GROWTH AND YIELD OF KOHLRABI AS INFLUENCED BY NITROGEN AND POTASSIUM

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CERTIFICATE

*This is to certify that the thesis entitled "**GROWTH AND YIELD OF KOHLRABI AS INFLUENCED BY NITROGEN AND POTASSIUM**" submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **HORTICULTURE**, embodies the results of a piece of bona fide research work carried out by **SABIHA AKHTER** Registration. No**. 12-04878** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

Dated: June, 18

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DEDICATED

TO

MY BELOVED PARENTS

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The Author

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ABSTRACT

The present study was undertaken with the aims to investigate the effect of nitrogen and potassium which influence the growth and yield of kohlrabi in the field condition. The experiment was conducted during the period from November 2017 to January 2018 at Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka. The experiment was performed with Randomized Complete Block Design which consists of two factors viz., four levels of nitrogen fertilizers; N_0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha and three levels of potassium fertilizers viz., k_0: Control, K_1:100kg/ha, K_2:120kg/ha. The results indicate that the morphological parameters and the reproductive components, as well as yield were influenced significantly among the treatments. The highest plant height (35.75cm), number of leaves plant^{-1} (10.33), knob length (7.38 cm), knob diameter (5.00 cm), weight of knob (168.66 g), dry matter content of knob (7.16 %), yield per hectare (16.06 t/ha) were obtained from treatment combination N_3K_1 while the lowest was recorded from N_0K_0. Hence it can be concluded that 140 kg/ha nitrogen and 100 kg/ha potassium gave the better growth and yield performances of kohlrabi.

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AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
cm	Centimetre
DAT	Days after transplanting
^{0}C	Degree Celsius
et al.	And others
FAO	Food and Agriculture Organization
g	Gram(s)
Ha^{-1}	Per hectare
No.	Number
%	Percent
SRDI	Soil Resources and Development Institute
Wt.	Weight

CHAPTER 1

INTRODUCTION

Kohlrabi (*Brassica oleraceae* var. *gongylodes*) is a Cole crop and it is the member of the botanical family Brassicaceae. Its edible portion is enlarged stem (knob). It is well known that, kohlrabi has enormous nutritional and medicinal values due to its high contents of 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 areas and total cultivated area is unknown.

Production of kohlrabi depends on many factors such as quality of seed, variety, plant spacing, fertilizer and proper management practices. The production of kohlrabi has not been extended much beyond the agricultural farms in Bangladesh (BBS, 2014). Kohlrabi responds greatly to major essential nutrients, like N, P, K and organic fertilizer in respect of growth and yield. In 2012-2013, Bangladesh produces 35 thousand tons of kohlrabi per year from 7.29 thousand hectares of land with an average yield of 4.80 t ha-1 which is very low against the potential yield (BBS, 2014).

Plants require food for growth and development in the form of proper doses of NPK. Kohlrabi responds greatly to major elemental nutrients like N, P and K in respect to its growth and yield (Thompson and Kelly, 1957). Nitrogen is a part of chlorophyll molecule, amino acid, proteins, nucleic acid and pigments. Addition of nitrogen enhances vegetative growth and its deficiency leads to stunted growth will small yellow leaves and low production (Haque and Jakhro, 1996). Proper supply of nitrogen favors the transformation of carbohydrates into proteins and promotes the formation of protoplasm and since protoplasm is highly hydrated, the plant becomes more succulent.

Normal metabolic activities can continue only in the presence of optimum level of nitrogen. The addition of nitrogen enhances vegetative growth and its deficiency leads to stunted growth with small yellow leaves and low production. Phosphorus plays a vital role in several key physiological processes, viz. photosynthesis, respiration, energy storage and transfer, cell division and cell enlargement. It stimulates root growth, blooming and fruit setting. Potassium is considered essential in photosynthesis, sugar translocation, nitrogen metabolism, enzyme activation, stomatal opening, water relation and growth of meristematic tissue. It acts as chemical traffic policeman, root booster, stalk strengtheners, protein builder and breathing regulator and retards diseases. But potassium is not fully effective without its co-efficient such as N and P (Chandra, 1989).

Again, Potassium is another essential macronutrient for plant growth and plays significant roles in activation of several metabolic processes including protein synthesis, photosynthesis, enzyme activation as well as in resistance to diseases and insects etc. (Rehm and Schmitt, 2002). (Kang et al., 1980) show that N and K responses are more common than response to P. Deficiency of potassium may hamper various physiological processes such as, respiration, photosynthesis, chlorophyll development, and may reduce water content of leaves which is directly related to plant growth and yield.

To attaining considerable production and quality yield for any crop it is necessary to proper management including ensuring the availability of essential nutrient components. In Bangladesh condition population is increasing day by day. On the other hand, area under crops production is decreasing day by day, because of the limitation of land. The chemical fertilizer gives the initial boost required by young plants and it is also essential for its development uniformly throughout the season. By the proper management of fertilizer, it will be easy to grow vegetable to meet up the requirement of food of the nation. Therefore, the present investigation will carry out to find out the suitability of application of N and K fertilizer and their combinations for successful kohlrabi production.

Therefore, the present investigation was carried out with a view to achieving the following objectives:

1.To determine the optimum level of nitrogen for yield contributing characters and higher yield of kohlrabi.

2.To investigate the optimum level of potassium for increasing the production of kohlrabi with lower cost.

3. To find out the suitable combination of nitrogen and potassium for ensuring the better growth and higher yield 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 thermosensitive crop and grown in Bangladesh and grown as an annual crop in winter crop. Growth and knob development of kohlrabi are greatly influenced by the 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 have been reviewed in this chapter under the following headings

Biswas *et al.* (2016) reported that, the effect of different salinity levels on growth, yield, yield attributes, and different parameters of germination and seedling growth of kohlrabi, *Brassica oleracea* var. *gongylodes*, a vegetable of the family Brassicaceae. This study was carried out using a completely randomized design in seven replications. Experimental treatment includes five levels of salinity (3, 6, 9, 12 and 15 dsm^{-1}) along with control. Highest germination energy (56.79%), shoot length (4.84 cm), root length (3.46 cm) and dry weight of seedling (75.88 mg) were observed in control which was statistically similar to 3 dsm^{-1} (50%, 4.81cm, 3.36 cm, and 69.29 mg respectively). The highly decreased germination percentage (46.79%), root length (2.17 cm) and dry weight of seedling (52.57 mg) were observed in 15 dsm^{-1} salinity level compared to their control values which were statistically similar to 12 dsm^{-1} salinity level. In the case of pot study, the highest leaf number plant-1 (15) and leaf width (15.31 cm) were obtained from the control condition. Moreover, highest diameter of knob (9.04 cm), dry weight of knob (46.86 g), fresh weight of shoot (128.3 mg) and dry weight of shoot (12.57 mg) were obtained from control condition which were statistically similar to 3 dsm^{-1} (8.19 cm, 36.01 g, 99.86 mg and 10.29 mg respectively), 6 dsm^{-1} (7.43 cm, 33.9 g, 104.6 mg and 10.71 mg respectively) and 9 dsm^{-1} (7.36 cm, 32.81 g, 124.7 mg and 11.14 mg respectively) salinity levels. Considering all the growth, yield and yield attributes observed in this study, kohlrabi was foundtolerant to salinity levels up to 9 dsm^{-1} while in respect of germination and seedling growth, it was found tolerant to salinity levels up to 3 dsm^{-1}.

Lošák *et al.* (2016) stated that three treatments were used in a two-year (2014– 2015) vegetation pot experiment with kohlrabi of the cv. Moravia: (1) untreated control; (2) digestate; (3) digestate + phosphorus (P). The nitrogen (N) rate was the same in treatments 2–3. There were significant differences between years in all parameters. The weight of single kohlrabi bulbs in the unfertilized control was significantly lower in both years (33.1–46.9%) than in the digestate treatment (100%). Digestate supplemented with P (treatment 3) increased the bulb yield significantly by 11.0–14.3% compared with pure digestate (treatment 2). In both years the content of bulb nitrates (mg NO_3–/kg FM (fresh matter)) was significantly the lowest in the unfertilized control (135 and 163, respectively). After digestate applications, the nitrates content (mg NO–/kg FM) increased significantly in both years, i.e. to 315–327 (2014) and to 486– 509 (2015) compared to unfertilized control. In two years the content of ascorbic acid (mg/kg FM) did not differ among the three treatments (274–288 in 2014 and 311–329 in 2015). Digestates can be recommended for kohlrabi fertilization prior to planting.

Osman and Salim (2016) reported that, under unfavorable growth conditions, the swollen tuber-like stem (marketable part) of kohlrabi plant becomes woody and tough which reflected on reducing its revenue. Studies on the effect of salinity on growth and quality of kohlrabi stems are extremely limited. Consequently, an outdoor pot experiment was conducted to evaluate the effect of different levels of NaCl salinity (0, 1000, 2000, 3000, 4000, 5000 and 6000 ppm) on the growth attributes of kohlrabi. Results of the preliminary experiment indicated that kohlrabi is a moderate salinity sensitive plant, where the growth of the stem significantly reduced after exposing to NaCl at 3000 ppm, whereas the high reduction in the growth of both leaves and stems recorded when the applied concentration of NaCl is equal or more than 4000 ppm. NaCl salt as a source of salinity stress was applied at 0 and 4000 ppm in the subsequent main experiment to study the promotive effect of urea and seaweed extract on enhancing the growth and quality of kohlrabi plant under salinity conditions. The concentration of foliar application treatments were four levels for urea (0, 5, 10 and 15 g/l) and two levels of seaweed extract (0 and 0.5 g/l), in addition to their combinations. Application of NaCl at 4000 ppm reduced leaf f.w, leaf area, leaf area index, photosynthetic pigments and total soluble sugars (TSS), which in turn reflected on the reduction of stem f.w, as a quantitative trait. In addition to that, salinity has a negative effect on the quality of kohlrabi stems, through increasing firmness value and fibre %. These negative effects of salinity on quantity and quality traits of kohlrabi plant disappeared when urea as individual applications or combined with seaweed extract were applied to the plant as foliar treatments. Moreover, most foliar treatments enhanced the stem f.w, whereas reduced firmness values and fibre %. Application of combined treatment of seaweed extract at 0.5 g/l + urea at 15 g/l maximized the quality and yield of kohlrabi swollen stems under stressed or non-stressed conditions.

Ekandjo and Ruppel (2015) stated that Biological Nitrogen Fixation (BNF) is a process of great importance in crop production systems, as it provides additional natural sources of mineral nitrogen. BNF is catalyzed by diazotrophs that are identified by the if operon presence comprising the nifH gene that encodes for enzyme nitrogenase synthesis. Thoroughly understanding of factors that influence diazotrophic abundance is crucial for their utilization to enhance sustainability and prevent land degradation in modern agriculture. In this study, the impacts of nitrogen fertilization on the diazotrophic abundance in Brassica oleracea roots and leaves was investigated in greenhouse experiments by real-time qPCR. One-way ANOVA was used to compare means and bivariate Pearson correlation tested for relationships between variables. Increased nitrogen fertilization significantly increased the nitrogen content in leaves but not in roots. No significant changes in nifh gene copy numbers nor in the proportion of nifH gene copy numbers were detectable. This indicates noeffect of mineral N fertilization on the abundance of total native diazotrophic bacterial numbers in Brassica oleracea plants.

