# INFLUENCE OF TRANSPLANTING TIME AND POULTRY MANURE ON KOHLRABI PRODUCTION

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# INFLUENCE OF TRANSPLANTING TIME AND POULTRY MANURE ON KOHLRABI PRODUCTION

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# *CERTIFICATE*

*This is to certify that the thesis entitled, "**INFLUENCE OF TRANSPLANTING TIME AND POULTRY MANURE ON KOHLRABI PRODUCTION**" submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in HORTICULTURE,** embodies the result of a piece of bona fide research work carried out by **MD.HOMAYUN KABIR,** Registration No. **11-04432** under my supervision and 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 and style of this thesis have been approved and recommended for submission.*

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***The Author***

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## ABSTRACT


This study was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2016 to February 2017. The experiment consisted of two factors: Factor A: Planting time (three levels) as $T_1$: Planting at 15 November, $T_2$: Planting at 30 November,$T_3$: Planting at 15 December and Factor B: Poultry manure (four levels) as $M_0$: Control i.e. no manure application; $M_1$: Poultry manure @ 8 t/ha; $M_2$: Poultry Manure @ 12 t/ha and $M_3$: Poultry manure @ 16 t/ha. The experiment was laid out with Randomized Complete Block Design with three replications. In planting time, the highest yield per hectare (10.64 t) was recorded from $T_2$, while the lowest (9.52 t) was recorded from $T_3$. For poultry manure, the highest yield per hectare (14.72 t) was found from $M_2$, whereas the lowest (4.94 t) was recorded from $M_0$. Due to the combined effect, the highest yield per hectare (15.57 t) was recorded from $T_2M_2$, whereas the lowest (4.83 t) was recorded from $T_3M_0$.The highest BCR (2.48) was from $T_2M_2$ and the lowest (1.08) from $T_3M_0$.Therefore, planting at 30 November with 12 t /ha poultry manure was best for the kohlrabi production.

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## ABBREVIATIONS AND ACRONYMS

| ABBREVIATIONS | ELABORATIONS |
|---|---|
| AEZ | : Agro-Ecological Zone |
| ANOVA | : Analysis of Variance |
| S.E. | : Standard Error |
| df | : Degrees of freedom |
| DM | : Dry matter |
| *et al.* | : and others |
| FAO | : Food and Agriculture Organization of United States |
| SAU | : Sher-e-Bangla Agricultural University |
| BAU | : Bangladesh Agricultural University |
| BBS | : Bangladesh Bureau of Statistics |
| DAT | : Days after Transplanting |
| DMRT | : Duncan's Multiple Range Test |
| BARC | : Bangladesh Agricultural Research Council |

# CHAPTER I

# INTRODUCTION

Kohlrabi (*Brassica oleraceae var. gongylodes*) belongs to family Brassicaceae and considered as a Cole crop and its edible portion is enlarged stem (knob). It is well known that, kohlrabi has enormous nutritional and medicinal values due to its high contents vitamins (A, $B_1$, $B_2$, $B_5$, $B_6$ and E), minerals (Ca , Mg, Zn and Fe) and antioxidant substances which prevent the formation of cancer causing agents (Beecher,1994). Kohlrabi is widely cultivated in European and American countries. In Bangladesh, still it is grown in a very limited scattered ares and total cultivated area is not exactly known.

Kohlrabi is planted in the winter season in Bangladesh .The temperature in Bangladesh remains fairly high up to mid-October and gradually goes down in mid-December. This cool period extends up to mid-February. The temperature increases sharply thereafter. Planting dates for each region is one of the factors that have a significant role in the performance of this product. Proper planting makes all the environmental factors occurring at the time of emergence, and seedling establishment of appropriate. Each stage of growth coincide with environmental conditions is desired. Due to the climatic conditions of each region are different varieties of the same species also having different reactions. The proper planting time for any amount due to climatic conditions, characteristics of cultivars and planting should be determined (Kochki *et al.*, 1995, Khajeh-poor, 1991).

It is therefore important to study the effect of planting time for achieving optimum growth and yield of kohlrabi (Das *et al.* 2000). Higher plant population reduced head size, lower average marketable knobs weight and delay maturity (Khan *et al.* 1991).

Organic matter is a source of food for the innumerable number of micro-organisms and creatures like earthworm who breaks down these to micronutrients, which are easily absorbed by the plants. Organic manure plays a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils. Organic manures such as cow dung, poultry manure and vermicomposting improves the soil structure, aeration, release the nutrients slowly thus support root development leading to higher growth and yield of kohlrabi plants (Abou El-Magd *et al.* 2005). The macronutrients like calcium and micronutrients such as boron, manganese,

molybdenum and iron are important for Cole crop development. Its cultivation in Bangladesh has not extended due to the lack of awareness regarding its nutritive value and appropriate method of planting including planting time and manure application. Therefore, the present experiment has been carried out with the following objectives:

1. To identify the proper planting time on growth, yield and nutritional status of kohlrabi,
2. To determine the appropriate dose of poultry manure application on growth, yield and nutritional status of kohlrabi and
3. To find out the combined effect of planting time and poultry manure application on growth, yield and nutritional status of kohlrabi.

# CHAPTER II

# REVIEW OF LITERATURE

Kohlrabi is one of the most widely grown vegetables in the temperate zones and is a biennial and herbaceous “Cole” crops in Bangladesh. It is a thermo sensitive crop and grown in Bangladesh and grown as an annual crop in winter crop. Growth and knob development of kohlrabi are greatly influenced by growing environment. As a minor vegetable and newly introduced crop it has less attention by the researchers on various production aspects especially the use of planting time and organic manure and a very few studies on the growth and yield of broccoli have been carried out in Bangladesh. Therefore, the research work so far done in Bangladesh is not adequate and conclusive. Nevertheless, some of the important informative works and research findings related to planting time and organic manure on kohlrabi so far had been done at home and abroad has been reviewed in this chapter under the following headings:

## 2.1 Effect of planting time on the growth and yield of kohlrabi

Khatun *et al.* (2012) conducted an experiment at the Horticultural Research Farm of Sher-e-Bangla Agricultural University, Dhaka to study the effect of different transplanting dates (October 5, October 25, November 14 and December 4) on the growth and yield of broccoli. Different transplanting dates showed significant influence on the yield and yield contributing characters of broccoli. Weight of curd plant-1 (319.11g), curd yield plot-1 (7.83 kg) and curd yield ha-1 (13.04 ton) were decreased with delay in transplanting. The highest curd yield ha-1 was obtained from the 25th October transplanting while the lowest from the 4th December transplanting.

Narendra *et al.* (2007) conducted a field experiment to determine the most suitable transplanting date (30 September, 15 and 30 October, and 15 November) and planting geometry (45×30, 45×45 and 45×60 cm) for broccoli

(*Brassica oleracea*) cultivation under the mid-hills conditions of Alomar, Uttar Pradesh, India. Data were recorded for plant height, leaves per plant, plant diameter, curd diameter, curd weight, secondary heads per plant, yield, fodder yield and total soluble solids. Results revealed that transplanting of broccoli can be done from 30 September to 15 October at a planting geometry of 45×30 cm for higher production of broccoli under the mid-hills conditions of the Himalayas.

El-Yazied *et al.* (2007) carried out a field experiment at the experimental farm of the Faculty of Agriculture, Ain Shams University, Shoubra Elkheima, Kalubia governorate, to study the effects of three sowing dates, i.e., the first of each of September, October and November, and four pinching treatments (pinching the apical head just after appearance, pinching the main head at the marketable stage, pinching the axillary head just after appearance on broccoli plants (*Brassica olerasea var Italica*), cultivar "Emperor". Plants were grown in Kilobit under loamy soil conditions. Plants of the second sowing date (first of October) produced the tallest plants and the highest number of leaves per plant.

Emam (2005) conducted consequently two field experiments to study the effect of two transplanting dates i.e., 22 August and 23 September and two within plant spacing 40, 60 cm for the second transplanting dates in 2000/2001 and 2001/2002 seasons, on vegetative growth, head quality and yield of broccoli (CV. Landmark) under the conditions of Kalyobeyia governorate. The results revealed that early planting increased plant height, number of leaves/plant and main stem diameter. On the contrary, the late transplanting on 23rd September increased head weight and diameter as well as total yield significantly.

Uzun and Kar (2004) carried out an experiment in the research field of the Black Sea Agricultural Research Institute in Turkey from spring to winter. Cultivar Platini, which is known as sprouting broccoli, was used in the study. Seedlings were raised in module seed trays. Planting procedure was repeated for the times, viz., 25 April (first, $P_1$), 27 May (second, $P_2$) and 27 June 1999

(third, $P_3$). The results showed that LWR decreased with time after planting while SWR increased with time. Generally, later planting times resulted in higher SWR and LWR while early planting times had higher RWR. Earlier planted plants had higher LAR and SLA. NAR and RGR were found to be lower with earlier plantings. LA and TPDW varied with planting times and ontogeny. Both LA and TPDW increased with time after planting and plants from earlier plantings had lower LA and TPDW values. LT was higher at later planting times and increased with time.

Yoldas and Esiyok (2004) conducted an experiment in Odemis, Turkey, to investigate the effects of plant spacing, sowing and planting dates on the growth of 3 cultivars of broccoli (Green Dome, KY-110 and Marathon). The trial was carried out in Kucuk Menderes Valley using seedlings planted between June and October. The yield tended to decrease when sowing was conducted towards autumn. When seeds were sown in autumn, the yield also tended to decrease from 5003 to 1390 kg/da.

Ahmed and Wajid (2004) carried out an experiment in Rawalakot, Pakistan to investigate the effect of sowing dates on growth and yield of broccoli cv. Green mountains. Seeds were sown in well prepared seedbeds on 20 April, 5 May, 20 May and June 2002. Seedlings were transplanted when 3-4 leaves were developed after 30 days. Sowing on 5 May produced more (18.48) and longer (47.31) leaves, taller (30.79 cm) plants, heads of greater diameter (14.97 cm) and weight (200.65 g), higher number of secondary heads (16.0) and yield per plant (15.50 kg) compared to other sowing dates. Sowing on 5 May is recommended for general cultivation of broccoli under temperate areas.

Wlazo and Kunicki (2003) carried out a field experiment in Poland to find out the effects of transplanting age (4, 6, 8 and 10 week old) and transplanting date (11 July and 6 August) on the yield and quality of broccoli cv. Lord $F_1$. The marketable yield of broccoli was highest with July planting, whereas the dry matter and ascorbic acid content in broccoli heads were highest with August planting. Ten week old, and 4 and 8 week old transplants recorded the highest

marketable yield in 2000 and 2001, respectively. Dry matter and ascorbic acid content were highest in 6 and 4 week old transplants, respectively.

