

A Review on the Effect of Integrated Nutrient Management on Yield and Quality of Major Seed Spice Crops in India

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Research indicates that a combined application of 50 to 75% of the recommended dose of fertilizers and 25 to 50% of organics leads to higher yield and better quality of seed spices as opposed to the application of organics alone.

Seed spices include a group of annuals whose dried fruit or seeds are used as spices. These are characterised by pungency, strong odour and sweet or bitter taste. Coriander, cumin, fennel, and fenugreek occupy the largest area among the seed spices grown in India, while ajowan, dil, celery, anise, nigella, and caraway are the other important seed spices. A majority of seed spices are grown in India in the states of Rajasthan and Gujarat, although Chattisgarh, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, and Uttar Pradesh also have some area under them. In 2008-09, the export of seed spices from India was 471,000 t. This helped earn INR 54,915 billion worth of foreign exchange.

Integrated nutrient management (INM) includes the combined use of organics (i.e. manures, composts, biofertilizers, green manures, crop residues, etc.) and inorganic fertilisers to increase crop yields and farmer profits, improve crop quality and minimise nutrient losses to the environment. This article reviews studies that evaluate the effect of INM on yield and quality of the major seed spice crops of India.

Coriander (*Coriandrum sativum*)

Kumar et al. (2002) studied the effect of N fertilizer (0, 30, 60, or 90 kg/ha) and biofertilizer (i.e. *Azotobacter*, *Azospirillum*, and *Azotobacter + Azospirillum*) on the yield and quality of coriander (cv. RCr-435). They found a positive response up to 60 kg N/ha and with the use of biofertilizers. Inoculation with *A. chroococcum* or *A. brasilense*, combined with *G. mossese* (VAM), gave significant increases in vegetative growth, total carbohydrates, photosynthetic characteristics, essential oils, seed parameters, N, P and K content, and linalool (Abou and Gomaa, 2002). In red, sandy loam soils, Manure et al. (2000) reported that yield attributes, seed and oil yield, and oil content were all enhanced by the application of N, S, and Zn fertilisers. Sharma et al. (1996) recommended the application of 10 to 20 t/ha of well-decomposed FYM or compost at the time of field preparation along with 20 kg N, 30 kg P₂O₅, and 20 kg K₂O/ha from inorganic fertilizers. Prabu et al. (2000) reported that seed yield of coriander was significantly higher with 25% recommended dose of fertiliser + FYM applied at 10 t/ha + *Azospirillum* + VAM over other combinations of nutrient sources and individual sources of nutrients at their recommended doses. However, Choudhary and Jat (2004) reported higher yield and net return at 100% inorganic N + *Azospirillum* + 5 t FYM (Figure 1).

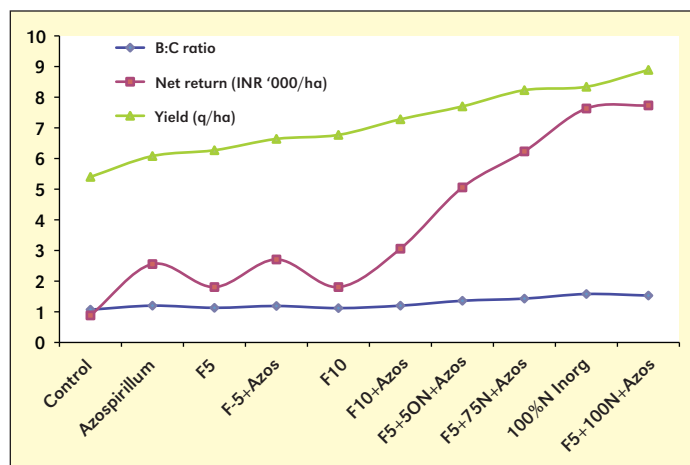


Figure 1. Yield, net return, and benefit-to-cost (B:C) ratio in coriander with different INM treatments. (F5 and F10 indicate FYM added at 5 t and 10 t/ha respectively, Azos refers to azospirillum, and Inorg refers to inorganic)

Cumin (*Cuminum Cyminum*)

Application of 15 to 20 t of FYM is sufficient for the nutrition of rain-fed cumin, but an additional 30 kg of N fertiliser/ha is recommended for irrigated conditions (Peter et al., 2000). Patel et al. (2004) reported that application of the recommended dose of N through mustard-cake and fertiliser in 1:1 ratio recorded the maximum seed yield (869 kg/ha), net return (INR 70,765/ha), and benefit-to-cost ratio (4.4:1) (Table 1). Additionally, cumin grown on loamy sand soils with 30 kg N, 20 kg P₂O₅, and 30 kg K₂O/ha reduced wilt incidence (Champawat and Pathak, 1988). Cumin grown in sequence with pearl-millet responded significantly to the recommended dose of 30 kg N and 15 kg P₂O₅/ha in loamy sand soils of Jodhpur, Rajasthan (Yadav and Poonia, 1996), while an application of 20 kg/ha of ZnSO₄ along with 30 kg N/ha significantly increased the seed yield in loamy sand soils of Jobner, Rajasthan (Meena and Chaudhary, 1998).