Benko et al. (2016) reported that Imbalance use of three major essential nutrients such as nitrogen, phosphorus, and potassium along with other production factors is the main cause of low yield of radish in Pakistan. To inquire the fact, a field experiment was conducted to find out the effect of nitrogen along with constant doses of phosphorus and potassium. Four different levels of i.e. 00, 50, 100 and 150 kg ha 1 of N in the form of urea were used in a randomized com plot 1 (Kg) and root yield (t ha 1) was 73.37, 86.81, 98.45 and 45.64, 64.00, 72.60 were obtained at 00, 100 and plate block design (RCBD) replicated three times on radish (Raphanussativus L.) cv. Early Long White). Phosphorus and potassium were used at constant rates of 75 and 100 kg ha 1 in the form of di-ammonium phosphate and potassium sulphate, respectively. After compiling the results it was known that an increase in nitrogen levels from 100 to 150 Kg ha 1 positively affected all growth and yield parameters of radish. Control plots where no fertilizers were applied remained inferior for all characteristics. The root yield 150 Kg ha 1 of nitrogen, respectively.

Pane *et al.* (2014) reported that the use of compost tea (CT) is becoming interesting for applications in organic agriculture. CTs are oxygenated extracts of compost that give positive effects on the crops because contain bioactive molecules and microorganisms that improve plant growth and health. This study was carried out to evaluate the effects of CTs applied as foliar spray and drenching, respectively, on kohlrabi and lettuce cultivation. The CT tested here was originated by an aerated water-extraction of two artichoke and fennel composts. CT treatments considerably improved crop yields. CT, in fact, increased lettuce and kohlrabi commercial yields higher 24% and 32%, respectively. Due to CT, the physiological and nutritional status of the plants increased, as noticed by foliar chlorophyll content assessment measured during crop cycles. The results provided encouraging indications about the practical application of CT in the horticultural organic farming system.

Antonova *et al.* (2014) stated that a new Bulgarian kohlrabi variety Niki was studied in two systems of organic crop production: an organic system without fertilizer and without pesticide treatment of the plants and organic system by use of biological fertilizer and plant protection with biological insecticides and bio-fungicides. The morphological characteristics: the size of leaf rosette, number, and weight of rosette leaves and weight, height, and diameter of the kohlrabi (knob) were investigated. It was established that the new kohlrabi variety demonstrates the relatively good biological potential for realization in organic crop production systems although the values recorded for almost all studied characters of the morphological characteristics were lower compared to those recorded in the conditions of conventional crop production. The phenotypical manifestations of the variety were better in organic system production with the use of bioproducts for fertilization and plant protection where the values of the characters from the morphological characteristics were with 6 % to 23 % lower than those recorded in the conventional production system. The values of thestudied characters of kohlrabi grown in organic production without application of products for fertilization and plant protection were with 15 % to 34 % lower compared to the recorded in the conventional production. The average weight of the kohlrabi (knob) was 1.110 kg in organic system production with the use of bioproducts for fertilization and 0.897 кg by growing in organic production without application of products for fertilization and plant protection which were smaller compared to the registered knob weight in conventional production 1.256 kg.

EI-Bassiony *et al*. (2014) reported that, two cultivars of Kohlrabi plants DelikatessWeisser and Burble Vina were grown in a sandy soil at the Experimental Station of the National Research Centre in El- Nubaria region, Behira Governorate on the two successive seasons of 2010/2011 and 2011/2012, to study the effect of two varieties and foliar spray of yeast, amino acid and chitosan on growth, yield and chemical content of kohlrabi plants. Obtained results show that the highest plant height was found by cv. DelikatessWeisserwith a foliar spray of chitosan.

Saleh *et al.* (2013) stated that, two field experiments were carried out in newly reclaimed land at El-Nobaria, Northern Egypt during the two successive seasons of 2009/2010 and 2010/2011 to study the response of Kohlrabi plants (Brassica oleracea var. Gongylodes L.) to different fertilizer sources and application rates of Nitrogen (N). The experiments were carried out in a split plot design with three replicates. Three fertilizer sources, i.e., mineral-N fertilizer (control) as ammonium nitrate (33.5% N), organic-N as chicken manure (3.4% N) and combined application of 50% mineral-N (ammonium nitrate) + 50% organic-N (chicken manure) were assigned to the main-plots, while three N rates, i.e., 50, 75 and 100 kg N/feddan (4200 m2) were randomized and occupied the sub-plots. Plant growth characters (plant height, number of leaves per plant and plant fresh weight), chlorophyll content and tuber yield, as well as chemical composition of edible part (tuber), were evaluated. The data showed that applying of mineral-N source ranked the first in increasing Kohlrabi yield followed by the combined application of 50% organic-N with 50% mineral-N and lastly coming organic-N source. Organically fertilized plants resulted in 83-87% yield containing less nitrate (75-68%) compared to the mineral-N source. The productivity of Kohlrabi plants fertilized by 50% mineral-N in combination with 50% organic-N was similar (approx 95-96%) to those fertilized by 100% mineral-N. Moreover, the edible part (tuber) had much vitamin C and TSS as well as less nitrate content. On the other hand, increasing the application rate of N within the range of 50 up to 100 kg N/fed. increased all studied plant growth characters, chlorophyll content and tuber yield, but the differences within application rate of 75 and 100 were not great enough to be significant. It could be concluded that the economic and useful fertilizer source and application rate of N for the best growth, productivity and tuber quality of Kohlrabi plants is the combined source of 50% organic-N with 50% mineral-N at an application rate of 75 kg N/feddan (4200 m2).

Sultana *et al.* (2012) stated that an experiment was carried out at the Horticulture Farm of the Bangladesh Agricultural University, Mymensingh during the period from November 2010 to January 2011 to study the effects of cowdung and potassium on growth and yield of Kohlrabi. The experiment consisted of three levels of cowdung (0, 20 and 40 t/ha) and four levels of potassium (0, 20, 50, 80 kg /ha). The experiment was laid out in randomized complete block design with three replications. All the parameters were significantly influenced by the application of cowdung and potassium. The highest plant height (44.65 cm), number of leaves per plant (12.11), length of largest leaf (37.54 cm), and breadth of largest leaf (18.66 cm) were obtained from thehighest dose of cowdung and potassium applied (40 t cowdung + 80 kg K/ha) while the lowest plant height (33.64 cm), number of leaves (9.01), length of largest leaf (27.94 cm), and breadth of largest leaf (11.00 cm) were obtained from control treatment combination. The highest fresh weight of leaves (49.33 g), fresh weight of knob (328.66 g) and fresh weight of roots (66.55 g) per plant were also recorded under the treatment combination of 40 t cowdung + 80 kg K/ha, while the lowest fresh weight of leaves (22.11 g), fresh weight of knob (136.00 g) and fresh weight of roots (23.33 g) were obtained from control treatment combination. Similarly, the dry weight of leaves (19.34%), knob (15.19%) and roots (32.75%) were highest under the same treatment combination of 40 t cowdung + 80 kg K/ha and the lowest dry weight of leaves (11.71%), dry weight of knob (7.38%) and dry weight of roots (15.29%) were obtained from control treatment combination C0K0. The marketable yields of knob per plot (7.86 kg) and per hectare (39.58 tons) were also the highest under the treatment combination 40 t cowdung/ha and 80 kg potassium per hectare.

Shams (2012) reported that field experiments were carried out on Kohlrabi (Brassica oleracea var. gongylodes) 'Purple Vienna cv.' at the Experimental Farm of the Faculty of Agriculture, Moshtohor, Benha University, Egypt, during the winter seasons of 2009 and 2010 under drip irrigation system. This study aimed to investigate the effect of organic manure and/or mineral Nfertilizer with or without biofertilizer inoculation on growth, yield, and quality of kohlrabi knobs. Results show that using 50% mineral-N + 50%

organic-N combined with biofertilizer, improved plant growth, yield, and knob quality compared to other N-fertilizer systems. Inoculation of kohlrabi transplants with biofertilizer gave good results in this respect. Therefore, this treatment gave the best growth and increased total yield with the best knob quality as compared with uninoculated one. The highest content of nitrate in knobs (803.84 mg kg-1 DW) was recorded by using 100% mineral-N treatment (average in both seasons). Whereas, adding 100% organic-N recorded the lowest content of nitrate in knobs (387.75 mg kg-1 DW) average of both seasons. It is worthy to mention that nitrate concentration in tested kohlrabi knobs is still in the safe 11 borders for human consumption. Finally, the kohlrabi plant contains good amounts of antioxidants substances positioned to be at the forefront of salad plants.

Losak *et al.* (2011) stated that in a one-year vegetation pot experiment we compared the effect of the digestate from a biogas station and mineral fertilizers on yield and quality characteristics of kohlrabi, variety Segura. Four treatments were used as follows: 1) untreated control, 2) urea, 3) digestate, 4) urea, triple superphosphate, KCl, $MgSO_4$. The rate of N was the same in treatments 2-4: 1.5 g N/pot. In treatment 4 the rate of P, K and Mg corresponded with the rate of these nutrients in the digestive treatment. The weight of single bulbs of the control unfertilized treatment were significantly the lowest (22.9%), as well as nitrate (6.0%) and ascorbic acid levels (66.2%) compared to the urea treatment (100%) and the other fertilized treatments. After the application of the digestate (treatment 3) and mineral fertilizers (treatment 4), the weight of single bulbs significantly increased by 27.9 and 29.2%, respectively, compared to the urea treatment. The concentration of ascorbic acid in the fertilized treatments did not differ (772-789 mg/kg) but it increased significantly compared to the unfertilized treatment (511 mg/kg). There were no significant differences between the two treatments fertilized with mineral fertilizers in the bulb nitrate conc. (678 and 641 mg NO_3^-/kg fresh matter, respectively). After digestate application, their levels decreased significantly to 228 mg NO_3^-/kg fresh matter. Digestate treatment resulted in comparable or better yield and qualitative characteristics compared to treatment with mineral fertilizers.

Uddin *et al.* (2009) reported that an experiment was conducted at Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during October-December, 2007 to study the effect of different organic manures on growth and yield of kohlrabi plant. Three types of organic manures viz. were compared with control (no manure) in the experiment. The maximum plant height (36.50 cm), plant canopy (63.50 cm), leaf length (30.42 cm), leaf breadth (14.25 cm), fresh leaves weight per plant (131.10g), diameter of knob(8.23cm), Knob weight (366.60 g), yield per hectare (22.90 t ha G) were found in poultry manure application. Only the maximum number of leaves (20.00) was 1 found in control treatment. On the other hand, the minimum plant height (32.25 cm), plant canopy (55.75 cm), leaf length (24.92 cm), leaf breadth (10.75 cm), fresh leaves weight per plant (86.97g), diameter of knob (7.95 cm), Knob weight (177.50 g), yield per hectare (15.40 t ha G) were found in control treatment. Minimum number of 1 leaves (14.33) was found with cowdung application Losák *et al.* (2008) stated that, in a greenhouse pot experiment with kohlrabi, variety Luna, we explored the joint effect of N (0.6 g N per pot = 6 kg of soil) and S in the soil (2 5–35–45 mg kg-1 of S) on yields, on N, S and NO^{3}- content in tubers and leaves, and on alterations in the amino acids concentration in the tubers. S fertilization had no effect on tuber yields. The ranges of N content in tubers and leaves were narrow (between 1.42– 1.48 % N and 1.21–1.35 % N, respectively) and the effect of S fertilization was insignificant. S concentration in the tubers ranged between 0.59 and 0.64 % S. S fertilization had a more pronounced effect on the S concentration in leaf tissues where it increased from 0.50 to 0.58 or to 0.76 % S under the applied dose. The NO3- the content was higher in tubers than in leaves. Increasing the S level in the soil significantly reduced NO3- concentrations in the tubers by 42.2–53.6 % and in the leaves by 8.8–21.7 %. Increasing the S content in the soil reduced the concentration of cysteine + methionine by 16–28 %. The values of valine, tyrosine, aspartic acid, and serine were constant. In the S0, S1, and S2 treatments the levels of threonine, isoleucine, leucine, arginine, the sum of essential amino acids and alanine decreased from 37 to 9 %. The histidine concentration increased with increasing S fertilization. S fertilization of kohlrabi can be recommended to stabilize the yield and reduce the undesirable NO3- contained in the parts used for consumption.

