EFFECT OF PLANTING TIME AND GIBBERELLIC ACID ON THE GROWTH AND YIELD OF CABBAGE

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*This is to certify that the thesis entitled, "**EFFECT OF PLANTING TIME AND GIBBERELLIC ACID ON THE GROWTH AND YIELD OF CABBAGE**" submitted to the Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE**, embodies the result of a piece of bonafide research work carried out by **JANNAT ARA LINA** Registration No. **08-03137** under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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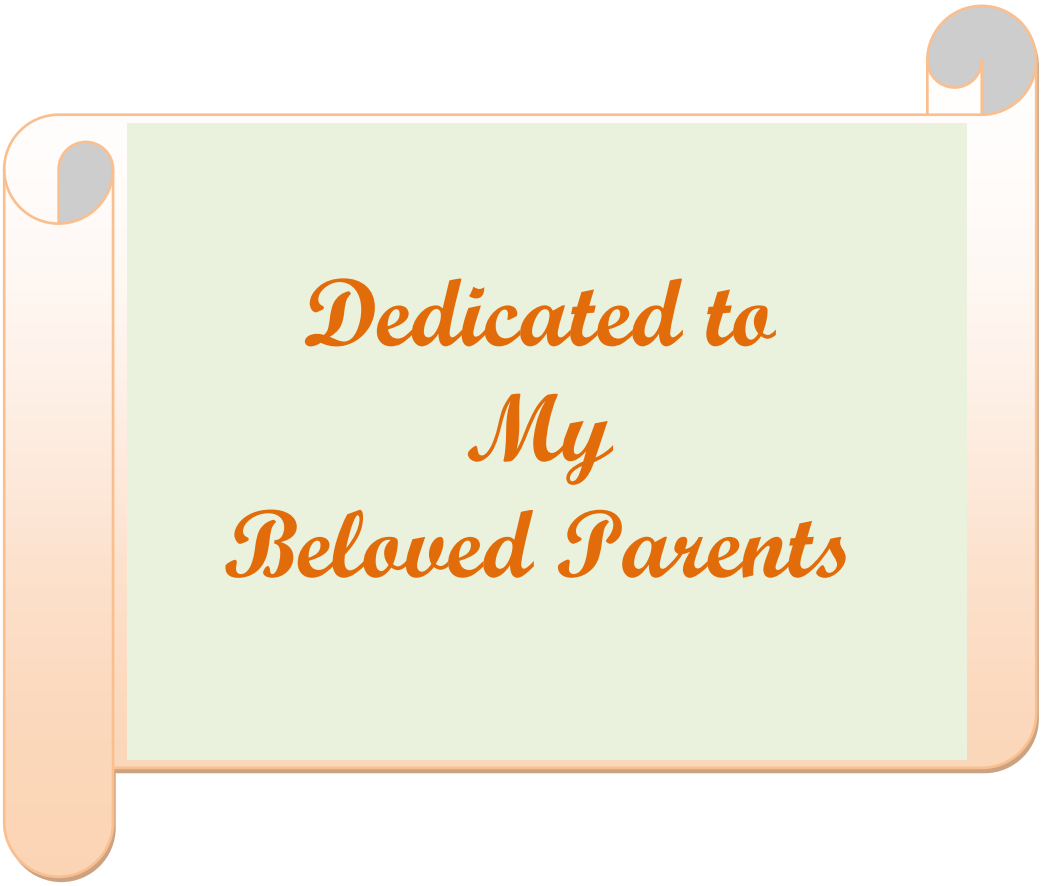
Dedicated to
My
Beloved Parents

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The Author

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BY

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ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October 2013 to March 2014. The experiment consisted of two factors: Factor A: Planting time (three levels) as - T_1= 05 Nov; T_2= 20 Nov and T_3= 05 Dec and Factor B: Gibberellic acid (four levels) as- G_0= 0 ppm (control); G_1= 75 ppm ; G_2= 95 ppm and G_3= 115 ppm GA_3, respectively. The two factors experiment was laid out in Randomized Complete Block Design with three replications. The variety of cabbage was Atlas-70. Due to different planting time, the maximum thickness of head (13.3 cm) and the highest marketable yield (49.1 t/ha) was obtained from T_2 and the minimum thickness of head (12.5 cm) and the lowest marketable yield (45.9 t/ha) was obtained from T_3. For GA_3, the maximum thickness of head (14.2 cm) and the highest marketable yield (54.7 t/ha) was found from G_2 and the minimum thickness of head (11.4 cm) and the lowest marketable yield (41.2 t/ha) was found from G_0. For combined effect, the maximum thickness of head (14.5 cm) and the highest marketable yield (59.4 t/ha) was found from T_2G_2 and the minimum thickness of head (10.8 cm) and the lowest marketable yield (37.1 t/ha) was found from T_3G_0. Economic analysis revealed that T_2G_2 gave the maximum benefit cost ratio (2.57). So, 20 Nov planting along with 95 ppm GA_3 was the best for growth and yield of cabbage.

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LIST OF ABBRIVIATIONS

@	at the rate of
ABA	Abscisic Acid
Adv.	Advanced
AEZ	Agro Ecological Zones
AHU	Accumulated Heat Unit
ANOVA	Analysis of variance
AVRDC	Asian Vegetable Research and Development Centre
BAU	Bangladesh Agricultural University
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
CV	Coefficient of variation
cv.	Cultivar
DAT	Days After Transplanting
DMRT	Duncan's Multiple Range Test
^{0}C	Degree Celsius
Environ.	Environmental
et al.	and others *(at elli)*
etc.	Etcetera
Expt.	Experiment
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agricultural Organization Corporate Statistical Database
FYM	Farm Yard Manure
g	Gram
GA_3	Gibberellic Acid
ha	Hectare (10000 meter square)
HRC	Horticulture Research Centre

ABBRIVIATIONS (Cont'd)

Int.	International
IAA	Indole Acetic Acid
LED	Land Equivalent Rati
LSD	Least Significant Difference
MoP	Murate of Potash
mg	Milligram
ml	Milliliter
mm	Millimeter
ns	Non-Significant
NAA	Naphthalene Acetic Acid
Nov	November
PGR	Plant Growth Regulator
pH	Hydrogen ion concentration
ppm	Parts Per Million
%	Percentage
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
SRDI	Soil Resource Development Institute
Tech.	Technology
TSP	Triple Super Phosphate
UNDP	United Nations Development Program
µg	Microgram

CHAPTER I

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the popular winter vegetables in Bangladesh belongs to the family Cruciferae. It is a short duration crop and grown for its compact head. This unique vegetable has been widely grown in both tropical and temperate regions of the world (Sarker *et al.*, 2002). It has been recognized as a very important vegetable to the farmers in providing income and nutrition worldwide (FAOSTAT, 2007).

Cole crops are biennials, but are generally grown as annuals. In 2010-2011, total vegetable (summer and winter season) production area was 645.04 thousand hectares of land with total production of 1.87 million tons (BBS, 2012). At present the annual production of cabbage is about 220 thousand metric tons (BBS, 2012). Among the five leading vegetables of Bangladesh, the cabbage occupied an area of 11.37 thousand hectares of land (BBS, 2012).

Cabbage is rich in vitamin C and tryptophan, an important amino acid for human (Rashid, 1993). FAO claimed that at least 5% total calories should have come from vegetables and fruits, which may fulfill the requirement of vitamins and minerals for human. It has been reported that 100 g of edible portion of cabbage contains 92% water, 24 calories of food energy, 1.5 g of protein, 9.8 g of carbohydrate, 40 mg of Ca, 0.6 mg of Fe, 600 IU of Carotene, 0.05 mg of thiamine, 0.05 mg of riboflavin, 0.3 mg of niacin and 60 mg of vitamin E (Rashid, 1993).

Cabbage can play a vital role in elevating the nutritional status of Bangladesh, as it is rich in vitamins and minerals such as ascorbic acid, contains appreciable quantities of thiamin, riboflavin, calcium and iron (Thompson and Kelly, 1985). However, low yield may be attributed to a number of reasons viz. unavailability of quality seeds of high yielding varieties, delayed sowing after the harvest of transplanted aman rice, fertilizer management, disease and insect infestation and improper or limited irrigation

facilities. Among different factors plant growth regulators and time of plantation can play an important role for increasing the production of cabbage in Bangladesh (Yadav *et al*., 2000).

