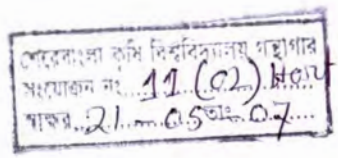
EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON THE GROWTH AND YIELD OF BROCCOLI

MD. ABDUR RASHID



DEPARTMENT OF HORTICULTURE AND POSTHARVEST TECHNOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

JUNE 2006

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON THE GROWTH AND YIELD OF BROCCOLI

By

MD. ABDUR RASHID
REGISTRATION NO. 25192/00319

A thesis
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 (M.S.)
IN
HORTICULTURE

SEMESTER: JANUARY–JUNE 2006

Approved by:

Prof. A.K.M. Mahtab Uddin
Supervisor

Dr. Md. Nazrul Islam
Co- supervisor

Dr. Md. Nazrul Islam
Chairman
Examination Committee

CERTIFICATE

This is to certify that the thesis entitled, "*EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON THE GROWTH AND YIELD OF BROCCOLI*" 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 HORTICULTURE*, embodies the result of a piece of bona fide research work carried out by *MD. ABDUR RASHID, Registration No. 25192/00319* under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:

(Prof. A. K. M. Mahtab Uddin)

Dedicated To
My
Beloved Parents

ACKNOWLEDGEMENTS

All praise, gratitude and thanks are due to the omniscient, Omnipresent and omnipotent Allah who enabled the author to complete this thesis successfully.

The author express his deepest sense of gratitude, sincere appreciation and immense indeptness to his supervisor Prof. A K M Mahtab uddin, for his guidance, constructive criticism and valuable suggestion in successful completion of the research work and preparation of this thesis. Profound gratitude is expressed to his honorable co-supervisor Associate Prof. Dr. Md. Nazrul Islam for the scholastic guidance and constant inspiration throughout the research work and preparation of this thesis.

He is thankful to Dr. Md. Nazrul Islam, chairman, Dept. of Horticulture and Postharvest Technology, SAU. The author express his cordial and most sincere gratitude to the Vice Chancellor of SAU and Postgraduate Dean ofSAU, taking initiative to open the MS courses in Sher-e-Bangla Agricultural University.

The author is highly grateful to Prof. Md. Ruhul Amin and Assistant Prof.Md. Hassanuzzaman Akond, Dept. of Horticulture and Postharvest Technology, SAU.

The author also express his heartfelt thanks to all the teachers of the Dept. of Horticulture and Postharvest Technology, SAU, for their help, valuable suggestions and encouragement during the period of the study.

Thanks are extended to his friends Md. Belal Hossain,Mehedi Mohai Men-ur Rahman, Md. Rasedul Islam, Md. Sadat Hossain, Hasanuzzaman, Mamun, Riton,Raju, Zubel and others friends for their help and inspiration. The author wishes to acknowledge his heartfelt in debthness and profound respect to his father Md. Hafiz Uddin and mother Ahema Begum for their sacrifice, blessings, patierce and encouragement and continuous prays for his success. The author express his sincere appreciation to his brother, sisters, relatives, well wishers and friends for their inspiration help and encouragement all time.

The Author

EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON THE GROWTH AND YIELD OF BROCCOLI

ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October 2005 to February 2006. The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications to study the effect of different levels of nitrogen and phosphorus on the growth and yield of broccoli. The growth and yield of broccoli were significantly influenced by the application of different levels of nitrogen. Phosphorus had a little effect on the vegetative growth of broccoli. But some yield contributing characters,such as, length of leaf, number of secondary curd, weight of secondary curd, yield per plot and yield per hectare were significant influenced by the application of different levels of phosphorus. The maximum average yield of 12.36 and 8.75 were obtained when the highest doses of nitrogen (180 kg /ha) and phosphorus (130 kg /ha) were applied independently. Different growth and yield parameters of broccoli were significantly influenced by the combined effect of nitrogen and phosphorus. The interaction effect of nitrogen and phosphorus on length of leaves, plant canopy, diameter of stem, weight of curd, weight of secondary curd nd yield per hectare were found to be statistically significant. The highest average yield (18.53 t/ha) was recorded in the plot receiving 180 kg N/ha and 130 kg P/ha, and the lowest yield (7.86 t/ha) was found from control teatment.

CONTENTS

CONTENTS (contd.)

CONTENTS (contd.)

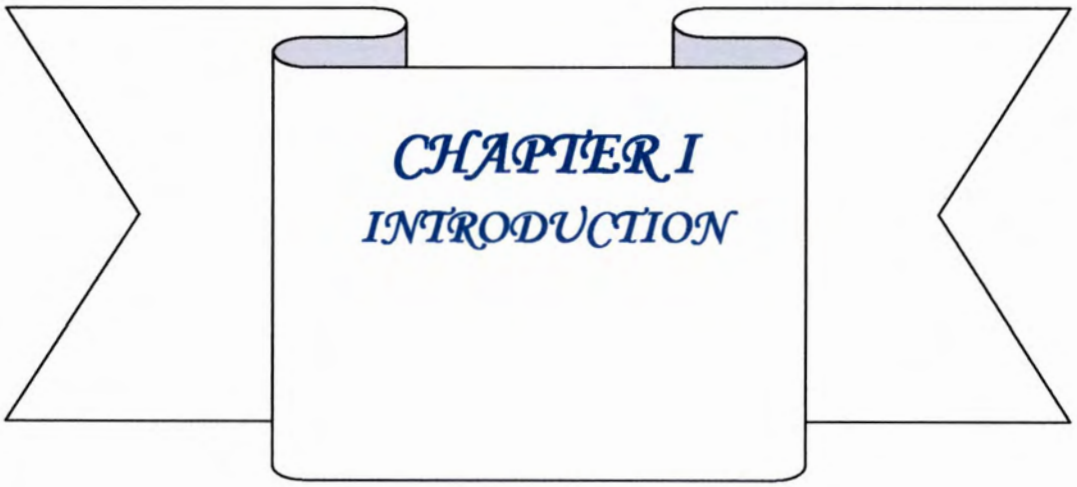
LIST OF TABLES

LIST OF FIGURE

LIST OF APPENDICES

LIST OF ABBREVIATED TERMS

FULL NAME	ABBREVIATION
Agro-Ecological Zone	AEZ
And others (at elli)	et al.
Bangladesh Bureau of Statistics	BBS
Centimeter	cm
Degree Celsius	°C
Duncan's Multiple Range Test	DMRT
Ton	T
Date After Transplanting	DAT
Etcetera	etc
Food and Agricultural Organization	FAO
Gram	g
Hectare	ha
Hour	hr
Kilogram	kg
Meter	m
Millimeter	mm
Month	mo
Murate of Potash	MP
Number	no.
Percent	%
Randomized Complete Block Design	RCBD
Sher-e-Bangla Agricultural University	SAU
Square meter	m^2
Triple Super Phosphate	TSP
Least significant Difference	LSD


CHAPTER I
INTRODUCTION

Chapter I

Introduction

Broccoli (*Brassica oleracea L.* var. italica plenk) is a member of the cruciferae family. Synonyms are B. *oleracea,* var. botrytis L. Sub var.*cymosa* and common names are sprouting broccoli, culubrese, asparagus broccoli, Italian broccoli and green sprouting broccoli. It is a horticultural hybrid closely related to cauliflower (Nonnecke, 1989). "Broccoli'' is an Italian word from the Latin brachium meaning an arm or branch. There are three classes of sprouting broccoli, namely green , white and purple, but the green type is the most popular (Shoemaker, 1962) . Broccoli is an important cole crop of Europe and USA, However, in India, broccoli is hardly considered as a commercial crop (Tindall, 1983; Nonnecke, 1989). It is grown a little in Bangladesh during the cool or rabi season. Broccoli is fairly rich in vitamin A and ascorbic acid and contains appreciable amounts of thiamin, riboflavin, niacin, calcium and iron (Thompson and Kelly, 1957; Lincoln, 1987). Analytical data presented by Nonnecke (1989) shows that sprouting broccoli contains more vitamins and minerals than those of other cole crops.

An early and rapid vegetative growth of plant is necessary for quality soft and succulent curd and stem of broccoli, which is believed to be influenced by the application of heterogeneous fertilizers to the soil . Experiments worked out by different researchers have shown that the total yield of the crop is greatly influenced by different doses of nitrogenous fertilizer (Thompson and Kely, 1957; Mital et al.1975; Pieters, 1976) Lincoln (1987) stated that broccoli stressed by inadequate soil nitrogen may develop button heads in which the terminal shoot fails to develop.

Thompson and Kelly (1957) stated that broccoli may need more nitrogen than cauliflower. Mitra *et al.*(1990) in trails with Green Comet hybrid seedlings found that yield , number of inflorescence, chlorophyll content and leaf nitrate reductase activity increased with the increase in nitrogen application from 56 to 112 kg/ha. Mitra *et al.* (1990) reported that increasing N rates from 56 to 224 kg/ha caused linear increase in broccoli head weight and total yield and decrease in cull yield. He obtained increased head weight from 127 to 157 (g) and increased head width from 8.8 to 9.7 cm with increased N rates (135 to 225kg/ha). Application of N and P substantially enhanced the terminal (central curd), lateral (axillary stalks) and total yield of broccoli and higher rates of N were effective when applied in combination with adequate P, while K application had slight but consistent effects on the terminal yield of broccoli (Mitra *et al.* 1990).

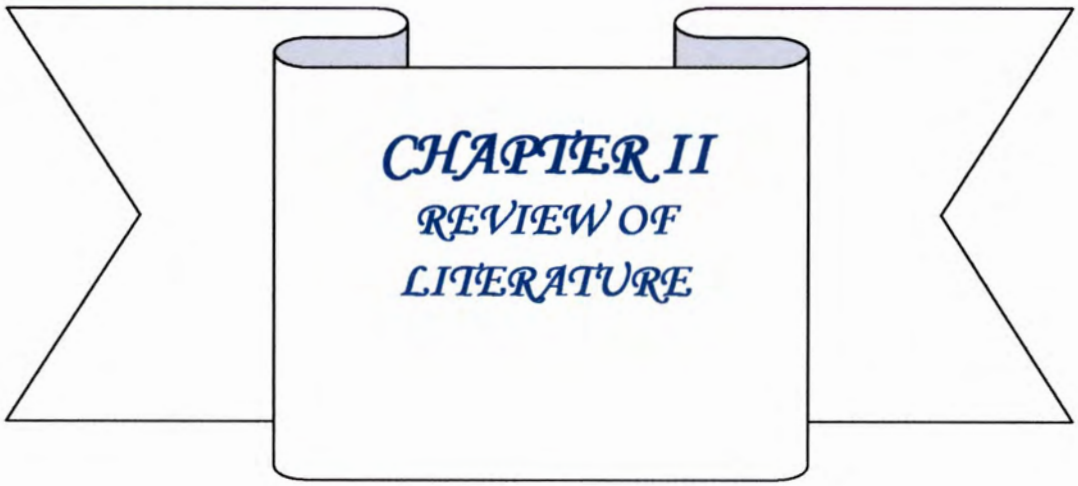
The horticulture division of BARI has evaluated a lot number of cultivars of broccoli and conducted experiments on different agronomical aspects (Anon., 1981; Anon., 1982. But little work has been done on fertilizer requirement especially N and P which is important for higher production.

Objectives:

The present study was undertaken to assess –

i) the effects of different levels of nitrogen and phosphorus on the growth and yield of broccoli, and

ii) to find out the optimum levels of the nutrients for profitable production.



CHAPTER II
REVIEW OF LITERATURE

Chapter II

Review of literature

Broccoli is a vegetable crop and is grown in rabi season. Its growth and yield is remarkably influenced by mineral nutrition especially nitrogen and phosphorus. Information on this crop is vary scanty in Bangladesh. Some of the pertinent literatures in this regard have been reviewed and presented in this chapter.

Mitra *et al.* (1990) stated that nitrogen application (90 kg/ha) greatly enhanced the yield of broccoli. In Green Comet hybrid seedlings it was found that yield, number of inflorescence, chlorophyII content and leaf nitrate reductase activity increased with the increase in N application from 56 to 224 kg/ha. Increasing N rates from 56 to 224 kg/ha caused linear increase in broccoli head weight and marketable yield and decrease in cull yield. It is also reported that orthogonal comparisons of N rates effects with held constant, orthogonal comparisons of population effects with N rate held constant. Mitra *et al.* (1990) observed higher head yield by application of N at 225kg/ha as conventional preplant and side dressing than by injecting N in the irrigation water. Higher incidence of hollow stem was recorded with the increasing rates of N application.

It was also reported that increasing nitrogen rates (135 to 225 kg/ha) increased head weight from 127 to 159, increased head width from 8.0 to 9.7 cm, increased length and width of hollow stem, but did not significantly increase the incidence of hollow stem. They also reported that the increase in total chlorophyII content was resulted from increasing rates of N application (225kg/ha).

It was reported that , increasing rates of N from 150 to 300 kg/ha gave higher yield, but decreased sugar and dry matter contents. However, the external quality of the curd and ascorbic acid content was not affected by the rates of N.

Mitra *et al.*(1990) also described higher yield of curd following application of N at the rate of 150 to 250 kg/ha Roy (1981) reported an increased curd diameter from 15.1 - 20.2 cm and yields from 108.3-2614 kg/ha by increasing the levels of N from 50-200kg/ha in a period of 3 years with cv. Dania. He, however , suggested 100kg/N ha as the most economical N rate which gave a yield of 251 kg/ha, the diameter of curds being 20 cm.

Mitra *et al.* (1990) stated that a yield of 51.5 tons/ha was obtained by applying nitrogen, phosphorous and potassium at the rate of 100, 50 and 50 kg/ha, respectively, compared with 33.5 tones/ha with 50 kg N, 25 kg P and 25 kg K/ha.

