EFFECT OF NITROGEN ON THE VARIETAL PERFORMANCE ON CORIANDER (*Coriandrum sativum L.*)

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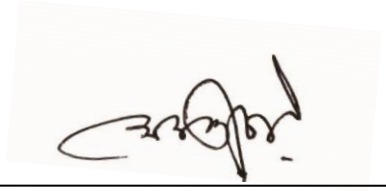

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CERTIFICATE

This is to certify that the thesis entitled, ***"EFFECT OF NITROGEN ON THE VARIETAL PERFORMANCE ON CORIANDER (Coriandrum sativum L.)"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE*** *in* ***SOIL SCIENCE,*** *embodies the result of a piece of bona fide research work carried out by* ***Nitai, Chandra Ghos*** *Registration No.* ***18-09058*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated:

Place: Dhaka, Bangladesh

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DEDICATED TO
MY BELOVED PARENTS

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ABSTRACT

Coriander is one of the most important and major spices in Bangladesh as well as world. A field experiment was conducted at the farm of Sher- E- Bangla Agricultural University, Dhaka from November 2018 to February 2019 to examine the effect of nitrogen on the varietal performance on coriander. The experiment consisted of two variety viz. V_1 = BARI Dhonia-1 and V_2 = BARI Dhonia-2 and six levels of nitrogen viz. 0, 20, 40, 60, 80 and 100 kg ha^{-1}. The experiment was laid out in Randomized Complete Block Design (factorial) with three replications. There were 12 treatment combinations in all. The BARI Dhonia-2 produced maximum number of branches per plant, number of umbel per plant, number of seed per plant, 1000 seed weight, seed yield per plot. The highest yield (1432.40 kg ha^{-1}) was obtained from BARI Dhonia-2. The tallest plant and maximum number of leaves $plant^{-1}$ were recorded at 60 kg N ha^{-1} followed by 80 kg N ha^{-1} at different growth stages. Application of 60 kg N ha^{-1} gave the maximum branches $plant^{-1}$, umbellates $umbel^{-1}$, seed $plant^{-1}$, 1000 seed weight, seed yield $plot^{-1}$ and seed yield (1691.65 kg ha^{-1}). Application of 60 kg N ha^{-1} coupled with BARI Dhonia-2 gave the maximum seed yield of (1699.98 kg ha^{-1}). The highest concentration of N and K in post harvest soil was recorded in the treatment combination of BARI Dhonia-2 with application of60 kg N ha^{-1}.

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LIST OF ABBREVIATION AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
HRC	=	Horticulture Research Centre
BBS	=	Bangladesh Bureau of Statistics
FAO	=	Food and Agricultural Organization
N	=	Nitrogen
et al.	=	And others
TSP	=	Triple Super Phosphate
MOP	=	Muriate of Potash
RCBD	=	Randomized Complete Block Design
DAT	=	Days after Transplanting
ha^{-1}	=	Per hectare
g	=	gram (s)
kg	=	Kilogram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
wt	=	Weight
LSD	=	Least Significant Difference
^0C	=	Degree Celsius
NS	=	Not significant
Max	=	Maximum
Min	=	Minimum
%	=	Percent
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of Coefficient of Variance

CHAPTER I

INTRODUCTION

Coriander (*Coriandrum sativum* L.) belonging to the family *Apiaceae* is an important spice crop grown in *rabi* season throughout Bangladesh and it is known as 'dhonia'. The young plant of corianderis used as appetizer in preparing fresh chutneys and sauces and leaves are used to flavour food, curries, soups, fish sauce, etc. and seeds are used in cakes, soups, sausage, pickles, curries, etc. (Janardhan and Thoppil, 2004; Tiwari and Agarwal, 2004).

Coriander is an annual plant which has slender green stems that can grow up to 40-60 cm and the leaves resemble parsley leaves (Mahr, 2017). The lower leaves are compounded, while the upper leaves are finely divided into very narrow segments (Blade *et al*., 2016). It produces white flowers and light brown seeds. The seeds are round and tannish brown. They are available in most markets as spice (Diederichsen, 1996; Mahr, 2017).

The production of coriander is very poor in India soil especially in Jharkhand due to imbalanced fertilizer application. For obtaining sustainable increase in production / productivity to over-come poor yield, improved cultural practices, high quality seeds, plant protection major and finally more need of balance fertilizers doses should be adopted (Sivamurugan *et al*. 2008). The fertilizers use in proper amount is essential for right growth, development and ultimately yield. The essential nutrients namely nitrogen, phosphorus and potash has more requirement to the plants and it influence the seed yield potential (Singh, 2011). The use of fertilizers are directly influence the yields of plants as well as major content of biological active compound in most of the aromatic and medicinal plants.

Variety plays an important role in producing high yield of coriander because different varieties perform differently for their genotypic characters also vary from genotype to genotype. Improved variety is the first and foremost requirement for initiation and accelerated crop production program. There are many high yielding (foliage/leaf) coriander varieties imported from abroad through different seed companies in Bangladesh. Among the various factors responsible for high yield, the variety itself plays a great role. There is a wide scope for increasing the foliage yield of this crop with the use of varieties that are suitable for cultivation in Bangladesh. For this reason prior to recommendation for the farmers, their performances need to be determined. Production technologies developed were limited because of not yet multiplied and popularized to farmers. As a result, the overall productivity and quality is low and the production systems so backward (Habtewold *et al*., 2017).

At present the cultivation of coriander has been increased for leaf purpose. But there is no recognized commercial variety except BARI Dhonia-1 and BARI Dhonia-2, which is used for seed production. Still there has not been developed any variety suitable for leaf (foliage) production.

Crop nutrient management is important phenomena in agricultural crop to provide ample nutrient demand for crop growth and development throughout the growing period. If the amount of any nutrient is limiting, there is a potential for yield loss in production (Reetz, 2016; Basak *et al*., 2017). By several means nutrients are exported from the fields where crops are grown and nutrient supply in the soil can become depleted. Thus, supplementing is required through application of external fertilizers. Furthermore, the farmer's economic returns have increased substantially due to fertilizer use in crop production (Reetz, 2016).

Of all the major nutrients provided to agricultural crops, nitrogen is generally considered the most important for plant growth. It is a constituent of many components in plants, including all proteins, which build cell material

and plant tissue and production of chlorophyll, making photosynthesis possible. Many enzymes need nitrogen for assimilation of nutrients and also the nucleic acids involved in reproduction of the genetic code, DNA and RNA, is dependent of nitrogen.

Nitrogen has the most profound influence on agricultural and biological traits of plants (Rumińska, 1983). This element is the basic component of protoplasm. It plays an important role in the synthesis of many chemical compounds (including proteins and enzymes), which translates into the processes involved in the growth and development of plants (Podsiadło, 2005, Carrubba, 2009, Khan *et al.* 2012, Khalid, 2013). Nitrogen deficit in soil leads to retarded growth and loss of weight of plant aerial organs as well as premature ripeness of plants (Oliveira *et al*, 2003). Excess nitrogen causes abundant growth of vegetative organs to the detriment of generative ones (Oliveira *et al*, 2003, Carrubba, 2009), makes plants more vulnerable to lodging and diseases, prolongs the period of vegetation and delays maturity and harvest (Ebert, 1982). In short, a proper course of onthogenesis depends on nitrogen, which functions as a limiting factor of agricultural yields (Okut and Yidirim, 2005, Rzekanowski *et al*, 2007, Khalid, 2013).

The applied nitrogen rate and variety are two important parameters influencing the yield of medicinal plants. Das *et al.* (1991) studied the effect of nitrogen fertilization on coriander and concluded that increased plant height and branch number per main stem with 40 kg N/ha application. Rahimi *et al*. (2009) stated that nitrogen application had significant and positive effect on plant height and branch number per main stem. Also, in another study Oliver *et al*. (2003) found that the highest of plant height observed in 80 kg N/ha application treatment which was 17.4% greater as compared with no nitrogen application treatment. In studies of some researchers reported that with increasing of nitrogen application increased essential oil percent of coriander (Gulen, 1995; Yalcintas, 1995; Bhati, 1988).

Keeping the above facts in view, the present study was undertaken to investigate the effect of nitrogen on the varietal performance on coriander with the following objectives:

1. To observe the effect of nitrogen on growth and yield of coriander.
2. To assess the varietal performance of coriander under nitrogen management,
3. To find out the effective dose of nitrogen for coriander in red soil.

CHAPTER - II

REVIEW OF LITERATURE

Coriander is one of the most important spice crops all over the world including Bangladesh. The yield of coriander depends on many factors such as land topography, soil fertility, soil productivity, environment (light, temperature, moisture, humidity and rainfall), and cultural practices. Different types of chemical fertilizers play an important role on its growth, yield and quality. Nitrogen is one of the major important macronutrients which are responsible for controlling growth and yield of coriander. A number of research works have been done on different levels of nitrogen and variety on the yield of coriander in various parts of the world, which had been made in this regard in Bangladesh. The present study has been taken to investigate effect of nitrogen levels and varietal performance on coriander. In this chapter an attempt had been made to collect related research findings of the present study.

2.1 Effect of Variety on Growth And Yield of Coriander

Variety is the most important factor for emergence, growth, development and yield of any field crops. Coriander is a field crops and its emergence, growth, development and yield depend on varieties.

Anilkumar *et al.* (2018) carried out at Department of Plantation, Spices, Medicinal and Aromatic crops, College of Horticulture, UHS campus, GKVK, Bengaluru, during November 2016 to February 2017. Sixteen coriander varieties were collected from different institutes and were evaluated using RCBD with three replications. From the study on mean performance of genotypes, based on growth, yield and quality attributes, the maximum plant height (99.45 cm), and plant spread (1470.40 cm^2) were recorded in RCr-446 followed by RCr-475.Number of primary branches per plant (13.65), number of umbels per plant (31.70), number of umbellets per umbel (8.25), dry weight (9.64 g), test weight

(19.50 g), seed yield per plant (7.36 g) and seed yield per hectare (14.35 q) was recorded in (CO(CR)-4) followed by ACr-1 and RCr-446. The maximum essential oil content was recorded in CO (Cr)-4 (0.66 %), CO-3 (0.60 %) and RCr-446 (0.53%). While, maximum linalool content was observed in RCr-728 (92.33%) and RCr-480 (89.13 %).

Mahajan *et al* (2017) present investigation indicated that, among the different shading intensities 50 per cent shading intensity recorded the minimum number days required for germination (8.00) and emergence of third leaf (13.50) as compared with remaining shading intensities. The highest number of leaves, plant height, number of branches, internodal length of leaves were observed in 50 per cent shading intensities (21.92, 19.17cm, 6.17 and 6.08 cm, respectively). The highest leaf area was observed in 50 per cent shading intensities (4.67 cm^2) while among the varieties, the variety, JD-1 recorded the highest leaf area (4.40 cm^2). The minimum days required for harvesting of coriander was recorded in 50 per cent shading intensities (36.67 days) as compared to open conditions (42.17 days). The highest yield per plot (3.40 kg) and per hectare (50.23 q) of coriander was recorded in 50 per cent shading intensity as compared to other shading intensities while highest yield per plot and per hectare was recorded variety of JD-1 (2.53 kg per plot) and (37.44 q per ha.), respectively.

