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Macro-nutrients requirement and their uptake distribution in some important cultivars of coriander for nutritional budgeting

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Abstract

The present study was carried out with seven coriander cultivars ie CO-2, GCr-2, RCr-41, RCr-446, ACr-1, Rajendra swati and Hisar sugandh under lower to medium fertile soil of semi-arid region of Rajasthan. Yield of both seed and straw of CO-2 was lowest and RCr-446 gave highest among the seven cultivars. Nitrogen content in seed and straw was highest in ACr-1 and Rajendra swati, respectively and was lowest in Hisar sugandh. Phosphorus content in seed and straw was more in RCr-446 and was least in GCr-2. While potassium content in seed of ACr-1 was more and least in CO-2. Uptake distribution indicates that highest N accumulated in seeds and straw of Rajendra swati and RCr-446, respectively. Highest P and K accumulation took place in both seed and straw of RCr-446. However, total removal of N, P and K by the cultivars was highest in RCr-446, RCr446 and RCr-41, respectively, while least in CO-2, GCr-2 and Rajendra swati, respectively. Nutrient budget sheet indicated that 37-57% N goes to food chain and 43-63% remains as recyclable. However, consumable and recyclable range of P was 28-38% and 62-72%, respectively, while 31-48% of K was as consumable part and 52-60% can be recycled through composting or in-situ management. The uptake in high yielding cultivars at their various stages indicated that 8-10% of total NPK removal by the crops was up to the age of 40 days. Whereas, 34-35% removal was at the age of 40-80 days and 55-56% was at 80-120 days of crops in general.

Keywords: coriander, cultivars, macro-nutrients, nutrient uptake, nutritional budgeting

Introduction

Coriander is an important seed spices gown in India, Morocco, Russia, Bulgaria, Mexico, Argentina, China, Romania, Japan and Italy. In India, the main growing states are Rajasthan, M.P., A.P., T.N. Karnataka, U.P. and Orissa. Rajasthan share is about 50-60% of the total area and production of coriander in the country. Whole or ground seeds are used as condiment to flavour foods and confectionery. Young leaves are also used in preparing chutney, seasoning in curry soups. Current export of coriander is more than 26000 tonnes and valuing more than 110 crores (Spice board, India).

Fertilizer recommendation for a particular crop depends on the varieties chosen for cultivation at a particular location. Flat recommendations of fertilizers given by the extension workers are rarely accepted by the growers until it is not varietal and/or location specific. Agri-world is moving towards the precision farming requires very specific input information for crop production. Therefore, it is essential to work out the varietal specific nutrient requirement of a crop. Even nutrient content and uptake distribution in various plant parts is equally important for actual removal of nutrients from a particular location so as to recycle rest of the nutrients through incorporation of crop residue in soil. Most of the studies carried out on the line are limited with crop response to nutrients. In coriander, response of N was found up to 100 kg, while crop was not responded with P and K application (Rao *et al.*, 1985). Yield increase of 26% was obtained in response to N at. 20 kg, P_2O_5 at 40 kg and K_2O at 20 kg ha^{-1} (Pillai and Boominathan 1975). In the cultivar RC-4 yield rose with increasing N rates up to 60 kg ha^{-1} and then declined (Mathur *et al.*, 1973). Yields were increased by up to 50 kg N ha^{-1} and 35 kg P_2O_5 ha^{-1} and were decreased by 50 kg P_2O_5 ha^{-1} (Tomar *et*

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al., 1971). The agronomic efficiency of N decreased with increasing N rate and seed yield increased with the increased in P_2O_5 rate, from 20 to 40 kg ha^{-1} and reduced thereafter (Channabasvanna, 2002). In Karnataka, 60:40:20 kg NPK ha^{-1} was found optimum for growth and yield of crop (Channabasvanna *et al.,* 2002). N and P application enhanced the yield and nutrient uptake and also P and organic carbon content in soil (Tiwari and Banafar, 1995). The effect of N fertilizer and biofertilizer (*Azotobacter*, *Azospirillum* and *Azotobacter* + *Azospirillum*) on the yield and quality of coriander was positive up to 60 kg N ha^{-1} and biofertilizers (Kumar *et al.,* 2002). Integrated use of fertilizer improved the yield of coriander, cumin, fennel and fenugreek (Sharma, 2010). All the above studies conducted on coriander are crop response to fertilizers, manures and biofertilizers. However, there is no study available on total N, P and K requirement of crop as well as its various stages and nutritional budgeting. Therefore, present investigation was carried out to assess the varietal and location specific nutrient requirement of coriander as well as nutritional budgeting.

