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Effects of Organic and Inorganic Fertilizers on the Growth, Yield and Nutrient Status of Coriander (Coriandrum sativum)

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Abstract: *Fertilizers increase crop yield and replace the nutrients that crops intake from the soil. Throughout the years, farmers have been using chemical fertilizers to increase the production of crops to meet the increasing demand. The high dependence on chemical fertilizers has virtually affected all forms of life by causing pollution of air and water, soil ecosystem by depletion of minerals, and the cost of crop production around the world (Elnasikhet al., 2017). Whereas, organic manures play an important role in enhancing soil fertility and productivity ensuring less environmental pollution than chemical fertilizers. Considering these facts, to examine the effects of various organic manures and chemical fertilizers on the growth performance and yield of coriander (Coriandrum sativum), a pot experiment was carried out in the net house of the Department of Soil, Water and Environment, University of Dhaka. Eight different organic manures viz. Bone Meal, Mustard Cake Crushed, Neem Cake Powder, Organic Compost, Trichocompost, Vermicompost, Coco Coir (moist), and Horn Meal were used as treatments for the comparison along with control and inorganic fertilizers. Significant variation in growth and yield contributing characteristics viz. plant height, leaf number, leaf area, and fresh and dry weights of plants were observed and recorded at 5 days intervals from the 15th day of seedlings up to harvest. After 40 days the plants were harvested. Horn meal showed the maximum single leaf area (26.72 cm2/plant), plant height(23.45 cm), leaf number (5.50/plant), branch number(5.50/plant), total fresh weight (1.87 gm/plant), and dry weight(0.21g/plant) of the whole plant at harvest. The concentrations of N, P, K, and S also varied significantly and the nutrient content recorded in Bone Meal was also very good. The overall results from the experiment showed that the organic manure Horn Meal showed the best growth performance and it might be better for healthy seedlings of coriander (Coriander sativum).*

Keywords: Chemical Fertilizers, Coriander Sativum, Harvesting, Organic Manure, Pot Experiment

Introduction

Coriander (*Coriandrum sativum*), commonly known as Dhonia in Bengali, is an annual plant that belongs to the family Apiaceae (Majeed *et* al.,2011*)*.It is also called cilantro or Chinese parsley, parts of which are used as spice and medicine. It is native to Southern Europe and Northern Africa to Southwestern Asia (Samuelsson, 2003). It has been used as a flavoring agent in food products, perfumes, and cosmetics. It is used for various purposes such as flavoring sweets, beverages, tobacco products, baked goods, and as a basic ingredient for curry powder (Mahendra *et al*.2011).

Coriander has its origin in the Near East. It is now naturalized in many tropical and subtropical regions of the world. In all South-East Asian countries, coriander is grown as a culinary herb and vegetable(Anwar *et al*.,2012). Coriander has numerous medicinal benefits as vitamins, minerals, and antioxidants in coriander provide significant health benefits. Coriander essential oil is a stimulant of gastric secretion. It has benefits as a carminative, eupeptic, estrogen, and spasmolytic. It also has antibacterial and antifungal effects (Laribi *et al*., 2015*)*. The C. sativum essential oil and extracts possess promising antibacterial, antifungal and anti-oxidative activities as various chemical components in different parts of the plant. The active ingredients of coriander are volatile oil (0.2%–1.5%) and linalool (58.0–80.3%). Also includes borneol, p-cymene, alpha-pinene, camphor, geraniol, and limonene. Fatty oil (13%–20%): acid, oleic, and linoleic (Mandal *et al*., 2015).

Coriander was used in time-honored Greek medicines by Hippocrates (460-377 BC).The Egyptians called this herb a “spice of happiness”, perhaps for the reason that it was well thought out to be an aphrodisiac. It was used for cooking and for children’s digestive sadden and diarrhea. The Romans and Greeks also used

coriander to flavor wine and also as a medication. Afterward, it was introduced into Great Britain by the Romans (Livarda *et al*., 2008).