Planting time plays an important role for yield of crop. For optimum growth and head formation cabbage needs cool temperature. Early planting produced the largest head and maximum yield in compared to late planting. The aspect of crop growth need to be understood and considered when planting, because the time from transplanting to maturity is primarily affected by the time from transplanting to curd initiation (Wur *et al*. 1986). Kryuchkov and Suddenko (1991) reported that late sowing reduced the head development. Hasan *et al*. (2003) revealed that in Jessore area cabbage cultivation is more profitable in pre-rabi period and least profitable in the late-rabi period.

Plant growth regulators (PGR's) are organic compounds, which in small amounts, somehow modify a given physiological plant process. It plays an essential role in many aspects of plant growth and development (Dharmender *et al*., 1996). These compounds has now been applied to a large variety of plant organs in several ways and it has been found to greatly enhance stem elongation as its most striking effect. This was observed in many plants after treatment with minute amount of gibberellic acid (GA_3). Cabbage was found to show a quick growth when treated with plant growth regulators (Islam *et al*., 1993). Application of GA_3 stimulates morphological characters like plant height, number of leaves, head diameter, thickness of head as well as the weight of the head. The concentrations of these chemicals interacting with the environmental conditions play an important role in modifying the growth and yield components of cabbage.

It is necessary to find out the effective dose of GA_3 in promoting growth and yield components of cabbage even in higher temperature that prevails in the later part of the growing season under Bangladesh condition. Nowadays plant growth regulators have been tried to improve growth and ultimately yield. Patil *et al*. (1987) tried various

growth regulators to obtain better yield of good quality heads in cabbage and obtained encouraging results. Among the growth regulators, auxin causes enlargement of plant cell and gibberellins stimulate cell division, cell enlargement or both (Nickell, 1982). Due to the diversified use of productive land, it is necessary to increase the food production, and gibberellic acid (GA_3) may be a contributor in achieving the desired goal. The production of cabbage can be increased by using GA_3. Cabbage was found to show a quick growth when treated with plant growth regulators (Islam *et al*., 1993). Application of GA_3 stimulates morpho-physiological, and yield and yield contributing characters of cabbage.

Considering the above factors, the present study was undertaken to find out the effect of different planting time and concentrations of GA_3 for better vegetative growth, maximum yield and economic return of cabbage. In view of the above facts, the present research work will undertaken with the following objectives-

1. To find out the suitable time of planting for the maximum growth and yield of cabbage;
2. To find out the appropriate concentration of GA_3 for increasing cabbage production; and
3. To find out the suitable combination of GA_3 and planting time for the better vegetative growth, maximum yield and economic return of cabbage.

CHAPTER II

REVIEW OF LITERATURE

As winter crop (rabi season), cabbage is very familiar in our country. Vegetable production in Bangladesh is far below of actual requirements, so the demand of vegetable is increasing day by day in our country and horizontal expansion of vegetable yield unit^{-1} area should be increased to meet this ever-increasing demand of vegetable but it will require adoption of new technology such as high management package, high yielding cultivar, higher input use etc. Management practices have considerable effects on the growth and development of any crop particularly vegetable crops. Among these, growth regulator is a modern concept as a management practices and also date of planting is a most important practice and both are also important factors. Numerous studies have been performed evaluating the influence of GA_3 as growth regulators and time of plantation on the performance of cabbage. Among the above factors some of the recent past information on GA_3 and date of planting on cabbage have been reviewed under the following headings:

2.1 Effect of planting time on the growth and yield of cabbage

Planting time had significant effect on growth and yield of cabbage. Kryuchkov and Suddenko (1991) reported that late sowing reduced the head development. Hasan *et al*. (2003) revealed that cabbage cultivation is more profitable in pre-rabi period and least profitable (actually negative profitable) in the late-rabi period.

An experiment was conducted by Khan *et al*. (2015) to determine the proper sowing time, fertilizer requirement and appropriate spacing for cabbage cultivar viz. Golden Acre. Results revealed that sowing dates, plant spacing and NPK application significantly influenced various growth characteristics of cabbage. Number of leaves increased with delayed planting while head diameter and also head yield decreased. Application of fertilizer increased the number of leaves per plant, diameter and weight of cabbage head. Close spacing was best for higher cabbage yield.

An experiment was conducted by Aboul and Ragab (2000) 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.

An experiment was conducted by Singh *et al.* (2015) assess the different date of planting viz; September 15 (D_1), September 30 (D_2) and October 15 (D_3) and different sources of organic and inorganic fertilizers. The result revealed that the growth parameters and yield attributing traits of tomato were significantly influenced by different planting dates and sources of nutrients. Planting on September 15 (D_1) recorded the highest plant height (254.95 cm), number of leaves per plant (33.47), fruits per plant (80.39), fruit length (6.75 cm), fruit girth (5.53 cm), mean fruit weight (124.26 g), yield per plant (10.39 kg), yield per plot (42.44 kg) and TSS (5.55 ºB) content over later date of planting. The plants treated with 50% RDF +10 t/ha FYM + 5 t/ha poultry manure + biofertilizer showed maximum number of leaves per plant (36.88), fruits per plant (74.69), fruit length (6.85 cm), mean fruit weight (134.33 g), yield per plant (10.77 kg), yield per plot (38.90 kg) and ascorbic acid content (40.02 mg/100g) over treatment having 100% RDF alone. Among interaction the plants planted on 15th September along with 50% RDF + 10 t/ha FYM + 5 t/ha Poultry manure + biofertilizer resulted better yield and quality traits.

A field experiment was conducted by Darnata *et al*. (2000) 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.

An experiment was conducted by Sari *et al*. (2000) 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.

An experiment was conducted by Hossain *et al.* (2013) to observe the effect of sowing dates on yield of tomato genotypes. Three sowing dates, viz. October 1, October 15 and October 30 were considered as factor A and tomato variety, viz. BARI Tomato-2, BARI Tomato-3, BARI Tomato-4, BARI Tomato-9 and BARI Hybrid Tomato-4 considered as factor B. The experiment was laid out in RCBD (Factorial) with three replications. Early flowering (52.40 days) as well as early fruit harvesting (119.13 days) was occurred in October 1 sowing, where as sowing on October 30 resulted in delayed flowering (71.73 days) and fruit harvesting (140.67 days), respectively. Number of fruits per plant was also the highest (27.40) in October 1 sowing and the lowest (13.73) was in October 30 sowing. Seed sowing of October 1 was found better in respect of yield (74.75 t/ha) compared to October 15 (58.55 t/ha) and October 30 (24.60 t/ha) sowing. Among the variety, BARI Tomat-2 produced the highest (68.12 t/ha) marketable yield followed by BARI Tomato-9 (56.16 t/ha) and BARI Tomato-3 while BARI Tomato-4 gave the lowest (36.91 t/ha) marketable yield.

A field experiment was conducted by Sari *et al*. (2000) 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; SG_1 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.

An experiment was conducted by Yoldas and Esiyok (2004) 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.

An experiment was carried out by Ahmed and Wajid (2004) 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.

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.

An experiment was conducted by Ahammad *et al*. (2009) to observe the effect of planting date and variety on the yield of late planting tomato. The potentiality of fruiting in the late season were evaluated for BARI tomato 4, 5, 6 and 12 by planting December 01, December 16, January 01, January 16 and February 01. A combination of December 01 planting with BARI Tomato 5 variety performed better in respect of yield (57.07 t/ha). The variety BARI Tomato 5 also showed potential fruiting capability during late winter season and February 01 planting produced 11 ton/ha of potential yield. All the four varieties showed potential fruiting capability during late winter season and February 01 planting produced 4-6 tons of potential yield during late season.

A field experiment was conducted by Narendra *et al*. (2007) 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 Almora, 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.

A field experiment was carried out by El-Yazied *et al*. (2007) 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 Kaliobia 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.

An experiment was conducted by Firoz *et al.* (2009) to find out the effect of sowing time (10, 20, 30 November and l0, 20, and 30 December) and spacing (50 × 30 cm and 50 x 45 cm) on lettuce seed production. Maximum lettuce seed yield (770 kg/ha) was found from 10 November sowing with 50 × 45 cm spacing followed by same sowing time with 50 × 30 cm and 20 November with both spacings. There was a trend to decrease seed yield with the advance of sowing time irrespective of spacing. Germination (%) and other quality also showed satisfactory result in the same treatment.

An experiment was conducted by Khatun *et al*. (2012) 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.