Cumin Crop

Common abbreviations and notes: AS = ammonium sulphate; Cu = copper; DAS = days after sowing; Fe = iron; FYM = farm yard manure; N = nitrogen; P = phosphorus; K = potassium; PSB = phosphorus solubilising bacteria; SSP = single superphosphate; VAM = vesicular arbuscular mycorrhizas; ZnSO₄ = zinc sulphate



Figure 2. Examples of coriander (left) and fennel (right) plants in unfertilised (top) and fertilised (bottom) plots. Dr. Aishwath (first author) and Dr. Anwer (third author) are pictured on the left and right, respectively.

Fennel (*Foeniculum vulgare*)

Application of 10 to 15 t/ha of well-decomposed FYM or compost at the time of field preparation, 90 kg N/ha in three equal splits (0, 30, and 60 DAS), and 40 kg P_2O_5 /ha at the time of sowing produced significantly higher fennel seed yield than obtained with no N application (Sharma et al., 1996). A combined application of 50% inorganic N (90 kg/ha) + *Azospirillum* + 5 t FYM/ha produced yields on par with 75 and 100% N through inorganic source + *Azospirillum* + 5 t FYM/ha as well as with 100% inorganic N alone, but proved superior to applied 5 t FYM+ *Azospirillum*, 5 and 10 t FYM alone, *Azospirillum* alone and control (Chaudhary, 2004). This indicated that we can substitute some of the inorganic fertiliser application with organics, but not all. On loamy sand soils of Jobner, Rajasthan, soil application of 20 kg $ZnSO_4$ /ha along with recommended doses of N, P, and K increased the fennel seed yield by 8% over the control (Sharma, 1998). Multi-nutrient deficiency symptoms in coriander and fennel are clearly visible (**Figure 2**).

Fenugreek (*Trigonella foenumgraecum*)

Growth and seed yield of fenugreek increased with the applications of 15 t/ha of FYM and 40 kg P_2O_5 /ha (Khiriya, et al., 2001). Similarly, combined inoculation of rhizobium and PSB resulted in significantly higher number of nodules per plant, plant height, and dry matter accumulation over individual inoculation and control treatments (Purbey and Sen, 2004). Highest fenugreek seed yield (1.26 t/ha), net returns (INR 9,761/ha) and B:C ratio (6:1) were recorded with 100% inorganic N alone closely followed by 100% inorganic N + Rhizobium applied at 1.5 kg/ha + 5 t FYM/ha (Jat and Chaudhary, 2004). For achieving optimum yield of fenugreek,



Fenugreek Crop

it was recommended to apply 15 t of FYM/ha and 25 kg N, 25 kg P_2O_5 , and 50 kg K_2O /ha (Rethinum and Sadanandan, 1994).

Nutrient interactions

Synergistic effects between N and P and N and S were observed for seed and essential oil yield in coriander (Sivakumar et al., 1996). Again, application of 250 kg AS and 120 kg SSP was found to be most suitable for maximum yield and improved quality of cumin (Chandola et al., 1970). Positive interaction among P, S, and growth regulators was found in fenugreek (Rethinum and Sadanandan, 1994).

Micronutrients play an important role in sustaining higher crop yields and improved crop quality. However, carbonates or sodium bicarbonate, either present in soil or in irrigation water, negatively trigger absorption of Cu, Fe, and Zn in coriander, while adversely affecting the translocation of Fe and cases of induced chlorosis have been observed in the calcareous soils of Rajasthan (Aishwath and Anwer, 2010).

Conclusions

An application of 50 to 75% of the recommended dose of inorganic fertilisers and the remaining 25 to 50% through organics gave higher yield and good quality seed spice crops when compared with the application of 100% recommended dose of inorganic fertilisers or organics alone. Micronutrients play a significant role towards improving growth, yield, and quality of seed spices. **ICASA**

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Table 1. Yield and economics of cumin with different INM treatments.

Treatment	Seed yield, q/ha	Net return**, INR/ha	Benefit-to-Cost ratio
RD-N* as caster-cake	6.53	49,070	3.02
RD-N as FYM	6.70	50,890	3.16
RD-N as caster-cake + fertiliser (1:1)	7.23	56,585	3.60
RD as fertiliser (NP)	7.59	60,383	3.89
RD-N as FYM + fertiliser (1:1)	7.69	61,245	3.19
RD-N as fertiliser (N)	7.46	59,372	3.90
RD-N as mustard-cake	7.74	60,330	3.53
RD-N as mustard-cake + fertiliser (1:1)	8.69	70,765	4.39
CD (p = 0.05)	0.78		

*RD-N refers to recommended dose of N.
 **Approximate costs (including application) (INR/q): Castor cake = 3,720; FYM = 3,516; Fertiliser (NP) = 2,753; Fertiliser (N) = 2,744; and Mustard cake = 3,081.

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