Coriandrum sativum L is an important seed and herb spice crop of Asia, used in several culinary purposes and also for treatment of several diseases. It is cultivated for its herb and also for seeds. In India, Rajasthan, Gujarat, Karnataka and Andrapradesh are the major state producing coriander. There is a need to standardize the production technology which may help to improve the herb yield, seed yield and quality so as to extend the farmers a hand of reliability so that they can get high net returns per unit area. The present review is focused on production practices of *Coriandrum sativum* L (Shashidhar *et al.*, 2017).

Katar *et al.* (2016) conducted in two successive vegetation seasons of 2013 and 2014 at the Isparta and Eskişehir ecological conditions. The aim of this study was to determine the performance and stability of coriander genotypes for yield

and yield components and essential oil content. In the study, Gamze, Kudret, Erbaa, Arslan and Pel-mus coriander cultivars and Burdur, Antalya and Tokat genotypes were evaluated growing seasons of 2013 and 2014 under the Isparta and Eskisehir ecological conditions in Turkey. Years and locations with different climatic and geographic characters had significant effects in coriander genotypes for yield, yield components and essential oil content. Increase in seed yield and decrease in essential oil content occurred with increasing rainfall. Results revealed that Arslan cultivar in Eskişehir location and Kudret in Isparta location had the highest seed yield. Besides Kudret cultivar and Gamze cultivar gave the highest seed yield as a means of locations; Eskisehir location had also higher seed yield.

Inan *et al*. (2014) conducted a study to find out the best variety and they found that plant height varied significantly due to various varieties of coriander.

Kizil and Ipek (2004) conducted a study to find out the effects of different row spacing on yield, yield components and essential oil content of some coriander (*Coriandrum sativum* L.) lines. They also found significant variation of plant height among various coriander lines.

Moniruzzaman *et al.* (2013) conducted a study to find out the suitable coriander genotypes for foliage yield and its attributes.

Qureshi *et al*. (2009) evaluated 29 indigenous germplasm of coriander and reported that days to maturity ranged from 190-194, branches per plant from 5-18, umbels per plant from 121-336, days to flowering from 96-152 and 1000-seed weight from 6.0-11.6 g.

Datta and Choudhuri (2006) evaluated and reported that 17 germplasm lines of coriander (*Coriandrum sativum* L.) showed significant variation for most of the character studied. Genotype RCr-41 produced the highest seed yield (1.51 t/ha) followed by DH-246 (1.43 t/ha). RCr-41 and ACR-69 were found free from wilt and stem gall disease incidence. In this experiment plant height ranged from 42.87-98.77 cm, primary branches plant^{-1} from 5.37-8.23, secondary branches

plant^{-1} from 10.10-16.75, umbels plant^{-1} from 20.83-34.67, seeds umbel^{-1}from 33.47-35.57 and 1000-seed weight from 9.33-13.82 g seed yield ranged from 686-1506 g per hectare. Seed colour was classified as yellowish green and light yellowish while seed shape, as oblong, roundish oblong and round. 9 lines infested with stem gall disease.

Singh *et al*. (2005) evaluated seventy genotypes of coriander (*Coriandrum sativum* L.) of diverse eco-geographical origin. The 70 genotypes were grouped into 9 clusters depending upon the genetic architecture of genotypes and characters uniformity and confirmed by canonical analysis. The maximum inter cluster distance was between I and IV (96.20) followed by III and IV (91.13) and I and VII (87.15). The cluster VI was very unique having genotypes of high mean values for most of the component traits. The cluster VII had highest seed umbel^{-1} (35.3 ± 2.24), and leaves plant^{-1} (12.93 ± 0.55), earliest flowering (65.05 ± 1.30) and moderately high mean values for other characters.

Islam *et al*. (2004) conducted a performance trial with 14 genotypes of coriander (*Coriandrum sativum* L.) at Bangabondhu Seikh Mujibur Rahman Agricultural University, Gazipur during Rabi season of 1999-2000. The genotype CR0013 took the shortest possible period of 43 days, whereas genotypes CR0008 and CR0013 took the longest period (52.25 and 52.00 days, respectively) for flower stalk emergence. The genotype CR0001 produced the highest seed yield per plant (11.30 g) as well as per hectare (1.73 t). Considering seed germination, the genotype CR0022 exhibited the highest score (78.25%) and CR0013 had the lowest (68.25%).

Kalra *et al.* (2003) evaluated a set of 120 Indian accessions of coriander (*Coriandrum sativum* L.) were screened under late planted conditions for time taken for flowering and fruit maturity, seed yield, seed size, percent content of essential oil in seeds, oil yield and susceptibility to powdery mildew and stem gall diseases. It was concluded that these accessions (CIMAP 2053 and CIMAP 2096) would be suitable for cultivation of coriander under late sown conditions in Indo-Gangetic plains for higher yield of seeds and essential oil, respectively.

Days to flowering ranged from 65-80, days to mature, from 100-125, Seed yield per plot (6 m^2), from 0.17-1.39, 1000- seed weight from 8.8-14.6 g.

The experiment taking three promising coriander lines (CR0001, CR0011 and CR0022) and a check (BARI Dhonia-1) was studied in two locations, at Spices Research Sub-Centre, BARI, Gazipur and Spices Research Sub –Centre, Magura and Gazipur. The crop was harvested on March 15, 2001 in both locations. At Magura plant height ranged from 84.00-91.43 cm, number of primary branches $plant^{-1}$ from 5.70 to 7.90, no. of umbels $plant^{-1}$ from 24.10-33.70, no. of Umbellates $umbel^{-1}$ from 12.22-19.58, wt. of fruits $plant^{-1}$ from 6.36-8.54 g and yield from 1.56-1.95 t/ha. But at Gazipur plant height ranged from 74.07-82.53 cm, number of primary branches $plant^{-1}$ from 5.63 to 6.73, no. of umbels $plant^{-1}$ from 62.13-69.93, no of Umbellates $umbel^{-1}$ from 7.43-7.80, and yield from 0.98-1.24 t/ha. CR0022 gave the highest yield at Magura (1.95 t/ha) while CR0011, at Gazipur (1.24 t/ha). BARI Dhonia-1 produced 1.80 t/ha at Magura and 1.02 t/ha at Gazipur (Anon., 2002).

Selverajan *et al*. (2002) reported that nine genotypes of coriander (*Coriandrum sativum* L), i.e. CS 97, CS 102 and CS 123 from Jobner (Rajasthan, India); CS 12 and CS 203 from Coimbatore (Tamil Nadu, India); and CS 8, CS 101, CS 208 from Hissar (Haryana, India), were evaluated to identify the suitable types for cultivation in Tamil Nadu under irrigated conditions. The result of the pooled analysis of the 3-years (1998-2000) data indicated that CS12 was the best with the highest yield of 579.3 kg/ha, followed by CS 102, recording yield of 56.10 kg/ha. The increase in yield for CS 12 was 10% over the control cultivar CO3, which recorded yield of 529.6 kg/ha.

Ayanoglu *et al*. (2002) reported that forty-three coriander lines were under east Mediterranean conditions for two years to determine the best yielding lines in winter season. The seed yields of coriander lines varied between 1138 (K11) and 2297 kg /ha (K46). The highest seed yields were obtained from the lines K67, K28, K69 and K46. The seed Yields of those lines were higher than currently planted cultivars.

Rahman (2000) evaluated 14 coriander genotypes reported that days to 50% germination ranged from 8.50-12.00days, leaves plant^{-1}from 23.13-36.00, days to green leaf harvest from 33.50-42.00 days, green yield ranged from 2.84-5.08 g/plant. The range of primary branches plant^{-1} and secondary branches plant^{-1} was 6.50-8.02 and 15.85-25.50, respectively. The green yield ranged from 0.94-1.78 t/ha. Among morphological characters, leaf colour was light to dark green, flower colour off white, whitish pink and pink, fruit colour light brown, deep brown and yellowish brown. Fruit shape was round and elliptical. He used plant spacing of 30 x 10 cm.

Patel *et al*. (2000) worked on 48 genotypes of *Coriandrum sativum* L which were collected from different villages of an important and major coriander growing district-Guna (Madhya Pradesh). Data were recorded on 10 different characters. D-square values between pairs of genotypes ranged from 2.50 to 96.96. By using D^2 analysis the genotypes were grouped into nine clusters. The clustering was at random and without any relationship between genetic diversity and geographic diversity. Seed yield per plant had highest contribution towards genetic divergence followed by secondary branches and umbellets per plant.

The population consisting of 40 genotypes of coriander was subjected to multivariate analysis using D^2 statistics by Srivastava *et al*. (2000). The characters studied were plant height, primary branches^{-1}, secondary branches^{-1}, days to flowering, and days to maturity, number of umbel^{-1}, and number of umbellets per umbel, number of seeds per umbel, 1000-seed weight and seed yield ha^{-1}. The assessment revealed considerable variability among the stock for all characters except primary branches^{-1}, umbellets per umbel and 1000-seed weight. The 40 genotypes were grouped into four clusters depending on similarities of their D^2 values. Clusters numbers II and IV captured 10 and 7 genotypes. Based on cluster means, characters such as days to flowering, days to maturity and number of secondary branches^{-1} were major factors of differentiation among genotypes, which may be taken into account while selecting parents for hybridization programme.

Kirici (1999) also concluded that the plant height varied significantly among the different varieties collected from different locations.

Rajagopalan *et al*. (1996) evaluated thirteen *Coriandrum sativum* cultivars for seed and essential oil yield during 1990-91 and 1991-92 at the Tamil nadu Agricultural University, Coimbatore, India. Seed yield was in the range of 359.2-683.4 kg/ha.

Mohideen *et al*. (1984) in a study reported that the variation in foliage yield of coriander was due to the variation of genetic inheritance.

Badguzar *et al.* (1987) conducted a study to find out the response of coriander to foliar application of urea and they also found significant variation of weight of coriander plant among various genotypes.

Chow *et al*. (1984) reported that the leaf yield of USA cultivar 'Sunbless' and local cultivar (13 and 8 t ha^{-1} , respectively) harvested in winter after 6-7 weeks of seed sowing.

2.2 Effect of Nitrogen Level on Growth And Yield of Coriander

Hossain and Pariari (2018) was carried out during Rabi season of 2015-2016 and 2016-17 at Horticultural Research Station, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, to determine the requirement of nitrogen and phosphorus for coriander variety Ajmer Coriander-1 for achieving maximum seed yield and quality parameter. Two different levels of nitrogen (40, and 60 kg/ha) and four different levels of phosphorus (30, 40, 50 and 60 kg P2O5/ ha) in different combination were distributed in the plots. The results indicated that yield parameters were declined with very high rate of nitrogen and phosphorous combination. Therefore, significantly maximum number of umbels per plant (66.30), umbellate per umbel (7.67), seeds per umbel (26.50), and seed yield per hectare (795.85 kg/ha), was recorded with treatment N_2P_2 (60 kg Nitrogen/ha + 40 kg P_2O_5/ha. Therefore, The treatment combination of (N60 +

P40 kg/ha) was observed to be the best and most profitable dose for coriander cultivation on new alluvial zone of West Bengal.