2.2 Effect of GA_3 on the growth and yield of cabbage

Growth regulators are organic compounds other than nutrients; small amounts of which are capable of modifying growth (Leopold, 1963). Among the growth regulators, auxin causes enlargement of plant cell and gibberellins stimulates cell division, cell enlargement or both (Nickell, 1982). Gibberellic acid (GA_3) and Naphthalene acetic acid (NAA) exhibited beneficial effect in several crops (Thapa *et*

al., 2013). Due to diversified use of productive land, it is necessary to increase the food production and growth regulators may a contributor in achieving the desired goal.

An experiment conducted by Chaurasiy *et al*. (2014) to study the response of cabbage cv. Pride of India to foliar application of PGRs namely GA_3 and NAA with different concentrations. The experiment was laid out in Randomized block design with three replications and seven treatments, the treatments comprised of three levels of each PGRs namely GA_3 (30, 60, 90 ppm) and NAA (40, 80, 120 ppm) along with control. Foliar spray of GA_3 and NAA was given at 30 and 45 DAT of cabbage. Looking to the results, it was noticed that GA_3 60 ppm significantly increased the plant height (33.26 cm), number of leaves (21.48), plant spread (55.59 cm), stem diameter (3.05 cm), plant weight (2.44 kg), head weight (1.73 kg), head diameter (18.88 cm) as well as head yield (51.26 t/ha) than the other treatments and control. Therefore it may be concluded that foliar application GA_3 60 ppm or NAA 80 ppm can be recommended to cabbage growers for obtaining better growth and yield of cabbage.

Roy and Nasiruddin (2011) was conducted the research work to study the effect of GA_3 on growth and yield of cabbage. Single factor experiment consisted of four concentrations of GA_3, viz. 0, 25, 50 and 75 ppm. Significantly the minimum number of days to head formation (43.54 days) and maturity (69.95 days) was recorded with 50 ppm GA_3 and 50 ppm GA_3 gave the highest diameter (23.81 cm) of cabbage head while the lowest diameter (17.89 cm) of cabbage head was found in control condition (0 ppm GA_3) treatment. The application of different concentrations of GA_3 as influenced independently on the growth and yield of cabbage. Significantly the highest yield (104.66 t/ha) was found from 50 ppm GA_3.

Studies on influence of GA, NAA and CCC at three different concentrations on different growth parameters of cabbage (cv. PRIDE OF INDIA) were studied by Lendve *et al*. (2010) and found that application of GA 50 ppm was found significantly superior over most of the treatments in terms of number of the leaves, plant spread,

and circumference of stem, left area, fresh and dry weight of the plant, shape index of head, length of root, fresh and dry weight of root. Except treatment GA 75 ppm, which gave better results for days required for head initiation and head maturity.

An experiment was conducted by Yu *et al*. (2010) with '8398' cabbage (*Brassica oleracea var. captata* L.) plants with 7 true leaves and 'Jingfeng No. 1' cabbage plants with 9 true leaves were vernalized in incubator. Then, '8398' cabbage plants vernalized for 18 days and 'Jingfeng No. 1' cabbage plants vernalized for 21 days were treated by high temperature of 370C for 12 hours to explore the changes of endogenous hormone during devernalization in cabbage. The results showed that: GA_3 content had less changes, IAA content rose and ABA content decreased during devernalization. Compared with CK (vernalization period), GA_3 and ABA content decreased significantly, whereas IAA content rose significantly when devernalization ended. Lower GA_3 and ABA content, and higher IAA content can benefit the accomplishment of devernalization.

A study was conducted by Roy *et al*. (2010) at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh to study the effect of starter solution and GA_3 on growth and yield of cabbage. The two factor experiment consisted of four levels of starter solution, viz. 0, 1.0, 1.5 and 2.0% of urea, and four concentrations of GA_3, viz. 0, 25, 50 and 75ppm. The application of starter solution and different concentrations of GA_3 influenced independently and also in combination on the growth and yield of cabbage. The highest yield (104.93 t/ha) was obtained from 1.5% starter solution which was significantly different from other solutions, and the lowest yield (66.86 t/ha) was recorded from the control. Significantly the highest yield (104.66 t/ha) was found from the treatment of 50 ppm GA_3, while the lowest yield (66.56 t/ha) was recorded from control. In case of combined effect, the highest yield of cabbage (121.33 t/ha) was obtained from the treatment combination of 1.5% starter solution + 50 ppm GA_3 followed by 1.5% starter solution + 75 ppm GA_3 (115.22 t/ha), while the lowest yield (57.11 t/ha) was produced by the control treatment. Economic analysis

revealed that 1.5% starter solution + 50 ppm GA_3 treatment was the best treatment combination in respect of net return (Tk. 173775/ha) with a benefit cost ratio of 3.52.

Chauhan and Tandel (2009) conducted an experiment in the Agronomy field of N.M. College of Agriculture, Navsari Agricultural University, Navsari during the Rabi season and they showed that spray of GA_3 and NAA significantly influenced the performance of growth, yield and quality characters of cabbage. The best plant growth regulator treatments for growth, yield and quality characters of cabbage was GA_3 100 mg l-1 foliar spray at 30 and 45 days after transplanting (DAT) followed by NAA 100 mg l-1 foliar spray at 30 and 45 DAT.

The effect of GA_3 and/or NAA (both at 25, 50, 75 or 100 ppm) on the yield and yield parameters of cabbage (cv. Pride of India) was investigated by Dhengle and Bhosale (2008) in the field at Department of Horticulture, college of Agriculture, Parbhani. The highest yield was obtained with GA_3 at 50 ppm followed by NAA at 50 ppm (332.01 and 331.06 q/ha, respectively) Combinations and higher concentrations of plant growth regulators proved less effective.

Yadav *et al*. (2000) was conducted an experiment in Rajasthan, India, during the rabi season of 1996-97 to investigate the effects of NAA at 50, 100 and 150 ppm, gibberellic acid at 50, 100 and 150 ppm and succinic acid at 250, 500 and 750 ppm, applied at 2 spraying levels (1 or 2 sprays at 30 and 60 days after transplanting), on growth and yield of cabbage cv. Golden Acre. The maximum plant height (28.4 cm) and plant spread (0.187 m_2) resulted from 2 sprays with gibberellic acid at 150 ppm. The highest number of open leaves (23.6) and yield (494.78 q/ha) was obtained in the treatment with 2 sprays of gibberellic acid at 100 ppm. Leaf area was highest in 2 sprays of 500 ppm succinic acid.

An experiment was conducted by Dharmender *et al*. (1996) to find out the effect of GA_3 or NAA (both at 25, 50 or 75 ppm) on the yield of cabbage (cv. Pride of India) in the field at Jobner, Rajstan, India. They recorded the highest yield following treatment

with GA_3 at 50 ppm followed by NAA at 50 ppm (557.54 and 528.66 q/ha, respectively). They also reported that combination and higher concentrations of plant growth regulators proved less effective and were uneconomic in comparison to control.

The effective concentration of NAA and GA_3 was determined by Islam *et al*. (1993), for promoting growth yield and ascorbic acid content of cabbage. They used 12.5, 25, 50 and 100 ppm of both the NAA and GA_3. They found that ascorbic acid content increased up to 50 ppm when sprayed twice with both the growth regulator, while its content was declined afterwards. They also added that two sprays with 50 ppm GA_3 was suitable both for higher yield and ascorbic acid content of cabbage.

An experiment was conducted by Patil *et al*. (1987) in a field trial with the cultivar Pride applied GA_3 and NAA each at 25, 50, 75 and 100 ppm one month after transplanting. The maximum plant height and head diameter and head weight were noticed with GA_3 at 50 ppm. Significant increase in number of outer and inner leaves was noticed with both GA_3. Head formation and head maturity was 13 and 12 days earlier with 50 ppm GA_3. Maximum number of leaves and maximum yield (63.83 t/ha) were obtained with 50 ppm GA_3.

An experiment was conducted by Islam (1985) at the Bangladesh Agricultural University Farm, Mymensingh with applying various growth regulators (CCC, GA_3, NAA and IBA) at 30 days after transplanting of 32 day old seedlings and found that GA_3 increased the plant height, number of loose leaves per plant, size of leaf and finally the yield.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from October 2013 to March 2014 to find out the growth and yield of cabbage as influenced by planting time and gibberellic acid. The materials and methods that were used for conducting the experiment have been presented in this chapter. It includes a short description of the location of experimental site, soil and climatic condition of the experimental plot, materials used for the experiment, design of the experiment, data collection procedure and procedure of data analysis.