Magnifico *et al.* (1979) carried out a fertilizer experiment on growth and nutrient removed by broccoli in the United States of America and found that broccoli plants removed 559 kg N, 23 kg P_2O_5 and 723 kg K_2O/ha . The total yields were 1,48,400 kg/ha fresh materials and 16,900 kg/ha of dry matter.

El-Behedi and El-Nansi (1975) conducted an experiment on the effect of nitrogen level and spacing on broccoli yield. The crop was planted at 50, 70 and 90 cm in the row and supplied with N at 0,20,40 and 60 kg. The highest N rate increased the total and early yields.

Thompson and Kelly (1957) indicated that broccoli may need more nitrogen than cauliflower, especially late in the growing season. A highly of side shoots can be obtained by liberal side –dressing of nitrogen after the central head is cut.

Rajput and Singh (1975) carried out an experiment in India and obtained higher head yield and increase in growth with the increasing rates of N application. Application of 60 kg N/ha as basal dose followed by two to dressings with 30 kg N/ha each showed marked results related to yield of broccoli. The results of foliar application were inferior to other methods of application.

In a 3 year trial conducted by Peiters (1976) at several places, sprouting broccoli received a basic dressing of N at 50 kg/ha supplemented by further incremental doses totaling 250 kg/ha, applied 1,3 and 4.5 months after planting. The highest yield were obtained with a total application of 300kgN/ha, a high proportion of the supplementary doses being applied early.

Lincoln (1987) reported that broccoli stressed with inadequate soil nitrogen may develop button heads in which the terminal shoot fails to develop. He also reported that substantial increases in growth rate take place during the transition to reproductive growth and as the terminal head nears maturity. Fertilization practices must ensure adequate nutrients, excessive nitrogen must be avoided it can increase the incidence of hollow stem.

Lewandowaska and Shakpski (1977) conducted a series experiments on broccoli to investigate into the effect of variety, spacing and levels of nitrogen fertilization on the quality and yield. In their studies with broccoli cultivars, the plants were planted at a density of 9, 7, 5, 4.5 and 3 /m^2 and supplied with N at the rate of 100,200 and 300 kg/ha and PK basal dressing. The total and marketable yields increased with plant density from 3 to 9 plants per m^2.

Mital *et al.* (1975) observed the response of broccoli to nitrogen and row spacing in India. In a 2- year trial, the effects of N at the rate of 40, 80 and 120 kg/ha and row

spacing of 30, 45 and 60 cm were obtained . Yield was the highest with 80kg N/ha and 45 cm row spacing. Curtliffe (1975) reported that raising N application from 89.7 to 269.1 kg/ha greatly increased the incidence of hollow stem (30-60%).

Simon (1976) conducted an experiment on the effects of gradual incremental rates of nitrogen and irrigation on the yield of broccoli. He observed that N application had a greater effect on yields than irrigation. Raising N rates increased yields and earliness proportionately.

Mathur *et al.*(1976) observed in their experiments conducted in India on the effect of different spacing-cum-nitrogen doses on the yield of broccoli that, plants spaced at 45 x 45,61 x 61 and 76 x 76 cm yielded 14317,10331 and 8077 kg /ha respectively. They also reported that the response of plants to N in the range of 50-150 kg/ha was found to be insignificant.

The vegetables section of BARI (Annon, 1981) conducted an experiment to observe the response of different levels of nitrogen on the growth and yield of broccoli and found the best yields by increasing the rate of nitrogen application up to a certain limit.

Broccoli cv.Appollo produced average individual head weight of 0.87 lb by the application of N , P and K at the rate of 300, 100 and 150 kg/ha, respectively as mentioned by Mitra *et al.*(1990).

Rajput and Singh (1975) suggested application of N at 60 kg/ha as a basal dose followed by top dressing with 30 kg N, 30 and 40 days after transplanting for cauliflower cv. Snowball -16.

Sharma and Arora (1984) in a trial with cv. Improved Japanese reported increased day matter yield and curd yield by increasing the nitrogen level from 0 to 180 kg/ha. Application of half dose of N at transplanting and the rest 40 days later showed higher yield than application of the entire dose of fertilizer at transplanting.

Steffen *et al.*(1994) carried out an experiment , on short –term and log-term impact of an initial large scale spent mushroom soil (SMS) amendment on vegetable crop productivity and resource use efficiency at Pennsylvania University,USA. They observed the effect of organic matter (spent mushroom compost at 64 mt/ha+ rotten cattle manure at 57 mt/ha, applied in spring 1990 on growth and yield of broccoli. No fertilizer or other amendments were added to previously amended treatments, but 100% recommended NPK was added to all control treatments in all years. Broccoli yield and head diameter were greater in the amended treatment.

Maynard (1994) conducted an experiment on sustained vegetable production for three years using composted animal manures. Intensive broccoli production trails in spring summer and autumn were conducted for 3 years in Connecticut Windsor (Sandy trac soil) and Mt. Carmel (loamy upland soil) following annual application of spent mushroom compost (SMC) or chicken manure compost (CMC) applied at either 56 or 112 t/ha as the sole source of nutrients. Yields of broccoli from these amended plots were compared with yields from control plots receiving NPK fertilizer. Yields of broccoli increased with the rate of compost. Compost analysis and broccoli yields are tabulated. The average yields of spring broccoli and autumn broccoli on all CMC – amended plots at both rates and sites in all three years, were equal to or greater than yields from the control plots.

Bracy *et al.*(1995) reported that field trails were conducted on direct –sown broccoli cv. Early (Dawn) during the autumn of 1991 and 1992. The effects of preplanting NPK fertilizer at a rate of 45kg N + 59kg P + 112 kg K and 90 kg N + 118 kg P + 118 kg P +224 kg /ha plus side dressed N fertilizer at 134, 196 or 258 kg/ha, either dropped onto or knifed into the bed were determined. The marketable yield, early yield, head weight and percentage of early to total yield were unaffected by fertilizer rate or method of application.

Brown et al (1994) in a field experiment on sandy loam soil in 1988- 89 at Crossville , Alabama applied 20 or 40 t/ha broiler litter or recommended NPK fertilizer in Sweet corn cv. Silver queen matured 1 week earlier in both years with 40 t broiler litter than with NPK fertilizer. This was related to improved P. nutrition.

Megnifico-v. *et al.*(1993) conducted a field trial on a silty clay soil at Policoro (Madtera) from January 1976 to September 1980 with broccoli, spinach, snap beans and picking cucumbers grown in rotation comparing 12 NPK fertilizer rates and 3 herbicides (For each crop) . Trifulralin, Chlorthal [-dimethy1] and Nitrofen were used on broccoli; Lenacil, Cycloate and Chlorbufam + Cycluron were applied on Spinach ; Trifluralin Alachlor and Nitrogen were applied on snap beans ; and Trifuralin, Chlorthal and Asulam were applied on cucumbers. Over the 5 years, 17 crops were grown : 4 of broccoli , 3 of spinach, 5 of snap beans and 5 of cucumber. An average of 94 days were needed for broccoli , 85 for spinach, 65 for beans and 58 for cucumber , a total of 302 days/ year/ The effects of sowing / transplanting dates and harvesting and the residual effects of herbicides were examined . Yields of each species varied widely and were mainly influenced by fertilizer rates and not herbicides. Cucumber was the only crop to show phytotoxicity from herbicides used

earlier on spinach. It was concluded that this intensive system could not be recommended to farmers since it required very careful planning and yields depended on a number of contingencies.

Demchak and Smith (1990) reported from field experiments conducted at Rock Springs. Prnnsyvania, Broccoli, cv. Green Comet was grown on plots to which 3 types of lime (calcitic lime, a 3 : 1 ratio of calcistic : dolomit1e lime, or dolomitic lime) had been applied at 4.5t/ha in 1972,1974 and 1978, and 56 kg N+ 56 kg P, 56 kg N + 56 KgN + 112 kg P + 56 kg N + 112 kg P + 56kg N/ha were applied in bands 10 cm to the side of plants and at depth of 10 cm. Fertilizer and lime control were included . Previous liming had raised the soil P^{H} from 5.3 to 7.2 – 7.4. The effects of liming on yields were greatest when on fertilizer was applied. Diplomatic lime was the most effective liming metrical increasing total yield by 49 %, terminal shoot weights by 54% and hastening maturity. Fertilizer effects were most evident when no lime had been applied with all fertilizer treatments increasing total yield, terminal shoot and plant weight , and hastening maturity. There were no significant differences between the 3 fertilizer treatments with respect to those of fertilizer when lime had been applied were less consistent. Lime alone, especially types containing My increased leaf P content, which generally followed the same trend as total yield. Calcites lime increased leaf Ca content and dolomites lime increased leaf Mg content compared with other lime treatments. The 3 : 1 calcites : dolomites lime treatment increased leaf Ca content but not leaf content compared with the control. All lime treatments decreased leaf Men, B and Zn contents. Fertilizer treatments usually increased leaf N and MP contents. P uptake was increased by either lime or fertilizer application. Regression analysis strongly suggested that P was the element most responsible for yield increases.

Sumiati (1988) stated that seedlings of broccoli cultivars Green King and Mikado were transplanted into Jiffy posts or into a 1 : 1 mixture of stable manure and soil supplemented or not supplemented with NPK compound fertilizer (15: 15: 15) and /or Metallic . There are no differences between cultivars in plant height, root length, LAI NAR and RGR at 2.3 or 4 weeks after transplanting . These factors were all highest at all stages in plants grown in manure + soil supplemented with NPK + Metallic and were generally lowest in plants grown in Jiffy pots. Interactions between cultivars and treatments on LAI, NAR and K uptake at 4 weeks after transplanting were noted.

Burghardt and Ellering (1986) observed that under sub-optimal total nutrient supply, a foliar fertilizer (12 N: 4 p : 6 K) at concentrations up to 15% was tolerated, without leaf damage by dwarf beans, carrots, beetroods, endives, broccoli, leeks and white cabbages. These concentrations were equivalent to > 100 kg N / ha. Plant development and leaf color improved and yields increased by 12 to 74%. Crop quality was unchanged in most crops by foliar spraying, but it improved in beetroots and leeks. Leaf nitrate content was little affected by foliar spraying.

Simoes et al (1993) reported that nursery an field trails were conducted on broccoli cv. Green Duke to investigate the effects of container size and substance on transplant growth and subsequent field performance. In the nursery the variables analyzed were plant height, leaf dry weight and leaf area per plant. In the field, the final yield the number of plants with heads, and the marketable yield at 2 different harvest dates were assessed. It was found that containers 21-31 mm wide and 71-75 mm deep, in combination with rich substrates (180-210mg N 120-240 mg P2O5 and 220-270 mg K_2o/litre) produced the best results.

Santamaria –P et al. (1994) in a crop rotation (spinach/beans/broccoli), begun in 1976 at Policoro, observed the effects of applying 100 or 200 kg N/ha and triflurain, chlorthal- dimethyl or oxfluorfen or broccoli cultivars X PH 4142 and 89006 in 1991. Trifluralin and oxyfluorfen were applied at 2 litres/ha and chlorthal dimethyl at 15 litres/ha. Comparsion was made with an unwedded control. Growth was at a maximum when the central head was almost ready for harvesting. Yield and central head quality were higher at the higher N rate. Chlorothal-dimethyl adversely affected both yield and quality at the lower N rate. Trifluralin and oxyflorfen had no adverse effect on yields.

Liu and Shelp (1993) reported a three year study conducted with field-grown broccoli (cultivars Emperor, Baccus and Commander, differing between trails) under different management regimes,i.e various NH_4 + : NO_3- ratios the addition of the nitrification inhibitor nitrapyrin, and B nutrition (rates and application methods) None of the treatments influenced the harvestable yield or the N composition I NO_3- NH_4 +, amino acids and protein) in xylem and phloem saps and plant tissue. The total N and the mol% NH_4 + in the xylem diminished over the growing season. NH_4 + constituted up to 20% of the N in the xylem, suggesting that this from of N as well as NO_3- was absorbed from the soil. The substantial recovery of NO_3- in xylem sap (30-70% N) indicated that , with an adequate supply of N, at least part of the incoming NO_3- was reduced in the shoot tissue. Concentrations of all N components in the tissues declined as growth advanced, from the base to top of the: hoot. The concentrations of NO_3- in the florets ranged from to 154 mg N /kg.fresh weight, and were considered to be beneath the permissible maximum levels by European standards, whereas some of these in the foliage exceeded the permissible levels. There were significant cultivar differences in NO_3- accumulation within and between the study sites. The B

concentrations in the florets ranged from 29 to 42 mg / kg dry weight even when no B was applied to the plants, the values being generally considered as adequate.