Nabi *et al*. (2018) conducted to the cultivation of nutrient responsive crop using eco-friendly innovative techniques like integrated use of organic manures along with inorganic fertilizer for sustainable use of available resources has proved to be best way to increase production level. Integration of organics with inorganic source of nitrogen (urea) resulted in significant influence on various growth and other parameters as compared to sole application of various levels of nitrogen through urea. Maximum number of lateral branches plant^{-1} (8.50) was recorded by treatment, T_9 (50% nitrogen of T_3 through urea + 50% nitrogen of T_3 through vermicompost. The study also revealed that minimum days taken for 50% germination (19.63) were also recorded by treatment T_9 (50% nitrogen of T_3 through urea + 50% nitrogen of T_3 through vermicompost) and maximum in control.

Mohammed *et al.* (2018) were carried out at Ghazala Experimental Farm, Fac.Agric., Zagazig Univ., Egypt, during the two consecutive seasons of 2016/2017 and 2017/2018 to investigate the effect of different NPK fertilization levels (0.0, 50, 75 and 100 % of recommended rate), Lithovit concentrations (0.0, 2 , 4 and 6 g / liter) and their combination treatments on growth, yield and its components, volatile oil and some chemical constituents of coriander plant. Plants were foliar sprayed with Lithovit three times at 30, 50 and 70 days after sowing. Obtained results demonstrated that the maximum values of plant height, No. of leaves/plant, root length, total dry weight/plant, fruit yield / plant and /fed. and total carbohydrates % were detected when plants were fertilize with $N_2P_2K_2$ or $N_3P_3K_3$ and sprayed with Lithovit at 6 g/l. While, the highest No. of branches/plant, No. of inflorescences/plant, volatile oil %, volatile oil yield/ plant and fed., N, P, K percentages and total chlorophyll content in leaf tissues were recorded as coriander plants were fertilized with $N_3P_3K_3$ and sprayed with 6 g/l Lithovit. The main constituents of Coriandrium *sativum* fruits as detected by GC/MS were linalool and camphor

which increased with treatment of $N_3P_3K_3$ and Lithovit at 6 g/l compared to control.

Mishra *et al.* (2018) conducted in the Department of Vegetable Science, College of Agriculture, OUAT, Bhubaneswar during Rabi 2013 - 2014 to assess the effect of nitrogen (50, 60 and 70 kg/ha), potash (50 and 60 kg/ha) in combination with FYM (20 t/ha), phosphorous (40 kg/ha) on growth, growth attributing characters of coriander leaves under two sets of experiment i.e. line sowing and broadcasting. It was found that inline sowing the number of day (8.25 day) to germinate was lowest in interaction effect of nitrogen and potash (N_2K_2). Similarly in broad casting i.e. 8 days in N_1K_1 and N_3K_3. Germination percentage was found maximum in N_2K_1 (90.78 %), N_3K_2 (85.83) in line sowing & broadcasting respectively. The height of the plant at 30 days is 17.48 in N_3K_2 treatment under line sowing whereas 18.38 cm was found in N_3K_2 under broadcasting.

Javiya *et al.* (2017) conducted during rabi season of 2014-15 on clayey soil at Junagadh to study the "Response of coriander (*coriandrum sativum* L.) to nitrogen and phosphorus in south saurashtra condition". The experiment results revealed that the 60 kg N/ha promoted growth parameters viz., plant height, plant spread, number of branches per plant; yield attributes viz., number of umbels per plant, number of umbellates per umbel, number of seeds per umbellate, weight of seed per plant, test weight, ultimately higher seed yield (1483 kg/ha) and stover yield (1760 kg/ha), with higher net return (65976/ha) and B:C ratio (3.48) over the control (N_1). It also significantly increased content and uptake of NPK kg/ha at 60 kg N/ha and 60 kg P_2O_5/ha in seed and stover.

Kamrozzaman *et al.* (2016) experiment on coriander (*Coriandrum sativum* L.) was carried out during rabi seasons of 2011-12 and 2012-13 in Low Ganges River Flood Plain Soil under AEZ-12 at Farming System Research and Development Site, Hatgobindapur, Faridpur to find out optimum and economic doses of fertilizers for coriander (var. BARI Dhania 1) for sustainable higher yield and to update balanced fertilizer recommendation for target yield. The highest seed yield (1373 kg ha^{-1}) was obtained from the treatment T_3 which was

statistically similar with T_1, T_2, T_3, T_4, T_5 and T_6 treatments. The soil test based treatment T_1 produced 1311 kg yield ha-1and yield difference of their added fertilizer treatment with T_1 was only 5%. The fertilizer added treatments didn't exert the significant difference with soil based treatment (T_1) on yield and yield contributing characters. However, T_1 treatment appeared to be the best suited combination because of its higher gross margin Tk 41,769 ha^{-1}, capability in reducing nutrient cost Tk 13106 $ha^{-1}$and the highest marginal rate of return (MRR) (108%) whereas treatment T_3 covered 21% MRR and the highest nutrient cost among the treatments and hence treatment, $N_{118}P_{47}K_{26}S_{10}Zn_{2.2}B_{0.8}Kg$ ha^{-1} (100% NPKSZnB from STB dose) may be recommended for coriander seed production in the study area.

Mishra *et al.* (2016) conducted in the Department of Vegetable Science, College of Agriculture, OUAT, Bhubaneswar, Odisha to study the effect of nitrogen and potassium on growth and yield of coriander (*Coriandrum sativum* L.) cv. Super Midori during Rabi season of 2013-14 in a factorial RBD with four replications. The treatment combinations consisting of three levels of nitrogen @ 50, 60 and 70 kg/ha, two levels of potassium @ 50 and 60 kg/ha with a common dose of phosphorous @ 40 kg/ha and FYM @ 20 t/ha. It was revealed that in an increase in the levels of N from 50 to 70 kg/ha and K from 50 to 60 kg/ha there was a significant variations in the plant growth, yield and other yield attributing characters. The interaction effect of N and K was found to be at par with other treatments. However, the optimum number of leaves, average weight of plants and highest foliage yield of 37.45, 07.88 g and 15.90 t/ha, respectively was obtained with the application of 70 kg N and 60 kg K/ha in the line sowed coriander. The trend was found to be the same in case of broadcasted crop also. Hence, an application of 70 kg N along with 60 kg K/ha with a common dose of phosphorous @ 40 kg/ha and FYM @ 20 t/ha may be recommended for obtaining optimum growth and green foliage yield of both of line sown and broadcasted crop of coriander.

Abdollahi *et al*. (2016) conducted to evaluate the separate and combined effect of nitrogen and biofertilizer Nitroxin (mixture of bacteria Azotobacter and

Azospirillum) fertilizer on vegetative traits, grain yield and essential oil yield of coriander, an experiment was conducted as a factorial in a randomized complete block design (RCBD) with three replications in the field research of Islamic Azad University, Jiroft, Iran. The experiment factors were consisted of three levels of nitrogen (0, 75 and 150 kg·ha^{-1}) and three levels of Nitroxin biofertilizer (0, 2 and 4 L·ha^{-1}). The results showed that application of 150 kg·ha^{-1}N significantlyincreased height and stem diameter, number of lateral branches and shoot dry weight, compared with control and application of 75 kg·ha^{-1}N. Nitroxin biofertilizer significantly improved vegetative traits of coriander when compared with control, so that application of 4 L·ha^{-1}of Nitroxin caused increase the mean of traits compared to control. In the most evaluated growth traits, the highest means were obtained with combining of 150 kg·ha^{-1}N with 4 L·ha^{-1}of Nitroxin. Application of 150 kg·ha^{-1}N increased the number of umbels per plant, 1000 seeds weigh, seed yield and essential oil yield, 29.9, 33.0, 72.9, 40.7, 147.4 and 177.1 percent, compared with the control, respectively. In the presence of Nitroxin, yield and yield component and essential oil yield of coriander increased significantly. Maximum average of these traits obtained when 4 L·ha^{-1} of Nitroxin was applied.

Szempliński and Nowak (2015) conducted an experiment during 2006–2008, in a random block design with four replications. The experimental factor was nitrogen fertilization in doses of 20, 40, 60, 80 and 100 kg N·ha^{-1} and a control treatment (no nitrogen fertilization). The objective was to determine the effect of nitrogen fertilization on the yield and quality of coriander herbal material (fruit). The experimental results showed that the weather conditions during the research determined the morphological traits and yield components as well as the volume of unprocessed herbal material obtained from coriander plants. The yield of coriander fruit was significantly higher in the season with high precipitations than in the other two years with lower precipitations. The respective differences were 44 and 32%. Nitrogen fertilization did not differentiate the number of plants per plot surface area, weight of fruits per plant or 1000 fruit weight,

meaning that the fruit yields were not differentiated, either. However, a significant relationship has been shown between coriander yields and nitrogen fertilization in the years of the experiment. The experiment evidenced that the chemical composition of coriander fruits was more strongly determined by the weather conditions during the growing season than by nitrogen fertilization. A higher content of essential oil in fruit (1.50%) was obtained by coriander growing under drier weather; when the growing season was much wetter, the content of essential oil was much lower (1.07%). The major component of coriander oil was linalool, which made up 67.4% of the chemical profile. Nitrogen fertilization did not differentiate the chemical profile of coriander essential oil.

Lokhande *et al*. (2015) conducted during *rabi* season at Panjabrao Krishi Vidyapeeth, Akola (Maharashtra), India. The experiment comprising sixteen treatments of different nitrogen and phosphorus levels was laid in factorial randomized block design with three replications. The maximum plant height, number of branches per plant, days for first flowering, days for 50% flowering, flesh and dry biomass weight, days required for harvesting, number of umbels per plant, seed yield, germination percent of primary and secondary umbels were recorded with 60 kg nitrogen and 30 kg phosphorus followed by 30 kg nitrogen and 45 kg phosphorus as compared to control without application of fertilizers. Higher dose 30 kg nitrogen and 45 kg P_2O_5 per hectare of both the fertilizers had no effect in increasing the seed yield.

Moniruzzaman and Rahman, (2015) conducted an experiment at BSMRAU farm, Gazipur to evaluate the effects of four nitrogen levels (0, 40, 80 and 120 $kgha^{-1}$) and four levels of leaf cutting (no cutting, one cutting at 30 DAS), two cuttings at 30 & 45 DAS and three cuttings at 30, 45 & 60 DAS) on three genotypes of coriander (*Coriandrum sativum* L.) (CS001, CS002 and CS003). The genotype CS003 produced the highest foliage yield (8.92 t/ha) and the genotype CS001 gave the highest seed yield (0.93 t/ha). The maximum seed

yields were obtained from the N application at 80 kg Nha^{-1}. The 80 kg N ha^{-1}coupled with three cuttings gave the top most foliage yield while the same rate accompanied with one cutting gave the top most seed yield for all genotypes.