Rekowska and Sodkowski (2002) conducted an experiment in Szczeccin, Poland to find out the effects of sowing date (10 and 25 April, 10 and 25 May, and 10 and 25 June) on the yield of broccoli cv. Lord $F_1$. The highest main head yield, weight, and diameter were obtained with sowing on 25 May, and 10 and 25 June. Sowing on 10 June resulted in the highest yield, weight, and diameter of secondary heads.

Singh (2001) conducted an experiment during the rabi seasons at Dhaulakuan, Himachal Pradesh, India to assess the plant height and head yield of broccoli planted at weekly intervals from 20 October to 22 December. The highest average values for plant height (41.75 cm) and head yield (99.05 q/ha) were recorded when the crop was transplanted on 27 October. These values were at par with those obtained from crops transplanted on 20 October and 3 November. Transplanting beyond 10 November significantly reduced both parameters.

Darnata *et al.* (2000) conducted a field experiment in Italy on two cultivars of broccoli with three sowing dates (August 27, October 20 and November 6). They reported that sowing time markedly influenced the yield, yield components and time of harvest. They also observing that when sowing was delayed by 36 days, yield decreased by 36% in the first year and 66% in the second.

Sari *et al.* (2000) conducted an experiment at Turkey on two cultivars of broccoli with five sowing dates (June 15, July 1 & 15 and August 2 & 16) during 1994 and 1995 in both the years, sowing dates significantly affected the total yield and the highest yield was obtained from the June 15 sowing (1065.11 g/plant). The main head weight and diameters for the early sowing dates were higher than the others.

Trotta *et al*. (2000) reported from Italy that yield in broccoli cultivars decreased when sowing was delayed from first fortnight of August to first fortnight of September. Yield of cultivars decreased when sowing was delayed. They also reported that central head weight decreased with delayed sown.

Sari *et al*. (2000) conducted a field experiment with five different sowing times in 1994 (16 June, 1 and 15 July, 2 and 16 August) and 1995 (15 June, 3 and 18 July, 3 and 17 August) were tested using 2 broccoli cultivars (Sultan and Marathon in the first year; SG1 and Marathon in the 2nd year) grown in the South-Eastern Anatolian Project (GAP) Area, Turkey, under irrigated conditions. The plants were transplanted on 5 different dates in 1995 (3, 16 and 25 August, 28 September and 26 October). In 1994, sowing time significantly affected primary head, lateral head and total head yield of broccoli. The 16 June sowing produced the highest primary head yield (395.92 g/plant), lateral head yield (322.19 g/plant) and total head yield (648.73 g/plant). Mean head weights and diameters for the early sowing dates were higher than for the last 2 sowing dates. Harvesting took place from November to February. In 1995, primary head yields were not affected by sowing date. The first sowing date (19 June) resulted in a lateral head yield higher (893.21 g/plant) than those of other sowing dates (531.71, 304.77, 216.51 and 157.53 g/plant). Sowing dates significantly affected the total yield. The highest yield was obtained from the 15 June sowing (1065.11 g/plant). Yields from the 3 and 18 July, and 2 and 17 August sowing dates were 726.98, 455.64, 318.38 and 218.20 g/plant, respectively.

Aboul and Ragab (2000) conducted an experiment on broccoli cv. Assiut I with two planting dates (October 1 and 15) and accumulated heat unit (AHU) on held quality at Assiut University, Egypt. They reported that average head weight and total yields were higher with later planting, which associated with 8.5 days longer growth before harvest. They also reported that head weight was positively correlated with AHU of the late vegetative stage.

Dellacecca *et al.* (1996) examined in Italy the effect of three planting dates (August 20, September 24 and October 25), four topping regimes (none, topping at planting, 15 or 30 days later) on four broccoli cultivars. They reported that topping at planting and particularly in August result in the best and earliest yield of inflorescence with a relatively high weight, good firmness and small stem diameter.

Bianco (1996) conducted an experiment in Italy with 4 broccoli cultivars to observe the effect of four sowing dates (September 25, October 21, December 4 and January 19) on yield. He reported that the yield decreased as sowing dates was delayed. Sowing on December 4 and January 19 reduced marketable yield by 57 and 96% respectively, compared to sowing on September 25. Head yield was higher when crops were planted early and showed a linear decreasing trend with delayed planting dates.

Moel (1992) conducted an experiment in the Netherlands to observe the effect of planting dates (May 30 and July 30) on broccoli cultivar Roxie. He reported that small head size (375 g) and high percentage of first class heads were obtained from the early planted trial. He suggested that it might be due to the association of high temperature during harvest. With the later planting, the average head weight was 572g. The harvest period was from 15 October to 5 November. The total yield amounting to 15t/ha of which 89% was graded as class 1.

Bracy and Contantin (1991) reported from Louisiana, USA that the transplanting date significantly affected the yield. Three broccoli cultivars were planted on 11 different dates during the autumn and spring season of 1985-1987. The highest yields and head weights were obtained for transplanting during spring or early autumn. Transplanting during late October and November produced lower head weights. They also suggested that the best harvesting time of broccoli heads reached 3-4 inches in diameter (0.30 to 0.44 lb/head) and florets were mature but not open.

Sterrett *et al.* (1990) carried out an experiment to explore the potential of sprouting broccoli with thirteen cultivars at East Virginia, USA and reported that the yield of some broccoli cultivars exceeded the target from the first sowing date (August 10) but it was below the target for the other two sowing dates (August 19 to September 10).

Begum *et al.* (1990) observed that wide variation in vegetative growth and head yield while transplanting of 30 days old broccoli seedling at an interval of 15 days from Septembers 14 to December 13. Planting during October 14 to November 13 resulted in increased vegetative growth and larger curd than earlier.

Diputado and Nichols (1989) conducted a field experiment in New Zealand on four cultivars of broccoli with six different sowing dates (September 18, November 19, January 17, March 21, and July 21). The heat unit concept was applied to relate temperature differences over the different sowing dates with time to head initiation, time to head maturity and rate of head growth. The time to head initiation appeared to be dependent on a heat unit summation above a base temperature of 10C while the rate of head growth was related best to a heat summation above 30C. They reported that the head and total dry weight (DW) production varied with sowing dates and with cultivars.

Thompson and Kelly (1985) say, “In temperate regions, broccoli is cultivated in the spring and in tropical (worm temperature) regions it is growth during the winter months”. As a result, broccoli is found to grow well in place where a mild temperature to moderate cool temperature exists. However, the yield of the crop, for obvious reason, depends on the environmental conditions prevailing during the growing season in a particular place. Ahmed and Abdullah (1986) reported that the time of planting significantly influenced the head yield and other characters of broccoli. Among the five planting dates (September 15, October 1 & 15 and November 1 & 15) the earlier planting produced taller plants and took more number of days for flower bud initiation.

The highest yield was obtained from the crop planted on October 15 followed by November 1, while September 15 planting produced the lowest yield.

### 2.2 Effect of poultry manure on the growth and yield of kohlrabi

Mehdizadeh *et al.*( 2013) observed that addition of organic fertilizers at rate of 20 ton/ha significantly (at $P<0.05$) increased tomato growth and yield compared to control (no fertilizer application). Also obtained results proved that tested treatments could be arranged in decreasing order as follows: municipal waste compost > poultry manure> cow manure> sheep manure > no fertilizer. Compost and poultry manure had a synergistic effect on both fresh and dry weights of tomato shoots and roots Application of poultry manure and 300 kg/ha NPK fertilizer significantly ($P<0.05$) increased plant N, P and K. Poultry manure at 20, 30 and 40 t/ha and NPK 15:15:15 fertilizer significantly ($P<0.05$) increased plant leaf, area height, number of leaves, branches fruits and fruit yield. Application of 10 t/ha poultry manure gave similar values of plant N, P and K and yield components compared with 300 kg/ha NPK fertilizer.

Ryan (2011) conducted a field experiments to assess the release of plant-available N to broccoli plants from five N-rich soil amendments approve for organic production. Data shows that fish meal supplied an optimal pattern of N for high broccoli yield in both years. Soil analysis in 2010 showed N availability from fish meal differed from other fertility sources, with greater initial NH4+ availability and consistently high $NO_3$ levels from early to mid-June.

Boari *et al.* (2010) investigated the effects of fertilization and cultivar on yield and quality of broccoli in organic farming. Three levels of organic manure 0, 40 and 80 kg/ha of amino sprint, respectively indicated with $F_1$, $F_2$ and $F_3$ on 4 cultivars of broccoli, were compared. Any effects of fertilization levels were observed on broccoli yield and quality, because of low quantity of main nutritional elements contained in the amino sprint.

Adeli *et al.* ( 2009) said that addition of poultry manure has been shown to improve the fertility of the cultivated soil by increasing the organic matter content, water holding capacity, oxygen diffusion rate and the aggregate stability of the soils .

Premsekhar and Rajashree (2009) observed that poultry manure application could be attributed to easy solubilisation effect of released plant nutrient leading to improved nutrient status of the soil the results obtained were in agreement with the findings in which they reported that higher yield response of crop due to organic manure application.

Ewulo et al. ( 2008) said that Manure applications increased leaf N, P, K, Ca and Mg concentrations of tomato, plant height, and number of branches, root length, number and weight of fruits. The 25 t/ha poultry manure gave highest leaf P, K, Ca and Mg.

Olaniyi and Ajibola (2008) observed that the combined application of the two types of fertilizers resulted in the highest marketable fruit yield. The content of essential nutrient elements increased and was also influenced by fertilizer treatments, except K in all the treatments Plant height, number of leaves, leaf area, number of fruits and tomato yield as well as N, P and K were increased with the increase in the level of poultry manure up to 30 t/ha. The soil treated with 30 t/ha poultry manure gave highest plant K with corresponding increase in yields. The yield and growth parameters were found to decrease at 40 t/ha compare to 30 t/ha poultry manure indicating nutrient imbalance at the highest rate of application. The better performance of 30 t/ha poultry manure might be as a result of higher nutrient uptake especially N, P and K. It was indicated in the result that 40 t/ha PM reduced plant P, K, Ca and Mg compared to 20 t/ha of poultry manure. The least plant N, P and K contents recorded for tomato without poultry manure agrees with the observation that poultry manure supplied.

Ayeni *et al. (*2008) observed that N, P and K 20, 30 and 40 t/ha poultry manure performed better than 300 kg/ha NPK 15:15:15 fertilizers. This work showed that increase in poultry manure up to 30 t/ha maximizes yield than 20 t/ha of poultry manure earlier recommended as, optimum level for the production of tomato in the rain forest zone of southwest Nigeria.