Ryan (2011) conducted a field experiments to assess the release of plantavailable 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 NO3 levels from early to mid-June.

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.

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 .

Gerendás *et al.* (2008) reported that Glucosinolates (GSss) represent bioactive compounds of Brassica vegetables whose health-promoting effects merelystem from their breakdown products, particularly the isothiocyanates (ITCs), released after hydrolysis of GSs by myrosinase. GSs are occasionally discussed as transient S reservoirs, but little is known concerning the interactive effect of S and N supply on ITC concentrations. Therefore, kohlrabi plants were grown in a pot experiment with varied S (0.00, 0.05, and 0.20 g pot−1) and N (1, 2, and 4 g pot−1) supplies. Plant growth exhibited a classical nutrient response curve with respect to both S and N. The ITC profile of kohlrabi tubers was dominated by methylthiobutyl ITC (11−1350 µmol (g DM)−1), followed by sulforaphan (7−120 μmol (g DM)−1), phenylethyl ITC (5−34 μmol (g DM)−1), and allyl ITC (5−38 μmol (g DM)−1), resulting from the hydrolysis of glucoerucin, glucoraphanin, gluconasturtiin, and sinigrin, respectively. The ITC profile was in agreement with reported data, and concentrations of all ITCs were substantially reduced in response to increasing N and decreasing S supply. A growth-induced dilution effect could be ruled out in most cases, and the results do not support the hypothesis that GS acts as a transient reservoir with respect to S.

Biesiada *et al.* (2007) reported that three field experiments were established in 1996-2003 in order to determine the effects of the term of harvest and stage of maturity on the biological value of leek, zucchini, and kohlrabi. The results of experiments showed that delay the harvest date associated with the considerable increment of crop yield caused the enhancement of dry matter, total and reducing sugars in leek and kohlrabi. In zucchini, the fruits of smaller size contained higher amounts of dry matter and similar sugars like more developed. Advanced term of harvest appeared to be favorable for vitamin C, phosphorus and potassium content in vegetables. Changes in magnesium and calcium concentration under the influence of the stage of maturity were highly dependent on plant species. Plants of kohlrabi and leeks harvested at a later stage of maturity contained a lower level of nitrates, but in zucchini, there was observed the increment of this compound in fruits of a bigger size at harvest.

Ahmed *et al.* (2003) reported that the effect of seven different NPK levels on the growth and yield of Kohlrabi was investigated. Nitrogen, phosphorus, and potassium were applied alone as well as in various combinations and had a significant effect on various plant growth and yield parameters. Maximum tuber weight (430.80 g) tuber diameter (10.23 cm), number of leaves per plant (14.38) and tuber yield (25850 kg ha-1) was recorded in plots fertilized with 160-120-160 kg NPK ha-1. It can be concluded that NPK @ 160-120-60 kg ha1 was found to be the best fertilizer dose for the higher yield of Kohlrabi.

Fischer (1992) stated that the aims of this study were to investigate the influence of fertilizer treatments on the chemical flavor composition of kohlrabi (Brassica oleraceavargongylodes L). Increasing nitrogen and potassium supply resulted in variable amounts of isothiocyanates, organic cyanides, sulphides and aldehydes measured by headspace analysis. Therefore, it could be suggested that the desirable flavor of kohlrabi is influenced by the level of fertilization. The effect of applied potassium on flavor quality is less clear cut. The observed inverse relationship between the amounts of flavor compounds and nitrogen supply might be utilized in production practices to obtain an optimal flavor quality.

Venter and Fritz (1979) reported that the influence of different nitrogen doses given in different nitrogen forms on the nitrate contents of kohlrabi plants was examined in greenhouse-and field experiments. Increasing nitrogen amounts applied are followed by an increase in the nitrate contents of kohlrabi. Nitrate fertilizers resulted in the highest and calcium cyanamide in the lowest nitrate contents. The nitrate contents of kohlrabi tubers sharply decreased along with a prolonged period of time between the last nitrogen fertilization and harvesting. The nitrate increase was highest in the leaf stalks on the external and middle leaves but was only 20 to 25% of that level in the leaf blades and in tubers. At about the same level of nitrogen fertilization, nitrate contents of greenhouse kohlrabi cultivated at a time of year poor in light were considerably higher than those of field grown kohlrabi in the summertime.

CHAPTER III

MATERIALS AND METHOD

This chapter describes the materials and methods which were used in the field to conduct the experiment entitled "growth and yield of kohlrabi as influenced by fertilizers and mulches" during the period from November 2017 to January 2018. It comprises a short description of experimental site, soil and climate, variety, growing of the crops, experimental design and treatments and collection of data presented under the following headings.

3.1 Experimental site

The study was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. Geographically the experimental area is located at $23^{0}41'$ N latitude and $90^{0}22'$ E longitudes at the elevation of 8.2 m above the sea level (FAO, 1988).

3.2 Characteristics of soil

Soil of the experimental field was silty loam in texture. The soil of the experimental area belongs to the Madhupur Tract under the AEZ No. 28. Soil sample of the experimental plot was collected from a depth of 0-30 cm before conducting the experiment and analyzed in the Soil Resources Development Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka and have been presented in Appendix I.

3.3 Climate and weather

The climate of the experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon or hot season from March to April and the monsoon period from May to October. Details of the meteorological data during the period of the experiment was collected from the Bangladesh Meteorological Department, Agargaon, Dhaka and presented in Appendix II.

3.4 Plating material

The “Quick Star” cultivar of Kohlrabi was used in the experiment. The seeds of the cultivar were collected from Siddique Bazar, Dhaka.

3.5 Seedbed preparation

Seedbed was prepared on November 2017 for raising seedlings of kohlrabi and the size of the seedbed was 3m×1m. For making seedbed, the soil was well ploughed to loosen friable and dried masses to obtained good tilth. Weeds, stubbles and dead roots were removed from the seedbed. Cowdung was applied to prepared seedbed. The soil was treated by Sevin 50WP @ 5kg/ha to protect the young plants from the attack of mole crickets, ants and cutworm.

3.6 Seed treatment

Seeds were treated by Provax 200WP @ 3g/kg seeds to protect some seed borne diseases.

3.7 Seed sowing

Seeds were sown on November 2017 in the seedbed. Sowing was done thinly in lines spaced at 5 cm distance. Seeds were sown at a depth of 2 cm and covered with a fine layer of soil followed by light watering by water can. Thereafter the beds were covered with dry straw to maintain required temperature and moisture. The cover of dry straw was removed immediately after emergence of seed sprout. When the seeds were germinated, shade by white polythene was provided to protect the young seedlings from scorching sunshine and rain.

3.8 Raising of seedlings

Light watering and weeding were done several times. No chemical fertilizers were applied for raising of seedlings. Seedlings were not attacked by any kind of insect or disease. Healthy and 25 days old seedlings were transplanted into the experimental field on December 2017.

3.9 Treatment of the experiment

Factor A: Four levels of nitrogen

N_0: 0 kg N /ha

N_1:100 kg N/ha

N_2:120 kg N /ha

N_3: 140 kg N /ha

Factor B: Three levels of potassium

K_0: 0 kg K /ha

K_1: 100 kg K/ha

K_2:120 kg K/ha

There are 12 treatment combinations such as N_0K_0, N_0K_1, N_0K_2, N_1K_0, N_1K_1, N_1K_2, N_2K_0, N_2K_1, N_2K_2, N_3K_0, N_3K_1, N_3K_2.

Plot Size: 1.2m x 1.6m **Spacing:** 35cm x 30cm

3.10 Design and layout of the experiment

The two-factorial experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The total area of the experimental plot was divided into three equal blocks. Each block was divided into 12 plots where 12 treatments combination were distributed randomly. There were 36-unit plots altogether in the experiment. The size of each plot was 1.05 m × 1.5 m. The distance maintained between two blocks and two plots were 1 m and 0.5 m, respectively. The plots were raised up to 10 cm. In the plot with maintaining distance between row to row and plant to plant were 35 cm and 30 cm, respectively.

3.11 Land preparation

The plot selected for conducting the experiment was opened in the 1 st week of December 2017 with a power tiller and left exposed to the sun for a week. After 22 weeks the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good tilth. Weeds and stubbles were removed and finally obtained a desirable tilth of soil was obtained for transplanting of seedling. In order to avoid water logging due to rainfall during the study period, drainage channels were made around the land. The soil was treated with Furadan 5G @ 15 kg ha^{-1} when the plot was finally ploughed to protect the young seedlings from the attack of cut worm.

3.11.1 Application of Fertilizer

Manure and fertilizer was applied as per the treatment. Organic manure and inorganic fertilizer was used as the source of nitrogen, phosphorus and potassium. Total amount of organic manure was applied during final land preparation as per treatment.

3.11.2 Application of mulching materials

Two types of mulch materials; viz., black polythene mulch and white polythene mulch were used. Polythene sheet with small opening which was made for maintaining proper plant to plant and row to row distance before placing over the plots. These polythene mulch materials were used as per the treatments.

3.11.3 Transplanting

The seedbed was watered before uprooting the seedlings to minimize the damage of roots. Twenty-five days old healthy seedlings were transplanted at the spacing of 35 cm × 30 cm in the experimental plots on December 2016. Planting was done in the afternoon. Light irrigation was given immediately after transplanting around each seedling for their better establishment. Watering was done up to five days until they became capable of establishing on their own root system.

3.12 Intercultural operations

3.12.1 Gap filling

Very few seedlings were damaged after transplanting and new seedlings from the same stock were replaced these.

3.12.2 Weeding

The plants were kept under careful observation. Weeding was done at two times. First weeding was done two weeks after transplanting. Another weeding was done after 30 days of first weeding.

3.12.3 Irrigation

Light irrigation was given immediately after transplanting around each seedling for their better establishment. Watering was done up to five days until they become capable of establishing on their own root system. Irrigation was given by observing the soil moisture condition. Four times irrigation were done during crop period.

3.12.4 Earthing up

Earthing up was done only on un-mulched plots by taking the soil from the space between the rows at 15 days after transplanting. Earthing up was not necessary in mulched plots.

3.12.5 Insects and diseases management

The crop was attacked by cutworms, mole cricket and field cricket during the early stage of growth of seedlings in the month of December. This insect was controlled by spraying Dursban 20 EC @ 0.1%.

3.12.6 General observation

The field was frequently observed to notice any changes in plants, pest and disease attack and necessary action was taken for normal plant growth.

3.12.7 Harvesting

Whole plants with knobs were harvested at proper matured time. Main knobs were harvested when the plants formed compact knobs. The final harvesting was done on January 2018.

3.13 Collection of data

The data pertaining to following characters were recorded from five plants randomly selected from each plot except yield of knobs which was recorded plot wise. The following parameters were studied for the present experiment.

1. Plant height (cm)
2. Number of leaves per plant
3. Diameter of leaf (cm)
4. Indivudual knob weight without leaves (g)
5. Weight of leaf (g)
6. Knob length (cm)
7. Knob breadth (cm)
8. Root weight (g)
9. Leaf dry weight (g)
10. Knob dry weight (g)
11. Yield per plot (kg/plot)
12. Yield per hectare (t/ha)

3.14 Data collection procedure

3.14.1 Plant height

Plant height was measured from base to the tip of the longest leaf at 30, 45 days after transplanting (DAT) and harvest time. A meter scale was used to measure plant height of the plant and expressed in centimeter (cm).

3.14.2 Number of leaves per plant

Total number of leaves produced by each plant was counted at 30, 45 DAT and harvest time. The time of main knob harvesting excluding the small leaves.

3.14.3 Diameter of knob

Knob diameter was taken by using a meter scale at the final harvest. Diameter of the knob was measured at different directions and finally the average of all directions was recorded and expressed in centimeter (cm).

3.14.4 Knob weight with and without leaves

Weight of the knob was recorded including leaves and excluding leaves and expressed in gram (g).