Coriander (*Coriandrum sativum* L.) is an important spices crop and widely cultivated in India. It has extensively employed as condiments in the preparation of curry powder, pickling spices, sauces and flavour. That is why, the trial was conducted on coriander with 27 treatment combinations of N (0, 50 and 100 kg/ha), P (0, 30 and 60 kg/ha) and K (0, 20 and 40 kg/ha) with three replications at Horticultural Gar-den, Birsa Agricultural University, Kanke, Ranchi. The treatment N100P30K0 proved better in respect of seed yield per hectare (18.84 q), seed weight (6.86 g) and straw weight per plant (24.33 g). Higher dose of N and medium dose of P gave the best result while K has no any enhancing contribution in yield parameter (Kumar *et al*., 2015)

Yousuf *et al.* (2014) conducted an experiment at the Spices Research Centre, Shibgonj, Bogra, Bangladesh during the rabi seasons of 2008-2009 and 2009-2010 to determine the requirement of N, P, K, and S of coriander (BARI Corinader 1) for achieving satisfactory seed yield of this crop. Different levels of nitrogen (0, 40, 70, and 100 kg/ha), phosphorus (0, 25, 50, and 70 $kgha^{-1}$), potassium (0, 30, 60, and 90 $kgha^{-1}$), and sulphur (0, 10, 20, and 30 $kgha^{-1}$) were distributed in the plot. The experiment was tested in randomized complete block design with three replications. There was positive impact of application of those nutrients on the yield and yield contributing characters of coriander up to a moderate level of $N_{70}P_{50}k_{30}S_{20}$ $kgha^{-1}$. The highest seed yield (2.06 t/ha in 2008-2009 and 2.09 t/ha in 2009-2010) was obtained with this moderate application of N, P, K, and S (70, 50, 30, and 20$kgha^{-1}$, respectively) and yield was declined with higher doses of these elements. The fertilizer treatment$N_{70}P_{50}k_{30}S_{20}$ $kgha^{-1}$was observed to bethe best suitable dose for coriander cultivation on Grey Terrace Soil of Amnura Soil Series under AEZ-25(Level Barind Tract) of Bangladesh.

Moniruzzaman *et al*. (2014) conducted a study to find out the influence of different rates and methods of nitrogen application on foliage yield of coriander.

They found that the maximum plant height was recorded from of 80 kg N ha^{-1}, being closely followed by 60 kg N ha^{-1}

Patel *et al*. (2013) conducted on loamy sand soil of Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* season of 2009-10 to investigate effect of varying levels of nitrogen and sulphur on growth and yield of coriander (*Coriandrum sativum* L.). Sixteen treatment combinations consisting of four levels each of nitrogen (20, 40, 60 and 80 kg Nha^{-1}) and sulphur (0, 10, 20 and 30 kg S ha^{-1}) replicated four times. Among the levels of nitrogen @ 80 kg ha^{-1} showed its producing highest seed yield (1203 kg ha^{-1}) and straw yield (1596 kg ha^{-1}). The highest performance is attributed to significant improvement in growth and yields parameters *viz.,* plant height, number of branches $plant^{-1}$, number of umbels $plant^{-1}$, number of umbellate $umbel^{-1}$, number of seeds $umbellate^{-1}$, Test weight (g) and seed weight $plant^{-1}$ (g). Similarly application of nitrogen @ 80 kg ha^{-1} recorded highest quality parameters (protein content, volatile oil content and total oil yield) and uptake of nitrogen and sulphur . Among the levels of sulphur @ 30 kg ha^{-1} recorded significantly higher seed yield (1184 kg ha^{-1}) and straw yield (1577 kg ha^{-1}). Sulphur application @ 30 kg ha^{-1} significant improvement in growth and yield parameters *viz.,* number of branches $plant^{-1}$, number of umbels $plant^{-1}$, test weight (g) and seed weight $plant^{-1}$ (g). Application of sulphur @ 30 kg ha^{-1} also showed positive effect on protein, volatile oil content and total oil yield as well as uptake of nitrogen and sulphur.

Nowak and Szempliński (2011) conducted an experiment during in 2006-2008 to evaluate the effect of nitrogen and boron fertilization on the morphometric features and yield of coriander. The research showed significant positive effect of increasing nitrogen fertilization on stem length, number of side branchings, inflorescences and fruit number per plant and negative effect on side branching height. With increasing nitrogen fertilization fruit number and fruit yield per

coriander plant were higher, and the maximum yield was obtained at the highest nitrogen rate. Coriander reacted to increasing nitrogen rates with an increase of fruit yield per plant, however at the same time decrease of the weight of 1000 fruits was observed, mainly as a result of formation of a greater number of them. In the research, boron fertilization did not differentiate morphometric features or the fruit yield of coriander.

Rahimi *et al*. (2009) stated that nitrogen application had significant and positive effect on plant height and branch number per main stem. Also, in another study Oliveira *et al*. (2003) found that the highest of plant height observed in 80 kg Nha^{-1} application treatment which was 17.4% greater as compared with no nitrogen application treatment. In studies of some researchers reported that with increasing of nitrogen application increased essential oil percent of coriander (Gulen, 1995; Yalcintas, 1995; Bhati, 1988).

Das *et al.* (1991) studied the effect of nitrogen fertilization on coriander and concluded that increased plant height and branch number per main stem with 40 kg N ha^{-1} application.

Pawar *et al*. (2007) conducted an experiment during the *rabi* season of 2003-2004 to study effect of nitrogen rates (50, 75 and 100 $kgha^{-1}$) and spacing on coriander. Application of nitrogen at a rate of 100 $kgha^{-1}$ resulted in the maximum plant height, number of leaves per plant, number of primary branches per plant, number of secondary branches per plant, east-west spread of the plant, fresh weight of plant and yield per hectare.

Moosavi *et al*. (2013) carried out in research field of Islamic Azad University, Birjand Branch, Birjand, Iran in 2010 based on a randomized complete block design with three replications. The main plots were nitrogen rates at four levels (0, 40, 80 and 120 kg N ha^{-1}) and the sub-plots were plant densities at three levels (30, 40 and 50 plants m^{-2}). The results showed that nitrogen rate had

significant effect on fruit yield, essential oil percent and yield traits and interaction between nitrogen rate and plant density only affected fruit yield but change in plant density significantly affected all traits except essential oil percent. Means comparison showed that as N fertilization rate was increased from 0 to 80 kg N ha^{-1}, plant height and fruit yield were increased by 19.8 and 74.1 %, respectively. Moreover, means comparison showed that the increase in plant density from 30 to 50 plants m^{-2}, increased plant height, first fruit distance from ground and fruit respectively. Given the results of the study, the treatment of 80 kg N ha^{-1} application with the density of 50 plants m^{-2} recommended for the cultivation of coriander in Birjand, Iran.

Akbarinia *et al.* (2006), In a study of the effect of nitrogen rates and plant densities on fruit yield, essential oil percent and yield of coriander fruits concluded that the highest fruit yield was obtained by using 60 kg N ha^{-1} while the highest essential oil percent and yield were obtained with 90 kg Nha^{-1} application stated that fruit yield was higher in 30 plants m^{-2} densities. Nevertheless, Ghobadi and Ghobadi (2010) and Diederichsen (1996) reported the highest fruit yield of coriander at density 50 plants m^{-2}.

Chapter III

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in carrying out the experiment. It includes a short description of location of the experimental plot, characteristics of soil, climate and materials used for the experiment. The details of the experiment were described below:

3.1 Location and site of the experiment field

The field experiment was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh from November 2018 to February 2019 to evaluate the effect of nitrogen levels on the varietal performance on coriander (*Coriandrum sativum L.*). It is located at $90^0 22'$ E longitude and 23°4l′ N latitude at an altitude of 8.6 meters above the sea level. The land belongs to Agro-ecological zone of Modhupur Tract, AEZ-28 which is shown in Appendix I

3.2 Climatic condition

The experimental area is under the sub-tropical climate that is characterized by less rainfall associated with moderately low temperature during rabi season, October-March.

3.3 Soil condition

The soil of experimental area is situated to the Modhupur Tract under the AEZ - 28 and Tejgoan soil series. The soil was sandy loam in texture having pH 6.27 – 6.49. The physical and chemical characteristics of the soil have been presented in Appendix II.

3.4 Crop

Coriander (*Coriandrum sativum* L.) is an annual herb and according to the climatic conditions, is cultivated as a summer or winter annual crop. At flowering, the glabrous plant can reach up to 1.40 m. in height. The germination

is epigeal and the plant has a tap root. The stem is more or less erect and sympodial, monochasial-branched, sometimes with several side branches at the basal node. Each branch finishes with an inflorescence. The colour of stem is green and sometimes turns to red or violet during the flowering period. The stem of the adult plant is hollow, and its basal parts can reach a diameter of up to 2 cm. The leaves are alternate, and the first ones are often gathered in a rosette. The inflorescence is a compound umbel. Sometimes there are one or two linear bracts. The umbel has two to eight primary rays, which are of different length, in such a way that the umbellets are located at the same level. Coriander has an inferior ovary and five calyx teeth are of different length, as are the petals in peripherally situated flowers.

3.5 Seed

In this experiment Coriander variety of BARI Dhonia-1 and BARI Dhonia-2 were used as a planting material. BARI Dhonia-1 and BARI Dhonia-2 were developed by Bangladesh Agricultural Research Institute (BARI). The seed was collected from the Regional Spice Research Centre, BARI, Joydebpur, Gazipur.

3.6 Fertilizers

Manures and fertilizers were applied at the following doses as per Moniruzzman (2011). Fertilizers doses were as follows

Fertilizers	Doses
Cowdung	5t ha^{-1}
Nitrogen (N)	As per treatment
Phosphorus (P)	11 kg ha^{-1}
Potassium (K)	25 kg ha^{-1}

The entire amount of cowdung, phosphorus from TSP and potassium from MoP with the half of nitrogen was applied during final land preparation. The rest of the nitrogen was applied at 25 days after sowing of seeds as top dress.

3.7 Treatments of the experiment

The experiment consisted of two factors which were as follows

Factor A: 6 Nitrogen doses (N)

N_0 = 0 kg N ha^{-1}

N_1 = 20 kg N ha^{-1}

N_2 = 40 kg N ha^{-1}

N_3= 60 kg N ha^{-1}

N_4 = 80 kg N ha^{-1}

N_5 = 100 kg N ha^{-1}

Factor B: 2 Coriander varieties

V_1 = BARI Dhonia-1

V_2= BARI Dhonia-2

3.8 Treatment combination

There were 12 treatment combinations of different N doses and plant densities used in the experiment which were as follows:

1.	V_1N_0	7.	V_2N_0
2.	V_1N_1	8.	V_3N_1
3.	V_1N_2	9.	V_4N_2
4.	V_1N_3	10.	V_5N_3
5.	V_1N_4	11.	V_6N_4
6.	V_1N_5	12.	V_7N_5

3.9. Design and layout of the experiment

The experiment consisted of 12 treatment combinations and was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The unit plot size was 3 m x 1 m (3.00 m^2). The distance between block to block was 1 m and distance between plots to plot was 0.5m.

3.10. Land preparation

The land was ploughed well with power tiller for four times. Ploughed soil was then brought into desirable fine tilth and leveled by laddering. The weeds were cleaned properly. The final ploughing and land preparation were done on 14 November, 2018. According to the lay out of the experiment the entire experimental area was divided into blocks and subdivided into plot for the sowing of coriander seed. In addition, irrigation and drainage channels were prepared around the plot.