Maurya *et al.* (2008) conducted a field experiment in Pantnagar, Uttaranchal, India to study the effects of the recommended fertilizer and farmyard manure on broccoli (cv. Fiesta): recommended fertilizers (RF; 120:60:60 kg NPK/ha), farmyard manure (FYM) at 20 t/ha, FYM at 10 t/ha + 50% FR, neem cake at 5 quintal/ha, neem cake at 2.5 quintal/ha + 50% RF, vermicompost at 5 t/ha, vermicompost at 2.5 t/ha + 50% RF, poultry manure at 5 t/ha, and poultry manure at 2.5 t/ha + 50% RF. Poultry manure + 50% RF and FYM + 50% RF resulted in the greatest plant height in 2005-06. In 2006-07, poultry manure + 50% RF, vermicompost + 50% RF, RF and poultry manure gave the tallest plants, the number of fully opened leaves in both years was highest for poultry manure + 50% RF. Leaf length was greatest for poultry manure + 50% RF and vermicompost + 50% RF. The greatest leaf weight per plant was recorded for poultry manure + 50% RF, FYM + 50% RF and vermicompost + 50% RF in 2005-06, and for poultry manure + 50% RF, RF, FYM + 50% RF and vermicompost + 50% RF in 2006-07. Poultry manure + 50%RF, FYM + 50% RF and vermicompost + 50% RF registered the greatest head weight in 2005-06, whereas poultry manure + 50% RF was superior for this trait in 2006-07. The highest yields were obtained with poultry manure + 50% RF.

Akanni and Ojeniyi ( 2007) observed that application of different levels (0, 10, 20, 40, 50 t/ha) of poultry manure on tomato, the 20 t/ha poultry manure gave highest value of number and weight of fruits and increase height, number of branches, leaf area and tap root length .Utilization of poultry manure in tomato production in Nigeria, and information about effects on soil physical properties and nutrient uptake, and sustainability of tomato production systems is scarce.

Abou *et al*. (2006) conducted two field experiments at El-Kassasein, Ismailia Governorate, Egypt to study the response of vegetative growth and yield of some broccoli varieties to apply organic manures (Cattle and poultry manures) compared with mineral fertilization. The highest vegetative growth of broccoli plants was recorded by plants which were supplied with 100% cattle manure. However, the highest total yield and quality of broccoli were recorded by adding poultry manure in the two seasons.

Aluko and Oyedele (2005) found that little information on the effects of organic waste on soil physical properties and they observed that poultry manure incorporation had no significant effect on soil density and porosity. The work being reported studied the effect of different levels of poultry manure on soil bulk density, moisture content, nutrient status, growth and fruit yield of tomato.

Akanbi *et al*. (2005) observed that application of broiler litter at the rate of 15 ton/ha, N at 40 kg/ha, P at 30 kg/ha and K at 30 kg/ha gave higher growth and fruit yield.

Ewulo (2005) said that Poultry manure contains high percentage of nitrogen and phosphorus for the healthy growth of plants Nitrogen is equally said to be the motor of plant growth.

Duncan (2005) observed that application of chicken manure acts as a good soil amendment and/or fertilizer (e.g. provides N, P and K) and can also increase the soil and leaf N, P, K, Ca and Mg concentrations. These soil chemical properties provide information on the chemical reactions, processes controlling availability of nutrients and ways of replenishing them in soils .

Akande and Adediran (2004) found that poultry manure at 5 t/ha significantly increased tomato and dry matter yield, soil pH, N, P, K, Ca and Mg and nutrient uptakes.

Adediran *et al.* (2003) compared poultry manure, household, market and farm waste and found that poultry manure at 20 t ha had highest nutrient contents and mostly increased yield of tomato and soil macro and micronutrients content.

IFA (2000) observed that Organic matter is the ultimate determinant of the soil fertility in most tropical soils and this account for its use to raise seedling in tropical areas, the fertility of the soil could be sustained with the addition of poultry manure .

Palm et al. (1997) recommended that 9-18 tons/acre of manure for good tomato yield.

Akter *et al.* (1996) carried out an experiment at Joydebpur to find out the effects of poultry manure (PM) and cow dung (CD) in presence and absence of chemical fertilizer on growth and yield of broccoli and reported that 10 ton/ha of poultry manure with recommended dose of nutrients produced the highest curd yield of broccoli. The application of only PM and CD caused yield depression even at higher doses. The highest curd yield of 20.70 and 16.75 tons per hectare were obtained with PM and CD against 9.0 tons per hectare in the control treatment. In absence of NKPS only organic manure could not produce higher yield of curd.

Hochmuth *et al*. (1993) conducted an experiment to investigate the response of cabbage yields, head quality and leaf nutrient status to poultry manure fertilization. They reported that the marketable yield of cauliflower responded quadratically to increasing rates of poultry manure, with the maximum yield (24.4 t/ha) being obtained by 18.8 t/ha. The results showed that manuring efficiency was initially higher with commercial fertilizer than the poultry manure alone, since lower amounts of total nutrients were applied using commercial fertilizer.

Warman (1986) said that the potential impacts of chicken manure on soil chemical properties and crop yield and in particular evaluating the critical application levels. Moreover, the need and utilization of chicken manure has overtaken the use of other animal manure (e.g. pig manure, kraal manure) because of its high content of nitrogen, phosphorus and potassium.

# CHAPTER III

# MATERIALS AND METHOD

This chapter includes the information regarding methodology that was used in execution of the experiment. It contains a short description of location of the experimental site, climatic condition, materials used for the experiment, treatments of the experiment, data collection procedure and statistical analysis.

## 3.1 Location of the experimental plot

The experiment was conducted at the Horticultural Farm of the Sher-e-Bangla Agricultural University, Dhaka during the period from October, 2016 to February, 2017. The site is $90.2^0$ N and $23.5^0$ E Latitude and at an altitude of 8.2 m from the sea level.

## 3.2 Characteristics of soil

The soil of the experiment was Non- calcareous, dark gray, medium high land. The soil texture was silty loam with a pH 6.7. Soil samples of the experimental plot were collected from a depth of 0 to 30 cm before conducting the experiment. Soil was analyzed in the Soil Resources Development Institute (SRDI) Farm gate, Dhaka. The experimental site was a medium high land (Appendix II) .

## 3.3 Climatic condition

The experimental area was under the sub-tropical monsoon climate, which is characterized by heavy rainfall during Kharif season and scanty in the Rabi season (October to March). There was no rainfall during the month of October, November, December and January. The average maximum temperature during the period of experiment was 26.82˚C and the average minimum temperature was 17.14˚C. Details of the meteorological data in respect of temperature, rainfall and relative humidity during the period of the experiment were collected from Weather Station of Agargaon, Dhaka.

### 3.4 Agro-ecological region

The experimental field belongs to the agro-ecological region of the Modhupur Tract (AEZ-28). The landscape comprises level upland, closely or broadly dissected terraces associated with either shallow or broad, deep valleys.

### 3.5 Experimental materials

“Quick Star” a variety of kohlrabi has been used as experimental material. The seeds of kohlrabi had been collected from Siddik Bazar, Dhaka.

### 3.6 Treatment of the experiment

The experiment consisted of two factors:

Factor A: Planting time (three levels) as

i. $T_1$: Planting at 15 November

ii. $T_2$: Planting at 30 November

iii. $T_3$: Planting at 15 December

Factor B: Organic manure (four levels) as

i. $M_0$: Control i.e. no manure application

ii. $M_1$: Poultry Manure @ 8 t/ha

iii. $M_2$: Poultry Manure @ 12 t/ha

iv. $M_3$: Poultry Manure @ 15t/ha

There were 12 (3 × 4) treatments combination such as $T_1M_0$, $T_1M_1$, $T_1M_2$, $T_1M_3$, $T_2M_1$ ,$T_2M_1$, $T_2M_2$, $T_2M_3$, $T_3M_0$, $T_3M_1$, $T_3M_2$ and $T_3M_0$.

### 3.7 Design and layout of the experiment

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The total area of the experimental plot

was 168$m^2$ with length 22.4 m and width 7.5 m. The total area was divided into three equal blocks. Each block was divided into 12 plots where 12 treatments combination were allotted at random. There were 36 unit plots altogether in the experiment. The size of the each plot was 1.5 m × 1.35 m. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m, respectively.

### 3.8 Preparation of the main field

The selected plot of the experiment was opened in the 1st week of October, 2016 with a power tiller, and left exposed to the sun for a week. Subsequently cross ploughing was done five times with a country plough followed by laddering to make the land suitable for transplanting the seedlings. All weeds, stubbles and residues were eliminated from the field. Finally, a good tilth was achieved. The soil was treated with insecticides (cinocarb 3G @ 4 kg/ha) at the time of final land preparation to protect young plants from the attack of soil inhibiting insects such as cutworm and mole cricket.

#### 3.8.1 Application of poultry manure

Poultry manure was applied as per treatment as a basal dose. Composition of cow dung, vermicompost and poultry manure are presented in Table 1. No inorganic fertilizers were applied in the experimental field.

Table 1. Composition of cowdung, vermicompost and poultry manure (Fertilizer Recommendation, BARC, 2005).

| Manures | Amount (%) | | |
|---|---|---|---|
| | N | P | K |
| Cowdung | 0.5-1.5 | 0.4-0.8 | 0.5-0.9 |
| Poultry Manure | 1.6 | 1.5 | 0.85 |
| Vermicompost | 1.5-2.0 | 0.9-1.7 | 1.5-2.4 |

### 3.8.2 Raising of seedlings

The seedlings of kohlrabi were raised at Horticulture Farm, of Sher-e-Bangla Agricultural University (SAU), Dhaka, under special care in four seed beds each of 3 m × 1 m size. Soil of the seed bed was ploughed, prepared well and clods were broken into small pieces and converted into loose, friable to obtain good tilth. All weeds, stubbles and dead roots of the previous crops were removed carefully. Seedbeds were dried in the sun to prevent the damping of disease. Seed were sown in each seed bed on 20th October, 5th November and 20th November, 2016 to get seedlings of 25 days old at the time of transplanting. After sowing, the seeds were covered with finished light soil. Seeds were completely germinated within 3-4 days after sowing. Shading was given by bamboo mat (chatai) over the seedbed to protect the young seedlings from scorching sunlight and rainfall. Weeding, mulching and irrigation were done from time to time to provide a favorable for good growth and raising quality seedlings.

