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Performance of Coriander (*Coriandrum sativum* L.) to Different Sources of Organic Phosphorus and PSB on Growth and Seed Yield

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A B S T R A C T

Field experiment was conducted during rabi-2018 at Research Institute of Organic Farming field unit, UAS, GKVK, Bengaluru to study the different sources of organic phosphorus and PSB on growth, seed yield and essential oil content in coriander laid out in Randomized Complete Block Design with 10 treatments replicated thrice and the variety used was Co Cr-4. Results of the experiment revealed that phosphorus at 40 kg ha^{-1} applied through neem cake + PSB at 2 kg ha^{-1} recorded significantly higher seed yield (665 kg ha^{-1}) and essential oil yield (4.72 kg ha^{-1}). These results are attributed to enhanced growth parameters like plant height (81.6 cm), primary branches per plant (5.40), leaf area (287.33 cm^2 plant^{-1}), dry matter production per plant (7.07 g) and yield attributes like number of umbels per plant (19.20), number of umbellets per umbel (6.28) and number of seeds per umbel (28.97). Whereas, phosphorus at 40 kg ha^{-1} applied through rock phosphate results in lower seed and essential oil yield (511 and 3.47 kg ha^{-1}, respectively).

Introduction

World population is increasing day by day. Hence, it is necessary to stabilize agricultural production and increase it further in a sustainable manner. Thus, there is need to maintain a natural balance at all cost for existence of natural life and property. Organic agriculture system as sustainable production management system that provides long term benefits to people and the environment. Seed spice are annual herbs, whose dried seeds or fruits are used as spices. They are natures gift to human kind as they add flavour to our food. In addition, they also have preservative and medicinal values (*Annon*, 2015). Coriander (*Coriandrum sativum* L.) is one of the important vegetables, spice and aromatic annual herb with small seeds belonging to the family Apiaceae. Coriander gives two primary products viz., fresh green herb and seed spice that are used for flavouring purposes.

Coriander fresh leaves are being used in cooking, flavouring etc., and seeds are being used for preparing value added products such as coriander powder, condiment, oleoresin, essential oil, medicine and cosmetic industries. India is the largest produces, consumer and exporter of coriander in the world. In India, the major coriander growing states are Rajasthan, Gujarat, Madhya Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh and Uttar Pradesh (Kader *et al.*, 1985). The area under coriander cultivation in India is 5.8 lakh hectares and production of 584.98 thousand metric tonnes and productivity of 908 kg ha^{-1}. Phosphorus has played a significant role in photosynthesis, respiration, energy storage, cell division and several other processes like seed formation, hastening maturity and also contributes to disease resistance in coriander (Pareek and Sethi, 1985). Added phosphorus undergo fixation due to complex exchanges within the soil (Altomare *et al.*, 1999). Several P-solubilizing microorganisms have the ability to convert insoluble phosphorus into soluble forms. PSBs solubilize insoluble form of phosphate by acidification, chelation and also by organic acid production (Chung *et al.*, 2005). In the recent days, more emphasis has been given on the possibility of utilizing indigenously available FYM, neem cake, poultry manure, rock phosphate and biogas slurry to meet out the phosphorus requirement crops with addition of PSB.