3.11. Sowing of Seed

The seeds (fruits) were for separating the two mericarps and soaked in water for 24 hours to enhance germination. Seeds were also treated Bavistin at the rate of 2g per kg of seeds before sowing. Sowing was done on 19 November, 2018 in rows as per treatments. Seeds were sown continuously in rows at the rate of 40 kg ha^{-1}. After sowing; the seeds were covered with soil and slightly pressed by hand.

3.12 Thinning and weeding

The optimum plant population was maintained by thinning excess number of plants from the rows at 15 days after sowing (DAS) maintaining 10cm distance between plants.

3.13 Irrigation

Two irrigations were given as plants required. First irrigation was given immediately after topdressing and second irrigation were applied 60 DAS. After irrigation when the plots were in zoe condition, spading was done uniformly and carefully to conserve the soil moisture.

3.14 Crop protection

The field was investigated time to time to detect visual differences among the treatments and any kind of infestation by weeds, insects and diseases so that

considerable losses by pest could be minimized. Diazinon 60 Ec was spayed twice at 15 days interval @ 2 ml L^{-1} of water to control aphid. Ssome plots started to die after rotting in the basal portion of the plant. For controlling this disease, Dithane M-45 was sprayed thrice at 10 days interval @ 2 g L^{-1} water.

3.15 Harvesting and threshing

Randomly selected ten plants, those were considered for data recording was collected from each plot to analyze the yield and yield contributing characters. The rest of the crops were harvested when 80% of the fruit in terminal matures. After collecting sample plants, harvesting was started on February 14 and completed on February 27, 2019. The harvested crops were tied into bundles and carried to the threshing floor. The crop bundles were sun dried by spreading those on the threshing floor. The seeds were separated from the plants by beating the bundles with bamboo sticks.

3.16 Drying and weighing

The seeds thus collected were dried in the sun for couple of days. Dried seeds of each plot were weighed and subsequently converted into yield kg/ha.

3.17 Data collection

Ten plants from each plot were selected as random and were tagged for the data collection. Some data were collected from sowing to harvesting with 20 days interval and some data were collected at harvesting stage. The sample plants were uprooted prior to harvest and dried properly in the sun. The seed yield and stover yield per plot were recorded after cleaning and drying those properly in the sun. Data were collected on the following parameters:

1. Plant height (cm)
2. Number of branches per plant
3. Number of umbels per plant
4. Number of seed per plant

5. 1000 seed weight (g)
6. Seed yield per plot (g)
7. Seed yield (kg/ha)

3.17.1 Plant height (cm)

Plant height was measured three times at 30, 50 and 70 after sowing (DAS). The height of the plant was determined by measuring scale considering the distance from the soil surface to the tip of the randomly ten selected plants and mean values were calculated for each treatment.

3.17.2 Number of branches per plant

The number of branches per plant was counted at harvest of coriander plants. Mean value of data were calculated and recorded.

3.17.3 Number of umbel per plant

The number of umbels from ten plants were counted and calculated as per plant basis.

3.17.4 Number of seeds per plant

The number of seed from ten plants were counted and calculated as per plant basis.

3.17.5 1000 seed weight (g)

A composite sample was taken from the yield of ten plants. One thousand seed of each plot were counted and weighed with a digital electric balance. The seed weight of 1000 was recorded in gram.

3.17.6 Seed weight per plot (g)

The separated seeds of plot were collected, cleaned, dried and weighed properly. The seed weight per plot was then recorded in gram.

3.17.7Yield tha^{-1}

After threshing, cleaning and drying, total seed from harvested area were recorded and was converted to tones per hectare

3.18 Post harvest soil sampling

After harvest of crop soil samples were collected from each plot at a depth of 0 to 15 cm. Soil sample of each plot were air-dried, crushed and passed through a two mm (10 meshes) sieve. The soil samples were kept in plastic container to determine the physical and chemical properties of soil.

3.19 Soil analysis

Soil samples were analyzed for both physical and chemical characteristics viz. organic matter, pH, total N and available P, K, and S contents. The soil samples were analyzed by the following standard methods as follows:

3.19.1 Textural class

Mechanical analysis of soil were done by hydrometer method (Bouyoucos, 1926) and the textural class was determined by plotting the values of % sand, % silt and % clay to the Marshall's textural triangular co-ordinate following the USDA system.

3.19.2 Soil pH

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 (Jackson, 1962).

3.19.3 Organic matter

Organic carbon in soil sample was determined by wet oxidation method of Walkley and Black (1935). The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and conc. H_3PO_4 and to titrate the excess $K_2Cr_2O_7$ solution with 1N $FeSO_4$. To obtain the content of organic matter was calculated by multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in percentage (Page *et al.*, 1982).

3.19.4 Total nitrogen

Total N content of soil were determined followed by the Micro Kjeldahl method. One gram of oven dry ground soil sample was taken into micro kjeldahl flask to which 1.1 gm catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10:

1), and 7 ml H_2SO_4 were added. The flasks were swirled and heated 160 ^{0}C and added 2 ml H_2O_2 and then heating at 360 ^{0}C was continued until the digest was clear and colorless. After cooling, the content was taken into 50 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar manner. These digests were used for nitrogen determination (Page *et al*., 1982).

Then 20 ml digest solution was transferred into the distillation flask, Then 10 ml of H_3BO_3 indicator solution was taken into a 250 ml conical flask which is marked to indicate a volume of 50 ml and placed the flask under the condenser outlet of the distillation apparatus so that the delivery end dipped in the acid. Add sufficient amount of 10N-NaOH solutions in the container connecting with distillation apparatus. Water runs through the condenser of distillation apparatus was checked. Operating switch of the distillation apparatus collected the distillate. The conical flask was removed by washing the delivery outlet of the distillation apparatus with distilled water.

Finally the distillates were titrated with standard 0.01 N H_2SO_4 until the color changes from green to pink.

The amount of N was calculated using the following formula:

$$\% \text{ N} = (\text{T-B}) \times \text{N} \times 0.014 \times 100 / \text{S}$$

Where,

T = Sample titration (ml) value of standard H_2SO_4

B = Blank titration (ml) value of standard H_2SO_4

N = Strength of H_2SO_4

S = Sample weight in gram

3.19.5 Available phosphorus

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.*, 1954). Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the

color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated the standard P curve (Page *et al*. 1982).

3.19.6 Exchangeable potassium

Exchangeable K was determined by 1N NH_4OAc (pH 7) extraction methods and by using flame photometer and calibrated with a standard curve (Page *et al*. 1982).

3.20Data analysis

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and mean separation were done by Least Significance Difference (LSD) test (Gomez & Gomez, 1986).

Chapter IV

RESULTS AND DISCUSSION

The experiment was conducted to investigate the potentiality of producing coriander as influenced by different nitrogen levels and varieties. Data of the different parameters were analyzed statistically and the results were presented in the Tables and Figures. The results of the present study were presented and discussed in this chapter under the following headings.

4.1 Plant height

The plant height of coriander was not significantly influenced by different variety (Fig.1). During the period of plant growth the tallest plant (75.14 cm) was observed in V_2 (BARI Dhonia-2) treatment and minimum (69.35 cm) in V_1 (BARI Dhonia-1) treatment (Fig.2). The varietal effect on plant height was supported by Haque (2005).

Significant difference in plant height was observed due to application of different level nitrogen (Fig.2). During the period of plant growth the maximum plant height (84.73 cm) was observed in N_3 (60 kg Nha^{-1}) treatment. On the other hand the shortest plant height (54.84 cm) was observed in N_0 (control) treatment. It is clear that all N levels maintained a lead over control with regard to plant height. It is also observed that plant height increased with the increase of nitrogen doses up to 60 kg Nha^{-1}. This corroborates the results of Moniruzzaman and Rahaman (2015), Szemplinski and Nawak(2015) obtained the maximum plant height at 100 kg N ha^{-1}.

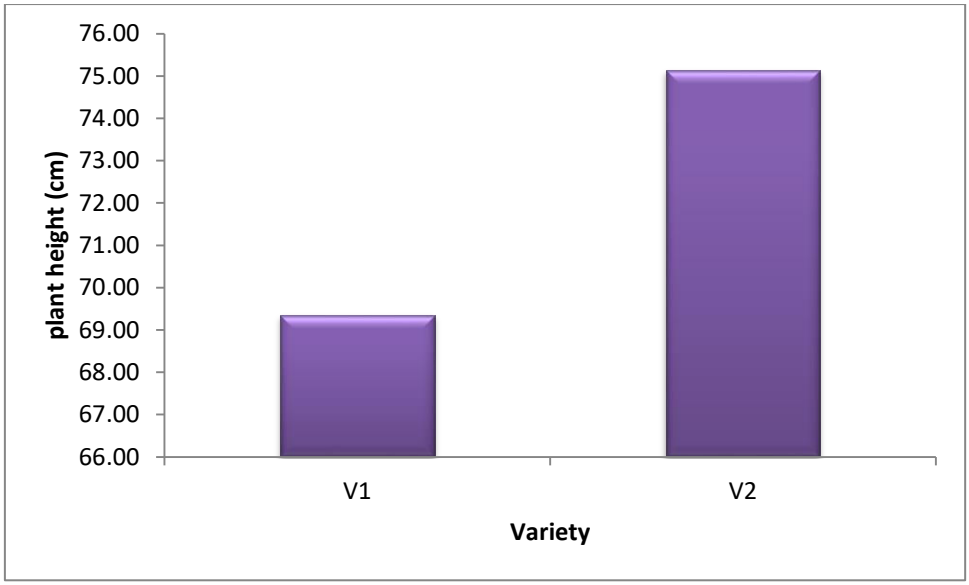

Fig. 1. Effect of variety on plant height of coriander

V_1= BARI Dhonia-1, V_2 = BARI Dhonia-2)

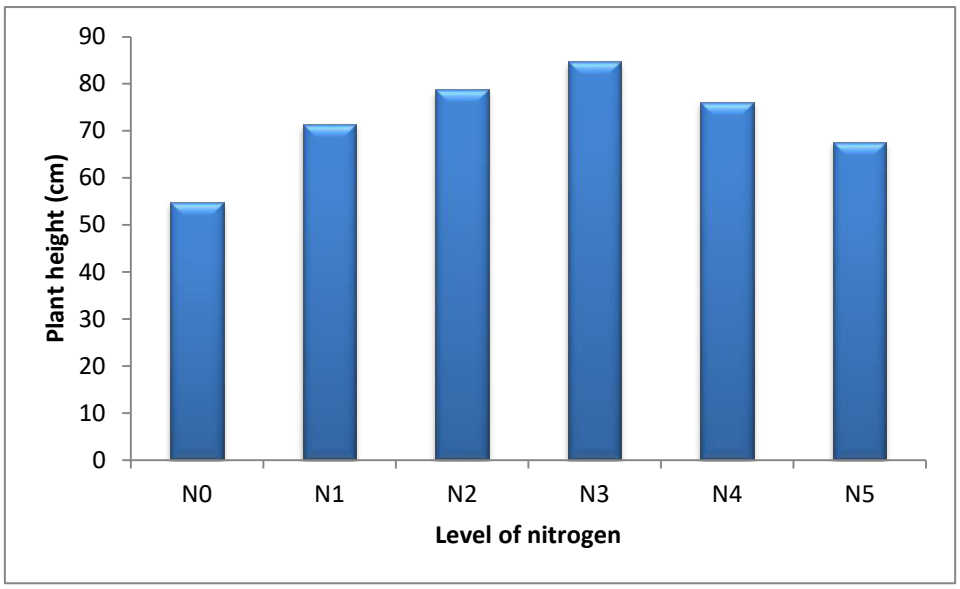

Fig. 2. Effect of nitrogen on plant height of coriander

(N_0= 0 kg ha^{-1}, N_1=20 kg ha^{-1}, N_2 = 40 kg ha^{-1} N_3 =60 kg ha^{-1}, N_4 =80 kg ha^{-1} N_5 =100 kg ha^{-1})

The plant height was significantly influenced by the interaction effect of variety and different doses of nitrogen (Table 1). The tallest plant (87.44) was found from the application 60 kg N ha^{-1} with BARI Dhonia-2 variety (V_2N_3), which was followed by V_2N_2, V_2N_1 and V_1N_3 treatment. The lowest plant height (50.48 cm) was obtained from no different doses of nitrogen application with BARI Dhonia-1 variety of coriander (V_1N_0).