3.14.5 Root length

Root of kohlrabi was measured using the measuring tape and express as centimeter (cm).

3.14.6 Yield per plot

The yield per unit plot was calculated by adding the yields of all plants of each unit plot and expressed in kilogram (kg).

3.14.7 Yield per hectare

The yield of knob per hectare was calculated by conversion of the knob weight per plot and recorded in ton.

3.14.8 Dry weight

The 100 g fresh of stem, roots and leaves was taken and kept in oven. Then the dry weight of 100 g of stem, roots and leaves was calculated and expressed in gram (g).

3.15 Statistical analysis

The data recorded on various parameters were statistically analyzed using SPSS (Version 20.00) to find out the statistical significance of the treatment effect. The mean values of *all the treatments were calculated and analyses of variance for all the characters were* performed by the p-test. The significance of the difference among the treatments and combinations of means was estimated by DMRT (Duncan's Multiple Range Test) at 5% level of probability.

CHAPTER: IV

RESULTS AND DISCUSSION

The experiment was conducted to observe the effect of growth and yield of kohlrabi influenced by nitrogen and potassium at 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-XVIII. 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

Effect of Nitrogen

With the application of fertilizers, plant height of kohlrabi showed increasing trend up to the harvest. Data showed that positively significant plant height of kohlrabi was found (Figure 1 and Appendix III, IV, V). The tallest plant of kohlrabi was recorded in the N_3 (26.22, 31.51 and 36.78 cm at 20 DAT, 40 DAT and harvesting time, respectively) treatment and the shortest plant was found in the N_0 application (19.52, 25.10 and 28.58 cm at 20 DAT, 40 DAT and harvesting time, respectively) treatment. The result might be due to the fact that fertilizer enhances the vegetative growth of kohlrabi. The present finding is agreed with the findings of Saleh *et al*. (2013). They found that plant height was significantly increased by the combined application of 50% Inorganic-N with 50% mineral-N.

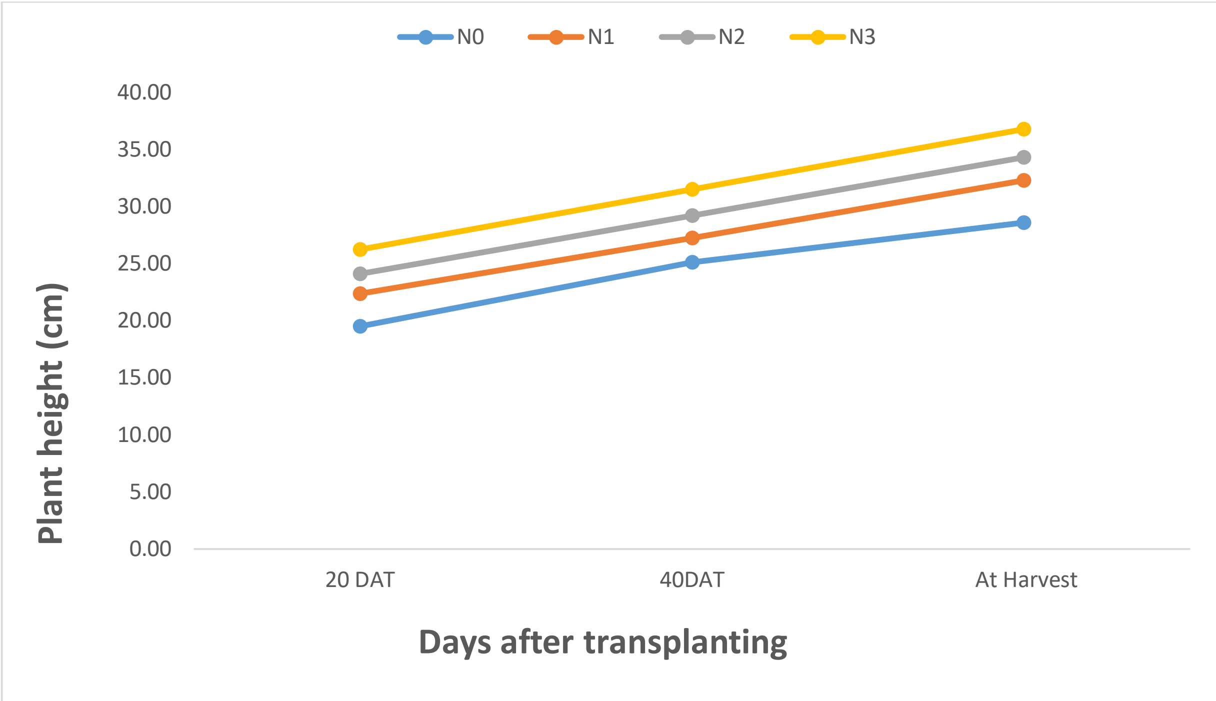

Figure1. Effect of Nitrogen on plant height at days after transplanting (DAT)

DAT= Days after transplanting; here, Nitrogen (N_0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha)

Effect of Potassium

The experiment significantly influences the application of potassium fertilizers.Here data showed that positively significant plant height of kohlrabi was found (Figure 1 and Appendix III, IV, V). The tallest plant of kohlrabi was recorded in the k_1 application 23.95, 30.50 and 34.74cm at 20 DAT, 40 DAT and harvesting time, respectively) and the shortest plant was found in the K_0 application (20.34,29.00 and 30.21 cm at 20 DAT, 40 DAT and harvesting time, respectively).This result shows that the proper application of potassium fertilizer increases the growth and development of kohlrabi plant.

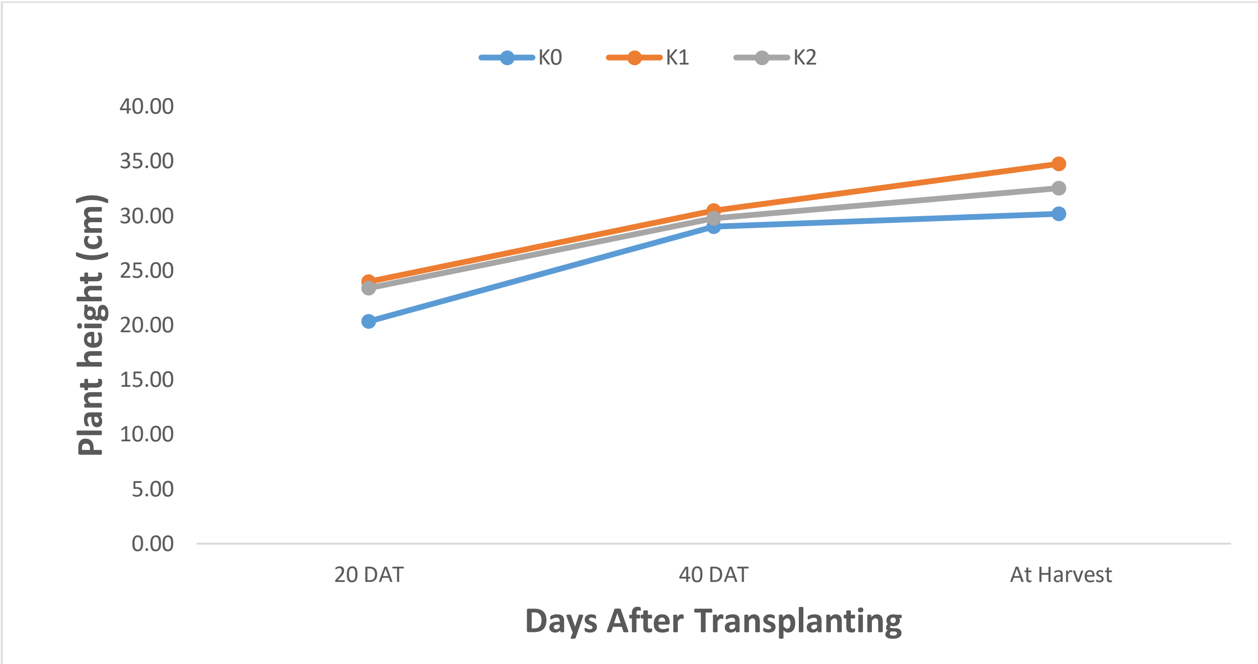

Figure 2. Effect of Potassium on plant height at days after transplanting (DAT)

DAT= Days after transplanting; here, k_0: Control, K_1:100kg/ha, K_2:120kg/ha

Combined effect of nitrogen and potassium:

The combined effect of different amount of nitrogen and potassium fertilizer showed positively significant variations all dates of observations (Table 1 and Appendix III-V). The tallest plant was found 26.80cm,32.61cm and 35.75cm at 20DAT, 40 DAT and at harvest respectively in N_3K_1 combination and the shortest plant heightwas recorded 21.60cm,27.57cm,29.57cm at 20 DAT, 40 DAT and at maturity respectively through the controlled applications of N_0K_0. Compared to other application.

Table:1: Combined effect of Nitrogen and Potassium on plant height of Kholrabi plant

Treatments	Plant height (cm) at		
	20 DPH	40 DPH	At Hervest
N_0K_O	21.60 bc	27.56 b	29.56 c
N_0K_1	23.10 abc	28.50 b	31.96 b
N_0K_2	24.53 ab	30.00 ab	34.56 a
N_1K_0	21.76 b	30.06 ab	34.80 a
N_1K_1	23.50 abc	30.06 ab	34.98 a
N_1K_2	24.70 ab	31.33 ab	33.73 ab
N_2K_0	21.20 bc	29.10 a	35.96 a
N_2K_1	20.16 c	28.73 a	34.35 a
N_2K_2	22.66 bc	29.76 a	35.66 a
N_3K_0	24.80 ab	31.00 ab	35.26 a
N_3K_1	26.80 a	32.61 a	35.75 a
N_3K_2	23.90 ab	30.90 ab	35.00 a
SE	0.402	0.35	0.34
Significant level	0.017	0.02	0.00

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. DAT= Days after transplanting; Nitrogen ($N_{0:}$ Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha); Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha);DPH= Days plant height

4.2 Number of leaves per plant

Effect of Nitrogen

With the application of fertilizers, the number of leaves per plant showed an increasing trend up to the harvest. Data showed that a positively significant number of leaves per plant of kohlrabi was obtained (Figure 3 and Appendix VI, VII, VIII). The maximum number of leaves per plant of kohlrabi was recorded in the N_3 (7.22, 8.00, 11.25 at 20 DAT, 40 and harvest time, respectively) treatment. A similar result was obtained by Sultana *et al*. (2012) and they observed that the number of leaves was increased by application of both organic and inorganic fertilizers DAT and harvest time, respectively) treatment. The minimum number of leaves per plant was found in the N_0 at 6.67, 8.11 and 9.67 at 20 DAT, 40 DAT and at maturity. These findings were also supported by Ekandjo and Ruppel (2015) and Ahmed *et al.* (2003).