3.1 Location of the experimental site

The experiment was conducted at the Horticulture Research Farm of Sher-e-Bangla Agricultural University (SAU). It is located in $23^0 74^/N$ latitude and $90^0 35^/E$ longitudes. The altitude of the location is 8 m from the sea level as per the data of Bangladesh Metrological Department, Agargaon, Dhaka-1207. Appendix 1 showed the map showing the experimental site under study.

3.2 Characteristics of soil

The experimental site belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28 and the selected plot of the land was medium high in nature with adequate irrigation facilities and remained fallow during the previous season. The soil texture of the experimental was sandy loam. The nutrient status of the farm soil under the experimental plot with in a depth 0-20 cm were collected and analyzed in the Soil Resources and Development Institute Dhaka, and result have been presented in Appendix III.

3.3 Climatic condition of the experimental site

Experimental area is situated in the sub-tropical climate zone, which is characterized by heavy rainfall during the months of April to September and scanty rainfall during the rest period of the year. Details of the meteorological data during the period of the experiment was collected from the Bangladesh Meteorological Department, Agargoan, Dhaka and presented in Appendix II.

3.4 Planting materials

The test crop used in the experiment was cabbage variety "Atlas-70".

3.5 Treatment of the experiment

The experiment consisted of two factors:

3.5.1 Factor A:

Planting time (three levels of planting time)

1) T_1 : 5 November
2) T_2 : 20 November
3) T_3 : 5 December

3.5.2 Factor B:

Gibberellic acid-GA_3 (four levels)

1) G_0 : 0 ppm GA_3 (control)
2) G_1 : 75 ppm GA_3
3) G_2 : 95 ppm GA_3
4) G_3 : 115 ppm GA_3

There were 12 (3×4) treatments combination such as T_1G_0, T_1G_1, T_1G_2, T_1G_3, T_2G_0, T_2G_1, T_2G_2, T_2G_3, T_3G_0, T_3G_1, T_3G_2 and T_3G_3.

3.6 Collection of seedlings

The seeds of cabbage variety Atlas-70 were collected from Bangladesh Agricultural Research Institute (BARI), joydebpur, Gazipur.

3.7 Design and layout of the experiment

The two factorial experiments were laid out in the Randomized Complete Block Design (RCBD) with three replications. 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 1.8 m × 1.6 m and spacing was 60 cm × 40 cm. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m, respectively. The layout of the experiment is shown in Figure 1.

3.8 Preparation of the main field

The selected plot of the experiment was opened 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. The experimental plot was partitioned into the unit plots in accordance to the experimental design.

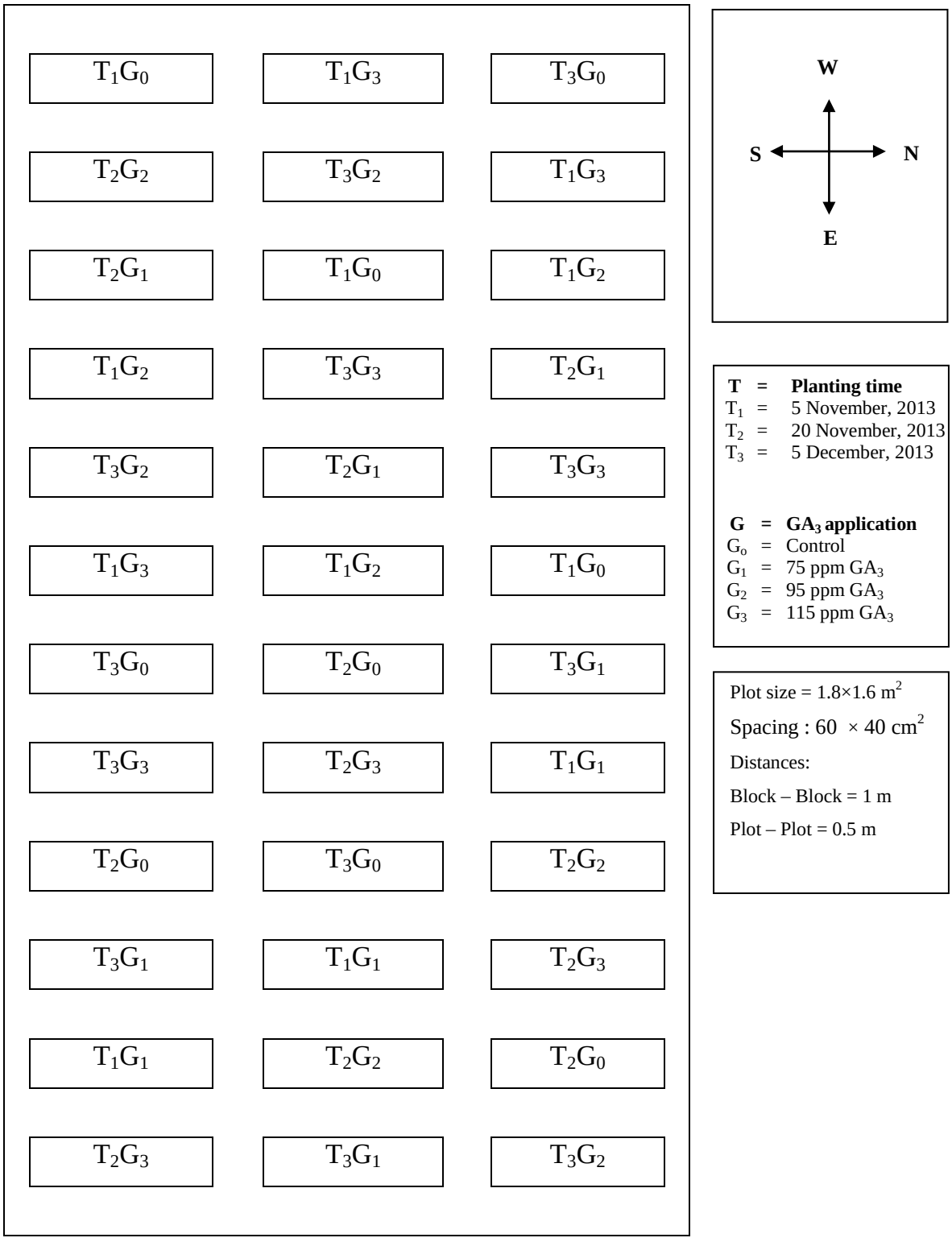


Fig. 1. Layout of experiment field

3.9 Application of manures and fertilizers

Manures and fertilizers were applied to the experimental plot considering the recommended fertilizer doses of BARI (2005).

Cowdung	=	10 t ha^{-1}
Urea	=	300 kg ha^{-1}
TSP	=	250 kg ha^{-1}
MOP	=	200 kg ha^{-1}

The total amount of cowdung, TSP and MOP was applied as basal dose at the time of land preparation. The total amount of urea was applied in three installments at 10, 30 and 50 days after transplanting.

3.10 Preparation and application of growth regulator

A 1000 ppm stock solution of GA_3 was prepared by dissolving 1 g of it in a small quantity of ethanol prior to dilution with distilled water in one liter of volumetric flask. The stock solution was used to prepare the required concentration for different treatment i.e. 75 ml of this stock solution was diluted in 1 litre of distilled water to get 75 ppm GA_3 solution. In a similar way, 95 ppm stock solutions were diluted to 1 litre of distilled water to get 95 ppm solution and 115 ppm stock solutions were diluted to 1 litre of distilled water to get 115 ppm solution. Control solution also prepared only by adding a small quantity of ethanol with distilled water. GA_3 as per treatment were applied at three times 30, 45 and 60 DAT by a mini hand sprayer.

3.11 Raising of seedlings

The seedlings were raised at the Horticultural Farm, SAU, Dhaka under special care in a 3 m × 1 m size seed bed. The soil of the seed bed was well ploughed with a spade and prepared into loose friable dried masses and to obtain good tilth to provide a favorable condition for the vigorous growth of young seedlings. Weeds, stubbles and

dead roots of the previous crop were removed. The seedbed was dried in the sun to destroy the soil insect and protect the young seedlings from the attack of damping off disease. To control damping off disease cupravit fungicide were applied.