4.2 Number of branch per plant

The number of branches per plant was influenced by variety of coriander (Fig. 3). However, the treatment V_2 produced maximum number of branches per plant (5.52) and the minimum (5.16) number of branches per plant was recorded in V_1 treatment.

Application of different doses of nitrogen had significant effect on number of branches per plant (Fig. 4). The N_3 gave the maximum number of branches per plant (6.23). The control treatment gave minimum (4.43) number of branches per plant.

Interaction of variety and different doses of nitrogen put a significant effect on number of branches per plant (Table 1). The maximum number of branches per plant (6.40) was obtained from V_2N_3 treatment while the minimum number of branches per plant (4.13) from V_1N_0treatment. There was significant difference observed among the other the treatment combination in respect of number of branches per plant.

Table 1. Interaction Effect of variety and nitrogen on plant height, number of branch, umbels per plant of coriander

Treatment	Plant height (cm)		Number of branch per plant		Number of umbella per plant	
V_1N_0	50.48	g	4.13	i	32.13	e
V_1N_1	67.82	de	4.87	gh	56.20	bc
V_1N_2	74.21	cd	5.53	cde	60.27	b
V_1N_3	82.03	abc	6.07	ab	71.27	a
V_1N_4	71.49	de	5.40	cdef	49.93	bcd
V_1N_5	70.09	de	4.93	fgh	47.27	cd
V_2N_0	59.19	f	4.73	h	43.33	d
V_2N_1	74.95	bcd	5.20	efgh	55.40	bc
V_2N_2	83.30	ab	5.80	bc	70.07	a
V_2N_3	87.44	a	6.40	a	80.13	a
V_2N_4	80.79	abc	5.73	bcd	52.73	bcd
V_2N_5	65.17	ef	5.27	defg	42.47	d
$LSD_{(0.05)}$	8.18		0.48		9.61	
CV (%)	6.68		5.33		10.3	

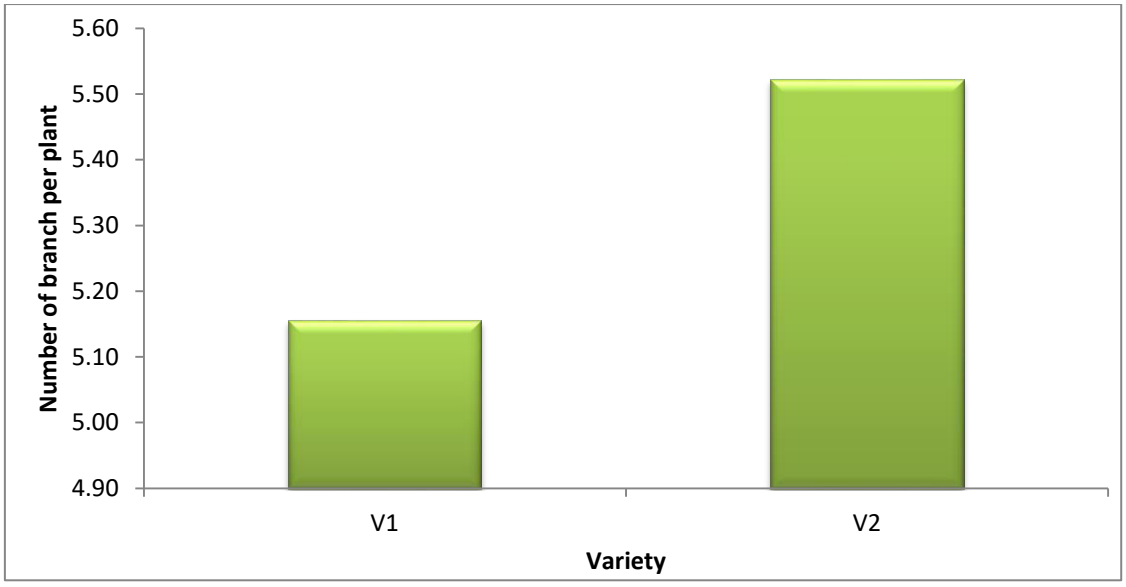

Fig. 3. Effect of variety on Number of branch per plant of coriander

V_1= BARI Dhonia-1, V_2 = BARI Dhonia-2)

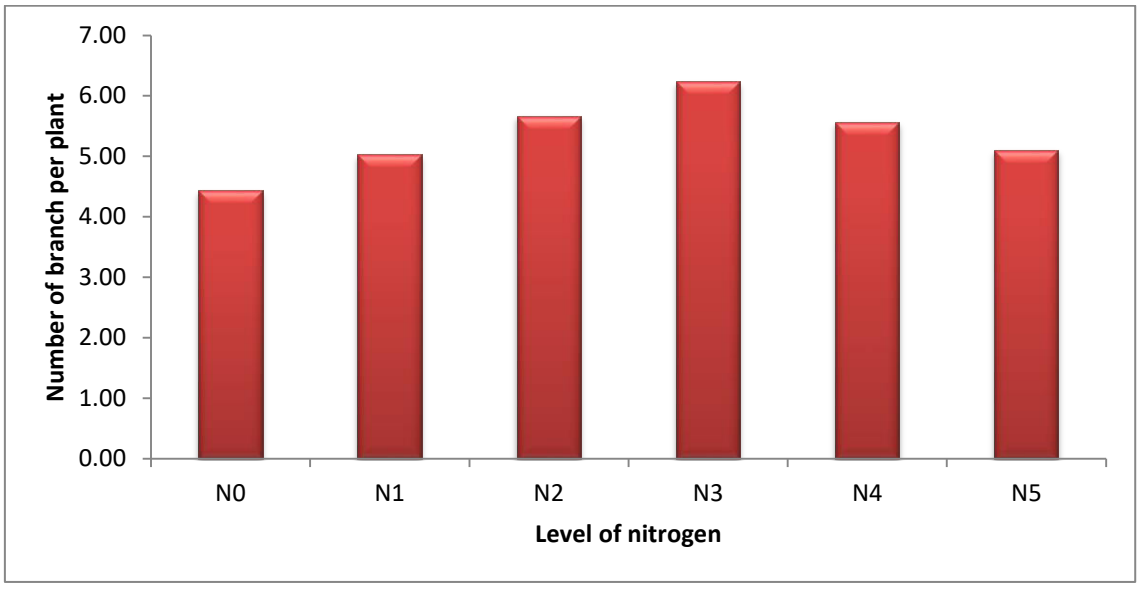

Fig. 4. Effect of nitrogen on Number of branch per plant of coriander

(N_0= 0 kg ha^{-1}, N_1=20 kg ha^{-1}, N_2 = 40 kg ha^{-1} N_3 =60 kg ha^{-1}, N_4 =80 kg ha^{-1} N_5 =100 kg ha^{-1})

4.3 Number of umbels per plant

The number of umbels per plant was influenced by variety (fig 5). The V_2 produced maximum number of umbels per plant (57.36) and the minimum (57.36) number of umbels per plant was recorded in V_1 treatment. Hossain *et al.* (1996) and Jahan and Zakaria (1997) also stated that there was marked statistical variation in numbers of umbels per plant.

Application of nitrogen significantly influenced the number of umbels per plant (Fig. 6). The maximum number of umbels per plant (75.70) was observed in N_3, and the minimum number of umbels per plant (37.73) was found in the N_0 treatment. This corroborates the result of Moniruzzaman and Rahman (2015).

The interaction effect of variety and nitrogen was significant in respect of number of umbels per plant (Table 1). The maximum number of umbels per plant (80.13) was recorded from V_2N_3 combination, which was statistically similar with V_2N_2 and V_1N_3 combination. On the other hand the minimum number (32.13) of umbels per plant was obtained from V_1N_0 treatment combination.

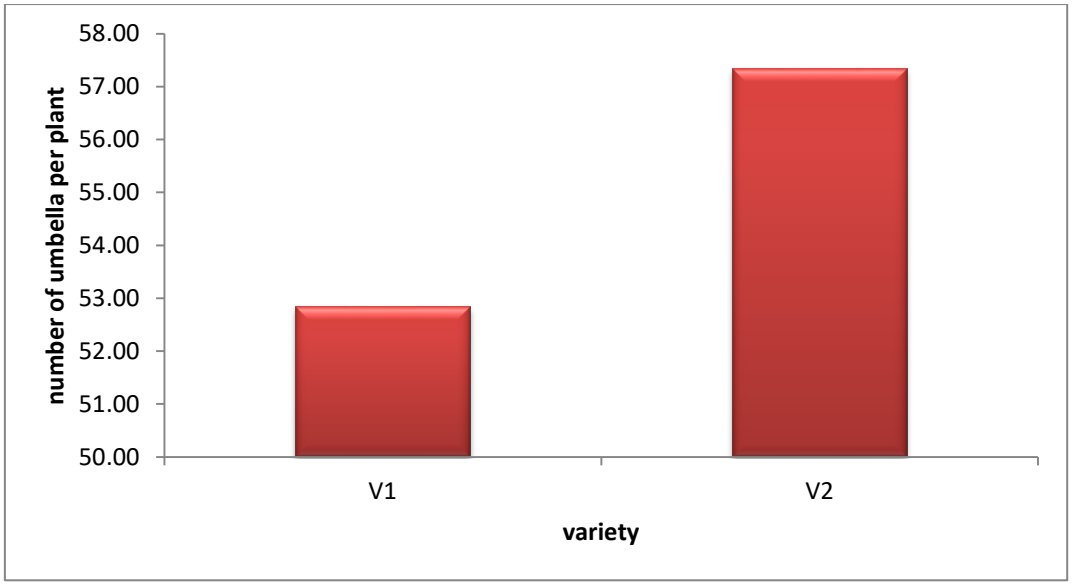

Fig. 5. Effect of variety on number of umbella per plant of coriander

V_1= BARI Dhonia-1, V_2 = BARI Dhonia-2)