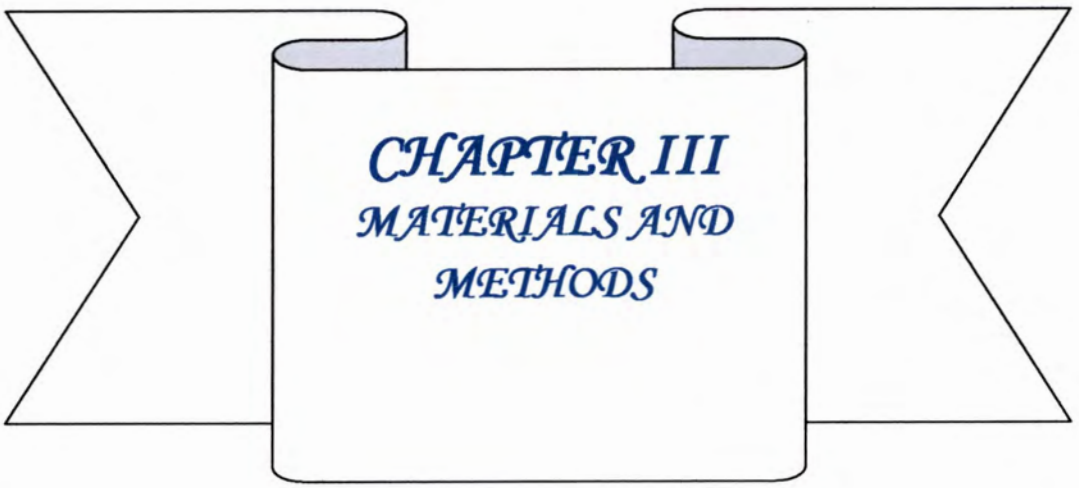
Magnifico et al. (1989) reported the growth and accumulation of macro- and micro elements in various stages of the cultural cycle of 2 cultivars of broccoli in Southern Italy. Plant samples were obtained every 2 weeks beginning at the time of thinning and contenting for 112 and 126 days, respectively, for cultivars Dig Geniis and Did Mario. Despite the different cultural recycle, the cultivars were similar in yield and element uptake. On a per hectare basis the plants removed about 460 kg N,140 kg P_2O_5, 692 kg K_2O,330 kg ca, 75 kgNa, and 42kg Mg. Microelement removal by Die Gennaio was 77kg S, 20 kg Al, 12kg Fe,1 kg Mn,479g Zn, 443 g So, 411 g B,72g Cu, 26g Mo, 23 Ni, and 20gCa. Total growth averaged 136 t/ha fresh material, which included 14 t/ha of main heads, 28 t/ha of secondary heads, and 14 t/ha day matter. The highest removal rates were recorded from flower stem emission to main head production.

Tremblay (1989) reported the effects of N source and rate on *Brassica oleracea* sp. Italic cv. Green Valiant in 2 years and on 2 soils. $NH_4 NO_3$, Ca $(NO_2)_2$, $(NH_4)SO_4$ and $Co(NO_2)_2$ were side- dressed in a factorial in a arrangement with N rates of 75, 150 and 225kg/ha. Increasing N rates resulted in resulted in greater vegetative growth but also in hollower stem development. In a swarm dry year, however, on a soil of near optimal pH, hollow stem development increased more with N rate than did marketable yield. In such conditions therefore, it was suggested to reduce N application. Nitrate congaing sources increased yields by 4% but induced 13% more hollow stem, and no N source produced high yields with minimum hollow stem. The

effect of N source was not a function of year or N rate; it would not therefore be advantageous to modify N rate according to N source.

Kowalenko (1983) stated that head yield increased linearly in response to up to 250kg N/ha without preferentially increasing vegetative growth. The maximum yields from nitrogen application had probably not been attained.

Letey *et al.* (1983) reported that two furrow irrigation experiments were conducted with the cv . Green Comet. The first consisted of 3 n rates 990, 180 and 270kg/ha), 2 irrigation treatments 9replenishment of water lost by evapotranspiration and evapotranspiration plus 30%) and 2 N application 9 to the soil or in the irrigation water). Plant growth increased with rising n rates. For a given N application, the average production was higher with the lesser amount of water. N application method had very little effect on production under low irrigating level but production was consistently higher for N application with water than to the soil at the high irrigation level. The ratio of N in the plant to N applied decreased with increasing N rate, with higher water application, and with N application in the irrigating water compared with soil application. The seconded experiment consisted of 2 N rates (115 and 225kg/ha) and 2 N application methods 9 to the soil or in the irrigation water) . Yield and N uptake were significantly higher with the higher n rate. Conventional pre-plant and side-dressing application to the soil resulted in significantly higher broccoli yield than injecting N into the irrigating water. Leaching of N was not a factor under the experimental conditions reported.



CHAPTER III
MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

Broccoli & cauliflower are cole crop and are commonly grown in the winter in Bangladesh. Cauliflower is a tasty & very much popular vegetable, being cultivated in large scale during growing period. Broccoli is also a tasty vegetable with an important source of vitamins and minerals. In Bangladesh, broccoli is being grown in a very limited scale, but a good deal of interest has been generated among for raising this crop due to its demand in foregin markets. It is necessary to explore the possibilities of growing broccoli in order to raise it yield level. So, this experiment has undertaken to find out appropriate or optimum nutrient supliment for exploiting the yield potential of this crops.

3.1 Experimental Site

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from September 2005 to February 2006. The experimental site was previously used as vegetable garden and recently developed for research work. The location of the site is 23° 74´ N latitude and 90° 35´ E longitude with an elevation of 8.2 meter from sea level (Anon 1981).

3.2 Climate

The climate of the experimental site is subtropical, characterized by heavy rainfall during the months from April to September (Kharif season) and scanty rainfall during the rest of the year (Rabi season). The total rainfall of the experimental site was 218 mm during the period of the experiment. The average maximum and the minimum

temperature were 29.45°C and 13.86° C respectively during the experimental period. Rabi season is characterized by plenty of sunshine. The maximum and minimum temperature, humidity rainfall and soil temperature during the study period were collected from the Bangladesh Meteorological Department (climate division) and have been presented Appendix v.

3.3 Soil

The soil of the experimental area belongs to the Modhupur Tract. The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka have been presented in appendix II.

The experimental site was a medium high land and pH of the soil was 5.6. The morphological characters of soil of the experimental plots as indicated by FAO (1988) are given below –

AEZ No. 28

Soil series – Tejgaon

General soil- Non-calcarious dark grey.

3.4 Plant Materials

Broccoli cultivar, Satomiduri (Takki company of Japan) was used in the experiment.

3.5 Raising of seedlings

For raising of seedlings, the soil was ploughed and converted into loose friable and dried messes were removed. All weeds, stubles and dead roots were removed. Cowdung manures was applied to the prepared seed beds at the rate of 10 t/ha.

The seeds were sown in the seed beds of 2.5m x 1m size on 16 October 2005. After sowing, the seeds were covered with a thin layer of soil. When the seeds were germinated, shade by bamboo mat (Chatai) was provided to protect the young seedlings for scorching sun-shine and rain. Light watering, weeding and mulching were done as and when necessary. No chemical fertilizers were applied for raising of the seedlings. Seedlings were not attacked by any kind of insects or diseases.

The healthy 21 days old seeldings were transplanted in the experimental field on 6 November 2005.

3.6 Land preparation

The experimental plot was opened first on the 2nd week of October 2005 by a power tiller for growing the desired crop. It was then throughly prepared by ploughing and cross ploughing several times with a power tiller followed by laddering to bring about a good tilth suitable for establishing the seedlings. Then the land was leveled and the corners of the experimental plot were shaped and the clods were broken into pieces. The land was cleaned of weeds and stables and was finally leveled. The soil was treated with insecticides when the plot was finally ploughed. Insecticide (Miral) was used @ 4 Kg/ha to protect the young plants from the attack of inhabiting insects. The planting pits were made 5 days before planting.

3.7 Treatments of the investigation

The experiment was undertaken to study the effects of 4 different levels of N and 4 different levels of P on the growth and yield of broccoli. Thus the experiments included two factors as follows :

A. Levels of nitrogen

1) 0 Kg of nitrogen (N)/ ha, coded as No

2) 80 Kg of nitrogen / ha, coded as N_1

3) 130 Kg of nitrogen / ha, coded as N_2

4) 180 Kg of nitrogen / ha, coded as N_3

B. Levels of phosphorus

1) 0 Kg of phosphorus (P) / ha, coded as Po

2) 70 Kg of phosphorus (P) / ha, coded as P_1

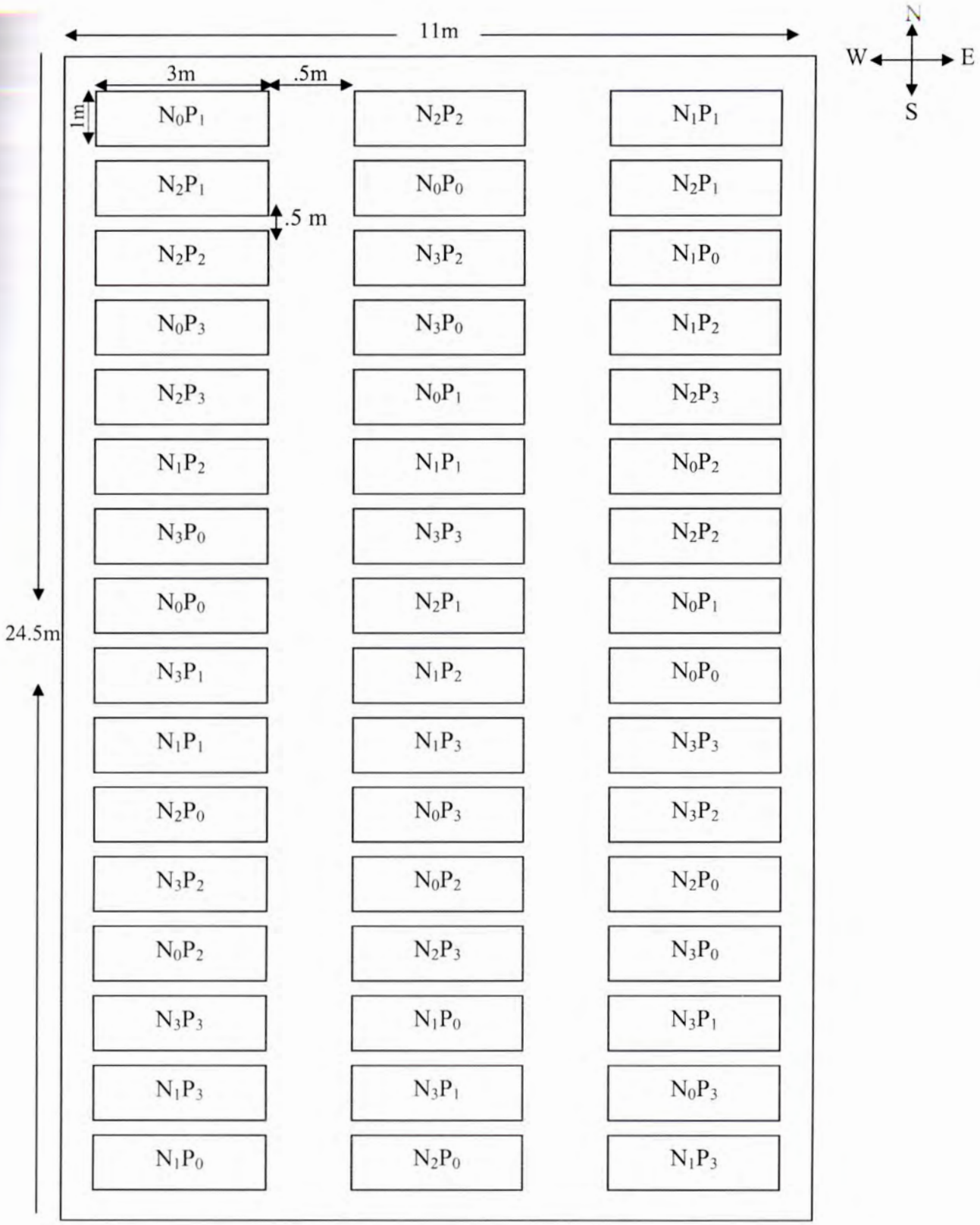
3) 100 Kg of phosphorus (P) / ha, coded as P_2

4) 130 Kg of phosphorus (P) / ha, coded as P_3

Thus there were 16 treatment combinations.

3.8 Experimental design and layout

The two factors experiment was laid out following Randomized Complete Block Desgin (RCBD) with three replications on 1 November 2005. The experimental plot was first divided into three blocks. Each block consisted of 16 plots. Thus the total number of plots were 48. Different combinations of nitrogen and phosphorus were



Number of treatment combinatin = 16, Unit Plot size = 1m × 3m, Plot Spacing = 0.5m, between replication = 0.5m

Fig. Field layout of the experiment in Randomized Complete Block Design (RCBD)

assigned to each block as per design of the experiment. The size of a unit plot was 1m ×3m. Both the plots and blocks distance were .05 m. Thus the total area of the experiment was 269.5 square meter.

3.9 Application of manures and fertilizers

Urea, triple superphosphate (TSP) and muriate of potash (MP) were applied as the sources of nitrogen, phosphate and potash, respectively. Well-decomposed cowding @ 20 t/ha and MP @200 Kg /ha were applied to the plots (Rashid, 1993).

Two thirds of each amounts of well-decomposed cowding and TSP were applied just after opening the land and the remaining one third of cowdung and tripple super phosphate were applied in small pits prepared before 5 days of transplanting of seedlings, and were troughly mixed with the soil. Urea and MP were applied in two instalments. One third of urea and muriate of npotash was applied in ring method after 21 days of transplanting. One third was applied after 42 days, and the rest of urea and MP were applied after 60 days of transplanting. Irrigation was done just after ferterlizer application.

3.10 Transplanting and after care

Healthy 21 days old seedlings were transplanted on 6th november, 2005 in the afternoon and light irrigation was given around each seedlings for their better establishment. The transplanted seedlings were protected from scorching sunlight by providing shed using banana leaf sheth. Dead seedlings were replaced by new healthy seedlings from same stock.

3.11 Gap filing

Dead, injured and weak seedlings were replaced by new vigour seedling from the stock kept on the border line of the experiment.

3.12 Intercultural operation

3.12.1 Weeding

A large number of weeds were found in the control treatment. Weeding was done three times in each plot where it was necessary.

3.12.2 Irrigation

Light irrigation was given just after transplanting the seedlings. A week after transplanting the requrement of irrigation was envisaged through visual estimation. Wherever the plants of a plot had shown the symptoms of wilting the plots were irrigated on the same day with a hosepipe until the entire plot was properly wet.