### 3.8.3 Transplanting of seedlings

Healthy and uniform seedlings of 25 days old seedlings were transplanting in the experimental plots on 15 November, 30 November and 15 December, 2016 as per treatment of planting time. The seedlings were uprooted carefully from the seed bed to avoid damage to the root system. To minimize the damage to the roots of seedlings, the seed beds were watered on hour before uprooting the seedlings. Transplanting was done in the afternoon. The seedlings were watered immediately after transplanting. Seedlings were sown in the plot with maintaining distance between row to row and plant to plant was 45 cm and 30 cm, respectively. The young transplants were shaded by banana leaf sheath during day time to protect them from scorching sunshine up to 7 days until they were set in the soil. They (transplants) were kept open at night to allow them receiving dew. A number of seedlings were also planted in the border if the experimental plots for gap filling.

### 3.8.4 Intercultural operation

After raising seedlings, various intercultural operations such as gap filling, weeding, earthing up, irrigation pest and disease control etc. were accomplished for better growth and development of the kohlrabi seedlings.

### 3.8.5 Gap filling

The transplanted seedlings in the experimental plot were kept under careful observation. Very few seedlings were damaged after transplanting and such seedling were replaced by new seedlings from the same stock. Planted earlier on the border of the experimental plots same as planting time treatment. Those seedlings were transplanted with a big mass of soil with roots to minimize transplanting stock. Replacement was done with healthy seedling having a boll of earth which was also planted on the same date by the side of the unit plot. The transplants were given shading and watering for 7 days for their proper establishment.

### 3.8.6 Weeding

The hand weeding was done at 15, 30, 45 and 60 days after transplanting (DAT) to keep the plots free from weeds.

### 3.8.7 Earthing up

Earthing up was done at 20 and 40 days after transplanting on both sides of rows by taking the soil from the space between the rows by a small spade.

### 3.8.8 Irrigation

Light watering was given by a watering cane at every morning and afternoon. Following transplanting and it was continued for a week for rapid and well establishment of the transplanted seedlings.

### 3.8.9 Pest and disease control

In spite of Cirocarb 3G applications during final land preparation few young plants were damaged due to attack of mole cricket and cut worm. Cut worms were controlled both mechanically and spraying Darsban 29 EC @ 3%. Birds pest such as nightingales (common Bulbuli) were seen visiting the kohlrabi field very frequently. The nightingale visited the fields in the morning and afternoon. The birds very found to puncture the soft levels and newly initiated knob and were controlled by striking a kerosene tin of metallic container frequently during day time.

### 3.8.10 Harvesting

Only the compact mature knobs were harvested with 15 cm long fleshy stalk by using as sharp knife. To prevent the rotting of steam the cut portion were slanted, so that rain water could not stay. The knobs were harvested in compact condition before the flower buds opened (Thomson and Kelly, 1985). Before harvesting of the kohlrabi knob, compactness of the knob was tested by pressing with thumbs.

## 3.9 Method of data collection

Five plants were randomly selected from each unit plot except yields of knob, which was recorded plot wise. Data were collected in respect of the following parameters to assess plant growth; yield attributes and yields as affected by different treatments of the experiment. Data on plant height, number of leaves and length of large leaf were collected at 15,30and 45 days after transplanting (DAT). All other yield contributing characters and yield parameters were recorded during harvest and after harvest.

### 3.9.1 Plant height

Plant height was measured from sample plants in centimeter from the ground level to the tip of the longest leaf and mean value was calculated. Plant height

was also recorded at 15 days interval starting from 15 days after Transplanting (DAT) upto 80 days and at harvest to observe the growth rate of plants.

### 3.9.2 Number of leaves per plant

The total number of leaves per plant was counted from each selected plant with the observation of fully open leaves. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot at 20 days interval starting from 20 days after transplanting (DAT) upto 80 days and at harvest.

### 3.9.3 Days from transplanting to first visible knob

Each plant of the experiment plot was kept under close observation for recording the data on days from transplanting to first visible curd. Total number of days from the date of transplanting to the first visible knob was recorded.

### 3.9.4 Length of stem

The length of stem was taken from the ground level to base of the main curd of plant during harvesting. A meter scale used to measure the length of stem and was expressed centimeter (cm).

### 3.9.5 Diameter of stem

The diameter of the stem was measured at the point where the central knob was cut off. The diameter of the stem was recorded by slide calipers.

### 3.9.6 Fresh weight of leaves per plant

The fresh weight of leaves was recorded from the average of five (5) selected plants in gram (g) with a beam balance.

### 3.9.7 Length of root

The length of root was considered from the base of the tip of the root. It was measured in centimeter (cm) with a meter scale after harvesting.

### 3.9.8 Fresh weight of roots

Per plant Fresh weight of roots was recorded in weighting the total roots and was recorded in gram.

### 3.9.9 Weight of knob

The weight of knob per plant was recorded in gram (g) by a beam balance.

### 3.9.10 Diameter of knob

The diameter of knob was measured in several directions with meter scale and the average of all directions was finally recorded and expressed in centimeter (cm).

### 3.9.11 Dry matter content of leaves

At first 100 g leaves of selected plant was collected, cut into pieces and was dried under sunshine for a few days and then dried in an oven at $70^0$C for 72 hours before taking dry weight till it was constant. The dry weight was recorded in gram (g) with a beam balance.

### 3.9.12 Dry matter content of knob Sample

100 g knob was taken, cut into pieces and was dried under direct sunshine for 3 days and then was dried in an oven at $70^0$ for 72 hours before taking the dry weight till it was constant. The dry weight was recorded in gram (g) with a beam balance.

### 3.9.13 Yield per plot

The yield per unit plot was calculated by adding the weight of all the central curds and secondary curds produced in the respective plot. The yield of all plants in each unit plot was recorded and was expressed in kilogram (kg).

### 3.9.14 Yield per hectare

The yield per hectare was calculated by converting from the per plot yield data to per hectare and was expressed in ton (t).

### 3.10 Statistical analysis

The data obtained for different characters were statistically analyzed by using SPSS computer package program to find out the significance of the difference for planting time and poultry manure on yield and yield contributing characters of kohlrabi. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the „F‟ (variance ratio) test. The significance of the difference among the treatment combinations of means was estimated by Duncan‟s Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

### 3.11 Economic analysis

The cost of production was analyzed in order to find out the most economic combination of planting time and poultry manure. All input cost included the cost for lease of land and interests on running capital in computing the cost of production. The interests were calculated @ 14% in simple rate. The market price of kohlrabi was considered for estimating the cost and return. Analyses were done according to the procedure of Alam et al. (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio ( BCR)} = \frac{\text{Gross return per hectare (TK.)}}{\text{Total cost of production per hectare (TK.)}}$$

# CHAPTER IV

# RESULTS AND DISCUSSION

The experiment was conducted to observe the effect of planting time and poultry manure on growth and yield of under the soil and agro climatic condition of Sher-e-Bangla Agricultural University (SAU), Dhaka. Data on different growth and yield parameter were recorded. The analyses of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendix III-XIII. The results have been presented and discusses with the help of table and graphs and possible interpretations given under the following headings:

**4.1 Plant height**:

Plant height varied significantly for different planting time at 30, 45 days after transplanting (DAT) and at harvest of kohlrabi under the present trial. From Figure-1, it was revealed that at 30 DAT the maximum plant height was 24.48cm ($T_2$) and the minimum plant height was 23.38($T_1$) cm which was statistically similar to 24.45cm ($T_3$) (Appendix III). Again at 45 DAT the maximum plant height was 28.16cm and the minimum plant height was 27.63cm which was statistically similar to 28.00cm (Appendix IV) and at harvest the maximum plant height was 29.98cm and the minimum plant height was 29.25cm which was statistically similar to 29.25cm (Appendix V). So the tallest plant was recorded from $T_3$ (planting at 15 December) which was statistically similar to $T_2$ (planting at 30 November), whereas the shortest plant height with $T_1$ (planting at 15 November). Data revealed that the planting at 15 December produced longest plant followed by 30 November planting and delayed planting produced tallest plant. Kohlrabi is known as thermo-sensitive crop and grown in Bangladesh in short day condition during winter season and needs cool temperature for its optimum growth and knob formation. Its growth and knob development are greatly influenced by growing environment which

was governed by time of planting. The optimum planting time ensures plant to grow properly through efficient utilization of moisture, temperature, light etc

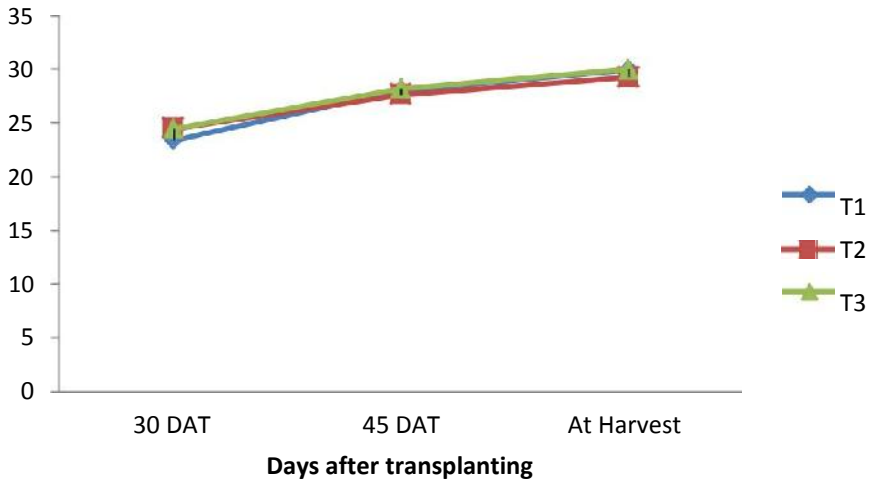


Figure1. Effect of time of transplanting on plant height at days after transplanting (DAT)

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December.