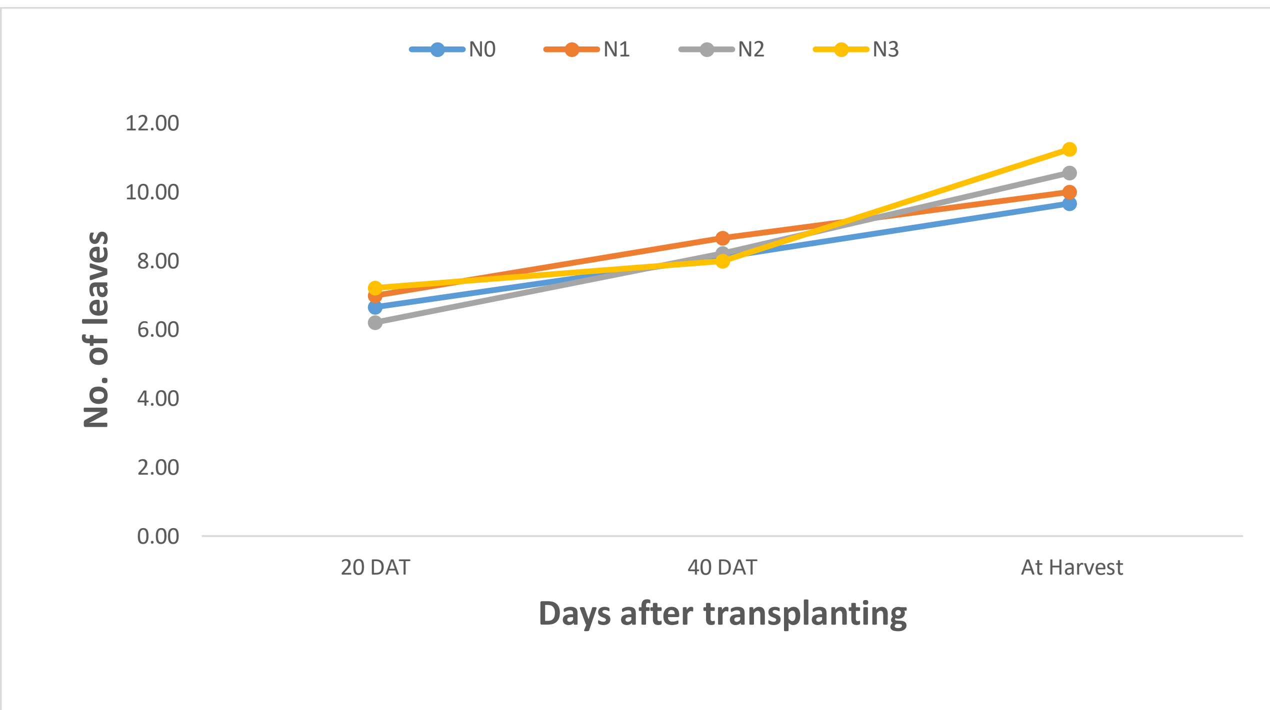

Fig. 3: Effect of Nitrogen on number of leaves per plant of Kohlrabi

DAT= Days after transplanting; here, Nitrogen (N_0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha)

Effect of potassium

With the application of potassium fertilizer (Figure 3 and Appendix VI, VII, VIII) the maximum number of leaves per plant of kohlrabi was recorded in the K_1 (6.83, 8.83 and 11.00 at 20 DAT, 40 and harvest time respectively) treatment. A similar result was obtained by Sultana et al. (2012) and they observed that the number of leaves was increased by application of both organic and inorganic fertilizers DAT and harvest time, respectively) treatment. The minimum number of leaves per plant was found in the K_0 at (6.25, 8.08 and 10.25 at 20 DAT, 40 DAT and at maturity). These findings were also supported by Ekandjo and Ruppel (2015) and Ahmed *et al.* (2003).

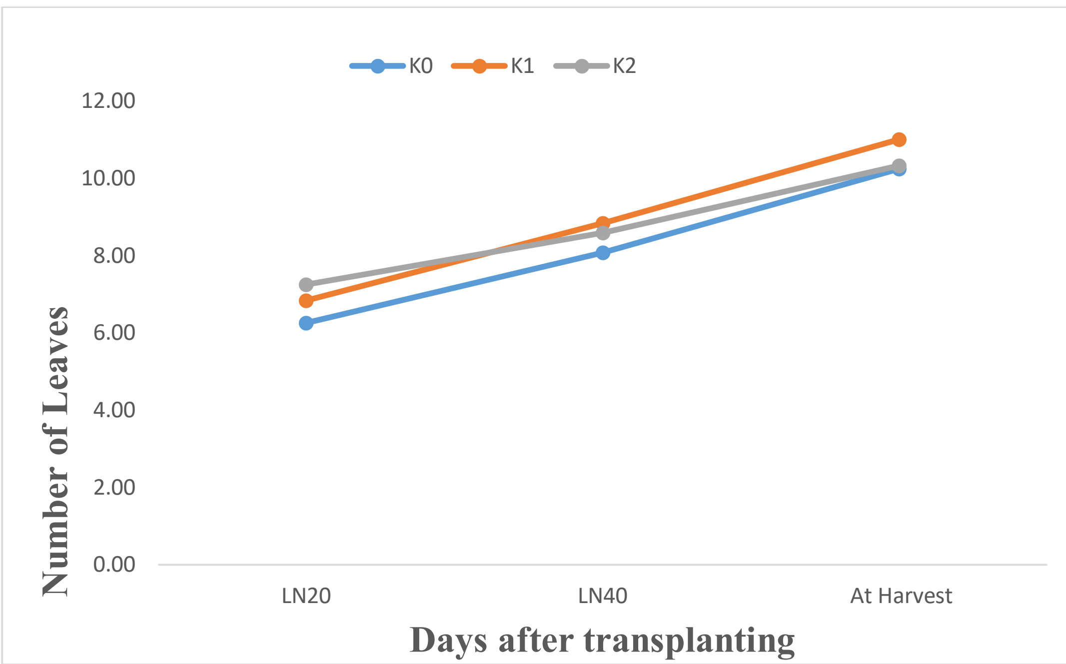

Fig. 4: Effect of Potassium on the number of leaves per plant of Kohlrabi

DAT= Days after transplanting; here, k_0: Control, K_1:100kg/ha, K_2:120kg/ha

Combined effect of nitrogen and potassium

The combined effect of fertilizers and mulches showed positively significant variation at all sampling dates (Table 2 and Appendix VI, VII, VIII). At 20 DAT the maximum number of leaves per plant was found (8.0). At 40 DAT the maximum number of leaves per plant was found (10.667) in N_3K_1 treatment combination. At harvesting time the highest number of leaves was found (15.57) in N_3K_1 treatment combination and the minimum number of leaves per plant was recorded (5.66, 7.67, 9.67 at 20 DAT, 40 DAT and harvesting time respectively) in N_OK_O combination compared to other treatment combinations.

Table 2: Combined effect of Nitrogen and Potassium on number of leaves per plant of kohlrabi

Treatments	Number of leaves/plant		
	20DAT	40DAT	At harvest
N_0K_O	5.66 c	7.66 b	9.66 b
N_0K_1	7.00 ab	8.33 b	9.66 b
N_0K_2	7.33 ab	8.33 b	9.66 b
N_1K_0	6.66 b	8.33 b	10.00 b
N_1K_1	7.00 ab	8.66 b	11.00 a
N_1K_2	7.33 ab	9.00 bc	11.00 a
N_2K_0	6.33 bc	8.33 b	10.66 b
N_2K_1	5.33 c	7.66 b	10.33 b
N_2K_2	7.00 ab	8.66 b	10.33 b
N_3K_0	6.33 bc	8.00 b	10.66 b
N_3K_1	8.00 a	10.66 a	15.57 a
N_3K_2	7.33 ab	8.33 b	10.33 b
SE	0.14	0.17	0.17
Significant level	0.00	0.00	0.00

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. DAT= Days after transplanting; Nitrogen (N0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha); Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha)

4.3 Diameter of Leaf

Effect of N fertilizer

With the application of nitrogenous fertilizers, the diameter of leaf showed positively significant variation (Table 3 and Appendix IX). The highest diameter of leaf on kohlrabi (11.977 cm) was recorded in the N_3 treatment which was closely followed by N_2 treatment. The lowest diameter of leaf (10.603 cm) was found in the N_0 treatment. The result might be due to the fact that N fertilizer enhances the growth of the diameter of leaf.

Effect of P fertilizer

Through application of potassium fertilizer, the diameter of leaf showed positively significant variation (Table 3 and Appendix IX). The highest diameter of leaf on kohlrabi (11.591 cm) was recorded in the k_2 treatment which was closely followed by K_1 treatment. The lowest diameter of leaf (10.358 cm) was found in the K_0 treatment.

Combined effect of N and P fertilizer

The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. (Table 4 and Appendix IX). The maximum diameter of leaf was found on the combination of N_3K_1 application (13.0 cm) and the minimum diameter of diameter of leaf was the at the control application of N_0K_0 (10.33) compared to other application.

4.4 Weight of knob without leaves

Effect of nitrogen fertilizer

With the application of fertilizers, individual knob weight without leaves showed positively significant variation (Table 3 and Appendix X). The highest individual knob weight without leaves of kohlrabi was recorded in the N_3 (153.54 g) treatment. The lowest individual knob weight without leaves was found in the N_0 (130.42 g) treatment.

The present finding is agreed with the findings of Losak *et al.* (2011) and they stated that application of mineral fertilizers increased the weight of single knobs.

Effect of Potassium fertilizer

With the application of fertilizers, individual knob weight without leaves showed positively significant variation (Table 3 and Appendix X). The highest individual knob weight without leaves of kohlrabi was recorded in the K_1 (144.48 g) treatment which is statistically similar to the application of K_2 (144.17g). The lowest individual knob weight without leaves was found in the K_0 (130.42 g) treatment. These findings is agreed with Moniruzzaman *et al.* (2007) and Farias-Larios *et al*. (1994).

Combined effect of N and P fertilizer

The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. (Table 4 and Appendix X). The maximum diameter of the leaf was found on the combination of N_3K_1 application (168.667g) and the minimum diameter of the leaf was the at the control application of N_0K_0 (125.67g) compared to other application.

4.5 Weight of Leaf

Effect of nitrogen fertilizer

With the application of fertilizers, individual knob weight without leaves showed positively significant variation (Table 3 and Appendix XI). The highest individual knob weight without leaves of kohlrabi was recorded in the N_3 (70.53 g) treatment. The lowest individual knob weight without leaves was found in the N_0 (53.34 g) treatment.

Effect of Potassium fertilizer

Through applying potassium fertilizer, individual knob weight without leaves showed positively significant variation (Table 3 and Appendix XI). The highest individual knob weight without leaves of kohlrabi was recorded in the K_1 (61.97 g) treatment which is statistically similar to the application of K_2 (61.94 g). The lowest individual knob weight without leaves was found in the K_0 (57.2 g) treatment.

Combined effect of N and P fertilizer

The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. (Table 4 and Appendix XI). The maximum diameter of the leaf was found on the combination of N_3K_1 application (74.40g) and the minimum diameter of the diameter of the leaf was the at the control application of N_0K_0 (51.70g) compared to other application.

Table:3 Effect of Nitrogen and Potassium fertizers on diameter of leaf, knob weight and weight of leaf

Treatments	diameter of leaf (cm)	weight of knob (g)	weight of leaf (g)
Effect of Nitrogen fertilizer			
N_0	10.60 b	130.42 c	53.34 b
N_1	11.54 a	142.78 ab	58.55 b
N_2	11.68 a	134.41 c	59.17 b
N_3	11.97 a	153.54 a	70.53 a
SE	0.15	2.45	1.51
Significant level	0.00	0.00	0.00
Effect of Potassium fertilizer			
K_0	10.35 b	132.21 b	57.29
K_1	11.41 a	144.48 a	61.97
K_2	11.59 a	144.17 a	61.94
S.E	0.93	2.45	1.51
Significant level	0.02	0.05	0.356

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. DAT= Days after transplanting; Nitrogen (N0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha); Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha).