In the development and implementation of sustainable agricultural techniques, bio-fertilization is of great importance in order to alleviate the deterioration of natural and environmental pollution. Vermicompost is stable granular organic matter, when added to clay soils loosen the soil, and provides the passage for the fast entry of air and water. The mucus, associated with earthworm cast being hygroscopic in nature absorbs water, prevents water logging, and improves water-holding capacity (Solanki *et al*., 2017). The global market for organic produce has surpassed 100 billion USD in 2018. However, the organic food supply lags behind the demand. Organic vegetable production was 1.1 % of the total vegetable production in 2017 (Willer*et al*., 2019). Sustainable practices providing organic amendments could be a useful tool to maintain or increase organic matter content in cultivated soils. These preserve and improve soil fertility and properties, and boost crop performance through the enhancement of root growth and nutrient uptake (Chuan, 1994). Consequently, there has been a growing interest in the use of organic manures. Manures are derived from animal and plant wastes or byproducts, and they contain plant nutrients in complex organic form (Reddy, 1999). Their addition to agricultural soil increases the organic matter content, the population of soil organisms, especially some bacteria, the activities of some soil enzymes such as urease, and the capacity of the soil to bind moisture and deter insects and weeds (Sneh*et al*., 2005). Vaughan and Ord (1985) reported that organic manures act as a reservoir of plant nutrients and prevent nutrient leaching by maintaining a high cation exchange capacity, as well as buffering growing plants against sudden changes in their chemical environment. Organic manures contain slow-release nutrients, which benefit both the present and the following crop (Verma, 2008). For that reason, besides their inherent low nutrient contents, organic manures must be applied in a large enough quantity of many tons ha^{-1} to the crop in order to sustainably maintain the soil at an optimum level of fertility and productivity. Therefore, this study was conducted to determine the influence of different organic manures on growth, biomass production, and nutrient content compared to the inorganic fertilizers and control.

Materials and methods

Soil Sample Collection

Soil samples (0-15 cm depth) were collected from Keraniganj, Dhaka. The sample was air-dried, ground, and sieved through a 2 mm sieve. Then a small amount of soil was preserved in plastic bottles and labeled properly. These were used for physio-chemical analysis by the following method. Soil moisture content was 20.27% (Miller and Donahue),sand 37.5%, silt 42.12%, clay 20.38%, and the textural class- loam (Bouyoucos 1965).The soil had a pH of 7.15 (1:2.5 w/v H2O), EC 445 µS/cm, available nitrogen 92 mg/kg (Kjeldahl extraction, Marr and Cresser 1983), available phosphorus 36 mg/kg (Murphy and Riley 1962), available potassium 24mg/kg and available sulfur 91 mg/kg.

Collection of Organic Manures

Eight different types of organic manures were collected from the local market of Siddikbazar, Dhaka. The names of these organic manures are as follows: Bone meal, Mustard Cake Crushed, Neem Cake Powder, Organic Compost, Trichocompost, Vermicompost, Coco Coir, and Horn meal.

Pot Experiment

A pot experiment (Fig. 1) was carried out in the net house of the Department of Soil, Water and Environment, University of Dhaka. 3.5 kilograms of soil were taken per pot (height 22cm and diameter 26cm). Among ten treatments, eight consisted of organic manures, one consisted of inorganic fertilizer (Urea, TSP, and Murate of potash), and the last one was control. All these were properly mixed separately at the rate of 5 ton/ha with soil. Three replications of each treatment were taken which consisted of thirty pots. Pots were arranged in a completely randomized design (CRD). Seeds of *C. sativum* were collected from the seed market of Siddikbazar, Dhaka. Ten seeds were sowed per pot for germination after three weeks seedlings were transported to compost mixed soils. The pots were watered every day in the morning. The number of leaves, branches, plant height, and length of leaves was measured at 5 days intervals.