3.13 Pest and control

Few plants were damaged by mole crickets and cut worms after the seedlings were transplanted in the experiment plots. Cut worms were controlled both mechanically spraying Diazinon 50 EC @ 0.55 Kg per hectare. Some of the plants were infected by *Alternaria brassicae.* To prevent the spread of the disease Rovral @ 2g / liter of water sprayed in the field. Bird pests such as Nightingale (Common Bulbuli) visited the fields from 8 to 11 a.m. and 4 to 6 p.m. The birds were founds to puncture the soft leaves and initiating curd and were controlled by striking of a metalic container.

3.14 Harvesting

Sprouting broccoli does not usually mature uniformly. Because curd initiation curd maturation period in different plants are not similar probably due to genetic or other factors. That is why, harvesting was not possible on a certain date. Firstly the central head was harvested whwn the plants formed compact curd. After harvesting the main head, secondary shootswere developed from the lesf axils which also developed into small secondary heads and were harvested over a period of time. Harvesting was started on 26 Decmber 2005, 52 days after transplanting and was completed on 14 February 2006 when the experiment was terminated. The heads were harvested with 20 cm of stem attached with sprouts.

3.15 Methods of Data collection

The data pertaining to following characters were recorded from ten (10) plants randomly selected from each unit plot, except yield of curds which was recorded plot wise. Data on plant height was collected on 10, 20, 30 and 40 days after transplanting and also at harvest. All other parameters were recorded at harvest.

Data were collected on the following parameters :

1. Height of plant

2. Number of leaves per plant

3.Length of leaf

4. Diameter of curd

5. Diameter of stem

6. Plant canopy

7. Weight of curd

8. Weight of secondary curd

9. Number of secondary curd

10. Days required for curd initiation

11. Yield per plant

12. Yield per unit plot

13. Yield per hectare

3.15.1 Plant height (cm)

Plant height was measured in centimeter (cm) by a meter scale at 10,20, 30, 40 days after transplanting (DAT) and at harvest from the ground level up to the tip of the longest leaf.

3.15.2 Number of leaves per plant

Total number of leaves produced per plant was counted at harvest excluding the small leaves and the leaves produce axillary shoots.

3.15.3 Length of leaf

A meter scale was used to mesure the length of leaves. The length of the leaf was mesured from the base of the petiole to the tip. The data was measured after the harvesting of curd.

3.15.4 Diameter of curd

Curd diameter was taken by using a meter scale. Diameter of the curd measured at different directions and finally the average of all direction was recorded.

3.15.5 Diameter of stem

When the central curd reached mature and merketable stage then the head was cut off and at that point the diameter of the stem was measured. The diameter of stem was recorded in three dimensions and the average of the three figures was taken into account.

3.15.6 Plant canopy

Plant canopy was measured by taking the diameter of the canopy of an individual plant at different directions and finally the average was taken.

3.15.7 Weight of curd

Weight of the central curd was recorded excluding the weight of all secondary marketable curds.

3.15.8 Weight of secondary curd

Weight of secondary curd was recorded by weighing the total marketable axillary curds of an individual plant.

3.15.9 Number of secondary curds

When the secondary curds reached marketable size. They were counted; the small shoots were not taken into consideration.

3.15.10 Days required for curd initiation

Total number of days from the date of transplanting of the date of visible curd initiation.

3.15.11 Yield per plant

The yield per plant was calculated by averaging the weight of ten randomly harvested curds and secondary curds.

3.15.12 Yield per unit plot

The yield per unit plot was calculated by adding the yields of all plants of each unit plot (kg/plot).

3.15.13 Yield per hectare

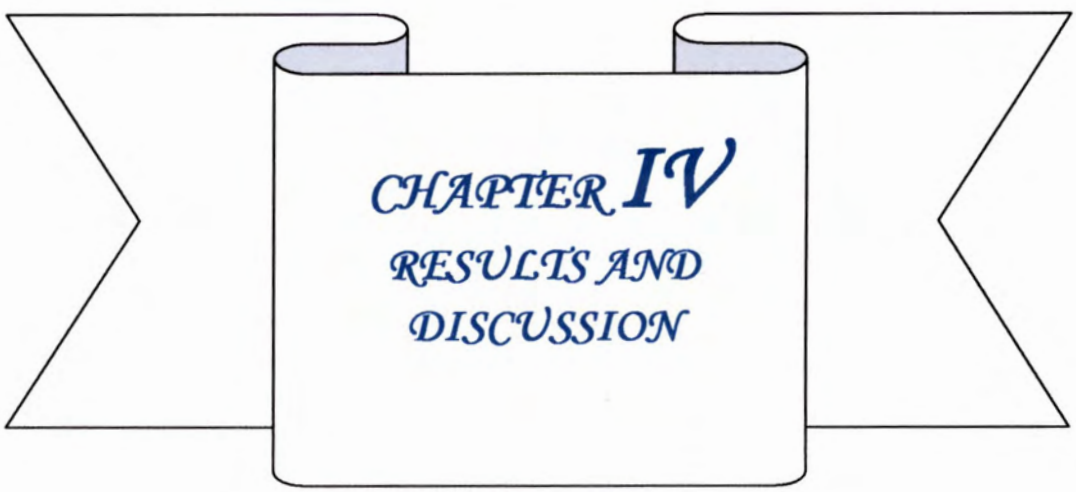
The yield per hectare was calculated from per plot yield data.

3.16 Statistical analysis

The data obtained from the characters were statistically analyzed to find out the variation resulting from experimental treatments following F variance test. The difference between treatments were adjudged Duncan New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

3.17 Cost and analysis

Cost and return analysis was done in details following the procedure of Alam et al. (1989).


CHAPTER IV
RESULTS AND
DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was consisted of different levels of nitrogen and phosphorus and was designed to find out their individual and combined effects on growth and yield of broccoli. The results of the experiment are presented in Tables 1 to 2. The analysis of variance for different characters are presented in appendices 1.

Height of plant

Application of nitrogen exhibited a significant influence on the height of broccoli. Plants on different dates after transplanting (Table 1). In all dates of observations, the height of plant increased with higher levels of N application. At 10, 20 and 30 DAT, N_2 (130 kg N/ha) treatment produced significantly higher plant height than N_1 (80 kg N/ha) treatment; but N_2 (130 kg N/ha) and N_3 (180 kg N/ha) produced plants of similar height. At 40 DAT, the highest value was recorded at N_3 (44.11cm), while the lowest figure (40.13cm) was recorded in control treatment. At harvest, the highest height was recorded with N_3 (50.50cm), and the lowest was recorded in control (40.65).

This increase in plant height due to higher N application was probably caused by enhanced mitotic activity that resulted in higher plant height.

It appeared from Table that plant height did not differ significantly in any of the stages due to the application of different levels of phosphorus. The highest value was recorded in P_0 treatment (42.19 cm) and the lowest value was found in P_1 treatment at 40 DAT. The plant height was significantly influenced by the treatment combinations of N and P at different days after transplanting (Table 2). The highest plant height was observed in the N_3P_3 treatment (180 kg Nx130 kg P/ha) in all dates of observation except 30 DAT.(Table 2).

Table 1. Main effect of Nitrogen and phosphorus on plant height, number of leaves per plant, length of leaves, plant canopy, days required to curd initiation

Treatments	Plant height at different DAT (cm)					Number of leaves/plant	Length of leaves(cm)	Plant canopy(cm^2)	Days required for curd initiation
	10	20	30	40	At harvest				
Factor A : Nitrogen									
No	14.18b	22.01c	30.94c	40.12b	40.65b	14.25b	30.22c	65.62b	60.00a
N_1	18.29a	25.84a	35.89b	41.21b	41.73b	16.00a	34.24b	74.20c	61.08a
N_2	18.55a	26.12a	37.74a	42.61a	44.95a	17.08a	35.84b	80.82b	59.34a
N_3	17.54a	24.38b	38.74a	44.11a	50.49a	16.33a	38.70a	88.10a	59.60a
Factor B : Phosphorus									
Po	16.47b	23.25b	35.91a	42.19a	44.21a	16.16a	34.12a	76.29a	61.00a
P_1	16.21b	24.27a	36.09a	41.75a	44.13a	16.58a	34.11a	75.75a	59.36a
P_2	17.21b	25.15a	35.60a	42.11a	44.74a	15.75a	35.78a	77.79a	59.67a
P_3	18.68a	25.67a	35.69a	42.00a	44.74a	15.16a	34.93a	78.92a	60.00a

Table 1(contd.). Main effect of Nitrogen and Phosphorus on stem diameter, curd diameter, curd weight, no. of secondary curds

Treatments	Diameter of Stem (cm)	Diameter of curd (cm)	Weight of curd (g)	No. of secondary curds
Factor A: Nitrogen				
N_0	1.83c	7.03d	136.4c	5.43b
N_1	2.47b	8.73c	140.3c	5.99b
N_2	2.57b	9.78b	150.4b	5.75b
N_3	3.24a	11.26a	200.2a	7.39a
Factor B: Phosphorus				
P_0	2.57a	8.86a	148.5c	5.60b
P_1	2.44a	9.32a	154.4b	6.06b
P_2	2.64a	9.48a	157.4b	6.42a
P_3	2.46a	9.14a	167.0a	6.48a

Table 1 (Contd.). Main effect of Nitrogen and Phosphorus on secondary curd weight, yield /plant, yield /unit plot and yield

Treatments	Weight of secondary curd (g)	Yield /Plant (g)	Yield / unit plot (kg)	Yield (t/ha)
Factor A: Nitrogen				
N_0	75.27d	202.0d	2.41d	8.03c
N_1	84.19c	212.4c	2.54c	8.465c
N_2	115.1b	277.8b	3.32b	11.06b
N_3	177.2a	437.8a	5.23a	17.43a
Factor B: Phosphorus				
P_0	96.11c	264.8c	3.17c	10.56c
P_1	103.3b	275.9b	3.30b	11.00b
P_2	125.3a	285.1b	3.40b	11.33b
P_3	127.0a	304.0a	3.64a	12.13a

Table 2: Combined effect of nitrogen and phosphorus on the growth and yield of broccoli

Treatment combination	Plant height at different DAT					Number of leaves/ plant	Length of leaves (cm)	Plant canopy (cm^2)	Diameter of stem (cm)	Days to curd initiation
	10	20	30	40	Harvest					
NoPo	14.15g	20.5d	30.05f	40.09cd	39.87ef	14.33cde	28.68g	63.23hi	1.70d	62.03ab
NoP_1	13.71g	22.47cd	29.66f	39.65cd	39.96ef	16.67a-d	29.74g	67.64gh	1.75d	59.70ab
NoP_2	15.27fg	23.02bcd	32.34ef	42.52abc	43.40def	14.00de	33.86def	69.96fg	2.43c	59.51ab
NoP_3	13.62g	22.06cd	31.71ef	38.25d	39.37f	12.00e	28.61g	61.66i	1.46d	58.74ab
N_1Po	17.12de	24.45abc	36.57bcd	41.48bcd	41.49def	17.00abc	35.53c-f	77.52cde	2.43c	59.72ab
N_1P_1	17.55cde	25.53ab	37.67a-d	41.02bcd	41.50def	14.00de	34.55def	75.47def	2.35c	59.73ab
N_1P_2	18.99bcd	26.52a	34.59de	41.90a-d	42.30def	17.00abc	33.20f	71.64efg	2.41c	60.56ab
N_1P_3	19.52b	26.86a	34.74cde	40.45cd	41.67def	16.00a-d	33.70ef	72.20efg	2.68bc	64.31a
N_2P_O	17.03ef	24.55abc	39.31ab	43.80abc	45.70bcd	16.33a-d	35.04c-f	80.80cd	3.11ab	61.46ab
N_2P_1	19.09bc	26.69a	38.31abc	41.66bcd	43.46def	18.00a	36.34cde	81.09cd	2.44c	57.60b
N_2P_2	18.17b-e	26.48a	34.62de	41.68bcd	44.57cde	17.00abc	36.70cd	81.96bc	2.45c	59.71ab
N_2P_3	19.92b	26.79a	38.73ab	43.31abc	46.07bcd	17.00abc	35.29c-f	79.47cd	2.28c	58.63ab
N_3P_0	17.62cde	23.51bc	37.75a-d	43.41abc	49.80ab	17.00abc	37.48bc	83.62bc	3.04ab	60.78ab
N_3P_1	14.50g	22.42cd	38.76ab	44.67ab	51.62a	17.67ab	35.81c-f	78.83cd	3.22a	60.42ab
N_3P_2	16.41ef	24.59abc	40.89a	42.37a-d	48.71abc	15.00bcd	39.39b	87.62b	3.27a	58.91ab
N_3P_3	21.66a	26.99a	37.59a-d	45.99a	51.87a	15.67a-d	42.14a	102.4a	3.41a	58.33b
Level of significance	**	**	**	*	**	**	**	**	**	NS
CV%	5.96	6.07	5.39	5.08	5.90	9.32	4.37	4.34	11.28	4.80

Table 2 (Contd.): Combined effect of nitrogen and phosphorus on the growth and yield of broccoli

Treatment combination	Diameter of curd (cm)	No. of secondary curds	Weight of curd (g)	Weight of secondary curd (g)	Yield /plant (g)	Yield /unit plot (kg)	Yield /(t/ha)
NoPo	6.55fg	4.85f	134.9f	65.34g	198.7h	2.36h	7.86c
NoP_1	7.22efg	5.18ef	135.2f	67.93g	198.8h	2.37h	7.90c
NoP_2	8.17def	5.76def	137.0f	89.32f	203.9gh	2.44gh	8.13c
NoP_3	6.19g	5.91c-f	138.6f	78.48fg	206.6gh	2.47gh	8.23c
N_1Po	8.97cde	5.20ef	137.2f	67.14g	203.2gh	2.43gh	8.10c
N_1P_1	9.01cde	5.96c-f	139.0f	66.86g	207.9gh	2.49gh	8.30c
N_1P_2	7.96d-g	6.23b-f	141.7ef	89.73f	214.1gh	2.56gh	8.53c
N_1P_3	8.98cde	6.54b-e	143.3ef	113.0de	224.6fg	2.69fg	8.96c
N_2P_O	9.35cd	5.71def	144.2ef	113.1e	240.1f	2.87f	9.56b
N_2P_1	9.50bcd	5.81def	145.2ef	109.6e	260.9e	3.12e	10.40b
N_2P_2	10.54abc	6.25b-f	151.2de	126.1cd	288.5d	3.45d	11.50b
N_2P_3	9.71bcd	5.23def	160.9d	111.6e	321.9c	3.85c	12.83b
N_3P_0	10.55abc	6.63bcd	177.7c	138.9c	417.3b	4.99b	15.63a
N_3P_1	11.55a	7.28abc	198.2b	168.9b	436.0b	5.22b	17.40a
N_3P_2	11.26ab	7.41ab	199.7b	196.2a	433.8b	5.16b	17.20a
N_3P_3	11.67a	8.21a	225.3a	204.9a	464.1a	5.56a	18.53a
Level of significance	**	**	**	**	**	**	**
CV%	10.68	11.85	4.06	6.86	4.25	4.10	4.28

Number of leaves per plant

Application of nitrogen showed a significant influence of the number of leaves per plant (Table 1). It was notable that application of nitrogen increased the number of leaves per plant over control but all the level of nitrogen application showed statistically identical results. However, the highest the number of leaves per plant (17.08) was observation in N_3 treatment. At harvest the number of leaves per plant with control treatment was the lowest (14.25). The increase in leaf number per plant was mainly due to the increased vegetative growth of the plants.