Materials and methods

Location and climate

The field experiments were carried out under the Typic Haplustepts during *Rabi* season of 2008 – 2009 and 2009 – 2010 at National Research Centre on Seed Spices, Tabiji, Ajmer, Rajasthan, India. This was laid between 74˚ 35'39" to 74˚ 36' 01"E longitude and 26˚ 22'12" to 26˚ 22' 31" N latitude. Climate of the Ajmer area characterized as semi-arid. The average annual rainfall of the area is 536 mm and most of it (85-90%) received between June to September. July and August are most rainy months contributing 60.0% of the average rainfall. The moisture control section remains dry for more than 90 cumulative days and hence moisture regime classified as Ustic. The mean annual temperature is 24.5 to 25.0˚C. January is the coolest month of the season and temperature remain around 7.0˚C. Currently frost is also occurring in this month with changing in climatic pattern (Singh and Shyampura, 2004).

Treatments and cultural practices

The treatments consisted of seven varieties of coriander viz., CO-2, GCr-2, RCr-41, RCr-446 ACr-1, Rajendra swati and Hissar sugandha were arranged in a Randomized Block Design (RBD) with three replications. Among these varieties, CO-2 and Rajendra swati are early and comparatively lower yielding. However, GCr-2 and Hissar sugandha are the medium yielding and medium maturity varieties, whereas RCr-41, RCr-446 and ACr-1 were the long duration high yielding varieties. Seeds of the crop varieties were sown in the 30cm line to tine apart and distance from plant to plant was maintained at 10 cm. Culture practices were uniformly followed during the growing seasons in both the years. The varieties were harvested as and when matured as these belong to different maturity groups. After harvest, seeds were separated from the straw by beating bundles thereafter winnowing.

Soil analysis

Soil samples were collected before planting of both year crops from the surface (0-15 cm depth). Samples were air dried and powdered with wooden mortar and pestle and passed through a 2 mm stainless steel sieve. Experimental soil was analyzed for texture (international pipette method), EC and pH (Richard, 1954), organic carbon content by rapid chromic titration (Walkley and Black, 1934), available N by alkaline permanganate (Subbiah and Asija 1956), available P by 0.5 M $NaHCO_3$ extractable P (Olsen *et al.,* 1954), available K by 1N NH_4OAc extracts method (Jackson 1973). Initial characteristics of the experimental soil are given in table 1.

Table 1. Soil properties of the experimental field

S.No	Parameters	Values
1	Texture	Sandy loam
2	EC (1:2.5:: Soil: Water Supernatant)	00.34
3	pH (1:2.5:: Soil: Water Suspension)	08.50
4	Soil available nitrogen (kg ha^{-1})	96.90
5	Soil available phosphorus (kg ha^{-1})	08.60
6	Soil available potassium (kg ha^{-1})	280.0
7	Calcium per cent (%)	05.00

Plant analysis

The plant samples were collected after the harvest of crops from all the treatments and their replications. Plant samples were successively washed with tape water, 0.1 M HCl and distilled water and dried at 70 ^{0}C. After proper drying samples were powdered in wily mill and passed through the 20 mesh steal sieve. Nitrogen was estimated by Kjeldahl method (Piper, 1966). The samples were digested in nitric and perchloric acid (10:4) for the estimation of P by Venado-molybdo yellow colour method (Chapman and Pratt 1962) and K by flame photometer.

Statistical Analysis

The data of both the years were analyzed by ANOVA and treatment differences were expressed for Least Significant differences (LSD) at 5% probability to determine the significance among the treatment means (Gomez and Gomez, 1984).

Results and discussion

Yield and nutrient content

Yield of both seed and straw of CO-2 was lowest and RCr-446 gave highest among the seven cultivars (Fig. 1). Nitrogen content in seed was highest in ACr-1 and was lowest in Hisar sugandh (Fig. 2). This may be due to this variety (ACr-1) also have more K content which helps in activation of enzyme responsible for the protein synthesis. However, in straw N content was more in Rajendra swati and lowest in Hisar sugandh. In case of P content in seed and straw was more in RCr-41 and was least in GCr-2 (Fig. 3). Cultivar RCr-41 has longest root system (root length about 3.0 m long) among the seven cultivars resultant higher root surface area leads to higher absorption and accumulation of phosphorus. The K content in seed of ACr-1 was more and least in CO-2 (Figure 4). The variety ACr-1 developed where the soil and