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a. general view of the pot experiment | b. *Coriandrum sativum* plant grown in trichocompost compared to control.

Figure 1

Harvesting

The plants were harvested, washed with tap water, and finally with distilled water, and wrapped with tissue paper. Immediately after the harvest, the fresh weights of plants were taken and then air-dried at room temperature and finally oven-dried at 65°C in the laboratory for 48 hours. The dry weight of the samples was recorded and the samples were ground with a mechanical grinder and stored in the polythene bags for further chemical analysis.

Results and Discussions

The plant development from a single cell to a mature plant consists of pattern formation, morphogenesis, growth, and differentiation. The capacity for growth and development originates from the embryonic tissue regions concerned with the formation of new cells. Thus, plant growth was assessed in terms of morphological characteristics viz. plant heights (table.1), number of leaves (table.2), number of branches (table.3), leaf area (table.4), leaf length (table.5), etc. Various parameters of treatments with the addition of organic manures, inorganic fertilizers, and without the addition of any fertilizer known as control treatment were compared respectively.

The overall plant height of coriander plants in all treatments increased with time. The maximum height of the coriander plant recorded was 23.45 cm in Horn Meal after 40 days. Table.1 explained that the least height 11.83 cm was obtained in cow manure. The variation in plant height may be credited to the better availability of nitrogen for plants as suggested by Hnamte*et al.* (2013). Horn meal fertilizer is a great source of nitrogen (12%) for plants. It also has a small amount of phosphorus (2%) for healthy roots and stems. Horn meal is equivalent to blood meal in Nitrogen content, but the nutrient availability is slower, which is better for organic crops and with less "leaf burn" damage and it contains Phosphorus. Its nutrient availability starts at around 4-6 weeks and can last 12 months. That could be one of the reasons why horn meal gave maximum height in coriander plants after 40 days.

Table 1: Effects of organic manures and NPK fertilizers on the height (cm) of *Coriandrum sativum*

Treatments	Days after sowing					
	15D	20D	25D	30D	35D	40D
Control	4.05	7.78	08.45	09.90	12.03	12.63
Bone meal	4.50	9.08	10.60	10.98	12.85	21.05
Mustard cake powder	2.95	7.48	09.03	11.73	15.60	20.50
Neem Cake powder	4.20	8.85	10.78	10.85	13.50	18.90
Cow manure	4.73	8.25	08.65	08.98	09.75	11.83
Trichocompost	4.10	8.28	10.05	11.70	11.85	19.03
Vermicompost	5.05	8.45	10.20	12.48	14.78	20.55
Coco Coir	3.60	7.55	09.43	11.28	13.40	19.13
Horn Meal	3.83	8.35	10.33	13.68	13.58	23.45
NPK	3.93	8.35	08.83	08.70	10.33	14.35
LSD at 5%	NS	5.28	07.80	19.30	30.56	40.35

The size of a leaf has a significant effect on water evaporation, water balance, material cycle, and economic efficiency, and also has an important influence on growth and development, resistance, and final production.

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It is also an important index for the measure of plants' production statements. Leaf number stimulates with the use of different types of fertilizers. From the table.2 and table.3 we can see that horn meal has shown the highest numbers of leaves and branches after 40 days among all the applied organic fertilizers and control treatment has shown the least number of leaves and branches which gives the same result as bone meal, neem cake powder, cow manure, coco coir, and NPK. The minimum leaf numbers in the control treatment suggest that the application of different kinds of organic manure makes a difference in vegetation growth which corroborates with studies that show the application of different manures, increased leaf numbers, and other growth parameters (Khadir*et al*., 1989, Qulsum*et al*., 2020).