Decomposed cowdung was applied to the prepared seedbed at the rate of 5 t/ha. Ten (10) grams of seeds were sown in seedbed. Three seed beds were prepared for to maintain three planting time. The 1st, 2nd and 3rd seed sowing on seed bed were done on 5 October , 20 October and 5 November respectively. After sowing, the seeds were covered with finished light soil. At the end of germination shading was done by bamboo mat (chatai) over the seedbed to protect the young seedlings from scorching sunshine and heavy rainfall. Light watering, weeding was done as and when necessary to provide seedlings with ideal condition for growth.

3.12 Transplanting

Healthy and uniform 30 days old seedlings were transplanted in the experimental plots. The 1st, 2nd and 3rd transplanting in the main field were done on 5 November, 20 November and 5 December, respectively. The seedlings were uploaded 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 one 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 was 60 cm and plant to plant was 40 cm. The young transplanted seedlings were shaded by banana leaf sheath during day 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 of the experimental plots for gap filling.

3.13 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 cabbage seedlings.

3.13.1 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. 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.

3.13.2 Weeding

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

3.13.3 Earthing up

Earthing up was done at 20 and 60 DAT on both sides of rows by taking the soil from the space between the rows by a small spade.

3.13.4 Irrigation

Light watering was given by a watering can at every morning and afternoon after transplanting. Following transplanting and it was continued for a week for rapid and well establishment of the transplanted seedlings. Beside this a routine irrigation was given at 3 days intervals.

3.13.5 Pest and disease control

Pest and disease control is important factor during the period of establishment of seeding in the field. 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%. Some plants were infected by Alternaria leaf spot diseases caused by Alternaria brassicae. To prevent the spread of the disease Rovral @ 2 g per liter of water was sprayed in the field. The diseased leaves were also collected from the infested plant and removed from the field. Birds pest such as nightingales (common Bulbuli) were seen visiting the cabbage field very frequently. The nightingale visited the fields in the morning and afternoon. The birds found to puncture the newly initiated head and were controlled by striking a kerosene tin of metallic container frequently during day time.

3.14 Harvesting

Harvesting of the cabbage was not possible on a certain or particular date because the head initiation as well as head maturation period in plants were not similar. Only the compact marketable heads were harvested with fleshy stalk by using sharp knife. Before harvesting of the cabbage head, compactness of the head was tested by pressing with thumbs.

3.15 Data collection

Five plants were randomly selected from each unit plot for avoiding border effect, except yields of heads, 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, 30, 45 and 60 days after transplanting (DAT) and at harvest. All other yield contributing characters and yield parameters were recorded during harvest and after harvest.

3.15.1 Plant height

Plant height was measured from sample plants by using meter scale 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 30 days after transplanting (DAT) upto 60 days and at harvest to observe the growth rate of plants.

3.15.2 Number of loose leaves per plant

The number of loose leaves per plant was counted and mean of five plants was recorded at 30, 45, 60 days after transplanting (DAT). At the time of counting of number of loose leaves dead leaves were excluded.

3.15.3 Spread of plant

The spread of plant was counted from each selected plant. Data were recorded as the average of 5 plants selected at random from each plot at 15 days interval starting from 30 days after transplanting (DAT) upto 60 days and at harvest.

3.15.4 Days from transplanting to head formation

Each plant of the experiment plot was kept under close observation to count days to 1st head formation. Total number of days from the date of transplanting to the 1^{st} head formation was recorded.

3.15.5 Fresh weight of stem plant^{-1}

The fresh weight of stem was recorded from the average of five (5) randomly selected plants in grams (gm) with a beam balance during harvest after detached from head of cabbage and roots.

3.15.6 Dry weight of stem

At first stem of selected plant was collected and was dried under sunshine for a 3 days and then dried in an oven at 70^0C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken in gram (g).

3.15.7 Thickness of head

The thickness of head was measured in centimeter (cm) with a meter scale as the vertical distance from the lower to the upper most leaves of the head after sectioning the head vertically at the middle position and mean value was calculated.

3.15.8 Diameter of head

The heads from sample plants were sectioned vertically at the middle position with a sharp knife. The diameter of the head was measured in centimeter (cm) with a meter scale as the horizontal distance from one side to another side of the widest part of the sectioned head and mean value was recorded.

3.15.9 Dry matter content of head (%)

At first 100 gm of head from selected plant was collected, cut into pieces and was dried under sunshine for a few days and then dried in an oven at 70^0C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken. The dry matter contents of head were computed by simple calculation from the weight recorded by the following formula:

$$\text{Dry matter content of head (\%)} = \frac{\text{Dry weight of head}}{\text{Fresh weight of head}} \times 100$$

3.15.10 Gross weight of head plant^{-1}

The heads from sample plants were harvested, cleaned and weighted with folding and unfolded leaves. The gross weight of each head were measured a weighing scale and mean values was counted in gram (g).

3.15.11 Gross yield plot^{-1})

Gross yield per plot was recorded by multiplying average gross weight of head per plant with total number of plant within a plot and was expressed in kilogram.

3.15.12 Gross yield ha^{-1}

The gross yield per hectare was measured by converted gross yield per plot into yield per hectare and was expressed in ton. Yield included with folded and unfolded leaves of cabbage.

3.15.13 Marketable yield plant^{-1}

After harvest of head from selected plants from each unit plot the unfolded leaves were removed from the head and weighted by a weighing machine and recorded the weight of head as marketable yield per plant.

3.15.14 Marketable yield plot^{-1}

Marketable yield per plot was recorded by multiplying average marketable yield weight of head per plant with total number of plant within a plot and was expressed in kilogram. Marketable yield included only the yield of marketable head.

3.15.15 Marketable yield ha^{-1}

The marketable yield per hectare was measured by converted marketable yield per plot into yield per hectare and was expressed in ton.

3.16 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference for different level of planting time and GA_3 application on growth and yield contributing characters of cabbage. 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) and mean separation was done by LSD at 5% level of significance. (Gomez and Gomez, 1984).

3.17 Economic analysis

The cost of production was analyzed in order to find out the most economic combination different level of planting time and GA_3 application. 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 cabbage 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

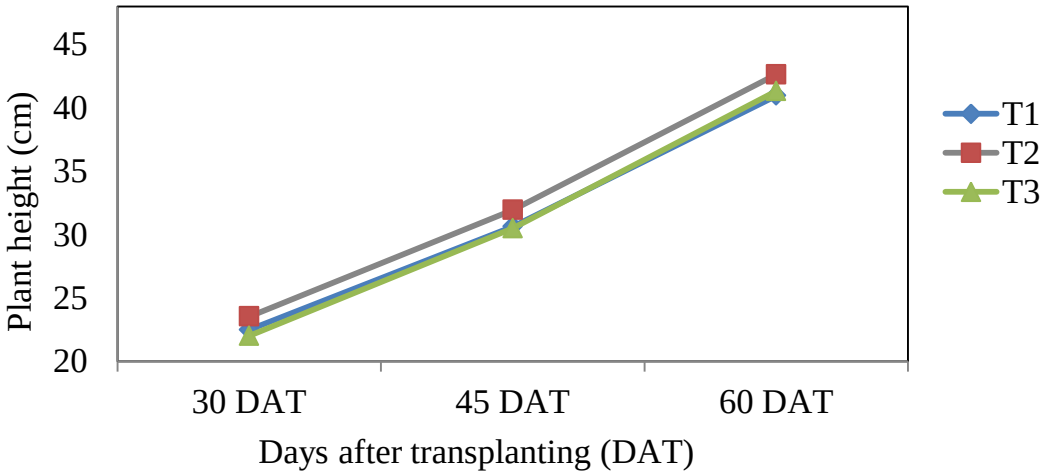
The experiment was conducted to find out the growth and yield of cabbage as influenced by planting time and GA_3. The analysis of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendices IV-XI. The results have been presented and discusses with the help of table and graphs and possible interpretations given under the following sub-headings:

4.1 Plant height

Different levels of planting time showed significant variation on plant height of cabbage at 30, 45, 60 DAT and at harvest (Appendix IV). The tallest plant (23.5, 31.9, 42.6 and 45.6 cm at 30, 45, 60 DAT and at harvest, respectively) was recorded from T_2 (20 November) whereas the shortest plant (22.0 cm) was found in T_3 (5 December) at 30 DAT but at 45, 60 DAT and at harvest, the shortest plant (30.6, 40.9 and 44.2 cm, respectively) was recorded from T_1 (5 November). The result obtained from T_3 (5 December) gave intermediate result considering highest and lowest plant height (Fig. 2). Sowing dates significantly influenced various growth characteristics of cabbage observed by Khan *et al*. (2015). Singh *et al.* (2015) recorded the highest plant height with early date of planting. Emam (2005) also observed that early planting increased plant height of broccoli.