Different poultry manure showed significant differences on plant height of Kohlrabi at 30, 45 DAT and at harvest. From Figure-2, it was revealed that at 30DAT maximum plant height was 27.98cm ($M_2$) which was statistically similar to 27.35cm ($M_3$) (Appendix III) and minimum plant height was 18.27cm ($M_0$).Again at 45DAT maximum plant height was 31.33cm which was statistically similar to 30.93cm (Appendix IV) and minimum plant height was 22.68cm. At harvest maximum plant height was 33.37cm which was statistically similar to 32.32cm (Appendix V) and minimum plant height was 24.35cm. So the tallest plant was found from $M_3$ (poultry manure @ 16 t/ha), which was statistically identical with $M_2$ (poultry manure @ 12t/ha) and closely followed by $M_1$ (Poultry manure @ 8 t/ha), while the shortest plant (18.27cm, 22.68cm and 24.35cm) was found from $M_0$ (control i.e. no manure) (Figure 2).Organic fertilizer released all type of micro and macro nutrients that improved soil physical properties for higher growth of kohlrabi plants

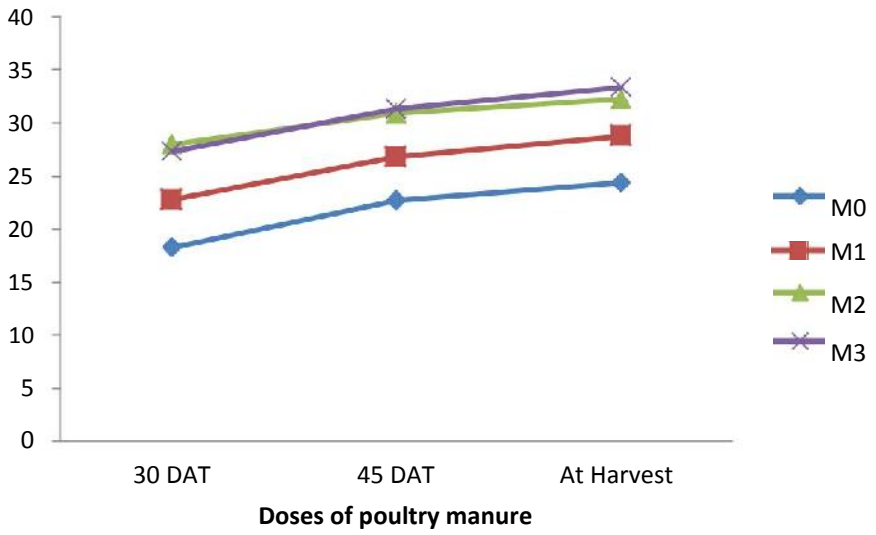


Figure 2. Effect of poultry manure on plant height of kohlrabi at different days after transplanting (DAT)

$M_0$= Control ( no manure application) , $M_1$= Poultry Manure @ 8 t/ha , $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha

Combined effect of different planting time and poultry manure showed significant differences on plant height of kohlrabi at 30, 45 DAT and at harvest. From table-2, it was revealed that at 30DAT maximum plant height was 28.80cm which was statistically similar to 28.40cm (Appendix III) and minimum plant height was 17.83cm. Again at 45DAT maximum plant height was 31.86cm which was statistically similar to 31.03cm (Appendix IV) and minimum plant height was 21.33cm and at harvest maximum plant height was 34.06cm which was statistically similar to 33.33cm (Appendix V) and minimum plant height was 22.93cm. So the tallest plant was recorded from $T_1M_3$ (planting at 15 November and poultry manure @ 16 t/ha) treatment combination, while the shortest was found from $T_2M_0$ (planting at 30 November and no manure application) treatment combination (Table 3). It was revealed that in a single effect of planting at 15 November and poultry manure @ 16t/ha produced the tallest plant under this trial.

Table 2. The combined effect of time of transplanting and poultry manure on plant height of kohlrabi at days after transplanting (DAT)

| Treatment | 30 DAT (cm) | 45 DAT (cm) | At harvest (cm) |
|---|---|---|---|
| $T_1M_0$ | 18.90c | 23.26b | 25.20bcd |
| $T_1M_1$ | 21.53bc | 25.96ab | 28.10abcd |
| $T_1M_2$ | 27.05ab | 30.93a | 32.16abc |
| $T_1M_3$ | 26.03ab | 31.86a | 34.06a |
| $T_2M_0$ | 17.83c | 21.33b | 22.93d |
| $T_2M_1$ | 23.66abc | 27.23ab | 28.80abcd |
| $T_2M_2$ | 28.80a | 30.86a | 32.56b |
| $T_2M_3$ | 27.63ab | 31.10a | 32.73b |
| $T_3M_0$ | 18.10c | 23.46b | 24.93c |
| $T_3M_1$ | 23.20abc | 27.16b | 29.43abcd |
| $T_3M_2$ | 28.10a | 31.00a | 32.23abc |
| $T_3M_3$ | 28.40a | 31.03a | 33.33a |
| **Standard Error (S.E)** | 1.97 | 2.16 | 2.26 |
| **Significant level** | 0.013 | 0.019 | 0.000 |

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December, $M_0$= Control ( no manure application) , $M_1$= Poultry Manure @ 8 t/ha, $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha

**4.2 Number of leaves per plant**:

Different planting time varied significantly for number of leaves per plant at 30,45DAT and at harvest of kohlrabi. From figure-3, at 30 DAT the maximum number of leaves per plant (9.09) was recorded from $T_3$ which was statistically similar (8.88) with $T_1$ (Appendix VI) and the minimum number (8.85) was recorded from $T_2$. At 45 DAT the maximum number of leaves per plant (13.85) was recorded from $T_1$ and the minimum number (9.98) was recorded from $T_2$ which was statistically similar (10.16) with $T_1$ (Appendix VII). At harvest the maximum number of leaves per plant (16.33) was recorded from $T_1$ and the minimum number (13.04) was recorded from $T_2$ which was statistically similar (13.05) with $T_1$ (Appendix VIII). Emam (2005) found that early planting increased number of leaves/plant.

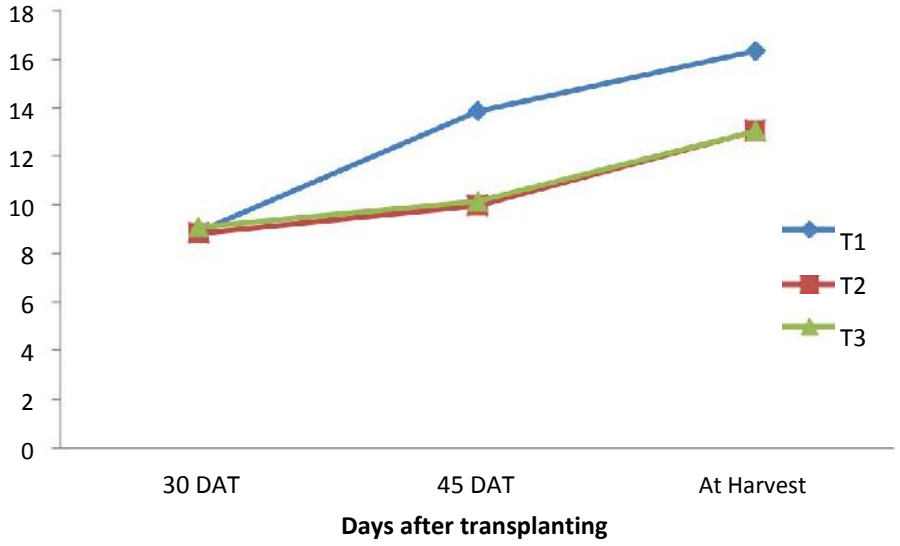


Figure 3. Effect of time of transplanting on number of leaves at different days after transplanting (DAT)

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December

Significant variation was recorded due to different poultry manure for leaves per plant of kohlrabi at 30,45DAT and at harvest .From Figure-4, at 30 DAT the maximum number of leaves per plant (10.81) was recorded from $M_2$,while the minimum number (6.44) from $M_0$ . At 45 DAT the maximum number of leaves per plant (15.28) was recorded from $M_2$ which was statistically identical

(13.04) with $M_3$ (Appendix VII) and closely followed (12.43) by $M_1$ ,while the minimum number (8.57) from $M_0$ .At harvest the maximum number of leaves per plant (15.31) was recorded from $M_2$ which was statistically identical (13.91) with $M_3$ (Appendix VIII) and closely followed (13.28) by $M_1$ ,while the minimum number (10.05) from $M_0$ .Thompson and Kelly (1988) reported that the rate of release of nitrogen from the poultry manure is higher than any other sources of manures which ultimately was reflected in maximum number of leaves per plant.

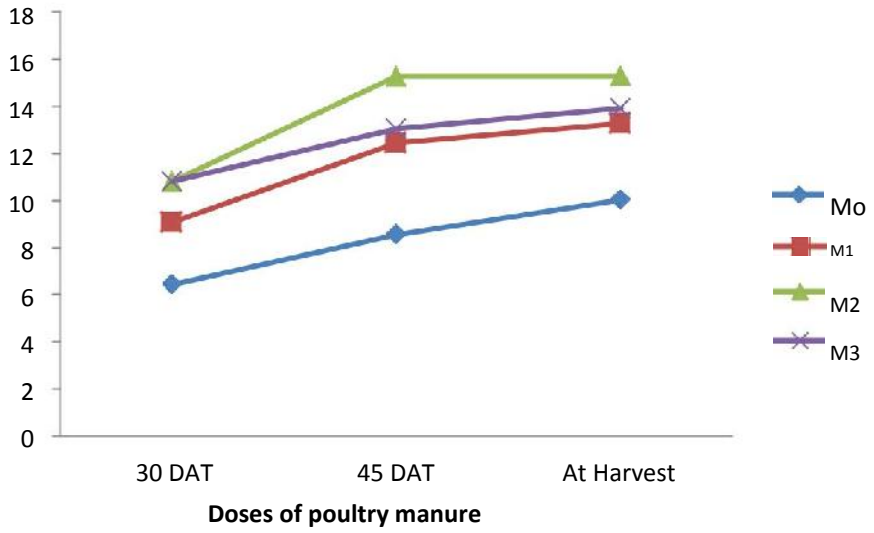


Figure 4. Effect of poultry manure on number of leaves at different days after transplanting (DAT)

$M_0$= Control ( no manure application) , $M_1$= Poultry Manure @ 8 t/ha , $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha

Planting time and poultry manure showed significant differences on number of leaves per plant of kohlrabi at 30, 45DAT and at harvest. At 30 DAT the maximum number of leaves per plant (11.06) was recorded from $T_3M_2$ treatment combination (Appendix VI) and the minimum number (6.40) was recorded from $T_2M_0$ and $T_1M_0$ combination. At 45 DAT the maximum number of leaves per plant (21.90) was recorded from $T_1M_2$ treatment combination and the minimum number (7.50) was recorded from $T_2M_0$ treatment combination. At harvest the maximum number of leaves per plant (15.73) was recorded from $T_2M_2$ treatment combination and the minimum number (9.40) was recorded from $T_3M_0$ treatment combination (Table 3).

Table 3. The combined effect of time of transplanting and poultry manure on number of leaves at different days after transplanting (DAT)

| Treatment | No. of Leaves at 30 DAT | No. of Leaves at 45 DAT | No. of Leaves at Harvest |
|---|---|---|---|
| **$T_1M_0$** | 6.40c | 10.66ab | 10.93f |
| **$T_1M_1$** | 9.13b | 17.03ab | 14.00bcd |
| **$T_1M_2$** | 10.73ab | 21.90a | 14.86abc |
| **$T_1M_3$** | 9.26b | 17.83ab | 13.53cde |
| **$T_2M_0$** | 6.40c | 7.50b | 9.83fg |
| **$T_2M_1$** | 9.16b | 10.20ab | 12.53e |
| **$T_2M_2$** | 10.63ab | 11.83ab | 15.73a |
| **$T_2M_3$** | 9.23b | 10.40ab | 14.06bcd |
| **$T_3M_0$** | 6.53c | 7.56b | 9.40g |
| **$T_3M_1$** | 8.96b | 10.06ab | 13.33bc |
| **$T_3M_2$** | 11.06a | 12.13ab | 15.33ab |
| **$T_3M_3$** | 9.80ab | 10.90ab | 14.13bcd |
| **Standard Error (S.E)** | 0.53 | 3.77 | 0.46 |
| **Significant level** | 0.266 | 0.000 | 0.000 |

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December, $M_0$= Control ( no manure application) ,$M_1$= Poultry Manure @ 8 t/ha , $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha.

