogen and phosphorus levels.

Treatments	Nutrient uptake (kg/ha)	
	Nitrogen	Phosphorus
40 kg/ha	232.00	11.72
50 kg/ha	234.69	12.71
60 kg/ha	236.11	13.32
70 kg/ha	236.93	13.82
F' Test	Sig	Sig
S.Em±	0.25	0.15
CD at 5%	0.74	0.45
30 kg/ha	234.70	12.70
40 kg/ha	234.73	12.87
50 kg/ha	235.36	13.11
F' Test	NS	Sig
S.Em±	0.22	0.13
CD at 5%	-----	0.39
Interaction effect (NX P)		
F' Test	NS	NS
SE(m)±	0.44	0.26
CD at 5 %	-----	-----

Table 2: Effect of nitrogen levels on seed yield attributes

Treatment	Number of umbels per plant	Number of Umbellate per umbel	Number of Seeds per umbel	Seed yield per plant (g)	Seed yield per plot (kg)	Seed yield per hectare (q)
Nitrogen Levels						
40 kg N/ha	11.68	3.78	16.35	3.01	260	7.22
50 kgN/ha	15.23	4.80	17.21	3.31	281	7.81
60 kgN/ha	17.93	6.69	18.34	4.01	341	9.46
70 kgN/ha	16.31	5.24	17.88	3.62	307	8.54
S.Em±	0.04	0.033	0.18	0.10	13.98	0.25
CD at 5%	0.11	0.10	0.52	0.28	29.1	0.75
Phoshphorus Levels						
30 kgP/ha	14.58	4.74	14.09	2.87	2.47	6.85
40 kgP/ha	15.29	5.10	17.65	3.43	292	8.10
50 kgP/ha	16.00	5.52	20.64	4.16	353	9.82
S.Em±	0.03	0.029	0.15	0.08	12.10	0.22
CD at 5%	0.09	0.085	0.45	0.24	25.10	0.65
Interaction (N×P)	Sig	Sig	Sig	Sig	Sig	Sig

Table 3: Cost of cultivation, Gross return, Net return and Cost benefit ratio as influenced by different nitrogen and phosphorus levels

Treatments	Cost of cultivation (Rs/ha)	Gross returns (Rs/kg)	Net returns (Rs/kg)	Cost benefit ratio
T_1 (40 kg N+ 30 kg P/ha)	32950.08	49895	8189.08	1.19
T2(40kg N+40kg P/ha)	33413.84	56950	13604.49	1.31
T_3 (40kg N+ 50 kg P/ha)	32990.61	61200	17569.3	1.40
T_4 (50kg N +30 kg P/ha)	33010.89	64940	200665.7	1.46
T_5 (50kg N+ 40 kg P/ha)	33439.74	60860	16836.8	1.38
T_6 (50kgN+ 50kg P/ha)	33460.06	66300	21349.9	1.47
T_7 (60kg N+ 30 kg P/ha)	33480.27	75055	286255	1.61
T_8 (60kg N+ 40 kg P/ha)	33500.55	73270	27117.7	1.58
T_9 (60kg N+ 50kg P/ha)	33929.4	73355	26759.7	1.57
T_{10} (70kgN+ 30 kg P/ha)	33949.72	75820	28793.6	1.61
T_{11} (70kgN + 40 kg P/ha)	33969.93	105060	53140.07	2.02
T_{12} (70kg N+50 kg P/ha)	33990.21	79560	31869.07	1.66

Conclusion

Nitrogen and phosphorus are the two major nutrient required for the good production or yield of any crop. The increase seed yield ultimately depends on good yield contributing characters, which results from proper dose of fertilizers. To standardize the rate of two major nutrients nitrogen and phosphorus, the study was conducted, and from the result of the study it could be concluded that treatment T_{11} i.e. (N_{60} + P_{50} kg/ha) was found to be best for obtaining higher seed yield. Considering the cost economics, nitrogen level N_3 (60 kg/ha) and phosphorus level P_3 (50 kg/ha) was observed to be most remunerative for coriander cultivation in black cotton soil of Akola, Maharashtra.

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