The effect of phosphorus on the number of leaves per plant was not significant. Because the highest number of leaves was recorded in P_1 treatment (15.16) and the lowest number of leaves was recorded in P3 treatment (15.16). The interaction effect of nitrogen and phosphorus was not significant in this respect. The number of leaves per plant was 12.00 in NoP3 and that in N_3P_3treatment was 17.67 (Table 2)

Length of leaf

The application of different levels of nitrogen caused significant effects on leaf size, but that due to application of phosphorus was not significant. Data in Table 1 shows that the land of leaf increases in rate of nitrogen fertilizer. The maximum leaf length 38.70 cm was attained with the application 180 kg N/ha whiles the minimum leaf length 30.22 cm in control treatment. The increase in leaf length caused by the application of nitrogen was probably due to increased mitotic activity of cells. Among the treatment combination, N_3P_3 produced in maximum size of leaves (42.14). There was little significant effect in length of leaf with application of P up to 100 kg/ha. The highest length of leaf was found in P_2 treatment (35.78 cm) and the lowest length of

leaf was found in P_1 treatment (34.01 cm). The present result is in agreement with that of Tremblay (1989) who reported greater vegetative growth higher leaf size with higher rates of nitrogen.

Diameter of curd

The effect of nitrogen application was significant for curd diameter in broccoli (Table1). The curd diameter was the highest (11.26 cm) at N_3 treatment followed by N_2 treatment producing curds of 9.78 cm in diameter. It was also observed that N_1 and N_2 treatments produced statistically identical curd diameter. The lowest curd diameter (7.03cm) was noticed in control treatment. The result of the present study agreement with that of Mitra et al. (1990). Similar result was also reported by Santamaria et al. (1994).

There was a little increase in curd diameter with application of phosphorus up to 100 kg /ha, but the increase was not statistically significant (Table 1). The maximum diameter (9.48 cm) was obtained in P_2 treatment while the minimum (8.86 cm) was observed from control treatment. It was also observed that the application of 130 kg P/ha significantly reduced the curd diameter (9.14 cm) (Table 1.)

There was significant interaction between nitrogen and phosphorus in respect of curd diameter (Appendix1). The maximum curd diameter (11.67) was obtained from N3P3 treatment, the lowest curd diameter was obtained from NoP3 (6.19 cm)(Table 2)

Diameter of stem

Analysis of variance revealed that the stem of broccoli was significantly influenced by the application of nitrogen (Table 1). The stem diameter increased significantly with increased rate of nitrogen. The stem diameter was the highest (3.24 cm) in N_3 treatment while the lowest (1.83 cm) was found from control treatment. Tremblay (1989) reported that stem diameter increased with higher levels of nitrogen application, which supports the present result.

Phosphorus application increased stem diameter up to P_2 and then declined (Table 1). The maximum stem diameter (2.64 cm) was observed in P_2 and the minimum (2.46 cm) was found from P_3 treatment. The result indicated that stem diameter was affected adversely at highest dose of P.

The interaction effect of nitrogen and phosphorus on stem diameter was significant at 1% level of significance (Appendix 1).Among the treatment combinationsN_3P_3 produced the highest diameter (3.41 cm). The lowest value was obtained from NoP_0 treatment (1.70 cm) which was statistically similar with NoP_1 treatment combinations (Table 2).

Plant canopy

Statistically significant difference was observed in spread of plant canopy as affected of different levels of nitrogen (Table 1). The spread of plant canopy increased with increasing rate of nitrogen application, and the widest spread (88.11 cm) was observed in N_3 treatment and the lowest spread (65.62 cm) was observed in control. The effect of phosphorus application on the spread of plant canopy was not significant.

The treatment combination produced significant effect on the spread of plant canopy. The results in Table 2 reveal that the widest spread (102.4 cm) was produced by N_3P_3 treatment. The lowest canopy spread (63.23 cm) was noticed in control (NoPo) treatment.

Weight of curd

Different levels of nitrogen showed a significant effect on the weight of central curd of broccoli. The maximum central curd weight (200.2 g) was recorded with 180 kg N/ha. The second highest central curd weight (150.4 g) was obtained with 130 kg N, and the lowest central curd weight (136.4 g)was recorded in control plots (No). Mitra et al. (1990) reported similar results, where application of 112 kg N/ha gave higher curd weight.

There was significant influence of phosphorus on the curd weight. The central curd attained maximum weight (167.0 g) when 130 kg P/ha was applied, and it was statistically at per with that obtained from 70 kg P/ha. The lowest of central curd (148.5 g) was noted in control treatment (Table 1).

The interaction effect of nitrogen and phosphorus on central curd of broccoli was significant. However, there was a significant variation among the treatment combinations in curd weight. The highest central curd weight (225.3 g) was obtained from the treatment combination of N_3P_3, and the lowest was obtained from the NoP_3 treatment (134.9 g) (Table 2). The result indicated that higher phosphorus application without nitrogen application adversely affected the central curd weight.

Weight of secondary curd

The effect of nitrogen on secondary curd weight was statistically significant. As in central curd weight, secondary curd weight increased with increase in the dose of N.

The maximum weight of secondary curd (177.2 g) was obtained with the application of 180 kg N/ha, and the minimum weight (75.27 g) was recorded in control treatment (Table 1)

Application of P had significantly on secondary curd weight of broccoli. The lowest secondary curd weight (96.11 g) was obtained from control. The maximum secondary curd weight (96.11 g) was obtained from control (Po) and the minimum (103.3g) was found from P_1 treatment (Table 1).

The interaction effect of nitrogen and phosphorus showed highly significant on secondary curd weight (Appendix 1). The highest secondary curd weight (204.9 g) was recorded from the combination of 180 kg N and 130 kg P/ha (N_3P_3). The lowest secondary curd weight (65.35 g) was obtained from control treatment (Table 2).

Number of secondary curd

Nitrogen had a highly significant effect on the number of secondary curd. The number of secondary curd increased significantly with increase of nitrogen rate. The highest number of secondary curd (7.39) was obtained when the plants were supplied with 180 kg N/ha. The second highest number of secondary curd (5.98) was obtained with 130 kg N/ha, while the lowest number of secondary curds (5.43) was obtained when no nitrogen was applied (Table 1).

The numbers of secondary curds were found to vary with the application of phosphorus. Likewise nitrogen, the number of secondary curd increased with increase in the level of phosphorus application. The highest of secondary curd (6.48) was obtained with the application of 130 kg P/ha, while the lowest secondary curd (5.6) was recorded from control treatment.

The number of secondary curd did not differ significantly among the treatment combinations. The highest number of secondary curd (8.21) was obtained with application of 180 kg N and 130 kg P/ha (N_3P_3) the lowest number of secondary curd (4.85) was observed in the combination N1P1 (80 kg N x 70 kg P/ha)

Days required for curd initiation

The number of days required for curd initiation was not significantly influenced by nitrogen application. The control treatment where no nitrogen was applied produced curd within 59.99 days after transplanting of seedlings; but in treatment where nitrogen was applied at different doses produced curd within 59.61 to 61.08 days after transplanting (Table 1).

The application of phosphorus significantly influenced the number of days required for curd initiation (Table 1). The number of days to curd initiation from transplanting was significantly reduced with increased rate of phosphorus application. The treatment receiving 70 and 100 kg phosphorus per hectare took identical number of days for initiation of curds, the figures being 59.36 and 59.67 days respectively. The least time (60 days) was required for curd initiation where 130 kg P was applied. The result indicated that P might have related vegetative growth and forced the plants to reach reproductive stages the earlier. Mitra et al. (1990) reported that application of phosphorus hastened the crop to reach reproductive stage, which is an agreement with findings of the present work.

The application of nitrogen and phosphorus was not significant interaction effect on the number of days for curd initiation (Appendix 1). There was not significant

variation among the treatment combinations in days to curd initiation (Table 2). The minimum days (57.60 days) was required curd initiation in the N_2P_1 treatment followed by N_3P_3 treatment (58.33 days). The maximum days (62.03 days) was required in control treatment (NoPo)

Yield per plant

The application of nitrogen exhibited significant influence on the yield of curds per plant. The highest yield per plant (437.8 g) was obtained from the highest dose of N (180 kg N/ha). The next highest yield per plant (277.8 g) was reduced from 130 kg N/ha. The lowest yield per plant (202.0 g) was recorded in control treatment (Table 1). The result of the present experiment is in agreement with other reports (BARI, 1981; Sarma and Arora, 1984).

The yield per plant was significantly influenced by the application of phosphorus (Table 1). The maximum yield per plant was (304.0 g) obtained from the plants supplied with 130 kg P/ha. The lowest yield per plant (264.8 g) was noted in control. Similar result was also reported by Brown et al. (1994).

The interaction effect of nitrogen and phosphorus on yield per plant was significant. The highest yield per plant (464.1 g) was obtained from N_3P_3, which was statistically identical with the use of N_3P_2 and N_3P_1. The lowest yield per plant (198.7 g) was observed in control plots which were statistically identical with that of NoP1 and NoP3. it was evident from the result that, when no nitrogen was applied the application of phosphorus failed to increase a higher extent. The result is consistent with the of Mitra et al. (1990). They reported that the cauliflower did not respond to phosphorus in absence of nitrogen.

Yield per plot and per hectare

The yield per plot as well as per hectare was found to be significantly influenced due to the application of nitrogen (Table 1). The interaction effect was also significant (Appendix 1). The maximum curd yield per plot (5.23 kg) and per hectare (17.43 t) were reduced by the application of 180 kg N /ha, which was significantly higher than 100 kg N /ha. The lowest curd yield (2.41 kg / plot and 8.03 t/ha) was obtained in the plots where no nitrogen was applied. Kowalenko (1983) reported that head yield increased linearly up to the application of 250 kg N/ha.

Application of phosphorus had a significant influence on yield per plot and per hectare. Application of 130 kg P per hectare produced the highest (3.64 kg per plot 12.13 t/ha) which were statistically similar with those obtained with 70 kg P/ha. The lowest yield (3.17 kg /plot and 10.56 t/ha) was obtained from control (Table 1), which was similar with that obtained from 100 kg P/ha. The results suggest that application of P beyond 100 kg/ha were not helpful, rather had deleterious effect on the yield of broccoli.

The yield per plot and per hectare was influenced significantly with the combined application of nitrogen and phosphorus. The highest yield per plot (5.56 kg) and per hectare (18.53 t) was achieved in N_3P_3 treatment which was statistically identical with N3P1 and N_3P_2. The lowest yield (2.37 kg/plot and 7.86 t/ha) was obtained from control (NoPo), which was statistically as per with NoP1.

Cost and return analysis

Total costs and returns for each treatment was calculated based on the prevailing market price during the study period. The details of cost analysis have been shown in Appendix 2. The benefit cost ratio was computed by dividing the total return with the total cost of production. The table 3 shows that the lowest costs for production (51955Tk/ha) was in NoPo where no nitrogen and no phosphorus were applied and the highest costs were in treatments N_3P_3. The gross return was obtained highest (277950 Tk /ha) with N_3P_3 treatment. The lowest gross return (117900 Tk /ha) was obtained in NoPo treatment. The maximum net return (213592 Tk/ha) was obtained from N_3P_3 treatment. The lowest net return from NoPo was 60609 Tk/ha.

The benefit cost ratio (BCR) was the highest (4.36) for N_3P_1 treatment which was followed by N_3P_2 (4.31). The lowest BCR was shown by NoP_2 treatment (2.06). The result indicated that application of phosphorus without nitrogen could increase yield, but cause economic loss. The present experiment revealed that the application of 180 kg N/ha along with 130 kg P/ha was found to be conducive to higher yield as well as higher economic return from broccoli under the Modhupur Tract Agro ecological Region of Bangladesh.