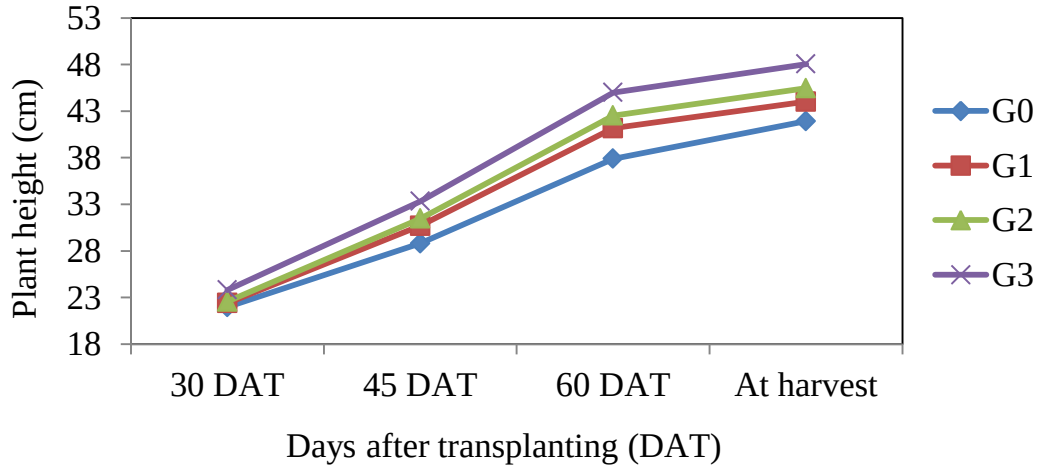
Significant variation was found on plant height of cabbage due to different concentrations of gibberellic acid at 30, 45, 60 DAT and at harvest (Appendix IV). At 30, 45, 60 DAT and at harvest, the tallest plant (23.8, 33.3, 45.0 and 48.0 cm, respectively) was recorded from G_3 (115 ppm GA_3) which was statistically different from all other treatments. The shortest plant (21.9, 28.8, 37.8 and 41.9 cm at 30, 45, 60 DAT and at harvest, respectively) was obtained from G_0 (control) (Fig. 3). The result obtained from G_1 (75 ppm GA_3) and G_2 gave intermediate result considering highest and lowest plant height. Islam (1985) reported that

application of GA_3 increased the plant height of cabbage. Patil *et al*. (1987) also noticed the maximum plant height with GA_3 at 50 ppm. Similar results were also found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the plant height (33.26 cm) than control.



T_1= 5 November; T_2= 20 November; T_3= 5 December

Fig. 2. Effect of planting time on plant height of cabbage.



G_0 = Control, G_1 = 75ppm GA_3 , G_2 = 95ppm GA_3 , G_3 = 115ppm GA_3

Fig. 3. Effect of gibberellic acid (GA_3) on plant height of cabbage.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences on plant height of cabbage at 30, 45, 60 DAT and at harvest (Appendix IV and Table 1). The tallest plant (23.97, 34.15, 46.59 and 49.86 cm at 30, 45, 60 DAT and at harvest, respectively) was obtained from T_2G_3 followed by T_1G_3, T_2G_2 and T_3G_3. The shortest plant (20.57 cm) was recorded from T_3G_0 at 30 DAT but at 45, 60 DAT and at harvest, the shortest plant (27.70, 35.63 and 41.90 cm respectively) was found in T_1G_0 followed by T_1G_1, T_2G_0, T_3G_0 and T_3G_1.

Table 1.Combined effect of planting time and gibberellic acid (GA_3) on plant height of cabbage.

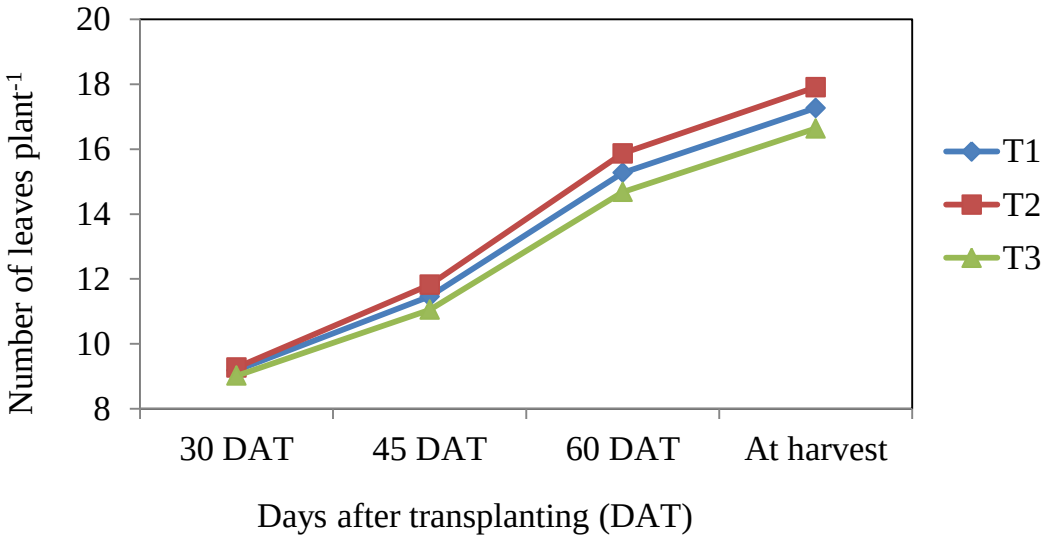
Treatment	Plant height (cm)			
	30 DAT	45 DAT	60 DAT	At harvest
T_1G_0	21.97 e	27.70 f	35.63 h	41.59 h
T_1G_1	22.71 cd	30.75 e	40.97 f	43.83 g
T_1G_2	21.51 ef	30.94 d	42.57 de	45.53 de
T_1G_3	23.84 a	33.20 ab	44.66 b	47.58 b
T_2G_0	23.41 ab	30.25 c	39.33 g	42.28 h
T_2G_1	23.17 bc	31.31 cd	41.63 ef	44.41 fg
T_2G_2	23.64 ab	32.25 b	43.03 cd	45.94 cd
T_2G_3	23.97 a	34.15 a	46.59 a	49.86 a
T_3G_0	20.57 g	28.50 f	38.67 g	41.90 h
T_3G_1	21.37 f	30.04 e	40.89 f	43.81 g
T_3G_2	22.51 d	31.10 d	41.96 d-f	44.87 ef
T_3G_3	23.64 ab	32.55 b	43.77 bc	46.71 c
$LSD_{0.05}$	0.538	0.7134	1.041	0.8450
CV (%)	8.39	9.16	7.42	10.12

T_1= 5 Nov. T_2= 20 Nov. T_3= 5 Dec.
G_0= Control G_1= 75 ppm GA_3 G_2= 95 ppm GA_3 G_3= 115 ppm GA_3