Table:4 Combined effect of Nitrogen and Potassium fertilizers on diameter of leaf, knob weight and weight of leaf

Treatments	diameter of leaf (cm)	weight of knob (g)	weight of leaf (g)
N_0K_O	10.33 cd	125.66 c	51.70 de
N_0K_1	9.71 d	138.33 c	45.20 e
N_0K_2	11.76 b	127.26 c	63.13 bc
N_1K_0	11.76 b	134.00 c	57.36 cd
N_1K_1	11.53 b	138.53 c	58.30 cd
N_1K_2	11.33 bc	155.83 b	60.00 c
N_2K_0	11.66 b	138.50 c	69.16 ab
N_2K_1	11.40 bc	132.40 c	51.26 de
N_2K_2	12.00 ab	132.33 c	57.10 cd
N_3K_0	11.66 b	130.70 c	69.66 ab
N_3K_1	13.00 a	168.66 a	74.40 a
N_3K_2	11.26	161.26 ab	67.53
SE	0.15	2.45	1.51
Significant level	0.00	0.00	0.00

(Means in the column followed by a different letter(s) differed significantly by DMRT at 5% level of significance). Here, Nitrogen (N_0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha); Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha)

4.6 Knob Length

Effect of nitrogen fertilizer

With the application of fertilizers, individual knob weight length showed positively significant variation (Table 5 and Appendix XII). The highest individual knob length without leaves of kohlrabi was recorded in the N_3 (7.25 cm) treatment. The lowest individual knob length was found in the N_0 application (6.25cm) which is statistically similar to N_1 application (6.625 cm). The present finding is agreed with the findings of EI-Bassiony *et al*. (2014) and Biesiada *et al.* (2007) similar to N_1 application (6.625 cm).

The present finding is agreed with the findings of EI-Bassiony *et al*. (2014) and Biesiada *et al.* (2007).

Effect of Potassium fertilizer

With the application of fertilizers, individual knob length showed positively significant variation (Table 5 and Appendix XII). The highest individual knob length of kohlrabi was recorded in the K_1 (6.85 cm) treatment which is statistically similar to the application of K_2 (6.68 cm). The lowest individual knob length was found in the K_0 (5.32 cm) treatment.

Combined effect of N and P fertilizer

The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. (Table 6 and Appendix XII). The maximum knob length was found on the combination of N_3K_1 application (7.38 cm) and the minimum knob length was the at the control application of N_0K_0 (5.65 cm) compared to other applications.

4.7 Knob breadth

Effect of nitrogen fertilizer

With the application of fertilizers, individual knob breadth showed positively significant variation (Table 5 and Appendix XIII). The highest individual knob breadth of kohlrabi was recorded in the N_3 (5.91cm) treatment. The lowest individual knob breadth was found in the N_0 application (4.00cm). Sari *et al.* (2000) reported that the main head diameters for the early sowing dates were higher than the others.

Effect of Potassium fertilizer

With the application of fertilizers, individual knob breadth showed positively significant variation (Table 5 and Appendix XIII). The highest individual knob breadth of kohlrabi was recorded in the K_1 (4.995 cm) treatment which is statistically similar to the application of K_2 (4.71 cm). The lowest individual knob breadth was found in the K_0 (4.012 cm) treatment.

The combined effect of N and P fertilizer

The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. (Table 6 and Appendix XIII). The maximum knob breadth was found on the combination of N_3K_1 application (5.066 cm) and the minimum knob breadth was the at the control application of N_0K_0 (4.02 cm) compared to other applications.

4.8 Root Weight

Effect of nitrogen fertilizer

With the application of fertilizers, individual root weight showed positively significant variation (Table 5 and Appendix XIV). The highest root weight of kohlrabi was recorded in the N_3 (6.11 g) treatment. The lowest individual root weight was found in the N_0 application (4.61 g). The present finding is agreed with the findings of Sultana *et al*. (2012).

Effect of Potassium fertilizer

With the application of fertilizers, individual root weight showed positively significant variation (Table 5 and Appendix XIV). The highest individual knob breadth of kohlrabi was recorded in the K_1 (5.82 g) treatment which is statistically similar to the application of K_2 (5.50 g). The lowest root weight was found in the K_0 (4.25 g) treatment.

The combined effect of N and P fertilizer

The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. (Table 6 and Appendix XIV). The maximum knob breadth was found on the combination of N_3K_1 application (6.867 g) and the minimum knob breadth was the at the control application of N_0K_0 (4.33 g) compared to other applications.

Table:5 Effect of Nitrogen and Potassium fertilizers on knob length, knob breadth and root weight

Treatments	knob length (cm)	knob breadth (cm)	root weight (g)
Effect of Nitrogen fertilizer			
N_0	6.31 b	4.00 b	4.61 b
N_1	6.62 b	4.91 a	5.82 a
N_2	6.62 ab	4.58 a	5.55 a
N_3	7.25 a	5.91 a	6.11 a
S.E	0.08	0.07	0.16
Significant level	0.017	0.021	0.005
Effect of Potassium fertilizer			
Treatments	knob length	knob breadth	root weight
K_0	5.32 b	4.01 b	4.25 b
K_1	6.85 a	4.95 a	5.82 a
K_2	6.68 ab	4.71 ab	5.50 a
S.E	0.08	0.07	0.16
Significant level	0.029	0.019	0.382

(Means in the column followed by a different letter(s) differed significantly by DMRT at 5% level of significance). Here, Nitrogen (N_0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha); Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha)

Table:6 Combined effect of Nitrogen and Potassium on knob length, knob breadth and root weight

Treatments	knob length (cm)	knob breadth (cm)	root weight (g)
N_0K_O	5.65 c	4.20 c	4.33 c
N_0K_1	6.50 b	4.88 b	5.00 bc
N_0K_2	6.80 abc	5.06 b	4.50 bc
N_1K_0	6.51 bc	4.54 bc	6.13 ab
N_1K_1	6.40 a	4.68 bc	5.41 abc
N_1K_2	6.96 abc	4.61 bc	5.93 abc
N_2K_0	6.53 bc	4.60 bc	4.96 abc
N_2K_1	6.46 bc	4.60 bc	6.00 ab
N_2K_2	6.56 bc	4.63 bc	5.70 abc
N_3K_0	6.62 bc	4.66 bc	5.56 abc
N_3K_1	7.38 a	5.66 a	6.86 a
N_3K_2	7.10 ab	5.06 b	5.90 abc
SE	.08496	.07360	.16566
Significant level	0.00	0.002	0.050

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. DAT= Days after transplanting; Nitrogen (N0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha); Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha)

4.9 Leaf dry weight

Effect of nitrogen Fertilizer

Significant effect of nitrogen fertilizer was observed on the dry weight of 100 g of leaves of kohlrabi (Table 7 and Appendix XV). The highest value of the dry weight of 100 g of leaves (12.166 g) was recorded in N_0 treatment while the lowest dry weight of 100 g of leaves (8.677 g) was found in N_0 treatment. This might be due to fertilizer helped to facilitate the dry matter production of kohlrabi. The present finding is agreed with the findings of Sultana *et al.* (2012) and Venter and Fritz (1979).

Effect of potassium Fertilizer

With the application of potassium, fertilizer was observed on the dry weight of 100 g of leaves of kohlrabi (Table 7 and Appendix XV). The highest value of the dry weight of 100 g of leaves (11.583 g) was recorded in K_1 treatment while the lowest dry weight of 100 g of leaves (10.011 g) was found in K_0 treatment.

The combined effect of nitrogen and potassium fertilizers

The combined effect of nitrogen and potassium fertilizers had a significant effect on the dry weight of leaves on kohlrabi (Table 8 and Appendix XVI). The highest dry weight of (13.166 g) was recorded in N_3K_1 treatment combination and the lowest value of dry weight (8.800 g) was recorded in N_0K_0 treatment combination.

4.10 Knob dry weight

Effect of nitrogen Fertilizer

Significant effect of nitrogen fertilizer was observed on the dry weight of 100 g knobs of kohlrabi (Table 7 and Appendix XVI). The highest value of the dry weight of 100 g of the knob (6.811 g) was recorded in N_3 treatment while the lowest dry weight of 100 g of the knob (5.85 g) was found in N_0 treatment. This might be due to fertilizer helped to facilitate the dry matter production of kohlrabi. The present finding is agreed with the findings of Sultana *et al.* (2012) and Venter and Fritz (1979).

Effect of potassium Fertilizer

With the application of potassium, fertilizer was observed on the dry weight of 100 g of the knob on kohlrabi (Table 7 and Appendix XVI). The highest value of the dry weight of 100 g of the knob of K_1 (6.539 g) treatment which was statistically similar to K_2 (6.371 g) treatment while the lowest dry weight of 100 g of leaves (5.273 g) was found in K_0 treatment.

The combined effect of nitrogen and potassium fertilizer

The combined effect of nitrogen and potassium fertilizers had a significant effect on the dry weight of leaves on kohlrabi (Table 8 and Appendix XVI). The highest dry weight of (7.166 g) was recorded in N_3K_1 treatment combination and the lowest value of dry weight (5.590 g) was recorded in N_0K_0 treatment combination.

4.11 Yield per plot

Effect of nitrogen Fertilizer

Fertilizers had a significant effect on yield per plot of kohlrabi (Table 7 and Appendix XVII). The highest value of yield per plot (2.895 kg) was recorded in N_3 treatment while the lowest yield per plot (1.948 kg) was found in N_0 treatment. This might be due to fertilizers helped in energy storage and transfer, cell division, cell enlargement, nitrogen metabolism, enzyme activation and growth of meristematic tissue. Poultry manure also helps to provide the necessary amount of N. As a result, yield per plot of kohlrabi were increased. The present finding is agreed with the findings of Pane *et al.* (2014).

Effect of potassium fertilizer

With the application of potassium fertilizer, it was observed that the production of kohlrabi (Table 7 and Appendix XVII) on yield per plot was increased. The highest value of yield per plot of K_1 (2.159 kg) while the lowest yield per plot was recorded (1.976 kg) in K_0 treatment.

The combined effect of nitrogen and potassium fertilizer

The combined effect of nitrogen and potassium fertilizers had a significant effect on the yield per plot of kohlrabi (Table 8 and Appendix XVII). The highest yield per plot (3.675 kg) was recorded in N_3K_1 treatment while The lowest value of yield per plot (1.883 kg) was recorded in N_0K_0 treatment combinations.

4.12 Yield per hectare

Effect of nitrogen fertilizer

Yield per hectare of kohlrabi varied significantly variable for the different amount of fertilizer applications. (Table 7 and Appendix XVIII). The highest yield per hectare (14.62 ton/ha) was recorded from N_3, while the lowest (10.40 ton/ha) was recorded from N_0 treatment. (Table 9 Appendix xv) 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 highest yield was obtained from the crop planted on October 15 followed by November 1, while September 15 planting produced the lowest yield.

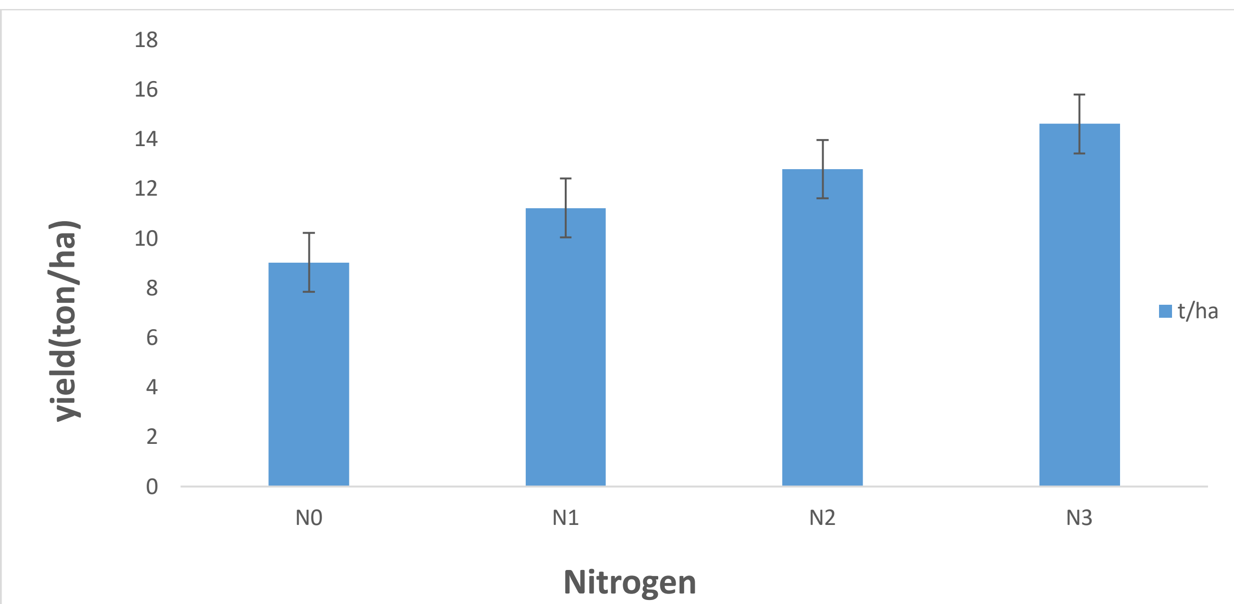

Figure 5: Effect of Nitrogen on yield per hectare Here, Nitrogen (N_0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha)

Effect of potassium fertilizer:

With the apply of potassium fertilizer yield per hectare of kohlrabi varied significantly. (Table 7 and Appendix XVIII). The different amount of fertilizer applications yield per plot of K_1 (13.75 ton/ha) which was statistically similar to K_2 (13.72 ton/ha) treatment while the lowest yield per plot was recorded (11.58 ton/ha) in K0 treatment.