### 4.3 Weight of Knob

Significant variation was recorded in terms of weight of knob for different planting time of kohlrabi (Appendix XI). The highest weight of knob (179.58 g) was recorded from $T_2$ which was statistically similar (163.90 g) with $T_1$, while the lowest weight (160.70 g) was recorded from $T_3$ (Table 4).

Weight of knob of kohlrabi varied significantly for different poultry manure (Appendix XI). The highest weight of knob (248.50 g) was attained from $M_2$, whereas the lowest weight (83.45 g) was found from $M_0$ (Table 5). Organic fertilizer released all type of micro and macro nutrients that improved soil physical properties for higher weight of knob .Statistically significant variation was recorded due to the combined effect of different planting time and poultry manure in terms of weight of knob (Appendix XI). The highest weight of knob (262.83 g) was found from $T_2M_2$ and the lowest weight (81.53g) was recorded from $T_3M_0$ (Table 6).

Table 4. The effect of time of transplanting on yield of kohlrabi at different dates after transplanting (DAT)

| Treatment | Knob Weight (g) | Knob Diameter (cm) | Dry Matter (g) | Yield/Plot (kg) | Yield (t/ha) |
|---|---|---|---|---|---|
| **$T_1$** | 163.90a | 6.43b | 22.91a | 1.96a | 9.71a |
| **$T_2$** | 179.58a | 6.77a | 21.78a | 2.15a | 10.64a |
| **$T_3$** | 160.70a | 6.32b | 22.25a | 1.92a | 9.52a |
| **Standard Error (S.E)** | 7.64 | 0.11 | 1.28 | 0.09 | 0.45 |
| **Significant level** | 0.382 | 0.801 | 0.756 | 0.761 | 0.832 |

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December

Table 5. The effect of poultry manure application on yield of kohlrabi

| Treatment | Knob Weight (g) | Knob Diameter (cm) | Dry Matter (g) | Yield/Plot (kg) | Yield (t/ha) |
|---|---|---|---|---|---|
| **$M_0$** | 83.45d | 5.52c | 23.13a | 1.00d | 4.94d |
| **$M_1$** | 155.35c | 6.36b | 22.88a | 1.86c | 9.20c |
| **$M_2$** | 248.50a | 7.46a | 22.54a | 2.98a | 14.72a |
| **$M_3$** | 184.93b | 6.69b | 20.68a | 2.22b | 10.96b |
| **Standard Error (S.E)** | 8.82 | 0.12 | 1.48 | 0.10 | 0.52 |
| **Significant level** | 0.000 | 0.584 | 0.000 | 0.000 | 0.000 |

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

$M_0$= Control ( no manure application) , $M_1$= Poultry Manure @ 8 t/ha , $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha

**4.4 Diameter of Knob**

Diameter of knob varied significantly for different planting time of kohlrabi (Appendix X). The highest diameter of knob (6.77cm) was recorded from $T_2$, whereas the lowest diameter (6.32 cm) was recorded from $T_3$ which was statistically identical (6.43 cm) with $T_1$ (Table 4). Sari *et al.* (2000) reported that the main head diameters for the early sowing dates were higher than the others.

Different poultry manure showed significant variation on diameter of knob of kohlrabi (Appendix X). The highest diameter of knob (7.46 cm) was found

from $M_2$, which was followed by (6.69 cm) from $M_3$, while the lowest diameter (5.52 cm) was attained from $M_0$ (Table 5).

Combined effect of different planting time and poultry manure showed significant differences on diameter of knob (Appendix X). The highest diameter of knob (7.89cm) was recorded from $T_2M_2$, while the lowest diameter (5.27 cm) was found from $T_3M_0$ (Table 6).

**4.5 Dry matter content of knob**

Planting time of kohlrabi varied significantly for dry matter content of knob (Appendix XI). The highest dry matter content of knob (22.91 g) was recorded from $T_1$ which was statistically similar (22.25 g) with $T_3$, whereas the lowest (21.78 g) was found from $T_2$ (Table 4). Diputado and Nichols (1989) reported that the knob dry weight production varied with sowing dates and with cultivars. Significant variation was recorded for different poultry manure in terms of dry matter content of knob of kohlrabi (Appendix XI). The highest dry matter content of knob (23.13 g) was found from $M_0$, which was statistically identical (22.88 g) with $M_1$, while the lowest (20.68 g) was attained from $M_3$, which was statistically similar (22.54 g) with $M_2$ (Table 5). Significant variation was recorded due to combined effect of different planting time and poultry manure on dry matter content of knob (Appendix XI). The highest dry matter content of knob (25.0 g) was recorded from $T_3M_1$, while the lowest weight (20.0 g) was attained from $T_3M_3$ (Table 6).

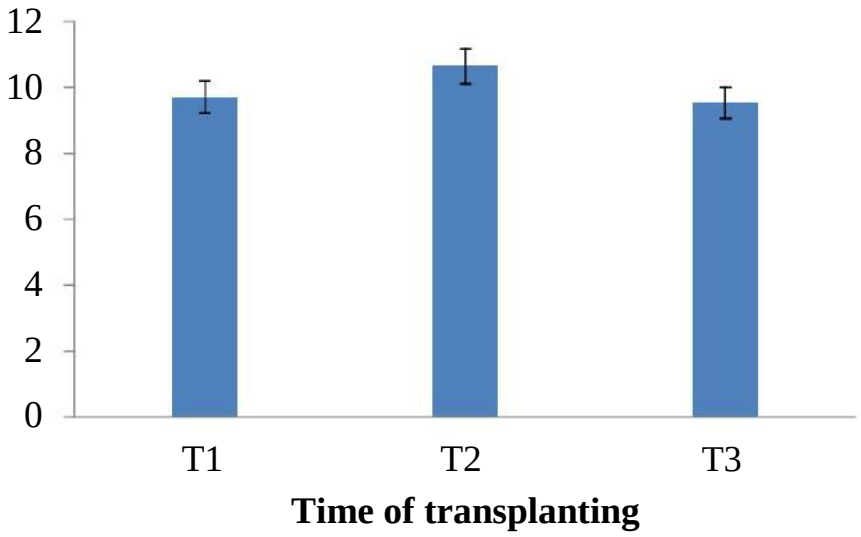


Figure 5. The effect of time of transplanting on yield of kohlrabi

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December

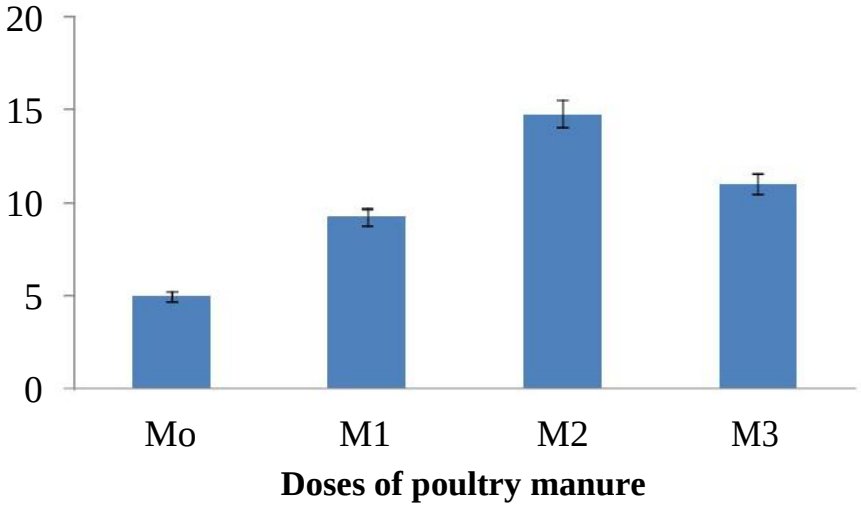


Figure 6. The effect of poultry manure on yield of kohlrabi

$M_0$= Control ( no manure application) , $M_1$= Poultry Manure @ 8 t/ha , $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha

Table 6.The combined effect of time of transplanting and poultry manure application on yield of kohlrabi.

| Treatment | Knob Weight (g) | Knob Diameter (cm) | Dry Matter (g) | Yield/Plot (kg) | Yield (t/ha) |
|---|---|---|---|---|---|
| $T_1M_0$ | 87.00e | 5.59fg | 23.60a | 1.04e | 5.15e |
| $T_1M_1$ | 147.20cd | 6.41de | 22.30a | 1.76cd | 8.72cd |
| $T_1M_2$ | 231.53ab | 7.37ab | 23.73a | 2.77ab | 13.73ab |
| $T_1M_3$ | 189.86bc | 6.35def | 22.00a | 2.28bc | 11.25bc |
| $T_2M_0$ | 81.83e | 5.69efg | 24.80a | .98e | 4.85e |
| $T_2M_1$ | 180.66cd | 6.51cde | 21.36a | 2.17cd | 10.70cd |
| $T_2M_2$ | 262.83a | 7.89a | 20.90a | 3.13a | 15.57a |
| $T_2M_3$ | 193.00bc | 7.00bcd | 20.06a | 2.32bc | 11.43bc |
| $T_3M_0$ | 81.53e | 5.27g | 21.00a | .98e | 4.83e |
| $T_3M_1$ | 138.20d | 6.17def | 25.00a | 1.65d | 8.18d |
| $T_3M_2$ | 251.13a | 7.14bc | 23.00a | 3.01a | 14.88a |
| $T_3M_3$ | 171.93cd | 6.73bcde | 20.00a | 2.06cd | 10.19cd |
| **Standard Error (S.E)** | 15.28 | 0.22 | 2.56 | 0.18 | 0.90 |
| **Significant level** | 0.000 | 0.915 | 0.000 | 0.000 | 0.001 |

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December, $M_0$= Control (no manure application) , $M_1$= Poultry Manure @ 8 t/ha , $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha

### 4.6 Yield per plot

Statistically significant variation was recorded for yield per plot of kohlrabi due to different planting time (Appendix XII). The highest yield per plot (2.15kg) was found from $T_2$, whereas the lowest (1.96 kg) was recorded from $T_1$ which was statistically similar (1.92 kg) with $T_3$ (Figure 5). Khatun et al. (2012) also reported similar findings from earlier experiment.