Table 2: Effects of organic manures and NPK fertilizers on the number of leaves plant^{-1} of *Coriandrum sativum*

Treatments	Days after sowing					
	15D	20D	25D	30D	35D	40D
Control	2.00	3.00	4.00	4.25	5.00	5.25
Bone meal	2.00	3.50	4.00	4.75	5.13	5.50
Mustard cake powder	2.50	3.25	4.13	4.88	5.50	5.38
Neem Cake powder	2.25	3.38	4.25	4.88	5.00	5.25
Cow manure	2.00	3.13	4.00	4.25	5.00	5.25
Trichocompost	2.50	3.50	4.00	4.63	5.13	5.38
Vermicompost	2.00	3.25	4.00	4.75	5.25	5.50
Coco Coir	2.00	3.38	4.00	4.63	5.00	5.25
Horn Meal	2.50	3.63	4.38	5.25	5.25	5.50
NPK	2.50	3.00	4.00	4.25	5.00	5.25
LSD at 5%	5.00	8.00	9.45	12.0	16.0	19.5

Table 3: Effects of organic manures and NPK fertilizers on the number of branches plant^{-1} of *Coriandrum sativum*

Treatments	Days after sowing					
	15D	20D	25D	30D	35D	40D
Control	2.00	3.00	4.00	4.25	5.00	5.25
Bone meal	2.00	3.50	4.00	4.75	5.13	5.50
Mustard cake powder	2.50	3.25	4.13	4.88	5.50	5.38
Neem Cake powder	2.25	3.38	4.25	4.88	5.00	5.25
Cow manure	2.00	3.13	4.00	4.25	5.00	5.25
Trichocompost	2.50	3.50	4.00	4.63	5.13	5.38
Vermicompost	2.00	3.25	4.00	4.75	5.25	5.50
Coco Coir	2.00	3.38	4.00	4.63	5.00	5.25
Horn Meal	2.50	3.63	4.38	5.25	5.25	5.50
NPK	2.00	3.00	4.00	4.25	5.00	5.25
LSD at 5%	5.00	8.00	9.45	12.0	16.0	19.5

The analysis of the data intable.4 reveals that the length of the longest leaf was significantly different among the applied organic and inorganic manures. The longest leaf 4.65 cm was recorded in plants receiving horn meal and the minimum length of a leaf was recorded at 2.8 cm in plants receiving the control treatment.

Table 4: Effects of organic manures and NPK fertilizers on the leaf length of *Coriandrum sativum*

Treatments	Days after sowing					
	15D	20D	25D	30D	35D	40D
Control	1.80	2.10	2.10	2.25	2.50	2.80
Bone meal	1.75	2.40	2.75	2.75	3.40	3.75
Mustard cake powder	1.90	2.15	2.25	2.85	3.40	3.90
Neem Cake powder	1.70	2.35	2.50	2.70	3.50	3.75
Cow manure	1.65	2.00	2.20	2.65	2.90	2.90
Trichocompost	1.85	2.45	2.85	2.85	3.75	4.05
Vermicompost	2.00	2.60	2.70	3.00	3.20	4.70
Coco Coir	1.85	2.40	2.55	2.75	3.05	4.45
Horn Meal	1.90	2.75	2.55	3.30	3.25	4.65
NPK	1.80	1.95	2.20	2.25	3.05	3.30
LSD at 5%	11.0	NS	19.2	35.0	38.7	41.1

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Leaf area growth determines light interception and is an important parameter in determining plant productivity (Gifford *et al.*, 1984; Koester *et al.*, 2014). From table.5 we can see that the highest leaf area 26.72 cm^2 was recorded in horn meal after 40 days. The second highest leaf area 25.44 cm^2 was recorded in vermicompost. On the other hand, the lowest leaf area was recorded in the control treatment.