Materials and Methods

A field experiment was conducted at research and demonstration block of Research Institute on Organic Farming, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru which is situated in Eastern dry zone of Karnataka. The experiment was conducted to study different organic phosphorus sources viz., FYM, rock phosphate, poultry manure, neem cake and biogas slurry along with PSB on growth seed yield of coriander during *rabi*- 2018. The experiment was laid out in Randomized Completely Block Design and treatments were replicated thrice. The net plot size was 3.3 m × 3.1 m (10.23 m^2) with spacing of 30 × 10 cm. Recommended dose of nutrients for coriander is 60:40:20 $N:P_2O_5:K_2O$ kg ha^{-1} and nutrients were supplies through organic manures on the basis of phosphorus equivalent. There were 10 treatments with different organic phosphorus sources and PSB viz., T_1 - Phosphorus at 40 kg ha^{-1} applied through FYM, T_2 - Phosphorus at 40 kg ha^{-1} applied through FYM + PSB at 2 kg ha^{-1}. T_3 - Phosphorus at 40 kg ha^{-1} applied through Rock phosphate, T_4 - Phosphorus at 40 kg ha^{-1} applied through Rock phosphate + PSB at 2 kg ha^{-1}, T_5 - Phosphorus at 40 kg ha^{-1} applied through poultry manure, T_6 - Phosphorus at 40 kg ha^{-1} applied through poultry manure + PSB at 2 kg ha^{-1}, T_7 - Phosphorus at 40 kg ha^{-1} applied through Neem cake, T_8 - Phosphorus at 40 kg ha^{-1} applied through Neem cake +PSB at 2 kg $ha^{-1,}$ T_9 - Phosphorus at 40 kg ha^{-1} applied through biogas slurry, T_{10} - Phosphorus at 40 kg ha^{-1} applied through biogas slurry + PSB at 2 kg ha^{-1}. Organic manures were incorporated into the soil, three weeks prior to sowing. Soil of the experimental site was red sandy loam with a pH of 6.73, EC 0.22 ds m^{-1}, low in organic carbon (0.41%) and medium in available nitrogen (290 kg ha^{-1}), phosphorus (29.50 kg $ha^{-1)}$ and potassium (224 kg ha^{-1}).

Results and Discussion

Effect of different organic phosphorus and PSB on growth and seed yield of coriander

The data presented in the (Table 1) revealed that significantly higher growth parameters of the coriander recorded with T_8 (Phosphorus at 40 kg ha^{-1} applied through neem cake + PSB at 2 kg ha^{-1}) i.e., plant height (81.64 cm), number of primary branches (5.40), leaf area

(287.33 cm^2) and dry matter production (7.07 g $plant^{-1}$). This was followed by T_{10} (phosphorus at 40 kg ha^{-1} applied through biogas slurry + PSB at 2 kg ha^{-1}), T_6 (phosphorus at 40 kg ha^{-1} applied through biogas slurry + PSB at 2 kg ha^{-1}) and T_2 (phosphorus at 40 kg ha^{-1} applied through biogas slurry + PSB at 2 kg ha^{-1}. Application of phosphorus to coriander significantly improves the growth parameters of the crop like plant height, number of primary branches, total leaf area as well as total dry matter production. An adequate supply of phosphorus during early life cycle of plant is important in laying down its reproductive parts. It was associate with stimulated root development, increased stalk and stem strength. The extensive root system of the coriander crop helps in exploiting the more amount of nutrients as well as water from the soil (Javiya *et al.,* 2017). These outcomes were in conformity with Naghera *et al.,* 1997 and Nandal *et al.,* 2010. Application of phosphorus along with PSB helps in sufficient supply of macro and micro nutrients through neem cake (Shivakumar *et al.,* 2011). Application of organic manures influenced the physiological processes, facilitated early leaf initiation and resulted in a net increase in leaf area. The increased leaf area may have facilitated the capture of more solar energy for metabolic use, more CO_2 fixation and produced greater photosynthates. It has a positive effect on biomass production and subsequently improved plant height and primary branches (Singh *et al.,* 2009).

Results obtained in the present field experimental trial showed that significantly higher seed yield (665 kg ha^{-1}) was produced in T_8 (phosphorus at 40 kg ha^{-1} applied through neem cake + PSB at 2 kg ha^{-1}) as compared to the other treatments. This was followed by T_{10} (phosphorus at 40 kg ha^{-1} applied through biogas slurry + PSB at 2 kg ha^{-1}), T_6 (phosphorus at 40 kg ha^{-1} applied through biogas slurry + PSB at 2 kg ha^{-1}) and T_2 (phosphorus at 40 kg ha^{-1} applied through biogas slurry + PSB at 2 kg ha^{-1}) (630, 626 and 624 kg ha^{-1}, respectively). Whereas, lower seed yield (511 kg ha^{-1}) was recorded with phosphorus at 40 kg ha^{-1} applied through rock phosphate (Table 2). The higher yield is due to the higher yield parameters of the coriander *i.e.,* number of umbels per plant (19.20), number of umbellets per umbel (6.28) and number of seeds per umbel (28.97). Lower yield parameters of the coriander were recorded with phosphorus at 40 kg ha-1 applied through rock phosphate alone.