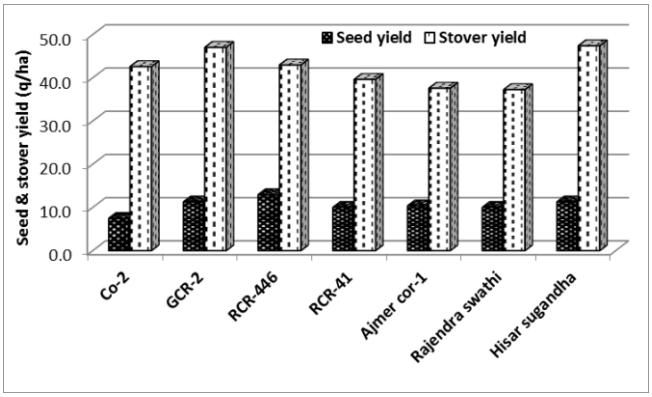

Fig 1. Seed and stover yield (q ha^{-1}) of coriander cultivars

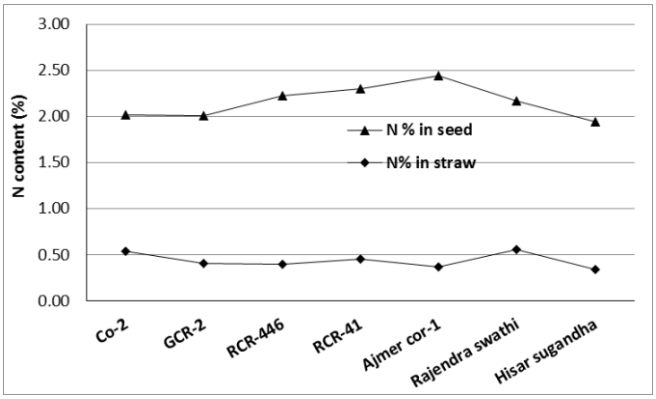

Fig 2. Nitrogen content per cent in coriander cultivars.

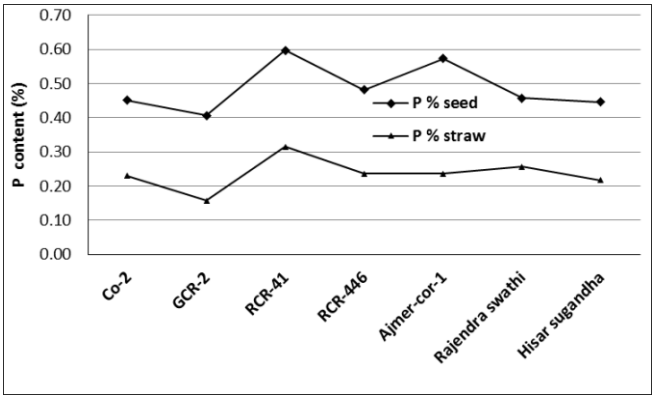

Fig 3. Phosphorus content per cent in coriander cultivars.

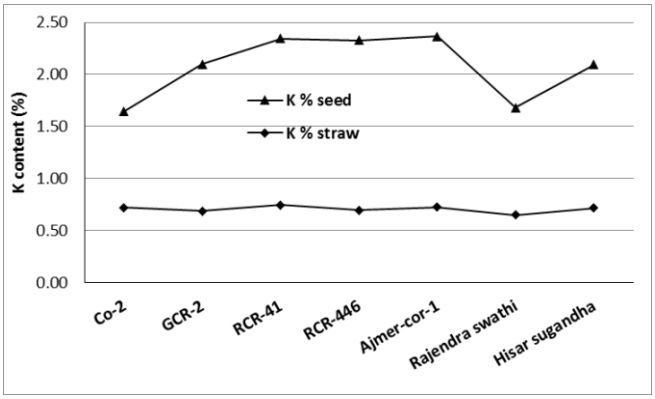

Fig 4. Potassium content per cent in coriander cultivars.

underground water is saline and slightly alkaline in nature. Therefore this variety has evolved the mechanism to accumulate more K for osmoregulation. Whereas, CO-2 variety developed in south India, where K moves out form the soil column by eluviations process and the variety has made the genetic sat up to survive with low potassium and ultimately low requirement of the crop. Plant accumulates more of cations can have salt includer type salinity tolerance as reported by Aishwath and Pal (2004).