4.2 Number of leaves plant^{-1}

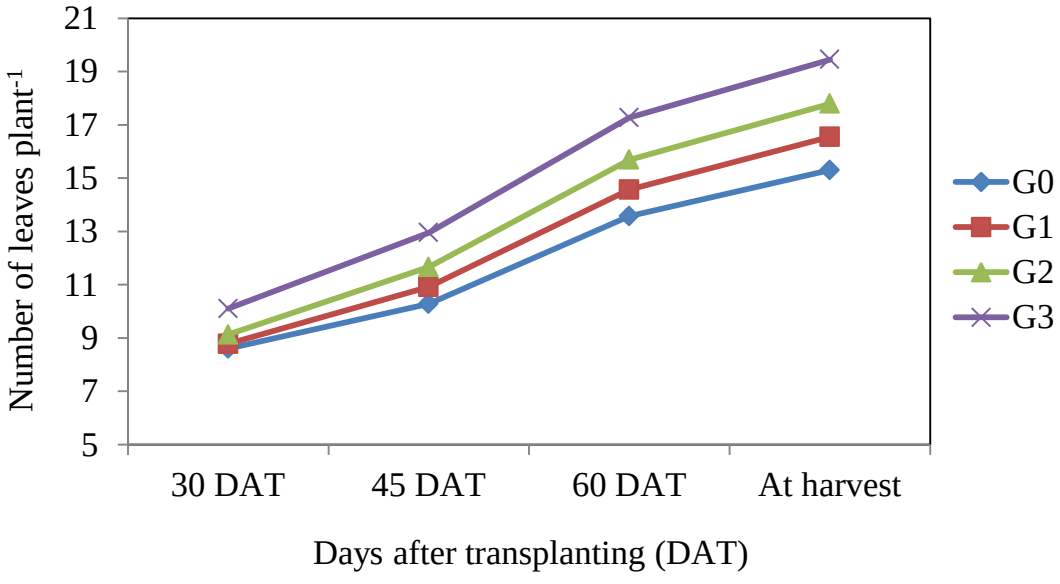
Different levels of planting time showed significant variation on number of leaves plant^{-1} of cabbage at 30, 45, 60 DAT and at harvest (Appendix V). The highest number of leaves plant^{-1}(9.2, 11.8, 15.8 and 17.9 at 30, 45, 60 DAT and at harvest, respectively) was found from T_2 (20 November) which was statistically identical with T_1 (5 November) at 30 and 45 DAT whereas the lowest number of leaves of plant (9.0, 11.1, 14.6 and 16.6 at 30, 45, 60 DAT and at harvest, respectively) was recorded from T_3 (5 December). The result obtained from T_1 (5 November) gave intermediate results at 60 DAT and at harvest considering the highest and the lowest plant height (Fig. 4). Khan *et al*. (2015) observed that sowing dates significantly influenced various growth characteristics of cabbage. They observed that number of leaves increased with delayed planting. Singh *et al.* (2015) recorded the highest number of leaves per plant from early planted plants. Emam (2005) also observed that early planting increased number of leaves/plant of broccoli.

Significant variation was recorded on number of leaves plant^{-1} of cabbage due to different concentrations of gibberellic acid at 30, 45, 60 DAT and at harvest (Appendix V). The highest number of leaves plant^{-1} (10.10, 12.95, 17.27 and 19.45 at 30, 45, 60 DAT and at harvest, respectively) was recorded from G_3 (115 ppm GA_3) which was statistically different from all other treatments. The lowest number of leaves plant^{-1} (8.60, 10.28, 13.57 and 15.30, at 30, 45, 60 DAT and at harvest, respectively) was recorded from G_0 (control). The result obtained from G_1 (75 ppm GA_3) and G_2 (95 ppm GA_3) gave intermediate result considering highest and lowest number of leaves plant^{-1}(Fig. 5). Patil*et al*. (1987) reported maximum number of leaves with 50 ppm GA_3. Yadav *et al*. (2000) also observed the highest number of open leaves (23.60) with 2 sprays of gibberellic acid at 100 ppm. Similar results was also found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the number of leaves (21.48) than control.



T_1= 5 November; T_2= 20 November; T_3= 5 December

Fig. 4. Effect of planting time on number of leaves of cabbage.



G_0 = Control, G_1 = 75ppm GA_3 , G_2 = 95ppm GA_3 , G_3 = 115ppm GA_3

Fig. 5. Effect of gibberellic acid (GA_3) number of leaves of cabbage.

Combined effect of different planting time and GA_3 showed significant differences on number of leaves plant^{-1} of cabbage at 30, 45, 60 DAT and at harvest (Appendix V and Table 2). Results showed that the highest number of leaves

plant^{-1} (10.73, 13.85, 18.47 and 20.68 at 30, 45, 60 DAT and at harvest respectively) was obtained from T_2G_3 followed by T_1G_0, T_1G_1 and T_2G_0. The lowest number of leaves plant^{-1} (8.27) was recorded from T_1G_0 at 30 DAT but at 45, 60 DAT and at harvest the lowest number of leaves plant^{-1} (10.15, 13.07 and 14.75 respectively) was found in T_3G_0 followed by T_1G_0, T_1G_1 and T_2G_0.

Table 2. Combined effect of planting time and gibberellic acid (GA_3) on number of leaves plant^{-1} of cabbage.

Treatment	Number of leaves plant^{-1}			
	30 DAT	45 DAT	60 DAT	At harvest
T_1G_0	8.27 f	10.17 f	13.59 hi	15.31 ij
T_1G_1	9.47 cd	11.25 b	14.53 fg	16.51 fg
T_1G_2	9.00 de	11.60 d	15.73 cd	17.83 cd
T_1G_3	10.00 b	12.83 b	17.22 b	19.40 b
T_2G_0	8.73 ef	10.60 e	14.03 gh	15.83 hi
T_2G_1	8.27 f	10.85 f	14.99 ef	16.99 ef
T_2G_2	9.33 cd	11.90 cd	15.99 cd	18.14 c
T_2G_3	10.73 a	13.85 a	18.47 a	20.68 a
T_3G_0	8.80 e	10.15 e	13.07 i	14.75 j
T_3G_1	8.60 ef	10.65 e	14.19 gh	16.14 gh
T_3G_2	9.07 de	11.42 d	15.33 de	17.40 de
T_3G_3	9.60 bc	12.10 b	16.11 c	18.26 c
$LSD_{0.05}$	0.476	0.3842	0.6313	0.6152
CV (%)	9.47	10.46	6.37	10.48

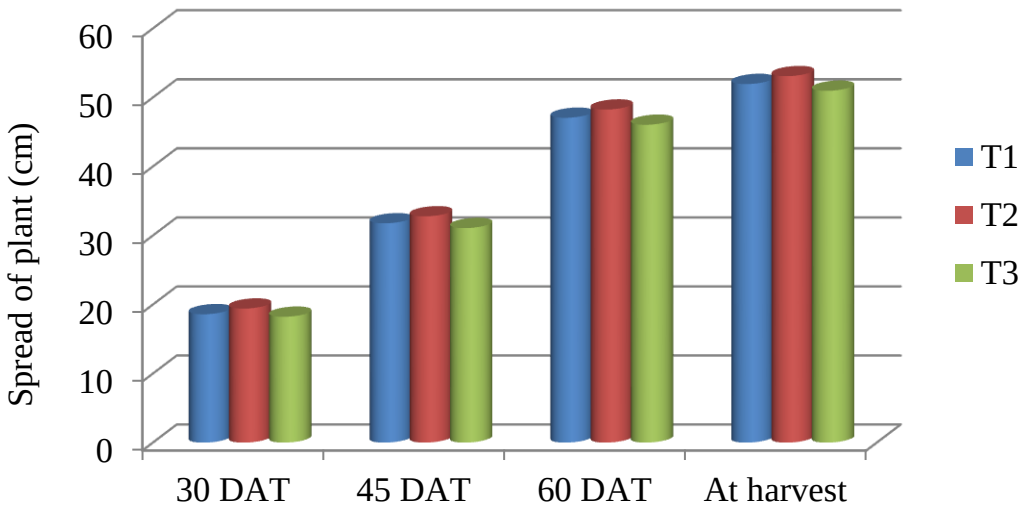
T_1= 5 Nov. T_2= 20 Nov. T_3= 5 Dec.
G_0= Control G_1= 75 ppm GA_3 G_2= 95 ppm GA_3 G_3= 115 ppm GA_3

4.3 Spread of plant

Different levels of planting time showed significant variation for spread of plant of cabbage at 30, 45, 60 DAT and at harvest (Appendix VI). The highest spread of plant (19.4, 32.7, 48.2 and 53.1 cm at 30, 60 DAT and at harvest**)** was recorded from T_2. The lowest spread of plant (18.2, 31.1, 46.1 and 50.9 cm at 30, 60 DAT and at harvest, respectively) was recorded from T_3 (Fig. 6). The result obtained from T_1 gave intermediate result considering highest and lowest spread of plant. Khan *et al*. (2015) observed that sowing dates significantly influenced various growth characteristics of cabbage.