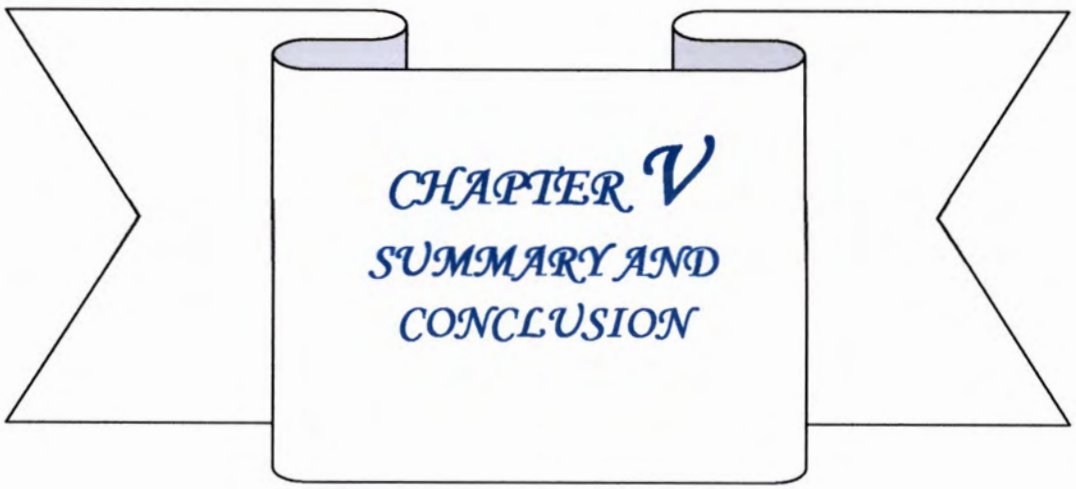
Table 3. Cost and return from broccoli as affected by different levels of nitrogen and phosphorus

Treatment combination	Yield (t/ha)	Gross return (Tk/ha)	Total costs of production (Tk/ha)	Net benefit (Tk/ha)	Benefit – cost Ratio
NoPo	7.86	117900	51956	60609	2.26
NoP_1	7.90	118500	57291	66544	2.28
NoP_2	8.13	122850	59575	63274	2.06
NoP_3	8.23	123450	61860	61590	2.38
N_1Po	8.10	121500	53067	68433	2.28
N_1P_1	8.30	124500	58103	66397	2.14
N_1P_2	8.53	127950	60678	67272	2.10
N_1P_3	8.96	134400	62972	71428	2.13
N_2P_O	9.56	143400	53764	89636	2.66
N_2P_1	10.40	156000	59099	96000	2.60
N_2P_2	11.50	172500	61384	111116	2.81
N_2P_3	12.83	192450	63668	128782	3.02
N_3P_0	15.63	249450	54454	194996	4.30
N_3P_1	17.40	261000	59790	201210	4.36
N_3P_2	17.20	258000	62074	195926	4.15
N_3P_3	18.53	277950	64358	213592	4.31

Where,

No = 0 kg N /ha
N_1 = 80kg N/ ha
N_2 = 130 N/ ha
N_3 = 150 N /ha

P_0 = 0 kg P / ha
p_1 = 70 kg / ha
p_2 = 100 kg/ha
P_3 = 130 kg /ha


CHAPTER V
SUMMARY AND
CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

SUMMARY :

An experiment was conducted to find out the effect of nitrogen and phosphorus on the growth and yield of broccoli at the Horticulture Farm of Sher-e Bangla Agriculture University, Dhaka during the period from November 2005 to February 2006. The experiment comprised four levels of nitrogen viz., 0, 80, 130, and 180 kg N/ha and four levels of phosphorus viz., 0, 70, 100 and 130 kg P/ha. The experiment was laid out in the Randomized Complete Block Design with three replications. The unit plot size was 1m x 3 m. both the distance between the plots and blocks were 0.5m. The land was supplied with 20 tons of well decomposed cowdung per hectare at the beginning of the ploughing operation. Muriate of potash was applied at the rate of 200 kg /ha to supply as K to the soil. Total amount of P were applied through triple superphosphate (TSP) during the final land preparation as per experimental treatment. The urea and MP were applied in two equal splits one at 15 Days after transplanting (DAT) and rest at 40 DAT. Irrigation and other intercultural operations were done as and when needed.

The height of the plants was taken after 10, 20, 30, 40 DAT and at harvest from randomly selected ten plants. The size of leaves, diameter of curd, diameter of stem, weight of central curd, weight of secondary curd, plant canopy, number of secondary curds, days required to curd initiation were recorded at harvest. The yield per plant, yield per plot were also recorded. All the collected data were analyzed statistically and the means were adjudged by DMRT.

The effects of nitrogen on plant height, leaf size, plant canopy spread, number of leaves per plant, stem diameter, curd diameter, number of secondary curd, central curd weight, secondary curd weight, yield per plant, yield per plot and yield per hectare were significant, but was not significant for the number of days to curd initiation. More or less all the characters mentioned above attained highest values when a dose of 180 kg N /ha was applied. The plant height with 180 kg N/ha were 17.55, 24.38, 38.74 and 44.11 cm at 10, 20, 30 and40 DAT, respectively, which were as per with those with 130 kg N/ ha. At harvest, highest plant height (50.49 cm) was observed with 180 kg N /ha. The maximum leaf length (38.70 cm) was with 180 kg N /ha, while that was only 30.22 cm in control. The numbers of leaves per plant with 130 kg N was 17.08 which was similar with those of the plants receiving 80 and 180 kg N /ha and the lowest in the control. The highest values for stem diameter, curd diameter, number of secondary curd, secondary curd weight, yield per plant, yield per plot and yield per hectare were 3.23 cm, 11.26 cm, 7.38, 177.2 g, 437.8 g, 5.23 kg and 17.43 t respectively while those with control were 1.83 cm, 7.03 cm, 5.42 cm, 75.27 g, 202.0 g, 2.41 kg and 8.03 t respectively.

The effect of phosphorus on plant height, spread of plant number of leaves per plant, diameter of stem, days to curd initiation and diameter of curd were not significant. But all other characters were found significant. It appeared that the number of days to curd initiation decreased with application of phosphorus. The maximum stem diameter (2.64 cm), curd diameter (9.48 cm), central curd weight (167 g), secondary curd weight (125.3 g), yield per plant (304.3 g), yield per plot (3.64 kg) and yield /ha (12.13 t) were obtained when 130 kg P/ha was applied and the corresponding values were 2.57 cm, 8.85 cm, 148.5 g, 96.11 g, 264.8 g, 3.17 kg and 10.56 t respectively with control.

The interaction effect of nitrogen and phosphorus was significant for all the parameters under study except for plant height at 20 DAT, 40 DAT, at harvest, days to curd initiation, diameter of curd and number of secondary curd. The highest plant height at 10 and 20 DAT were 21.66 and 26.99 cm with N3P3 (180 kg N x 130 kg P/ha) but at 30 DAT the plant height showed maximum value of 40.89 cm with N_3P_2 (180 kg N x 100 kg P /ha) treatment. It was noted that at all the dates of observation the lowest plant height was recorded in control plots. The maximum spreading of plant (102.4 cm) was found with N_3P_3 treatment and the lowest (61.66 cm) in NoP_3. The maximum duration to curd initiation (62.03 days) required with NoPo treatment combinations. The least time (57.60 days) was required to initiate curd for N_2P_1 treatment. The stem diameter and number of secondary curd were the highest with N_3P_3 treatment (3.41 cm and 8.21 respectively) which were statistically similar with values obtained for N_3P_1 and N_3P_2. The curd diameter was the maximum with N_3P_3 treatment (11.67 cm) that was statistically as per with N_3P_1 and N_3P_2 treatments.

The maximum curd yield per plant (464.1 g) was obtained with N_3P_3 treatment which was also statistically identical with N_3P_2 and N_3P_1 treatments. The lowest yield per plant (198.7 g) was recorded under control. The highest curd yield (5.56 kg /plot and 18.53 t/ha) were recorded with N_3P_3 treatment and were similar with that obtained for N_3P_2 and N_3P_1 treatments. The plots under control treatment gave the lowest yield (2.36 kg/plot and 7.86 t/ha). The benefit cost ratio (BCR) was the highest (4.36) for N_3P_1 treatment which was followed by N3P2 (4.31). The lowest BCR was shown by NoP_2 treatment (2.06).

CONCLUSION:

The present experiment revealed that the application of 180 kg N/ha along with 130 kg P/ha was found to be conducive to higher yield as well as higher economic return from broccoli.

REFERENCES

Alam, M. S., M. T. Iqubal, M. S. Amin and M. A. Gaffer. 1989. Krishitattik Fasaler Utpudan 0 Unnayan. T. M. Jubair Bin Iqubal. Ilb. Manik Potal, Meghai, Sirajgonj. Pp. 231-239.

Anonymous, 1981. Annual Report, Bangladesh Agricultural Research Institute, Joydebpur, Dhaka. P. 29.

Anonymous, 1981. Annual Report, Bangladesh Agricultural Research Institute, Joydebpur, Dhaka. P. 7.

Bracy, R. P.; R. i. Parish; P. E. Burgeron, 1995. Sidedress N application methods for broccoli production. Journal of Vegetable crop Production. 1 (1): 63-71.

Brown, J. E.; J. M. Dangle.; C. H. Gilliam; D. W. Porch; R. L. Shumack, 1994. Comparison of broiler litter and inorganic nitrogen, phosphorus, and potassium for double cropped sweet corn and broccoli. Journal of Plant Nutrition. 17 (5): 859-867.

Burghardt, H. and K. Ellering . 1986. Tolerance and effect of leaf fertilization treatments on vegetables. Gartebauwissenscharft, 51 (2): 58-62.

Curtliffe, J. A. 1975. Hollowstem in broccoli. Canada Agriculture, 2(3): 19[cited from Hort. Abst. 46(5): 397(1976)].

Demchak, K.T.and C.B. Smith. 1990. Yield responses and nutrient uptake of broccoli as affected by lime type and fertilizer . Journal of the American Society for Horticultural Sciences, 115 (5): 737-740.

El-Beheidi, M.and A.A. El-Mansi. 1975. The effect of nitrogen level and spacing on broccoli yield. Beitrage fur Tropsichan lundwirteschaft and veterinarmedizin. 11(3) : 291 -297.

FAO. 1988.land Resources Appraisal of Bangladesh for Agricultural Development. Report No .2. Agro-ecological Regions of Bangladesh. Food and Agriculture Organization of the United Nationbs, Rome, Italy. Pp. 212-221.

Gomez, K.A. and A.A.Gomez. 1984. Statistical Procedures for agricultural research second edition. A wiley Inter Science Production , John Whiley & Sons.New York. p. 680.

Kowalenko, C.G. 1983. Brccoli responds to nitrogen application . Research Review, Research Station – Agassiz-B.C. May – August 8-9. [CAB abst. 1984-1986.].

Letey, J,; W.M. Jarrell; N. Valoras and R. Beverly . 1983. Fertilizer application and irrigation management of broccli production and fertilizer use efficiency. Agronomy Journal, 75(3) : 502-507.

Lewandowska, A.M. and H. Skapski. 1977. Effect of variety , spacing and level of nitrogen fertilizations on the quality and broccoli yield . Biulotyn Warzywniczy , 20: 99-118.

Lincoln, C.P. 1987. Vegetable Characteristics, Production and Marketing. John Wiley and Sons. Inc. New York . P.217.

Liu, L. and B.J. Shelp. 1993. Broccoli yield and nitrogen composition in response to different management regimes. . Communications in Soil Science and Plant Analysis, 24 : 1-2, 61-64.

Magnifico, V.V. lattanzio, and G. Sarli, 1979. Growth and nutrient removed by broccoli. Journal of the American Society for Horticultural Science, 104 (2): 201-203.

Magnifico,V,; V. Lattanzio; A. Elia and M.Molfetta. 1989. Growth and nutrient removal by broccoli raub. Advances in Horticultural Science, 3(2): 68-72.

Magnifico,V.; V.V. Bianco.; V. Marzi; E. Taranteno; P. Montemurro and G. Sarli. 1993. Research on a sequence of four vegetable crops for processing in one year. I Feasibility and yields in a five year period. Annali-della-Facolta-di- Agraria-Universitia –di-Bari. 34 : 125-132.[CAB Abst. 1995].

Mathur, M.M. and K.S. Vashistha. 1976. Effect of different spacing cum- nitrogen doses on the yield of broccoli. Upyanika, 2:45-47.

Maynard. A.A. 1994. Sustained vegetable production for three years using composted animal manures. Compost Science and Utilization , 2(1) : 88-96.

Mital,R.K.; T.Singh; M. Bhugat and K.P Maheshwari. 1975. Response of broccoli to nitrogen and row spacing . Indian Journal of Agronomy , 20 (3) : 278-279.

Mitra, S.K.; M.K. Sadhu and T.K Bose. 1990. Nutrition of Vegetable crops. Naya Prokash; Calcutta 700006 ; India. pp. 157-160.

Nonnecke. I.L. 1989. Vegetable Production . Van Nostrand Reinhold, New York. pp.394-399.

Pieters, J.H. 1976. Effect of supplementary broccoli for multiple harvesting. Bedrijfsont Wikkeling , 7(2) : 111-115.

Rajput, C.B.S. and K.P. Singh. 1975. Response of Broccoli cultivars to various levels and methods of nitrogen application. Journal of Indian Horticultural Sciences , 3 (1) : 23-30.

Rajput, C.B.S. and Singh, K.P. 1975.Response of cauliflower cultivar snowball – 16 of various levels and methods of nitrogen application . Bangladesh Horticulture, 3 : 23-30.

Rashid, M.M.1993. Sabji Bijnan. Text Book Division, Bangla Academy, Dhaka, Bangladesh. p. 217.