Table 5: Effects of organic manures and NPK fertilizers on the single leaf area of *Coriandrum sativum*

Treatments	Days after sowing					
	15D	20D	25D	30D	35D	40D
Control	4.50	5.61	05.86	06.05	07.57	09.47
Bone meal	4.11	7.54	10.20	10.37	15.59	17.47
Mustard cake powder	5.01	5.89	06.30	09.21	14.75	19.33
Neem Cake powder	3.69	7.39	08.71	09.63	16.04	15.43
Cow manure	3.49	5.70	06.01	08.93	10.69	10.81
Trichocompost	4.61	7.21	10.41	08.22	09.82	18.58
Vermicompost	5.16	9.45	09.84	12.19	13.54	25.44
Coco Coir	4.61	6.94	07.86	08.89	15.47	25.17
Horn Meal	4.59	7.62	10.08	13.73	14.19	26.72
NPK	4.49	4.90	06.43	06.59	12.03	12.31
LSD at 5%	29.0	NS	32.7	NS	44.11	49.21

There was a significant difference between the fresh and dry weights of coriander. The yields of total fresh and dry weights have shown in table.6. Plants from horn meal-treated showed the highest fresh and dry weight which means that the highest yields were achieved due to the application of horn meal which is rich in Nitrogen (12%) and Phosphorus (2%). Nitrogen is the most imperative element for the proper growth and development of plants which significantly increases the yield and its quality by playing a vital role in the biochemical and physiological functions of plants (Leghari *et al.*, 2016). The minimum total fresh weight of 1.07 gm/plant was recorded in vermicompost and a dry weight of 0.075 g/plant was recorded in chemical fertilizers.

Table 6: Effects of organic manures and NPK fertilizers on the fresh weight and dry weight of *Coriandrum sativum*

Treatments	FreshWeight gm/plant	Dry Weight gm/plant
Control	1.17	0.08
Bone meal	1.31	0.17
Mustard cake powder	1.83	0.18
Neem Cake powder	1.40	0.17
Cow manure	1.24	0.14
Trichocompost	1.33	0.16
Vermicompost	1.07	0.12
Coco Coir	1.47	0.19
Horn Meal	1.87	0.21
NPK	1.18	0.07
LSD at 5%	0.27	0.34

We can see the significant differences in nutrient accumulation between the control experiment and other treatments. The average N concentration in the plants ranged from 1.11% to 2.40%. The average P concentration in the plants ranged from 0.34% to 0.60%. The average K concentration in the plants ranged from 4.48% to 18.50%. The average S concentration in the plants ranged from 1.71% to 2.56%. The Bone Meal treated plant showed the highest accumulation of N whereas the Coco Coir showed the lowest value. Accumulation of P was highest in the chemical fertilizer NPK treated sample and lowest in the Bone Meal and Horn Meal treated sample. K content was highest in the Mustard Cake Powder and lowest in the Cow Manure contained treatment. The highest and lowest accumulation of S content was found within the control treatment and cow manure.

Table 7: Effects of organic manures and NPK fertilizers on the nutrient concentrations of *Coriandrum sativum*

Treatments	N	P	K	S

Control	1.48	0.53	3.67	0.56
Bone meal	2.40	0.34	3.77	0.38
Mustard cake powder	1.98	0.42	4.50	0.23
Neem Cake powder	1.62	0.51	2.91	0.40
Cow manure	2.12	0.45	1.48	0.24
Trichocompost	1.58	0.40	1.13	0.29
Vermicompost	2.38	0.40	2.56	0.28
Coco Coir	1.11	0.38	1.78	0.41
Horn Meal	1.55	0.35	2.32	0.25
NPK	2.33	0.60	2.46	0.40
LSD at 5%	0.16	0.05	0.17	0.07

Conclusion

Horn meal provided nutrient-rich vegetables along with the highest yield as this fertilizer is a great source of nitrogen and phosphorus. Nitrogen is the most imperative element for preparing the growth and development of plants which significantly increases the yield as well as vegetable quality by playing a vital role in the biochemical and physiological functions of plants (Leghari *et al*., 2016). From overall results, it can be concluded that among the applied organic and chemical fertilizers Horn meal might be preferable to get the best production of *Coriandrum sativum.*

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