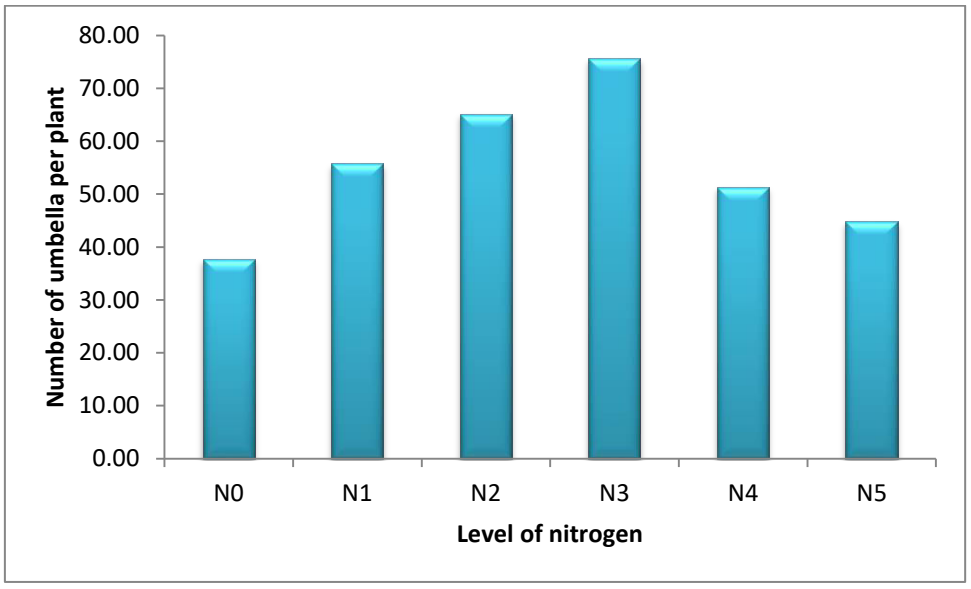

Fig. 6. Effect of nitrogen on Number of umbellae per plant of coriander

(N_0= 0 kg ha^{-1}, N_1=20 kg ha^{-1}, N_2 = 40 kg ha^{-1} N_3 =60 kg ha^{-1}, N_4 =80 kg ha^{-1} N_5 =100 kg ha^{-1})

4.4 Number of seeds per plant

The number of seeds per plant was influenced by variety (Table 2). Treatment V_2 produced maximum number of seeds per plant (860.81). The minimum number of seeds per plant (775.28) was recorded in V_1 treatment.

Application of different doses of nitrogen had significant effect on numbers of seeds per plant (Table 2). The treatment N_3 produced the highest number of seeds per plant (880.00) and the control treatment produced the lowest number of seeds per plant (754.30).

The interaction of effect of variety and different doses of nitrogen was found significant in respect of number of seeds per plant (Table 2). The highest number of seeds per plant (945.00) was obtained from the treatment combination of V_2N_3. The minimum number of seeds per plant (706.70) was found in the treatment combination of V_1N_0 treatment.

Table 2. Effect of nitrogen on yield and yield contributing character of coriander

treatment	Number seed per plant		Thousand seed weight (g)		seed weight per plot (g)		seed yield (kg/ha)	
Effect of variety								
V_1	775.28		9.83		417.22		1334.25	
V_2	860.61		10.36		429.72		1432.40	
CV (%)	5.94		7.54		12.54		8.75	
Effect of nitrogen								
N_0	754.30	e	8.5	c	309.2	d	1061.112	d
N_1	790.00	d	10.33	ab	431.7	bc	1238.872	c
N_2	835.00	b	10.83	a	455	ab	1516.657	b
N_3	880.00	a	11.42	a	507.5	a	1691.647	a
N_4	838.30	b	10.33	ab	463.3	ab	1544.447	b
N_5	810.00	c	9.167	bc	374.2	c	1247.223	c
LSD $_{(0.05)}$	13.71		1.224		62.19		59.11	
CV (%)	5.99		7.56		12.54		8.75	
Interaction effect of variety and nitrogen								
V_1N_0	706.70	f	8.33	f	293.30	d	1022.20	h
V_1N_1	760.00	e	10.00	bcde	426.70	abc	1038.89	h
V_1N_2	790.00	de	10.33	bcd	430.00	abc	1433.31	d
V_1N_3	815.00	cd	11.00	ab	505.00	a	1683.31	a
V_1N_4	800.00	cde	10.00	bcde	461.70	abc	1538.89	c
V_1N_5	780.00	de	9.33	cdef	381.70	bcd	1272.22	e
V_2N_0	802.00	cde	8.67	ef	325.00	d	1083.33	g
V_2N_1	820.00	cd	10.67	abc	436.70	abc	1455.54	d
V_2N_2	880.00	b	11.33	ab	480.00	ab	1600.00	b
V_2N_3	945.00	a	11.83	a	510.00	a	1699.98	a
V_2N_4	876.70	b	10.67	abc	465.00	abc	1550.00	c
V_2N_5	840.00	bc	9.00	def	366.70	cd	1222.22	f
LSD $_{(0.05)}$	41.42		1.29		89.94		39.83	
CV (%)	5.99		7.56		12.54		8.75	

4.5 Thousand Seed Weight

Thousand seed weight was not also significantly influenced by variety (Table 2).Treatment V_2 produced maximum thousand seed weight (10.36g) and the minimum (9.83g) thousand seed weight was recorded in V_1 treatment.

Different doses of nitrogen levels significantly influenced thousand seed weight (Table 2).However, the N_3 treatment produced the highest thousand seed weight (11.42 g), which was statistically similar with N_2 treatment and the control treatment produced the lowest thousand seed weight (8.50 g).

The interaction of variety and different doses of nitrogen was found significant in respect of thousand seed weight (Table 2). The highest thousand seed weight (11.83 g) was obtained from the treatment combination of V_2N_3 treatment. The minimum thousand seed weight (8.33) was found in the treatment combination of V_1N_0 treatment.

4.6 Seed yield per plot (g)

The seed yield per plot was also found to differ by variety. The maximum seed yield per plot (429.72 g) was obtained from V_2 treatment. The V_1treatment gave the minimum seed yield per plot (417.22g).

A significant variation was observed on seed yield per plot due to the use of nitrogen (Table 2). The maximum seed yield per plot (507.50 g) was recorded from N_3 (60 kg N^{-1}ha) treatment. The minimum seed yield per plot (309.20 g) was from the control (N_0) treatment.

The interaction of variety and nitrogen put significant effect on seed yield per plot (Table-2). The combination V_2N_3 gave the maximum seed yield per plot (510.00g) which was statistically similar with V_1N_3 combinations. Minimum seed yield per plot (293.30g) was produced V_1N_0, which was statistically similar with V_2N_0 treatment combination.

4.7 Seed Yield (kg ha^{-1})

The yield of coriander per hectare was varied by variety (Table 7). The highest yield (1432.40 kg ha^{-1}) was obtained from V_2 (BARI Dhonia-2) and the lowest yield (1334.40 kg ha^{-1}) was obtained from V_1 treatment. . Mendham *et al*. (1990) and Rahman (2002) also showed that seed yield was dissimilar due to varietal differences.

Yield of coriander varied significantly due to different nitrogen levels (Table 2). The maximum yield (1691.65 kg ha^{-1}) was recorded from 60 kg N ha^{-1} (N_3) treatment. This is in partial agreement with Moniruzzaman and Rahman (2015), Szemplinski and Nowak (2015) who got the maximum seed yield of coriander from the application of 80 kg $Nha^{-1.}$ Application of 120 kg Nha^{-1} gave the highest number of primary branches $plant^{1}$, number of umbels $plant^{-1}$, number of seeds $plant^{-1}$ and thus gave the maximum seed yield ha^{-1}.The minimum yield (1064.11 kg ha^{-1})was obtained found from control (N_0) treatment.

A significant combined effect of variety and different doses of nitrogen was also observed on yield of coriander per hectare (Table 2). The highest yield of coriander (1699.98 kg ha^{-1}) was obtained from $V_2N_{3,}$ which was statistically similar with V_1N_3 combinations. Minimum seed yield (1022.20 kg ha^{-1}) was produced V_1N_0, which was statistically similar with V_1N_1 treatment combination.

4.8 Nitrogen Concentration in Post-harvest Soil of Coriander Field

The effect of variety did not show a statistically significant variation in the N concentration in post-harvest soil (Table 3) of coriander field. The total N content of the post-harvest soil varied from 0.027% to 0.028 %. The highest total N content (0.028 %) was observed in V_2 treatment. The lowest value of N (0.027 %) was observed under control (V_1) treatment.

The effect of different doses of nitrogen fertilizer showed a statistically insignificant variation in the N concentration in post harvest soil (Table 3) of coriander field. The total N content of the post harvest soil varied from 0.021 % to 0.021 %. Among the different doses of nitrogen fertilizer, N_3 (60 $kgha^{-1}$) treatment showed the highest N concentration (0.031 %) in soil. The lowest value was 0.021 % under control treatment and N_0.

Interaction effect of different doses of nitrogen and variety on the N concentration was not observed significant in post harvest soil of coriander field (Table 3). The highest concentration of N in post harvest soil (0.031 %) was recorded in the treatment combination of V_2N_5. On the other hand, the lowest N concentration (0.017%) in post harvest soil was found in V_1N_0.

Table 3. Combined effect of variety and nitrogen on the total nitrogen, available phosphorus, exchangeable potassium concentrations in post-harvest soil

Treatment	Total N (%) NS	available P (ppm)		exchangeable K (meg/100g soil)	
Effect of variety					
V_1	0.0272			0.18	
V_2	0.0280	19.06		0.24	
CV (%)	5.580	7.27		6.69	
Effect of nitrogen					
N_0	0.021	12.09	c	0.09	b
N_1	0.028	16.13	abc	0.20	ab
N_2	0.028	17.42	ab	0.22	ab
N_3	0.031	14.51	bc	0.23	ab
N_4	0.028	19.42	a	0.24	ab
N_5	0.028	19.41	a	0.27	a
LSD $_{(0.05)}$	0.021	3.936		0.15	
CV (%)	5.580	7.27		6.69	
Interaction effect of variety and nitrogen					
V_1N_0	0.017	9.32	g	0.08	b
V_1N_1	0.028	10.74	fg	0.17	ab
V_1N_2	0.033	12.21	f	0.21	ab
V_1N_3	0.032	12.87	ef	0.21	ab
V_1N_4	0.029	18.62	c	0.22	ab
V_1N_5	0.026	19.83	bc	0.18	ab
V_2N_0	0.025	14.87	de	0.11	ab
V_2N_1	0.028	21.53	ab	0.23	ab
V_2N_2	0.024	22.63	a	0.24	ab
V_2N_3	0.030	16.15	d	0.25	ab
V_2N_4	0.027	20.21	bc	0.26	ab
V_2N_5	0.031	18.99	c	0.36	a
LSD $_{(0.05)}$	0.054	2.03		0.23	
CV (%)	5.580	7.27		6.69	

NS=Non Significant

4.9 Available Phosphorus Concentration in post-harvest soil of Coriander Field

The effect of variety showed a variation in the available P concentration in post harvest soil (Table 3) of coriander field. The highest available P content (19.06 ppm) was observed in V_2 treatment. The lowest value of available P (13.93) was observed under V_1 treatment.