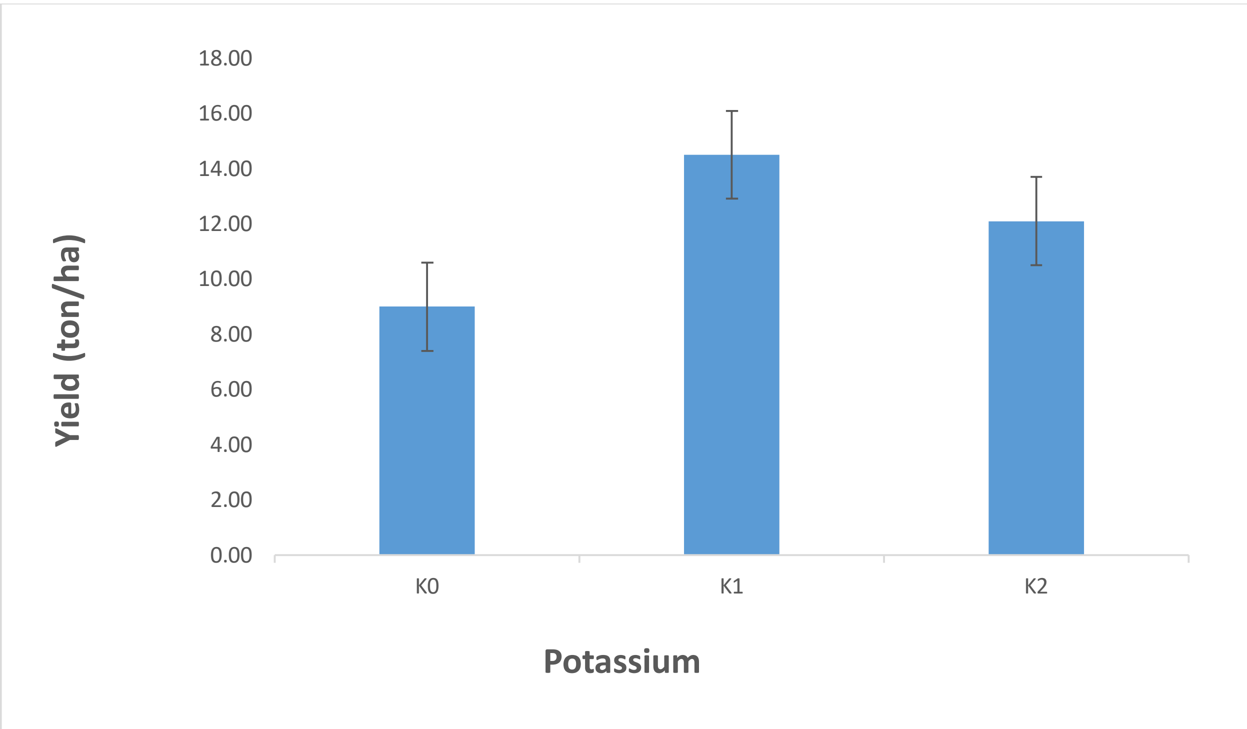

Figure 6: Effect of Potassium on yield per hectare

Here, Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha)

The combined effect of nitrogen and potassium fertilizer

Yield per hectare of kohlrabi showed significant differences due to the combined effect of different amount of fertilizer applications. (Table 8 and Appendix Xv). The highest yield per hectare (16.063 ton/ha) was recorded from N_3K_1 treatment while the lowest (11.933 ton/ha) was recorded from N_0K_0 (Table 11). It was revealed that planting at 30 November 2017 with a combination of different doses of fertilizer applications ensured the highest vegetative growth as well as the highest yield of kohlrabi under this trial.

Table 7: Effect of Nitrogen and Potassium fertilizers on leaf dry weight, knob dry weight, yield per plot and yield per hectare on kohlrabi

Treatments	leaf dry weight (g)	knob dry weight (g)	yield per plot (kg/plot)	yield per hectare (t/ha)
Effect of Nitrogen fertilizer				
N_0	8.67 b	5.85 c	1.94 c	10.40 c
N_1	11.46 a	6.41 b	2.13 ab	13.59 ab
N_2	11.10 a	6.49 b	2.01 bc	12.79 bc
N_3	12.16 a	6.81 a	2.89 a	14.62 a
S.E	0.36	0.46	0.094	0.23
Significant level	0.002	0.00	0.002	0.002
Effect of Potassium fertilizer				
K_0	10.01 a	5.27 a	1.97 b	11.58 b
K_1	11.58 a	6.53 a	2.15 a	13.75 a
K_2	10.42 a	6.37 a	2.00 a	13.72 a
S.E	0.36	0.07	0.036	0.23
Significant level	0.03	0.037	0.057	0.062

(Means in the column followed by a different letter(s) differed significantly by DMRT at 5% level of significance). Here, Nitrogen (N_0: Control, N_1:100Kg/ha, N_2:120kg/ha, N_3:140kg/ha); Potassium (k_0: Control, K_1:100kg/ha, K_2:120kg/ha)

Table 8: Combined effect of nitrogen and potassium fertilizer on leaf dry weight, knob dry weight, yield Per Plot and yield Per hectare on kohlrabi

Treatments	leaf dry weight (g)	knob dry weight (g)	yield per plot (kg/plot)	yield per hectare (t/ha)
N_0K_O	8.80 bc	5.59 e	1.88 c	11.93 c
N_0K_1	10.23 abc	6.05 cde	2.06 c	13.160 c
N_0K_2	7.00 c	5.93 de	1.90 c	12.11 c
N_1K_0	11.50 ab	6.23 bcd	2.00 c	12.75 c
N_1K_1	11.70 ab	6.50 bc	2.07 c	13.19 c
N_1K_2	11.20 ab	6.50 bc	2.33 b	14.82 b
N_2K_0	10.86 ab	6.70 ab	2.01 c	13.18 c
N_2K_1	11.23 ab	6.43 bcd	1.98 c	12.59 c
N_2K_2	11.20 ab	6.35 bcd	1.99 c	12.60 c
N_3K_0	11.03 ab	6.56 bc	1.94 c	12.44 c
N_3K_1	13.16 a	7.16 a	3.67 a	16.06 a
N_3K_2	12.30 ab	6.70 ab	2.01 ab	15.35 ab
SE	.36991	.07763	.03668	.23402
Significant level	0.05	0.00	0.00	0.00

(Means in the column followed by a different letter(s) differed significantly by DMRT at 5% level of significance). Here, Nitrogen (N0: Control, N1:100Kg/ha, N2:120kg/ha, N3:140kg/ha); Potassium (k0: Control, K1:100kg/ha, K2:120kg/ha)

CHAPTER: V

SUMMARY AND CONCLUSION

The investigation was conducted at the Horticultural farm of Sher-e-Bangla Agricultural University to study the growth and yield of kohlrabi as influenced by different fertilizers (Nitrogen and Potassium) application on November 2017 to January 2018. The experiment consisted of four levels of nitrogen viz., N_0: Control, N_1: 100 kg of nitrogen per ha, N_2:120 kg nitrogen per ha and N_3:140 kg nitrogen per ha and 3 levels of potassium fertilizer application viz; K_0: Control, K_1:100 Kg Potassium per ha, K_2:120 kg potassium per ha. The experiment was laid in Randomized Complete Block Design (RCBD) with three replications. There were altogether twelve treatment combinations in this experiment. After transplanting of seedlings, various intercultural operations were accomplished for better growth and development of the plant. Data on growth and yield parameters were collected and analyzed statistically.

The tallest plant of kohlrabi was recorded in the N_3 (26.22, 31.51 and 36.78cm at 20 DAT, 40 DAT and harvesting time, respectively) treatment and the shortest plant was found in the N_0 application (19.52, 25.10 and 28.58 cm at 20 DAT, 40 DAT and at harvesting time, respectively) treatment.In k_1 case of potassium fertilizer application the tallest plant of kohlrabi was recorded in the application (23.95, 30.50, 34.74cm at 20 DAT, 40 DAT and harvesting time, respectively) and the shortest plant was found in the K_0 application (22.34, 29.00 and 30.21 cm at 20 DAT, 40 DAT and at harvesting time, respectively). The combined effect of different amount of nitrogen and potassium fertilizers showed positively significant variations at all dates of observations. The tallest plant was found 26.80cm, 32.61cm and 35.75cm at 20 DAT, 40 DAT and at harvest respectively in N_3K_1 combination and the shortest plant height was recorded 21.60cm, 27.57cm,29.57cm at 20 DAT, 40 DAT and at maturity respectively through the controlled applications of N_0K_0 compared to other applications.

The maximum number of leaves per plant of kohlrabi was recorded in the N_3 (7.22, 8.0, 11.25 at 20 DAT, 40 and at harvesting time respectively) treatment and the minimum number of leaves per plant was found in the N_0 at 6.67, 8.11 and 9.67 at 20 DAT, 40 DAT and at maturity. With the application of potassium fertilizer the maximum number of leaves per plant of kohlrabi was recorded in the K_1 (7.25, 8.83, 11.00 at 20 DAT, 40 and harvest time respectively) treatment and the minimum number of leaves per plant was found in the N_0 at 6.25, 8.08 and 10.25 at 20 DAT, 40 DAT and at maturity. The combined effect of fertilizers and mulches showed positively significant variations at all sampling dates. At 20 DAT the maximum number of leaves per plant was found (8.0). At 40 DAT the maximum number of leaves per plant was found (10.667) in N_3K_1 treatment combination. At harvesting time the highest number of leaves was found (15.57) in N_3K_1 treatment combination and the minimum number of leaves per plant was recorded (5.66, 7.67, 9.67 at 20 DAT, 40 DAT and harvesting time respectively) in N_OK_O combination compared to other treatment combinations.

With the application of nitrogenous fertilizers, the highest diameter of leaf on kohlrabi (11.97 cm) was recorded in the N_3 treatment and the lowest diameter of the leaf (10.603 cm) was found in the N_0 treatment. Through the application of potassium fertilizer, the highest diameter of a leaf on kohlrabi (11.591 cm) was recorded in the k_1 treatment and the lowest diameter of the leaf (10.358 cm) was found in the K_0 treatment. The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. The maximum diameter of the leaf was found on the combination of N_3K_1 application (13.0 cm) and the minimum diameter of the leaf was at the control application of N_0K_0 (10.33) compared to other applications.

The highest individual knob weight without leaves of kohlrabi was recorded in the N_3 (153.54 g) treatment and the lowest individual knob weight without leaves was found in the N_0 (130.42 g) treatment. With the application of potassium fertilizer, the highest individual knob weight without leaves of kohlrabi was recorded in the K_1 (144.48 g) treatment and the lowest individual knob weight without leaves was found in the K_0

(130.42 g) treatment. The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations.The maximum diameter of the leaf was found on the combination of N_3K_1 application (168.66g) and the minimum diameter of the leaf was the at the control application of N_0K_0 (125.67g) compared to other application.