Table.1 Effect of different organic phosphorus sources and PSB on growth parameters of coriander

Treatment no.	Plant height (cm)	No. of primary branches	Total leaf area (cm^2 $plant^{-1}$)	Total dry matter production (g $plant^{-1}$)
T_1	64.16	4.10	244.58	5.02
T_2	74.31	4.60	257.33	6.28
T_3	61.19	3.90	223.67	4.35
T_4	63.28	4.00	232.67	4.80
T_5	67.45	4.15	242.67	5.11
T_6	76.04	4.85	274.00	6.38
T_7	71.40	4.40	250.50	5.42
T_8	81.64	5.40	287.33	7.07
T_9	68.67	4.28	258.67	5.24
T_{10}	78.99	5.10	278.67	6.52
SE.m±	3.37	0.21	12.24	0.27
CD at 5%	10.02	0.64	36.65	0.80

Table.2 Effect of different organic phosphorus sources and PSB on yield parameters of coriander

Treatment no.	No. of umbels per plant	No. of umbellets per umbel	No. of seeds per umbel	1000 seed test weight (g)	Seed yield (kg ha^{-1})
T_1	15.09	5.15	23.00	9.45	547
T_2	17.48	5.56	25.60	9.92	624
T_3	14.39	4.80	22.33	9.02	511
T_4	14.88	5.10	24.20	9.17	542
T_5	15.86	5.43	23.73	9.20	565
T_6	17.88	5.60	26.57	10.20	626
T_7	16.79	5.27	24.90	9.32	576
T_8	19.20	6.28	28.97	10.90	665
T_9	16.15	5.33	23.50	9.07	571
T_{10}	18.58	5.80	27.67	10.60	630
SE.m±	0.79	0.26	1.19	0.46	27.76
CD at 5%	2.36	0.77	3.53	NS	84.47

In the present investigation, the differences in the various yield components which lead to significant yield differences might be traced back to significant variation in production of dry matter and its accumulation in plant. Application of neem cake along with PSB enhances the yield parameters of coriander. The higher assimilates accumulation in these treatments reflected in higher number of umbels per plant, number of umbellets per plant and number of seeds per umbel, this indicating their yield superiority. These results were in conformity with those of Thomas Abraham and Lal (2003). The increase in yield parameters through organic nutrient management might be due to enhanced uptake of N, P and K, which results in better vegetative growth, while phosphorus improves the root growth and productive ability of the coriander. Neem cake has ability to improves the soil structure and biological activity of soil. Further, by improving the structure of the soil by more aggregation, water holding capacity and air permeability are increased by neem cake application along with PSB. This comprehensive change in soil might have improved the vegetative growth and yield parameters. Similar results were obtained in coriander (Sahu *et al.*, 2014, Vasmate *et al.,* 2008), fennel (Abbou *et al.,* 2004) and fenugreek (Singh, 2013). Integration of organics and biofertilizers might have increased yield contributing attributes. Similar results of improvement in growth and yield parameters were also observed by Patil *et al.*, (2012a) in chickpea and Sharada (2013) in green gram- *Rabi* sorghum cropping system.

From the present study, it can be concluded that application of organic phosphorus sources and along with PSB helps higher growth and yield of coriander. Among the different sources used in the experiment, phosphorus at 40 kg ha^{-1} applied through neem cake + PSB at 2 kg ha^{-1} are beneficial in improving growth and yield of coriander crop.

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