Santamaria, P.; A.Elia and G. Conversa, 1994. Growth and yield of broccoli (Brassica olerucea L var. Italica) In a vegetable crops sequence. Effects of nitrogen and herbicides. Rivista –di- Agronomia. 28 (2) : 135-141.

Sharma, R.P. and P.N. Arora. 1984. Response of mid season broccoli to rates and time of nitrogen application and plant density. Indian Journal of Agronomy, 29: 468-70.

Shoemaker, J.S.; J.E. Benjamin and Teskey. 1962. Practical Horticulture. John Wiley & Sons. Inc. New York. p.219.

Simoes, A.M.; F. Calouro; E. Abrantes; E. Sousa, M.A.C Fragoso and M.L Beusichem. 1993. Influence of container size and substrate mineral composition on transplant growth and yield of broccoli cv. Green Duke. Optimization of plant nutrition . Lisbon.Portugal. pp.87-92.

Simon, J.1976. The effect of graduated rates of nitrogen and irrigation on the yield of broccoli, Sbornik UVTI. Zahradnietivi,2(5) : 37-45.

Steffen, K.L.; M.S. Dann; K. Fager; S.L Fleischer and J.K. Harper. 1994. Short term and long term impact of an initial large scale SMS soils amendment on vegetable crop productivity and resource use efficiency. Compost Science and Utilization, 2(4) : 75 -83.

Sumiati. H. 1988. The effect of cultiar and growing medium on the growth and development of Broccli seedlings in the nursery. Bulletin- Penelitian-Horticulture, 16(4): 14-23.

Thompson, H.C., W.C. kelly. 1957. Vegetable Crops sMegraw Hill Book Company, Inc. New York. P. 308.

Tindall, H.D. 1983. Vegetables in the Tropics. Macmillan Education. Ltd. Honndills., Basingstoke, Hampshire. pp. 126-128.

Tremblay, N. 1989. Effect of nitrogen sources and rates on yield and hollow stem development in broccoli. Canadian Journal of Plant Science, 69 (3) 1049-1053.

APPENDICES

Appendix I. Analysis of variance for plant characters of broccoli

Source of variation (SV)	Degree of freedom (df)	Mean squire values						
		Plant height at different DAT					Number of leaves/ plant	Length of leaves
		10	20	30	40	Harvest		
Replication	2	15.39	9.42	7.22	2.66	4.59	2.64	4.28
Treatment	15	17.33**	12.86**	35.25**	11.49*	51.24**	8.02**	39.18**
Factor A	3	48.92**	42.44**	144.22**	35.79**	234.42**	17.29**	150.28**
Factor B	3	14.71**	13.52**	0.59ns	0.45ns	1.32ns	4.39ns	7.36*
A x B	9	7.68**	2.78ns	10.49*	7.08ns	6.82ns	6.15*	12.76**
Error	30	1.04	2.23	3.75	4.55	6.89	2.20	2.31

* Significant at 5% level of probability
** Significant at 1% level of probability
ns: Not significant

Appendix I (Contd.) Analysis of variance for plant characters of broccoli

Source of variation (SV)	Degree of freedom (df)	Mean squire values					
		Plant canopy	Dia meter of stem	Days to curd initiation	Diameter of curd	No. of secondary curd	Weight of curd (g)
Replication	2	18.31	0.044	5.929	0.23	0.12	23.31
Treatment	15	296.26**	1.00**	7.93ns	8.50**		2362.07**
Factor A	3	1100.76**	3.95**	6.98ns	37.86**	8.94**	10459.35**
Factor B	3	24.92ns	0.10ns	6.03ns	0.86ns	1.93*	720.37**
A x B	9	118.54**	0.31**	8.88ns	1.26ns	0.52ns	210.20**
Error	30	11.20	0.08	8.30	28.95	0.53	40.46

* Significant at 5% level of probability
** Significant at 1% level of probability
ns: Not significant

Appendix I (Contd.) Analysis of variance for plant characters of broccoli

Source of variation (SV)	Degree of freedom (df)	Mean squire values			
		Wt. of secondary curd (g)	Yield / Plant (g)	Yield / Unit plot (kg)	Yield (t / ha)
Replication	2	6.79	133.17	0.016	0.13
Treatment	15	6037.82**	29463.53**	4.21**	1702.72**
Factor A	3	25539.14**	142116.38**	20.31**	112.61**
Factor B	3	2907.98**	3353.52**	0.48**	2.37**
A x B	9	580.66**	615.91**	0.09**	0.52**
Error	30	59.99	144.16	0.01	0.11

* Significant at 5% level of probability
** Significant at 1% level of probability
ns: Not significant

Appendix II. Cost of production of broccoli per hectare under different treatment combinations

A. Input costs excluding the cost of Urea and TSP

	Items of costs	Cost (Tk)
1.	**Non material costs**	
a)	Land preparation including removal of weeds, stubbles	3000/-
b)	Making irrigation channel and drains	500/-
c)	Making seedbed for seedling raising	250/-
d)	Seedling transplanting	2000/-
e)	Weeding, mulching and earthing up	2500/-
f)	Bird driving	3000/-
g)	Spraying of insecticides and fungicides	350/-
h)	Spreading of manures and fertilizers	2000/-
i)	Harvesting and transplanting	3000/-
	Total non material cost	16600/-
2.	**Material costs**	
a)	Seeds	800/-
b)	Manures and fertilizers :	10000/-
	Cowdung- 20 t/ha (500 t/t)	2800/-
	MP @200 kg/ha @14 t/kg	
c)	Irrigation water	2500/-
d)	Insecticides and fungicides	2000/-
	Total material cost	18100/-
	Total input cost	34700/-

Appendix II (Contd.). Cost of production of broccoli per hectare under different treatment combinations

B. Total variable and overhead costs

Treatments	Variable cost (Taka)				Overhead cost (Taka)			Total cost of production (A+B)
	Input cost*	Cost of urea	Cost of TSP	Total variable cost (A)	Hiring of land for six months	Interest on running capitals	Total cost (B)	
NoPo	34700	-	-	34700	15000	2256	17255	51955
NoP_1	34700	-	5010	39710	15000	2581	17581	57291
NoP_2	34700	-	7155	41855	15000	2721	17721	59576
NoP_3	34700	-	9300	44000	15000	2860	17860	61860
N_1Po	34700	1044	-	35744	15000	2323	17323	53067
N_1P_1	34700	1044	5010	40754	15000	2649	17649	58103
N_1P_2	34700	1044	7155	42899	15000	2788	17788	60687
N_1P_3	34700	1044	9300	45044	15000	2928	17928	62972
N_2P_O	34700	1698	-	36398	15000	2366	17366	53764
N_2P_1	34700	1698	5010	41408	15000	2692	17692	60000
N_2P_2	34700	1698	7155	43553	15000	2831	17831	61384
N_2P_3	34700	1698	930	45698	15000	2970	17970	63668
N_3P_0	34700	2346	-	37046	15000	2408	17408	54454
N_3P_1	34700	2346	5010	42056	15000	2734	17734	59790
N_3P_2	34700	2346	7155	44201	15000	2873	17873	62074
N_3P_3	34700	2346	9300	46346	15000	3012	18012	64358

*Excluding the cost of urea and TSP

Where,

No = 0 kg N /ha Po = 0 kg P / ha

N1 = 80 kg N/ ha P1 = 70 kg / ha

N2 = 130 N/ ha P2 = 100 kg / ha

N3 = 150 N /ha P3 = 130 kg /ha

Appendix III. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from October 2005 to March 2006

Year	Month	Air temperature (°c)			Relative humidity (%)	Rainfall (mm)	Soil temperature		
		Maximum	Minimum	Mean			5 cm depth	10 cm depth	20 cm depth
2005	October	30.97	23.31	27.14	75.25	208	16.09	17.2	17.3
	November	29.45	18.63	24.04	69.52	00	13.8	14.4	14.8
	December	26.85	16.23	21.54	70.61	00	12.6	13.6	14.0
2006	January	24.52	13.86	19.19	68.46	04	11.3	11.3	13.0
	February	28.88	17.98	23.43	61.04	03	12.9	12.9	13.8

Source: Bangladesh Meteorological Department (climate division) Agargoan, Dhaka-1212

Appendix IV. Characteristics of Horticulture Farm soil as analyzed by Soil Resources Development Institute (SRDI), Khamar Bari, Farmgate, Dhaka

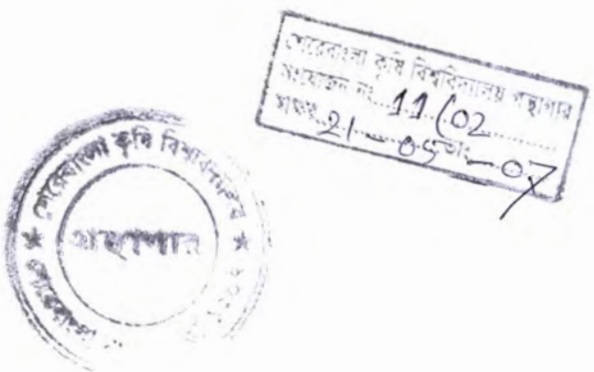
A. morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture Garden ,SAU, Dhaka
AEZ	Madhupur 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	Fellow – broccoli

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis	
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI



শেরেবাংলা কৃষি বিশ্ববিদ্যালয়
শেরেবাংলা নগর
ঢাকা-১২০৭।

স্মারক নং-শেকৃবি/ডি.আর(এ)/৩(২৩)/১১/ ৩৪২২ তারিখঃ ২৬-১১-২০১১

বিজ্ঞপ্তি

২৫-১১-২০১১ তারিখে অনুষ্ঠিত ২০১২ শিক্ষাবর্ষের স্নাতক (সম্মান) কোর্সের লেভেল-১ সেমিস্টার-১ এর ভর্তি পরীক্ষার ফলাফল (মেধা, কোটা ও অপেক্ষমান) তালিকা এতদ্সঙ্গে প্রকাশ করা হলো। ভর্তিযোগ্য প্রার্থীদের নিম্নবর্ণিত শর্তাদি অনুসরণপূর্বক বর্ণিত তারিখে ভর্তি করা হবে।

শর্তাদিঃ

১। মেধা তালিকায় ও বিভিন্ন কোটায় ভর্তিযোগ্য প্রার্থীদের আগামী ২৭/১১/২০১১ তারিখ সকাল ১০.০০ টা থেকে ০৩/১২/২০১১ তারিখ দুপুর ২.০০ টার মধ্যে ফ্যাকাল্টি পছন্দের অনুক্রম নির্ধারিত ফরমে রেজিস্ট্রার কার্যালয়ে জমা দিতে হবে। উক্ত ফরম বিশ্ববিদ্যালয়ের ওয়েব সাইট (www.sau.edu.bd) এবং রেজিস্ট্রার দপ্তরে পাওয়া যাবে।

২। প্রার্থীর মেধা এবং পছন্দক্রম অনুসারে ফ্যাকাল্টি (কৃষি অনুষদ/এগ্রিবিজনেস ম্যানেজমেন্ট অনুষদ/এনিম্যাল সায়েন্স এন্ড ভেটেরিনারী মেডিসিন অনুষদ) নির্ধারন করা হবে।

৩। ভর্তিযোগ্য প্রার্থীদের আগামী ০৪/১২/২০১১ ও ০৫/১২/২০১১ তারিখ সকাল ৯.০০ টা হতে বিকাল ৫.০০ ঘটিকার মধ্যে শেকৃবি'র শিক্ষক কনফারেন্স কক্ষে উপস্থিত থেকে ভর্তি হতে হবে।

৪। অপেক্ষমান তালিকায় রোলনম্বরধারীদের ০৭/১২/২০১১ তারিখ দুপুর ০২:০০ ঘটিকার মধ্যে স্ব-শরীরে উপস্থিত হয়ে রেজিস্ট্রার দপ্তরে স্ব স্ব আইডি কার্ড এবং ফ্যাকাল্টির পছন্দক্রম জমা দিতে হবে। একই তারিখ বিকাল ৫ঃ০০ ঘটিকায় অপেক্ষমান তালিকা হতে মেধাক্রম অনুসারে ভর্তিযোগ্য প্রার্থীদের তালিকা প্রকাশ করা হবে এবং ০৮/১২/২০১১ তারিখ সকাল ৯ঃ০০ টা হতে বিকাল ৫ঃ০০ ঘটিকার মধ্যে শেকৃবি'র শিক্ষক কনফারেন্স কক্ষে উপস্থিত থেকে ভর্তি হতে হবে।

৫। ভর্তির সময় শিক্ষাগত যোগ্যতার সকল মূল সনদপত্র ও ট্রান্সক্রিপ্ট, প্রশংসাপত্র, ০৪ কপি সত্যায়িত রঙিন ছবি, সরবরাহকৃত স্ব স্ব আই ডি কার্ড মুক্তিযোদ্ধা সন্তানদের ক্ষেত্রে মুক্তিযোদ্ধা সনদের মূল কপি, উপজাতি, আদিবাসী ও ওয়ার্ড (পোষ্য) দের ক্ষেত্রে উপযুক্ত প্রমাণপত্রের মূল কপি জমা দিতে হবে।

৬। প্রার্থী কর্তৃক পরিবেশিত/সরবরাহকৃত কোন তথ্য/ডকুমেন্ট ভুল বা অসত্য প্রমাণিত হলে উক্ত প্রার্থী ভর্তির অযোগ্য বলে গণ্য হবে। এমনকি ভর্তির পরেও কোন তথ্যগত ভুল বা অসত্য ডকুমেন্ট সরবরাহের বিষয় উদঘাটিত হলে ভর্তি বাতিল বলে গণ্য হবে।