Yield per plot of kohlrabi varied significantly for different poultry manure under the present trial (Appendix XII). The highest yield per plot (2.98 kg) was recorded from $M_2$, while the lowest (1.00 kg) was found from $M_0$ (Figure 6).

Different planting time and poultry manure showed significant differences due to their combined effect in terms of yield per plot (Appendix XII). The highest yield per plot (3.15kg) was attained from $T_2M_2$ and the lowest (0.98 kg) was found from $T_3M_0$ and $T_2M_0$ (Table 6).

### 4.7 Yield per hectare

Yield per hectare of kohlrabi varied significantly for different planting time of kohlrabi (Appendix XIII). The highest yield per hectare (10.64 ton) was recorded from $T_2$, while the lowest (9.52 ton) was recorded from $T_3$ which was statistically similar (9.71 ton) with $T_1$ ( Figure 5). The yield of the crop, for obvious reason, depends on the environmental conditions prevailing during the growing season in a particular place. Ahmed and Abdullah (1986) reported that highest yield was obtained from the crop planted on October 15 followed by November 1, while September 15 planting produced the lowest yield.

Significant variation was recorded for different poultry manure on yield per hectare of kohlrabi (Appendix XIII). The highest yield per hectare (14.72 ton) was found from $M_2$, which was closely followed (10.96 ton) by $M_3$, whereas the lowest (4.94 ton) was recorded from $M_0$ (Figure 6). Hochmuth et al. (1993) reported that that manuring efficiency was initially higher with commercial fertilizer than the poultry manure alone, since lower amounts of total nutrients

were applied using commercial fertilizer. Akter et al. (1996) reported that the highest curd yield of 20.70 and 16.75 tons per hectare were obtained with poultry manure and cow dung against 9.0 tons per hectare in the control treatment. Abou et al. (2006) reported that the highest total yield and quality of broccoli were recorded by adding poultry manure in the two seasons.

Yield per hectare of kohlrabi showed significant differences due to the combined effect of different planting time and poultry manure (Appendix XIII). The highest yield per hectare (15.57 ton) was recorded from $T_2M_2$ which was statistically similar with (14.88) $T_3M_2$ whereas the lowest (4.83 ton) was recorded from $T_3M_0$ ( Table 6). It was revealed that planting at 30 November, 2016 and poultry manure @ 12 t/ha ensured the highest vegetative growth as well as highest yield of kohlrabi under this trial.

### 4.8 Economic analysis

Input costs for land preparation, fertilizer, irrigation and manpower required for all the operations from seed sowing to harvesting of kohlrabi were recorded as per experimental plot and converted into cost per hectare. Price of kohlrabi was considered as per market rate. The economic analysis presented under the following headings-

#### 4.8.1 Gross return

The combination of different planting time and poultry manure showed different value in terms of gross return under the trial (Table 7). The highest gross return (Tk. 467,100) was obtained from the treatment combination $T_2M_2$ (Planting at 30 November, 2016 with Poultry Manure @ 12 t/ha). The lowest gross return (Tk. 144,900) was obtained from treatment $T_3M_0$.

#### 4.8.2 Net return

In case of net return, different planting time and poultry manure showed different levels of net return under the present trial (Table 10). The highest net return (Tk. 279,125) was found from $T_2M_2$ (Planting at 30 November, 2016

with Poultry Manure @ 12 t/ha) and the lowest (Tk. 10,550) net return was obtained in $T_3M_0$.

### 4.8.3 Benefit cost ratio

The highest benefit cost ratio (2.48) was noted from the combination of $T_2M_2$ and the lowest benefit cost ratio (1.08) was obtained from $T_3M_0$ (Table 7). From economic point of view, it is apparent from the above results that $T_2M_2$ (Planting at 30 November, 2016 with Poultry Manure @ 12 t/ha) was more profitable treatment combination than rest of the combinations.

Table 7. Cost and return of kohlrabi cultivation as influenced by planting time and poultry manure

| Treatments combinations | Total cost of production (Tk) | Yield (ton/ha) | Gross return (Tk/ha) | Net return (Tk /ha) | Benefit cost ratio |
|---|---|---|---|---|---|
| $T_1M_0$ | 133,350 | 5.15 | 154,500 | 21,150 | 1.16 |
| $T_1M_1$ | 166,670 | 8.72 | 261,600 | 94,930 | 1.57 |
| $T_1M_2$ | 175,595 | 13.73 | 411,900 | 236,305 | 2.35 |
| $T_1M_3$ | 202,370 | 11.25 | 337,500 | 135,130 | 1.67 |
| $T_2M_0$ | 134,350 | 4.85 | 145,500 | 11,150 | 1.08 |
| $T_2M_1$ | 169,050 | 10.70 | 321,00 | 151,950 | 1.90 |
| $T_2M_2$ | 187,975 | 15.57 | 467,100 | 279,125 | 2.48 |
| $T_2M_3$ | 200,750 | 11.43 | 342,900 | 142,150 | 1.71 |
| $T_3M_0$ | 134,350 | 4.83 | 144,900 | 10,550 | 1.08 |
| $T_3M_1$ | 169,050 | 8.18 | 245,400 | 76,350 | 1.45 |
| $T_3M_2$ | 177,975 | 14.88 | 446,400 | 268,425 | 2.21 |
| $T_3M_3$ | 200,750 | 10.19 | 305,700 | 104,950 | 1.52 |

$T_1$=Planting at 15 November, $T_2$= Planting at 30 November and $T_3$=Planting at 15 December, $M_0$= Control ( no manure application) , $M_1$= Poultry Manure @ 8 t/ha , $M_2$= Poultry Manure @ 12 t/ha and $M_3$=Poultry Manure @ 15t/ha

# CHAPTER V

# SUMMARY AND CONCLUSION

The experiment was conducted at the Horticulture Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from October 2016 to March 2017 to observe the effect of planting time and poultry manure on growth and yield of kohlrabi. The test crop used in the experiment was kohlrabi variety Quick Star. The experiment consisted of two factors: Factor A: Planting time (three levels) as $T_1$: Planting at 15 November, $T_2$: Planting at 30 November, $T_3$: Planting at 15 December and Factor B: Poultry manure (four levels) as $M_0$: Control i.e. no manure application; $M_1$: Poultry manure @ 8 t/ha; $M_2$: Poultry Manure @ 12 t/ha and $M_3$: Vermicompost @ 16 t/ha. There were 12 (3 × 4) treatments combination. Data on different growth and yield parameter were recorded and significant variation was recorded for each of the parameters.

In planting time, at 30,45 DAT and at harvest the tallest plant (24.48 cm,28.16 cm and 29.98 cm) was recorded from $T_3$ (planting at 15 December) , whereas the shortest plant (23.38 cm,28.00 cm and 29.25 cm) with $T_1$ (planting at 15 November). At 30,45 DAT and at harvest the maximum number of leaves per plant (8.88, 16.85 and 13.33) was recorded from $T_1$, again the minimum number (8.85, 9.98 and 13.04) was recorded from $T_2$. The highest weight of knob (179.58 g) was recorded from $T_2$, while the lowest weight (160.70 g) was recorded from $T_3$. The highest diameter of knob (6.77 cm) was recorded from $T_2$, whereas the lowest diameter (6.32 cm) was recorded from $T_3$. The highest dry matter content of knob (22.91 g) was recorded from $T_1$, whereas the lowest (21.78 g) was found from $T_2$. The highest yield per plot (2.15 kg) was found from T2, whereas the lowest (1.96 kg) was recorded from $T_1$. The highest yield per hectare (10.64 ton) was recorded from $T_2$, while the lowest (9.52 ton) was recorded from $T_3$.

For poultry manure, at 30,45 DAT and at harvest the tallest plant (27.35 cm,31.33 cm and 33.37 cm) was found from $M_3$ (poultry manure @ 16 t/ha),while the shortest plant (18.27 cm, 22.68 cm and 24.35 cm) was found from $M_0$ (control i.e. no manure). At 30, 45 DAT and at harvest the maximum number of leaves per plant (10.81, 15.28 and15.31) was recorded from $M_3$, while the minimum number (6.44, 8.57 and10.05) from $M_0$. The highest weight of knob (248.50 g) was attained from $M_2$, whereas the lowest weight (83.45 g) was found from $M_0$. The highest diameter of knob (7.46 cm) was found from M2, while the lowest diameter (5.52 cm) was attained from $M_0$. The highest dry matter content of knob (23.13 g) was found from $M_0$, while the lowest (20.68 g) was attained from $M_3$. The highest yield per plot (2.98 kg) was recorded from $M_2$, while the lowest (1.00 kg) was found from M0. The highest yield per hectare (14.72 ton) was found from $M_2$, whereas the lowest (4.94 ton) was recorded from $M_0$.

Planting time and poultry manure showed significant differences on number of leaves per plant of kohlrabi at 30, 45DAT and at harvest. At 30 DAT the maximum number of leaves per plant (11.06) was recorded from $T_3M_2$ treatment combination (Appendix VI) and the minimum number (6.40) was recorded from $T_2M_0$ and $T_1M_0$ combination. At 45 DAT the maximum number of leaves per plant (21.90) was recorded from $T_1M_2$ treatment combination and the minimum number (7.50) was recorded from $T_2M_0$ treatment combination. At harvest the maximum number of leaves per plant (15.73) was recorded from $T_2M_2$ treatment combination and the minimum number (9.40) was recorded from $T_3M_0$ treatment combination.

The highest weight of knob (262.83 g) was found from $T_2M_2$ and the lowest weight (81.53g) was recorded from $T_3M_0$. The highest diameter of knob (7.89cm) was recorded from $T_2M_2$, while the lowest diameter (5.27 cm) was found from $T_3M_0$. The highest dry matter content of knob (25.0 g) was recorded from $T_3M_1$, while the lowest weight (20.0 g) was attained from $T_3M_3$. The highest yield per plot (3.15 kg) was attained from $T_2M_2$ and the lowest

(0.98 kg) was found from $T_3M_0$. The highest yield per hectare (15.57 ton) was recorded from $T_2M_2$, whereas the lowest (4.83 ton) was recorded from $T_3M_0$. The highest BCR (2.48) was from $T_2M_2$ and the lowest (1.08) from $T_2M_0$.

It was revealed that the above results that the combination of $T_2M_2$ was more suitable in consideration of yield contributing characters. Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Another experiment may be carried out with another planting time.

2. Different level of organic manure may be used for further study.

3. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.