The highest individual knob weight without leaves of kohlrabi was recorded in the N_3 (70.53 g) treatment. The lowest individual knob weight without leaves was found in the N_0 (53.34 g) treatment. Through applying potassium fertilizer, individual knob weight without leaves showed positively significant variations. The highest individual knob weight without leaves of kohlrabi was recorded in the K_1 (61.97 g) treatment and the lowest individual knob weight without leaves was found in the K_0 (57.2 g) treatment. The combined effect of nitrogen and potassium fertilizers the maximum diameter of the leaf was found on the combination of N_3K_1 application (74.40g) and the minimum diameter of the leaf was found the at the control application of N_0K_0 (51.70g) compared to other application.

With the application of nitrogenous fertilizer, the highest individual knob length without leaves of kohlrabi was recorded in the N_3 (7.25 cm) treatment. The lowest individual knob length was found in the N_0 application (6.25cm). The highest individual knob length of kohlrabi was recorded in the K_1 (6.85 cm) and the lowest individual knob length was found in the K_0 (5.32 cm) treatment. The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations. The maximum knob length was found on the combination of N_3K_1 application (7.38 cm) and the minimum knob length was the at the control application of N_0K_0 (5.65 cm) compared to other applications.

The highest individual knob breadth of kohlrabi was recorded in the N_3 (5.91cm) treatment. The lowest individual knob breadth was found in the N_0 application (4.00cm). Through the application of potassium fertilizer, the highest individual knob breadth of kohlrabi was recorded in the K_1 (4.99 cm) treatment, the lowest individual knob breadth was found in the K_0 (4.01 cm) treatment. The combined effect of nitrogen and potassium fertilizers showed positively significant variation at all observations.The maximum knob breadth was found on the combination of N_3K_1 application (5.06 cm) and the minimum knob breadth was the at the control application of N_0K_0 (4.02 cm) compared to other applications.

Through the application of nitrogenous fertilizer, the highest root weight of kohlrabi was recorded in the N_3 (6.11 g) treatment and the lowest individual root weight was found in the N_0 application (4.61 g). The highest individual knob breadth of kohlrabi was recorded in the K_1 (5.82 g) treatment and the lowest root weight was found in the K0 (4.25 g) treatment. The maximum knob breadth was found on the combination of N_3K_1 application (6.867 g) and the minimum knob breadth was found at the control application of N_0K_0(4.33 g) compared to other applications.

The highest value of the dry weight of 100 g of leaves (12.16 g) was recorded in N_3 treatment while the lowest dry weight of 100 g of leaves (8.67 g) was found in N_0 treatment. This might be due to fertilizer helped to facilitate the dry matter production of kohlrabi.With the application of potassium fertilizer, the highest value of the dry weight of 100 g of leaves (11.58 g) was recorded in K_1 treatment while the lowest dry weight of 100 g of leaves (10.01 g) was found in K_0 treatment. The combined effect of nitrogen and potassium fertilizers had a significant effect on the dry weight of leaves on kohlrabi. The highest dry weight of (13.16 g) was recorded in N_3K_1 treatment combination and the lowest value of dry weight (8.80 g) was recorded in N_0K_0 treatment combination.

The highest value of the dry weight of 100 g of the knob (6.81 g) was recorded in N_3 treatment while the lowest dry weight of 100 g of the knob (5.85 g) was found in N_0 treatment. This might be due to fertilizer help to facilitate the dry matter production of kohlrabi. Through the application of potassium fertilizer, the highest value of the dry weight of 100 g of the knob was found at K_1 (6.53 g) treatment which was statistically similar to K_2 (6.37 g) treatment while the lowest dry weight of 100 g of knob (5.27 g) was found in K_0 treatment. The combined effect of nitrogen and potassium fertilizers the highest dry weight of (7.16 g) was recorded in N_3K_1 treatment combination and the lowest value of dry weight (5.59 g) was recorded in N_0K_0 treatment combination.

With the application of nitrogenous fertilizer, the highest value of yield per plot (2.89 kg) was recorded in N_3 treatment while the lowest yield per plot (1.94 kg) was found in N_0 treatment. And through potassium fertilizer, it was observed that the production of kohlrabi the highest value of yield per plot of K_1 (2.15 kg) while the lowest yield per plot was recorded (1.97 kg) in K_0 treatment. The combined effect of nitrogen and potassium fertilizers had a significant effect on the yield per plot of kohlrabi. The highest yield per plot (3.67 kg) was recorded in N_3K_1 treatment while the lowest value of yield per plot (1.88 kg) was recorded in N_0K_0 treatment combinations.

Yield per hectare of kohlrabi varied significantly variable for a different amount of fertilizer applications. With the application of nitrogenous fertilizer, the highest yield per hectare (14.62 ton/ha) was recorded from N_3, while the lowest (10.40 ton/ha) was recorded from N_0 treatment. Through applying potassium the highest value of yield per plot of K_1 (13.75 ton/ha) and the lowest yield per plot was recorded (11.58 ton/ha) in K_0 treatment. Yield per hectare of kohlrabi showed significant differences due to the combined effect of different amount of fertilizer applications. The highest yield per hectare (16.06 ton/ha) was recorded from N_3K_1 treatment and the lowest (11.93 ton/ha) was recorded from N_0K_0 treatment.

It was revealed that the above results showed that the combination of N_3K_1 was more suitable in consideration of yield contributing characters. By considering the results of the present experiment, further studies in the following areas are suggested below:

I. Studies of a similar nature could be carried out in different agro-ecological zones (AEZ) in different seasons of Bangladesh for the evaluation of zonal adaptability.

II. In this study, few levels of fertilizers were used, it is recommended to apply different types of fertilizer to get an accurate result.

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APPENDICES

Appendix I. Physical characteristics and chemical composition of soil of the experimental plot

Soil characteristics	Analytical results
Agrological Zone	Madhupur Tract
Ph	6.00-6.63
Organic mater	0.84
Total N (%)	0.46
Available phosphorus	21 ppm
Exchangeable K	0.41 meq / 100g soil

Source: Soil resource and development institute (SRDI), Dhaka

Appendix II. Monthly recorded the average air temperature, rainfall, relative humidity and sunshine of the experimental site during the period from October 2017 to March 2018.

Month	Air temperature		Relative humidity (%)	Total rainfall (mm)	Sunshine (hr)
October, 2017	31.6	23.8	78	172.3	5.2
November, 2017	29.6	19.2	77	34.4	5.7
December, 2017	26.4	14.1	69	12.8	5.5
January, 2018	25.4	12.7	68	7.7	5.6
February, 2018	28.1	15.5	68	28.9	5.5
March, 2018	32.5	20.4	64	65.8	5.2

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargaon, Dhaka – 1212.

Appendix III. Analysis of variance of plant height at 20 DAT

Source	DF	SS	MS	F value	P value
Nitrogen	3	66.03	22.01	5.11	0.00
Potassium	2	16.00	8.00	1.40	0.02
Nitrogen x Potassium	11	114.68	10.42	2.81	0.01

Appendix IV. Analysis of variance of plant height at 40 DAT

Source	DF	SS	MS	F value	P value
Nitrogen	3	41.68	13.89	3.66	0.02
Potassium	2	7.13	3.56	0.75	0.04
Nitrogen x Potassium	11	64.65	5.87	1.43	0.02

Appendix V. Analysis of variance of plant height at harvest

Source	DF	SS	MS	F value	P value
Nitrogen	3	65.84	21.94	8.00	0.00
Potassium	2	4.27	2.13	0.47	0.01
Nitrogen x Potassium	11	111.41	1.71	4.41	0.00

Appendix VI. Analysis of variance of number of leaves at 20 DAT

Source	DF	SS	MS	F value	P value
Nitrogen	3	5.11	1.70	2.35	0.09
Potassium	2	6.05	3.02	4.50	0.01
Nitrogen x Potassium	11	18.88	1.71	4.41	0.00

Appendix VII. Analysis of variance of number of leaves at 40 DAT

Source	DF	SS	MS	F value	P value
Nitrogen	3	4.55	1.51	1.49	0.02
Potassium	2	3.50	1.75	1.72	0.01
Nitrogen x Potassium	11	20.33	1.84	2.66	0.00

Appendix VIII. Analysis of variance of number of leaves at harvest

Source	DF	SS	MS	F value	P value
Nitrogen	3	12.75	4.25	5.18	0.00
Potassium	2	4.05	2.02	1.91	0.16
Nitrogen x Potassium	11	27.63	2.51	5.32	0.00

Appendix IX. Analysis of variance of diameter of Leaf

Source	DF	SS	MS	F value	P value
Nitrogen	3	9.55	3.18	4.83	0.00
Potassium	2	0.36	0.18	0.19	0.02
Nitrogen x Potassium	11	21.99	1.99	5.56	0.00

Appendix X. Analysis of variance of weight of Knob

Source	DF	SS	MS	F value	P value
Nitrogen	3	2824.73	941.57	6.34	0.00
Potassium	2	1174.27	587.13	3.02	0.05
Nitrogen x Potassium	11	6412.53	582.95	12.01	0.00

Appendix XI. Analysis of variance of weight of Leaf

Source	DF	SS	MS	F value	P value
Nitrogen	3	1416.25	472.08	10.36	0.00
Potassium	2	174.22	87.11	1.06	0.35
Nitrogen x Potassium	11	2495.67	226.87	14.39	0.00

Appendix XII. Analysis of variance of knob Length

Source	DF	SS	MS	F value	P value
Nitrogen	3	2.45	0.82	3.95	0.01
Potassium	2	1.75	0.87	3.94	0.02
Nitrogen x Potassium	11	6.04	0.55	4.32	0.00

Appendix XIII. Analysis of variance of knob Breadth

Source	DF	SS	MS	F value	P value
Nitrogen	3	0.88	0.29	1.57	0.21
Potassium	2	1.46	0.73	4.51	0.01
Nitrogen x Potassium	11	4.43	0.40	4.04	0.002

Appendix XIV. Analysis of variance of root weight

Source	DF	SS	MS	F value	P value
Nitrogen	3	11.44	3.81	5.27	0.00
Potassium	2	1.91	0.98	0.99	0.38
Nitrogen x Potassium	11	17.41	1.58	2.21	0.05

Appendix XV. Analysis of variance of leaf dry weight

Source	DF	SS	MS	F value	P value
Nitrogen	3	62.05	20.68	5.99	0.00
Potassium	2	9.70	4.85	0.98	0.03
Nitrogen x Potassium	11	85.33	7.75	2.13	0.05

Appendix XVI. Analysis of variance of knob dry weight

Source	DF	SS	MS	F value	P value
Nitrogen	3	4.23	1.41	13.46	0.00
Potassium	2	0.43	0.21	0.99	0.03
Nitrogen x Potassium	11	5.52	0.50	5.82	0.00

Appendix XVII. Analysis of variance of yield per plot

Source	DF	SS	MS	F value	P value
Nitrogen	3	0.61	0.20	6.07	0.002
Potassium	2	0.27	0.13	3.13	0.05
Nitrogen x Potassium	11	1.44	0.13	12.63	0.00

Appendix XVIII. Analysis of variance of yield (t/ha)

Source	DF	SS	MS	F value	P value
Nitrogen	3	25.90	8.63	6.41	0.00
Potassium	2	10.72	5.36	3.03	0.06
Nitrogen x Potassium	11	58.46	5.31	12.09	0.00

Plate 1: Growing of seedling in the seedbed

Plate 2: Planting of seedlings

Plate 3: Collection of data

Plate 4: Measuring the diameter of knob

Plate 5: Weight of leaves

Plate 6:Measurement of dry matter content