৭। ভর্তির জন্য আনুমানিক ১০,০০০/- (দশ হাজার) টাকা প্রয়োজন হবে।

৮। ০২-০১-২০১২ তারিখ সকাল ১১.০০ টায় বিশ্ববিদ্যালয় অডিটরিয়ামে ভর্তিকৃত ছাত্র-ছাত্রীদের ওরিয়েন্টেশন অনুষ্ঠিত হবে এবং ০৩-০১-২০১২ তারিখ থেকে ক্লাশ শুরু হবে।

৯। আবাসিক হলে সীটের অপ্রতুলতা হেতু ভর্তিকৃত ছাত্র-ছাত্রীদের বিশেষ করে ছাত্রীদের হলে সীট বরাদ্দের আপাততঃ কোন সুযোগ নেই। আবাসিক হলে সীট বরাদ্দ না পাওয়া পর্যন্ত নিজ দায়িত্বে আবাসনের ব্যবস্থা করতে হবে।

ভাইস-চ্যান্সেলর মহোদয়ের অনুমোদনক্রমে

সংযুক্তঃ ফলাফলের কপি ০৪ পাতা।

(মোহাম্মদ আলী) ২৬.১১.১১
রেজিস্ট্রার

বিতরণঃ

১। ডীন, কৃষি অনুষদ/এগ্রিবিজনেস ম্যানেজমেন্ট অনুষদ/এনিম্যাল সায়েন্স এন্ড ভেটেরিনারী মেডিসিন অনুষদ /পোষ্ট গ্রাজুয়েট স্টাডিজ, শেকৃবি, ঢাকা।
২। প্রফেসর/ড./জনাব ....., চেয়ারম্যান/সদস্য/ সদস্য-সচিব, স্নাতক (সম্মান) কোর্সে ছাত্র-ছাত্রী ভর্তি কমিটি' ২০১২, শেকৃবি, ঢাকা।
৩। বিভাগীয় চেয়ারম্যান (সকল).....বিভাগ, শেকৃবি, ঢাকা।
৪। পরিচালক (সকল)/প্রক্টর/হল প্রভোষ্ট (সকল).....শেকৃবি, ঢাকা।
৫। পরীক্ষা নিয়ন্ত্রক /লাইব্রেরীয়ান (ভারপ্রাপ্ত), শেকৃবি, ঢাকা।
৬। আহবায়ক, টেকনিক্যাল উপ-কমিটি' ২০১২, শেকৃবি, ঢাকা।
৭। সভাপতি, ওয়েব সাইট উপ-কমিটি, শেকৃবি, ঢাকা।
৮। প্রধান প্রকৌশলী, শেকৃবি, ঢাকা।
৯। চীফ মেডিকেল অফিসার (অ.দা.), শেকৃবি, ঢাকা।
১০। ডেপুটি রেজিস্ট্রার (শিক্ষা)/উপ-পরিচালক (অর্থ ও হিসাব/বাজেট), শেকৃবি, ঢাকা।
১১। খামার তত্ত্বাবধায়ক(ভারপ্রাপ্ত)/জনসংযোগ কর্মকর্তা শেকৃবি, ঢাকা।
১২। একান্ত সচিব, ভিসি মহোদয়ের কার্যালয়, শেকৃবি, ঢাকা। (ভিসি মহোদয়ের সদয় অবগতির জন্য)
১৩। সহকারী রেজিস্ট্রার (প্রশাসন/পরিষদ), শেকৃবি, ঢাকা।
১৪। সহকারী পচিালক (অডিট), শেকৃবি, ঢাকা।
১৫। সহকারী রেজিস্ট্রার (স্টোর)/এস্টেট, শেকৃবি, ঢাকা।
১৬। নিরাপত্তা কর্মকর্তা, শেকৃবি, ঢাকা।
১৭। পি.এ. টু ট্রেজারার/রেজিস্ট্রার, শেকৃবি, ঢাকা। (সদয় অবগতির জন্য)
১৮। নোটিশ বোর্ড (সকল), শেকৃবি, ঢাকা। ১৯। অফিস নথি/মহানথি।

Sher-e-Bangla Agricultural University
Result of the Admission Test-2012

Table 1. General Merit List_Roll Numbers in Order of Merit_Column-wise:

16508	11159	12520	12195	14554	13384	13387	10007	12076	15547
17106	13880	15243	12736	14937	16113	11467	10498	12770	15559
16150	15551	13611	10938	15989	10815	12445	11125	13634	16763
14008	16960	15198	12220	16531	11918	13534	12337	14267	17007
11036	17317	11809	12659	11570	11931	13663	13106	14974	17054
13532	15340	14031	13032	15210	14410	15423	15741	16475	17231
13292	11209	15279	15453	17595	17473	15800	15909	16551	13044
11530	12084	15869	15693	14801	15590	16175	17696	17256	15591
11421	13010	12522	16594	12234	10741	14426	12935	17562	15019
16396	14005	15410	17336	13758	13724	12025	14738	12968	15969
17087	15483	15536	16510	16722	14398	14306	16026	11776	17716
10716	12442	15931	11709	15098	15214	10086	16225	11055	15841
11748	16186	17630	12570	11417	15687	13046	10729	12363	15711
10777	10914	12196	14017	11529	12521	13407	12430	10832	11721
12728	11882	14578	14071	16099	10148	14833	13670	16138	12748
14097	11866	14816	14293	10768	12788	15722	15002	13687	10211
12787	12024	15494	14776	11554	14421	15965	15701	15161	10262
14516	12252	11079	17582	12661	14618	16105	11557	10783	11258
14656	14765	10388	14178	13059	16855	16754	10326	13226	13513
14889	10445	17550	13062	15134	15689	10320	11515	13698	13681
13224	13163	10712	14900	15153	13607	11300	13951	16482	14018
12325	13241	15855	11766	15367	11484	12070	13973	17483	15146
11333	11377	14958	13862	15405	12099	14207	14505	10603	15191
12340	12582	15141	14002	16303	15126	14504	15614	12596	15424
14437	15676	16012	14799	13974	15376	15510	17365	13291	16421
15246	17079	16472	14988	12496	16201	15688	12044	10612	17421
12650	17086	11398	15264	10368	17617	17702	15169	10744	13314
13402	12924	15478	10093	12268	15144	14629	13812	13033	10432
15352	13591	11772	12129	12638	15479	12683	15102	13278	15541
15572	15897	12063	12891	12858	14346	11216	10863	13597	17379

Table 1 Cont.. General Merit List_Roll Numbers in Order of Merit_Column-wise:

15395	12217	12669	11932	17340	16882	17220	15734	14761	10561
10100	12660	13330	11947	12855	10994	17316	15767	15858	10985
10215	13294	13929	12254	14758	11422	17353	16011	14354	11350
10751	13298	14114	12952	10467	14044	17567	16221	12253	11930
11747	13716	14449	14795	12060	15503	16127	16455	13901	12225
12498	15124	14748	15056	14024	11862	13613	16845	14957	12651
13377	15489	14867	15219	13347	10279	16137	14634	11249	12928
15456	12330	15396	16940	10566	10487	15692	11117	11349	13656
16776	13878	15904	17427	10902	11269	16972	12543	13884	15195
11808	17280	17429	16400	11770	12295	14728	17432	14967	15438
16191	12368	17658	10569	11953	12444	10571	11677	15351	
11174	16109	12200	11499	12526	13433	12339	14362	15378	
12554	16957	12394	12509	12744	14261	13198	10912	15898	
15838	10312	13084	13993	15159	14450	13897	11865	17018	
16202	10805	13772	14854	17568	14960	14033	12020	17566	
10194	11561	13871	15751	12199	15104	14920	12566	11142	
13905	11989	16313	16436	12581	16895	15484	13898	11517	
14487	12593	15671	16614	16439	17100	15499	14558	16483	

Table 2. Quota_Roll Numbers in Order of Merit_ Column-wise:

Freedom Fighter						Tribe/Aborigin		Ward
13864	13585	17689	17456	13245		17116		10127
14970	13907	12848	12905	14366		13486		
12111	11208	11218	10952	12414				
10835	10064	15393	14372	16747				
14014	17431	12121	12534	14435				

Table 3. General Waiting List_Roll Numbers in Order of Merit_ Column-wise:

15745	10872	13382	13562	11501	17081	14392	13612	15239	10267
16386	11232	13643	15273	12823	12152	10764	14027	14009	11065
17235	11315	13865	17157	13729	12607	10838	14263	10650	11111
17523	11767	14170	11688	14521	13186	10895	14289	10898	11146
10111	11912	17142	11868	14731	15359	10905	14456	12159	11296
15626	12503	17282	13309	14944	13252	12338	15427	11695	12016
13735	12755	14473	13529	15520	17041	12760	15699	10515	12050
15511	13432	13766	13864	16348	17363	13271	16639	11447	12466
16369	14303	11877	14831	16713	10083	13583	16726	11948	12572
10174	14571	14919	15416	16876	10610	13722	17146	12058	12605
11224	14587	15135	15663	16908	10772	13791	16585	12148	12699
11739	14720	12475	16446	17442	11720	13954	14382	12304	13595
13765	14750	12474	16687	15347	12564	14712	15731	12789	15211
14298	14835	13546	17477	16040	12711	14902	11724	12988	15568
15518	15030	16748	17587	12646	12717	15194	17371	13351	15647
16073	15604	11887	15971	16655	14065	15504	10876	13358	15683
16231	15737	12319	16031	11528	14180	16547	17638	14598	17262
17034	15805	12960	16836	11599	14311	17147	15248	15500	17338
17189	16007	12965	11437	13302	14874	13246	12018	16027	17352
17439	16213	13484	16721	10519	14966	15999	11788	16077	17729
16279	16226	13540	14605	11650	15034	16206	12281	16536	11132
10995	17359	14834	10907	11834	15850	14406	12420	17334	13959
14969	14401	15106	17261	13111	16911	12713	12814	17693	17134
17479	14543	15349	15006	13814	16694	17418	13287	14823	13180
11311	14448	15517	14196	14353	16015	13983	13564	10568	15053
15666	14936	10942	16304	14374	15095	11493	13852	14922	16958
17596	15325	14135	10454	14947	14970	15936	14713	14931	10835
13913	12244	15880	10654	16146	17641	16804	15460	17069	10877
16366	10329	16449	10673	16659	12111	11816	16652	14649	13469
10427	11943	11595	11323	16829	10128	13312	16888	17053	17194

Table 3 Cont.. General Waiting List_Roll Nos. in Order of Merit_ Column-wise:

14247	15129	12068	14841	14308	14103	15027	15842	14880	13569
14774	10492	12065	13984	15847	16775	15529	10138	15412	14535
12490	10926	10354	10578	17267	17075	16645	11669	15794	14983
17115	11014	11722	11471	16038	13253	17035	12203	16416	15637
12231	11991	12110	11790	12927	13523	17046	10330	16474	15801
13303	12315	12726	13202	13501	15627	17150	10335	17274	16129
13316	13463	12949	13227	15747	10202	17406	11208	17513	16290
13970	14811	13392	15485	11520	10984	17519	11387	12978	16481
14014	14911	13815	15824	11906	11334	17678	11415	16867	16558
14434	14948	14019	15990	11979	11552	14766	11870	15445	16683
14859	15371	14059	15998	12003	12116	15233	11927	16658	17540
15667	16325	14945	16080	12763	12647	12411	12751	10144	17309
16070	16707	15155	16230	14060	13786	12708	13438	11379	12232
16363	17719	16741	16734	14335	13907	13429	13665	14012	16238
17505	12786	17097	16992	15825	14375	16042	13911	17687	16021
17531	13585	17141	12011	16494	14463	16399	14028	10576	13366
11089	14266	17525	11000	11875	14627	13420	14351	11141	11147
17563	16128	12014	14352	14010	14708	11351	14645	12100	15162
11939	15798	13491	17564	14514	14747	13960	14812	12171	10358
10941	13064	11516	12981	10314	14751	14467	14878	13336	10671

Table 4. Quota_Waiting List_Roll Numbers Merit-wise:

Freedom Fighter:	16450	17705	15552	15274	13813	15442
Tribe/Aboriginal:	Nil					
Ward:	Nil					

শেরেবাংলা কৃষি বিশ্ববিদ্যালয়
শেরে বাংলা নগর, ঢাকা-১২০৭
লেভেল ১, সেমিস্টার ১ ভর্তি পরীক্ষা-২০১২

অনুষদ পছন্দের অনুক্রম

বর্তমানে শেরেবাংলা কৃষি বিশ্ববিদ্যালয়ে তিনটি অনুষদ রয়েছে, যথা (ক) কৃষি অনুষদ, (খ) এগ্রিবিজনেস ম্যানেজমেন্ট অনুষদ এবং (গ) এনিম্যাল সয়েন্স এন্ড ভেটেরিনারি মেডিসিন অনুষদ।

১ম পছন্দঃ .....

২য় পছন্দঃ .....

৩য় পছন্দঃ .....

ভর্তি পরীক্ষার রোল নং..... প্রার্থীর স্বাক্ষর .....

শেরেবাংলা কৃষি বিশ্ববিদ্যালয়
শেরে বাংলা নগর, ঢাকা-১২০৭
লেভেল ১, সেমিস্টার ১ ভর্তি পরীক্ষা-২০১২

অনুষদ পছন্দের অনুক্রম

বর্তমানে শেরেবাংলা কৃষি বিশ্ববিদ্যালয়ে তিনটি অনুষদ রয়েছে, যথা (ক) কৃষি অনুষদ, (খ) এগ্রিবিজনেস ম্যানেজমেন্ট অনুষদ এবং (গ) এনিম্যাল সয়েন্স এন্ড ভেটেরিনারি মেডিসিন অনুষদ।

১ম পছন্দঃ .....

২য় পছন্দঃ .....

৩য় পছন্দঃ .....

ভর্তি পরীক্ষার রোল নং..... প্রার্থীর স্বাক্ষর .....