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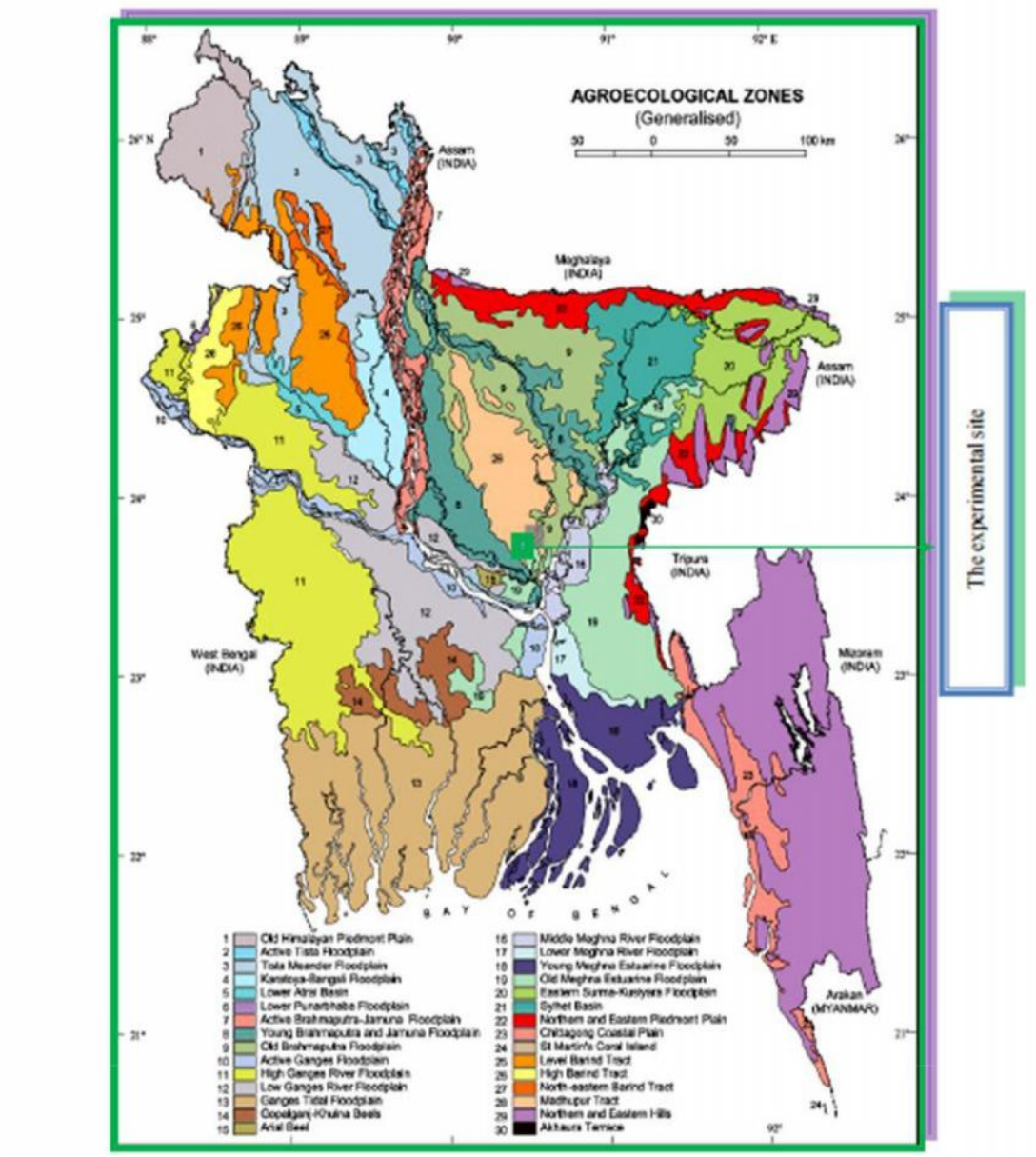
# APPENDICES

## Appendix I. Map showing the experimental site



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

| **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 level |
| Flood level | Above flood level |
| Drainage | Well drained |
| Cropping pattern | Fallow – Kohlrabi |

**Appendix III.** **Analysis of variance of plant height at 30 DAT**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 1.801 | .900 | .038 | .963 |
| **Poultry manure** | 3 | 444.365 | 148.122 | 13.594 | .000 |
| **Combination** | 11 | 457.056 | 41.561 | 2.968 | .013 |

**Appendix IV.** **Analysis of variance of plant height at 45 DAT**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 3.705 | 1.853 | .074 | .929 |
| **Poultry manure** | 3 | 448.339 | 149.446 | 12.496 | .000 |
| **Combination** | 11 | 463.168 | 42.106 | 2.747 | .019 |

**Appendix V.** **Analysis of variance of plant height at Harvest**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | .394 | .197 | .058 | .943 |
| **Poultry manure** | 3 | 89.949 | 29.983 | 44.502 | .000 |
| **Combination** | 11 | 90.969 | 8.270 | 9.663 | .000 |

**Appendix VI.** **Analysis of variance of plant no. of leaves at 30 DAT**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 368.311 | 184.155 | 4.746 | .015 |
| **Poultry manure** | 3 | 210.196 | 70.065 | 1.558 | .219 |
| **Combination** | 11 | 625.476 | 56.861 | 1.334 | .266 |

**Appendix VII.** **Analysis of variance of plant no. of leaves at 45 DAT**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | .662 | .331 | .070 | .933 |
| **Poultry manure** | 3 | 133.599 | 44.533 | 59.454 | .000 |
| **Combination** | 11 | 142.361 | 44.533 | 59.454 | .000 |

**Appendix VIII.** **Analysis of variance of plant no. of leaves at Harvest**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 2451.149 | 1225.574 | .276 | .760 |
| **Poultry manure** | 3 | 126671.561 | 42223.854 | 60.959 | .000 |
| **Combination** | 11 | 132008.632 | 12000.785 | 17.116 | .000 |

**Appendix IX.** **Analysis of variance of plant Knob weight**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 1.311 | .655 | .990 | .382 |
| **Poultry manure** | 3 | 17.574 | 5.858 | 33.549 | .000 |
| **Combination** | 11 | 19.579 | 1.780 | 11.926 | .000 |

**Appendix X.** **Analysis of variance of plant knob diameter**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 7.667 | 3.834 | .224 | .801 |
| **Poultry manure** | 3 | 33.263 | 11.088 | .658 | .584 |
| **Combination** | 11 | 97.983 | 8.908 | .451 | .915 |

**Appendix XI. Analysis of variance of plant knob Dry matter**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | .360 | .180 | .282 | .756 |
| **Poultry manure** | 3 | 18.238 | 6.079 | 60.895 | .000 |
| **Combination** | 11 | 19.015 | 1.729 | 17.160 | .000 |

**Appendix XII. Analysis of variance of kohlrabi Yield per Plot**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 8.589 | 4.295 | .276 | .761 |
| **Poultry manure** | 3 | 444.814 | 148.271 | 60.969 | .000 |
| **Combination** | 11 | 463.548 | 42.141 | 17.117 | .000 |

**Appendix XIII. Analysis of variance of kohlrabi Yield per Hectare**

| Source of Variance | DF | SS | MS | F-value | P-value |
|---|---|---|---|---|---|
| **Time** | 2 | 9.453 | 4.727 | .185 | .832 |
| **Poultry manure** | 3 | 551.482 | 183.827 | 19.439 | .000 |
| **Combination** | 11 | 574.262 | 52.206 | 4.477 | .001 |

**Appendix XIV. Per hectare cost of production of kohlrabi as influenced by time transplanting and poultry manure application**

**A. Input cost**

| Treatments combination | Labor cost (Tk) | Ploughing cost (Tk) | Seed cost (Tk ) | Insectcide cost (Tk) | Irrigation cost (Tk) | Poultry Manure cost (Tk) | Sub Total (Tk) |
|---|---|---|---|---|---|---|---|
| $T_1M_0$ | 24,000 | 15,000 | 5,000 | 4,000 | 15,000 | 0 | 63,000 |
| $T_1M_1$ | 24,000 | 15,000 | 5,000 | 4,000 | 15,000 | 25,000 | 88,000 |
| $T_1M_2$ | 24,000 | 15,000 | 5,000 | 4,000 | 15,000 | 40,000 | 103,000 |
| $T_1M_3$ | 24,000 | 15,000 | 5,000 | 4,000 | 15,000 | 60,000 | 123,000 |
| $T_2M_0$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 0 | 65,000 |
| $T_2M_1$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 25,000 | 90,000 |
| $T_2M_2$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 40,000 | 105,000 |
| $T_2M_3$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 60,000 | 125,000 |
| $T_3M_0$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 0 | 65,000 |
| $T_3M_1$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 25,000 | 90,000 |
| $T_3M_2$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 40,000 | 105,000 |
| $T_3M_3$ | 26,000 | 15,000 | 5,000 | 4,000 | 15,000 | 60,000 | 125,000 |

**B. Overhead cost**

| Treatment Combination | Cost of lease of land for 6 months | Miscellaneous cost (Tk. 5% of the input cost | Interest on running capital for 6 months (Tk. 14.0% of cost/year | Subtotal (Tk) (B) | Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)] |
|---|---|---|---|---|---|
| $T_1M_0$ | 56,000 | 3,550 | 9,820 | 63,000 | 133,350 |
| $T_1M_1$ | 56,000 | 4,400 | 12,320 | 88,000 | 166,670 |
| $T_1M_2$ | 56,000 | 5,150 | 14,420 | 103,000 | 175,595 |
| $T_1M_3$ | 56,000 | 6,150 | 17,220 | 123,000 | 202,370 |
| $T_2M_0$ | 56,000 | 3,250 | 9,100 | 65,000 | 134,350 |
| $T_2M_1$ | 56,000 | 4,500 | 12,600 | 90,000 | 169,050 |
| $T_2M_2$ | 56,000 | 5,250 | 14,700 | 105,000 | 187,975 |
| $T_2M_3$ | 56,000 | 6,250 | 17,500 | 125,000 | 200,750 |
| $T_3M_0$ | 56,000 | 3,550 | 10,100 | 65,000 | 134,350 |
| $T_3M_1$ | 56,000 | 4,500 | 12,600 | 90,000 | 169,050 |
| $T_3M_2$ | 56,000 | 5,250 | 14,700 | 105,000 | 177,975 |
| $T_3M_3$ | 56,000 | 6,250 | 17,500 | 125,000 | 200,750 |

**Plate 1:** Pictorial representation of the experimental field

a

b

c

d

e

f **Plate 2**: a. Seedling of kohlrabi, b. Growing knob of kohlrabi, c. Harvesting of kohlrabi, d.Collections of harvested knobs, e. Measurement of knob weight, f. Measurement of knob diameter