Nutrient uptake pattern

Uptake distribution of nitrogen indicates that N uptake through coriander straw was highest in cultivar RCr-446 and was least in cultivars CO-2, which was approximately double (Fig. 5). This may be because of higher biomass accumulation and higher seed yield of RCr-446 than the CO-2. However, rest of the cultivar showed medium level of N uptake through straw. In case of N uptake through coriander seed, it was maximum in Rajendra swati and CO-2 followed by GCr-2 and was least in Hisar sugandh. Phosphorus accumulation was maximum in seeds of ACr-1 and was least in CO-2 accounting half of RCr-41 (Fig. 6). However, P accumulation in straw was highest in RCr-446 and was least GCr-2. This might be due the fact that these cultivars have more P content in seed and stover with higher plant biomass. Potassium accumulation in seeds of coriander cultivars RCr-41 showed maximum and was least in CO-2 which was approximately 2.5 times more than the lowest one (Fig. 7). However, potassium accumulation in straw was also more in RCr-446 and was least in Rajendra swati as these varieties having higher and lower content of potassium and biomass, respectively resulted in vide variation in K accumulation observed.

Total nutrient removal and budget

The total N removal was highest in RCr-446 followed by Rajendra swati and was least in CO-2 (Fig. 8). This might be due to higher biomass accumulation in RCr-446 and lowest in CO-2. The total P removal was also highest in RCr-446 followed by RCr-41, whereas least in GCr-2, this account approximate 1.5 times more than the GCr-2. This is because of cultivars-RCr-446 have more root and shoot biomass as well as more P content in seed and stover leads to higher accumulation of phosphorus. The total removal of K was the highest in RCr-41 followed by Hisar sugandha and was least in Rajendra swati, obviously these cultivars have more K content and biomass leads higher accumulation of potassium. It indicates that highest N and P required by RCr-446 and least N and P by CO-2 and GCr-2, respectively. Potassium requirement is more of RCr-41 and least of Rajendra swati. The difference among least and the highest removal of K was 1.5 times.

The uptake of N, P and K at various stages of high yielding cultivars (ACr-1, RCr-41 and RCr-446) indicated 8-10% of total N, P and K removal by the crops was up to the age of 40 days (Fig. 9). Whereas, 34-35% removal was at the age of 40-80 days and 55-56% was at 80-120 days of crops. These findings reflect that the highest N, P and K

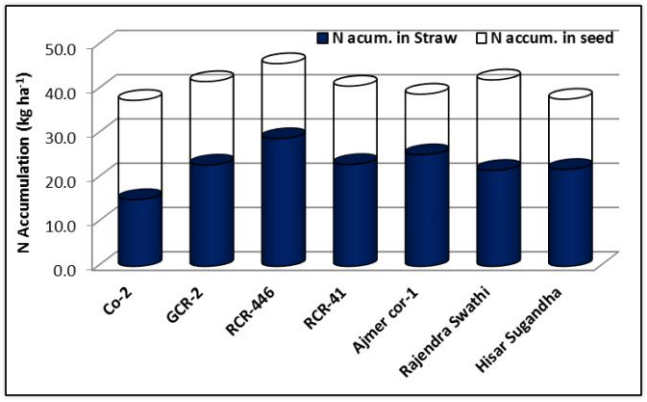

Fig 5. N accumulation in seed and straw (kg ha^{-1}) cultivars.

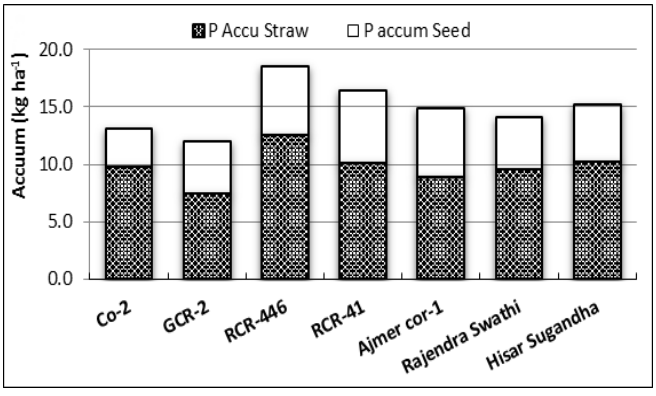

Fig 6. P accumulation in seed and straw (kg ha^{-1}) cultivars.

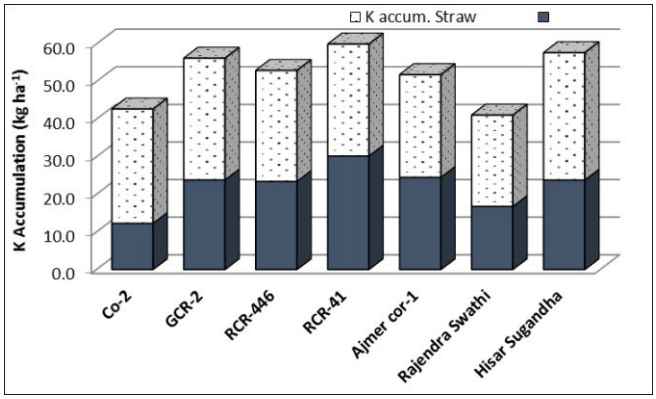

Fig 7. K accumulation in seed and straw (kg ha^{-1}) of coriander cultivars.