The effect of different doses of nitrogen fertilizer showed a statistically significant variation in the available P concentration in post harvest soil (Table 3) of coriander field. Among the different doses of nitrogen fertilizer, N_4 (80 $kgha^{-1}$) treatment showed the highest available P concentration (19.42 ppm) in soil, which was statistically similar with N_5 treatment. The lowest value was 12.09 ppm under control treatment and N_0.

Significant interaction effect of variety and different doses of nitrogen on the P concentration was observed in post harvest soil of coriander field (Table 3). The highest concentration of available P in post harvest soil (22.63 ppm) was recorded in the treatment combination of V_2N_2. On the other hand, the lowest available P concentration (9.32 ppm) in post-harvest soil was found in V_1N_0.

4.10 Exchangeable potassium concentrations in post-harvest soil of coriander field

The effect of variety showed a variation in the exchangeable K concentration in post-harvest soil (Table 3) of coriander field. The exchangeable K content of the post-harvest soil varied from 0.18 to 0.24 meg/100g soil. The highest exchangeable K content (0.24) was observed in V_2 treatment. The lowest value of K (0.18 meg/100g soil) was observed under control (V_1) treatment.

The effect of different doses of nitrogen fertilizer showed a statistically significant variation in the exchangeable K concentration in post-harvest soil (Table 3) of coriander field. The exchangeable K content of the post-harvest soil varied from 0.09 to 0.27 meg/100g soil. Among the different doses of nitrogen fertilizer, N_5 ($100kgha^{-1}$) treatment showed the highest exchangeable K concentration (0.27 meg/100g soil) in soil. The lowest K value was 0.09 meg/100g soil under control treatment and N_0.

Significant effect of combined application of different doses of nitrogen and variety on the K concentration was observed in post harvest soil of coriander field (Table 3). The highest concentration of K in post harvest soil (0.36 meg/100g soil) was recorded in the treatment combination of V_2N_5. On the other hand, the lowest nitrogen concentration (0. 08 meg/100g soil) in post harvest soil was found in V_1N_0.

Fig: Field view of experimental plot.

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka to examine the effect of nitrogen on the varietal performance on coriander. The experiment consisted of two variety viz. V_1 = BARI Dhonia-1 and V_2 = BARI Dhonia-2 and six levels of nitrogen viz. 0, 20, 40, 60, 80 and 100 kg ha^{-1}. The experiment was laid out in Randomized Complete Block Design (factorial) with three replications. There were 12 treatment combinations in all.

Data on different growth, yield and post harvest soil analysis parameters a such as Plant height, number of branches per plant, number of umbel per plant, number of seed per plant, 1000 seed weight, seed yield per plot and seed yield per hectare and N, P, K concentration in soil were recorded and analyzed statistically.

Variety was influenced all parameter of coriander. The tallest plant (75.14 cm) was observed in V_2 (BARI Dhonia-2) treatment. The treatment V_2 produced maximum number of branches per plant (5.52). The V_2 produced maximum number of umbels per plant (57.36). The BARI Dhonia-2 produced maximum number of seeds per plant (860.81). The BARI Dhonia-2 produced maximum thousand seed weight (10.36g).). The maximum seed yield per plot (429.72 g) was obtained from BARI Dhonia-2. The highest yield (1432.40 kg ha^{-1}) was obtained from BARI Dhonia-2 and the lowest yield (1334.40 kg ha^{-1}) was obtained from BARI Dhonia-1. The highest total N content (0.028 %) was observed in V_2 treatment. The highest available P content (09.06 ppm) was observed in V_2 treatment. The highest exchangeable K content (0.24) was observed in V_2 treatment.

The plant height recorded significantly due to application of nitrogen application. During the period of plant growth the maximum plant height (84.73 cm) was observed in N_3 (60 kg Nha^{-1}) treatment. The N_3 gave the maximum number of branches per plant (6.23). The maximum number of umbels per plant (75.70) was observed in N_3 treatment. The treatment N_3 produced the highest number of seeds per plant (880.00). The 60 kg Nha^{-1} treatment produced the highest thousand seed weight (11.42 g). The maximum seed yield per plot (507.50 g) was recorded from N_3 (60 kg $N^{-1}ha$) treatment. The maximum yield (1691.65 kg ha^{-1}) was recorded from 60 kg N ha^{-1} (N_3) treatment. The minimum yield (1064.11 kg ha^{-1}) was obtained found from control (N_0) treatment. the different doses of nitrogen fertilizer, N_3 (60 $kgha^{-1}$) treatment showed the highest N concentration (0.031 %) in soil. N_4 (80 $kgha^{-1}$) treatment showed the highest available P concentration (19.42 ppm) in soil. N_5 (100$kgha^{-1}$) treatment showed the highest exchangeable K concentration (0.27 meg/100g soil) in soil.

All parameter was significantly influenced by the interaction effect of variety and nitrogen. The tallest plant (87.44) was found from the application 60 kg N ha^{-1} with BARI Dhonia-2 variety. The maximum number of branches per plant (6.40), number of umbels per plant (80.13), and number of seeds per plant (945.00), thousand seed weight (11.83 g) were obtained from V_2N_3 treatment. The combination V_2N_3 gave the maximum seed yield per plot (510.00g). The highest yield of coriander (1699.98 kg ha^{-1}) was obtained from V_2N_3. Minimum seed yield (1022.20 kg ha^{-1}) was produced V_1N_0. The highest concentration of total N in post harvest soil (0.031 %) was recorded in the treatment combination of V_2N_5. The highest concentration of available P in post harvest soil (22.63) was recorded in the treatment combination of V_2N_2. The highest concentration of exchangeable K in post harvest soil (0.36 meg/100g soil) was recorded in the treatment combination of V_2N_5.

The result of the present study generated some information which may help increase the higher seed yield of coriander. Hence, the present study may be concluded as follows:

I. BARI Dhonia-2gave the highest yield of coriander.
II. Application of 60 kg N ha^{-1} produced the tallest plant, maximum number of leaves $plant^{-1}$, branches $plant^{-1}$, umbels and seeds $plant^{-1}$ and gave the maximum seed yield of coriander.
III. Application of 60kg N ha^{-1} coupled with BARI Dhonia-2 gave the maximum seed yield.

RECCOMENDATION

i. Application of 60 kg N ha^{-1} in combination with BARI Dhonia-1was suitable for coriander cultivation.

ii. The study might be conducted at the same Agro Ecological Condition for the conformation of the result.

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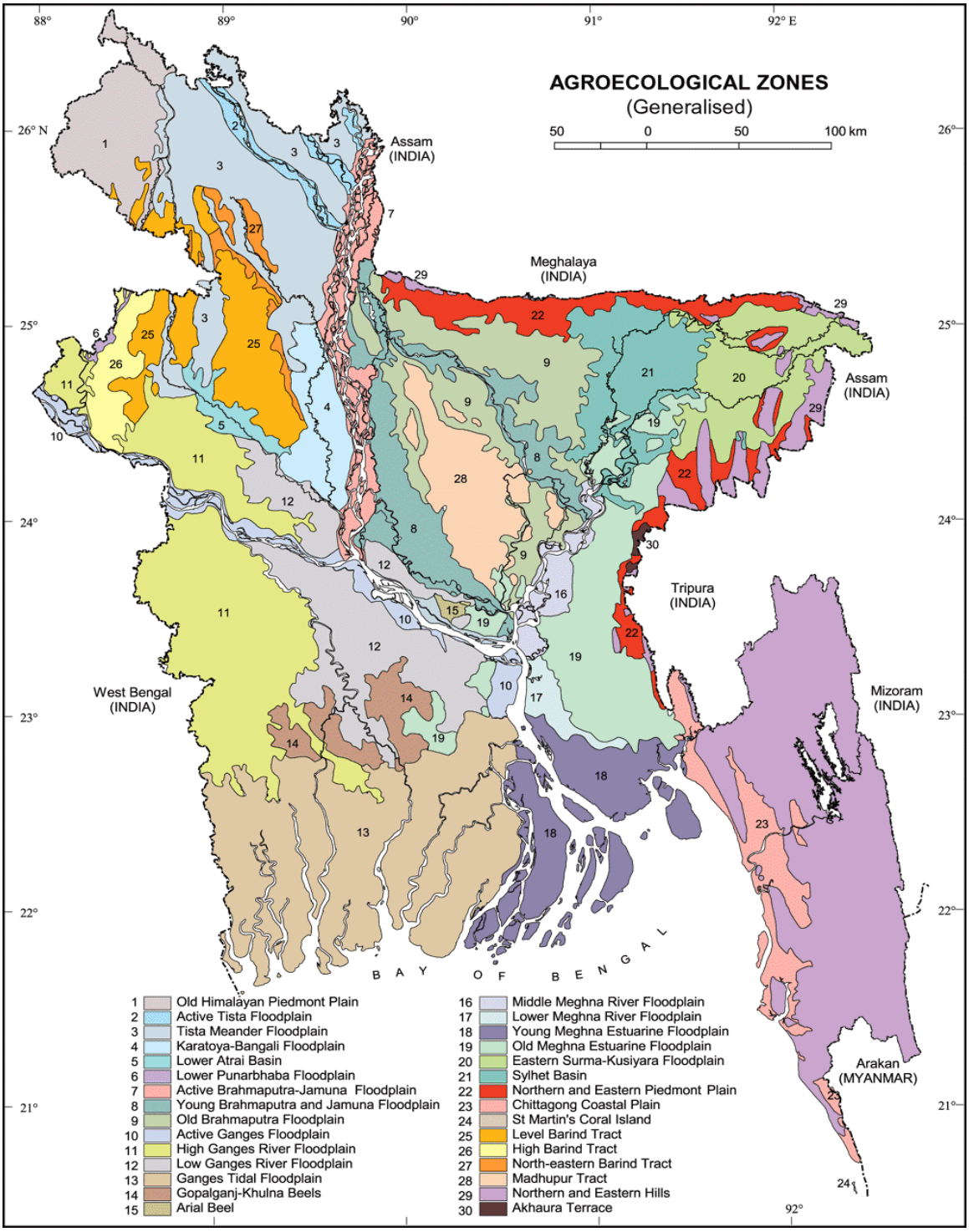
APPENDICES

Appendix I: Experimental location on the map of agro-ecological zones of Bangladesh



Appendix II: **Soil characteristics of Sher-e-Bangla Agricultural University Farm, Dhaka analyzed by Soil Resources Development Institute (SRDI), Farmgate, Dhaka**

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Farm, SAU, Dhaka
AEZ	Modhupur tract (28)
General soil type	Shallow Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	**N/A**

Source: Soil Resources Development Institute(SRDI)

B. Physical and Chemical properties of the Initial soil

Characteristics	Value
Practical size analysis	
Sand (%)	16
Silt (%)	56
Clay (%)	28
Silt + Clay (%)	84
Textural class	Silty clay loam
Ph	6.27-6.49
Organic matter (%)	0.25
Total N (%)	0.033
Available P (ppm)	22.63
Available K (me/100g soil)	0.66

Source: Soil Resources Development Institute (SRDI)