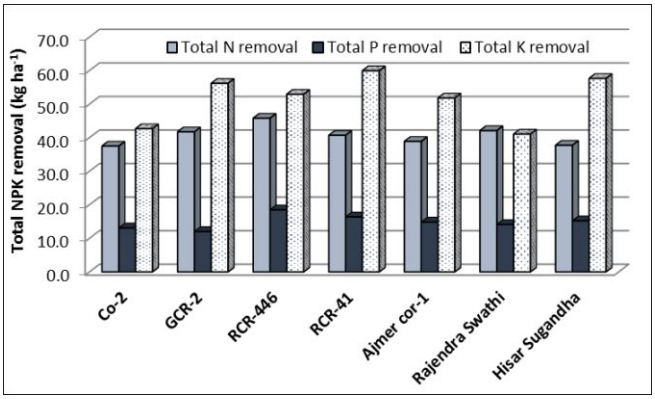

Fig 8. Total NPK Removal (kg ha^{-1}) by coriander cultivars.

requirement of high yielding and long duration coriander cultivars was at the age of 80-120 days, whereas CO-2 and Rajendra swathi require maximum NPK up to the age of 60 days.

More than half of the nitrogen goes to the food chain out of the total removed by cultivar CO-2 and 42.6% can be recycled for the preparation of composting or direct incorporation in soil (Table 2). However, more than half of the N can be recycled as it remains in the non consumable parts (stover) in rest of the cultivars. Likewise, 62-72% P remained in the non-consumable parts and rest of the portion goes to the consumable parts of coriander cultivars. However, RCr-446 has least K in recyclable part than the other cultivars and the highest in CO-2 which accounts about 70%.

Therefore, quantity of fertilizers should be applied as per the nutrient requirement of crop cultivars and time of application on the basis of crop duration for maximum nutrient use efficiency and higher yield.

The precise nutrient management not only reduces the cost of cultivation but also complements in reduction of water pollution as nitrate contamination of underground water and also algal bloom and Eutrofication in open water bodies.

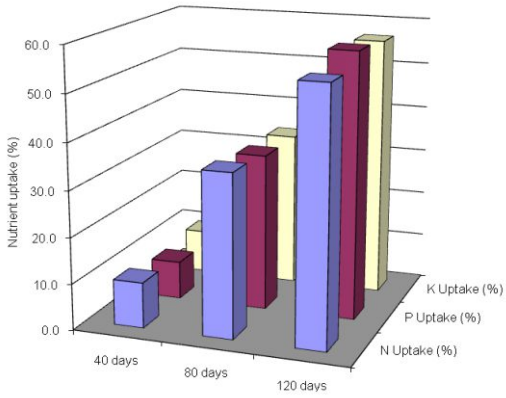

Fig 9. Uptake (% of total) of N, P & K by ACr-1, RCr-41 and RCR-446 at various stages.

Table 2. Nutritional budgeting for per cent nutrients consumed through food and per cent nutrient can be recycled through crop residue recycling.

Coriander	% N consum.	% N Recycl.	% P consum.	% P Recycl.	% K consum.	% K Recycl.
CO-2	57.4	42.6	27.6	72.4	31.0	69.0
GCr-2	46.3	53.7	37.2	62.8	41.3	58.7
RCr-446	37.6	62.4	35.6	64.4	47.9	52.1
RCr-41	43.5	56.5	33.9	66.1	45.8	54.2
ACr -1	36.9	63.1	38.3	61.7	45.5	54.5
Rajendra Swati	48.6	51.4	32.3	67.7	40.8	59.2
Hisar Sugandha	41.4	58.6	33.3	66.7	42.0	58.0
Mean	44.5	55.5	34.0	66.0	42.0	58.0

Consum. = Consumable, Recycl. = Recyclable

Conclusion

The Highest N and P required by RCr-446 and least N and P by CO-2 and GCr-2, respectively. However, K requirement was the highest in RCr-41 followed by Hisar sugandha and was least in Rajendra swati. High yielding coriander cultivars like ACr-1, RCr-41 and RCr-446 require maximum N, P and K at the age of 80-120 days, whereas CO-2 and Rajendra swati require maximum N, P, K up to the age of 40-60 days and should be applied accordingly. In general, uptake of NPK was always higher in straw than the seed and that can be utilized for recycling of nutrients.

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