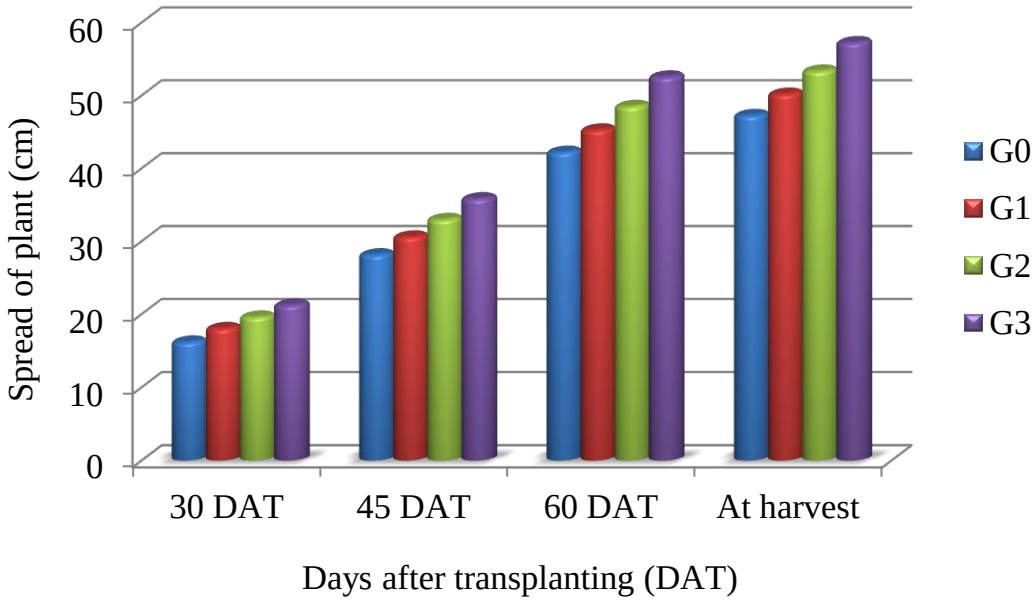
Significant variation was obtained on spread of plant of cabbage due to different concentrations of gibberellic acid at 30, 45, 60 DAT and at harvest (Appendix VI). The highest spread of plant (21.2, 35.8, 52.5 and 57.2 cm at 30, 45, 60 DAT and at harvest, respectively) was recorded from G_2 (95 ppm GA_3) which was statistically different compare to all other treatments. The lowest spread of plant (16.17, 28.13, 42.20 and 47.25 cm at 30, 45, 60 DAT and at harvest, respectively) was recorded from G_0 (Fig. 7).

Due to combined effect of planting time and GA_3 showed significant variation on spread of plant (Appendix VI). The highest spread of plant (22.3, 37.1, 54.1 and 58.7 cm at 30, 45, 60 DAT and at harvest, respectively) was obtained from T_2G_2. The lowest spread of plant (15.64, 27.32, 41.11 and 46.21 cm at 30, 45, 60 DAT and at harvest, respectively) was recorded from T_3G_0. The result obtained from T_2G_1 gave intermediate result considering the highest and the lowest spread of plant.



T_1= 5 November; T_2= 20 November; T_3= 5 December

Fig. 6. Effect of planting time on spread of plant of cabbage.



G_0 = Control, G_1 = 75ppm GA_3 , G_2 = 95ppm GA_3 , G_3 = 115ppm GA_3

Fig. 7. Effect of gibberellic acid (GA_3) spread of plants of cabbage.

Table 3. Combined effect of planting time and gibberellic acid (GA_3) on spread of plant of cabbage.

Treatment	Spread of plant (cm)			
	30 DAT	45 DAT	60 DAT	At harvest
T_1G_0	16.38 h	28.40 h	42.53 h	47.59 h
T_1G_1	17.68 g	30.51 g	45.45 f	50.37 ef
T_1G_2	19.47 de	32.58 e	47.81 d	52.66 d
T_1G_3	20.88 b	35.61 b	52.46 ab	57.18 ab
T_2G_0	16.51 h	28.68 h	42.97 gh	47.97 gh
T_2G_1	18.80 f	31.15 f	45.61 ef	50.51 ef
T_2G_2	22.34 a	37.17 a	54.11 a	58.77 a
T_2G_3	20.04 cd	34.12 cd	50.31 c	55.11 c
T_3G_0	15.64 i	27.32 i	41.11 h	46.21 h
T_3G_1	17.60 g	30.09 g	44.70 fg	49.65 fg
T_3G_2	19.26 ef	32.26 e	47.37 de	52.25 de
T_3G_3	20.44 bc	34.68 c	51.04 bc	55.79 bc
$LSD_{0.05}$	0.5717	0.5234	1.778	1.945
CV (%)	8.72	7.32	6.14	9.38

T_1= 5 November T_2= 20 November T_3= 5 December
G_0= Control G_1= 75 ppm GA_3 G_2= 95 ppm GA_3 G_3= 115 ppm GA_3

4.4 Days to head formation of cabbage

Different levels of planting time showed significant variation on days to head formation of cabbage (Appendix VII). Results revealed that the highest days to head formation **(**36.94 days**)** was recorded from T_3 where the lowest days to head formation (35.88 days) was recorded from T_2 which was statistically identical to T_1 (Table 4).

Significant variation was recorded for days to head formation of cabbage due to different concentrations of gibberellic acid (Appendix VII). Results revealed that the highest days to head formation **(**39.98 days**)** was recorded from G_0 (control) where the lowest days to head formation (32.70 days) was recorded from G_2 (Table 4). Similar trends results was found by Patil *et al*. (1987) and they reported that head formation was 13 days earlier with 50 ppm GA_3. Roy and Nasiruddin (2011) also showed the minimum number of days to head formation (43.54 days) and maturity (69.95 days) with 50 ppm GA_3.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences for days to head formation of cabbage (Appendix VII and Table 4). The highest days to head formation of cabbage (40.37 days) was obtained from T_3G_0 which was statistically similar to T_2G_3 (40.04). The lowest days to head formation of cabbage (32.16 days) was provided by T_2G_2 which was statistically similar to T_2G_0 (32.34 days).

4.5 Fresh weight of stem

Different levels of planting time showed significant variation on fresh weight of stem of cabbage (Appendix VII). The highest fresh weight of stem of cabbage **(**60.09 g**)** was obtained from T_2 and the lowest fresh weight of stem (58.17 g) was obtained from T_1 treatment (Table 4).

Different levels of concentrations of gibberellic acid showed the significant variation on fresh weight of stem of cabbage (Appendix VII and Table 4). Results revealed that the highest fresh weight of stem of cabbage **(**65.06 g**)** was obtained from G_3 (115 ppm GA_3) whereas the lowest fresh weight of stem of cabbage (51.79 g) was recorded from G_0 (Control) whereas the result obtained from G_1 (75 ppm GA_3) gave intermediate result considering highest and lowest for fresh weight of stem of cabbage. Similar trend results was also found by Chaurasiy *et al*.

(2014). They noticed that GA_3 60 ppm significantly increased the fresh plant weight than control.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences for fresh weight of stem of cabbage (Appendix VII and Table 4). The highest fresh weight of stem of cabbage (65.90 g) was obtained from T_2G_3 which was statistically identical to T_3G_3 (64.73g) and T_1G_3(64.55g). The lowest fresh weight of stem of cabbage (51.03 g) was obtained from T_1G_0 which was statistically similar to T_3G_0 (51.43 g) and T_2G_0 (52.91 g).

4.6 Dry weight of stem

Different levels of planting time demonstrated significant variation for dry weight of stem of cabbage (Appendix VII). Results indicated that **t**he highest dry weight of stem of cabbage **(**8.40 g**)** was obtained from T_2 (20 November) where the lowest dry weight of stem of cabbage (8.15 g) was recorded from T_1 (5 November) which was statistically identical with T_3 (5 December)(Table 4).

Different concentrations of gibberellic acid demonstrated significant variation on dry weight of stem of cabbage (Appendix VII). Results showed that **t**he highest dry weight of stem of cabbage **(**8.98 g**)** was obtained from G_3 (115 ppm GA_3) which was statistically similar toG_2 (95 ppm GA_3). The lowest dry weight of stem of cabbage (7.38 g) was recorded from G_0 (control) (Table 4). Dharmander *et al*. (1996) got the similar trend of findings in their observation.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences for dry weight of stem of cabbage (Appendix VII and Table 4). The highest dry weight of stem of cabbage (9.08 g) was obtained from T_2G_3 which was statistically similar toT_1G_3 (8.92 g), T_2G_2 (8.72 g), T_1G_2 (8.52 g). T_2G_3 (8.94 g), and T_3G_2 (8.62 g). The lowest dry weight of stem of cabbage (7.27 g) was obtained from T_1G_0 which was statistically similar to T_3G_0 (7.31g) and T_2G_0 (7.56 g).

Table 4. Effect of planting time and gibberellic acid (GA_3) on days from transplanting to head formation, fresh weight of stem and dry weight of stem.

Treatment	Days from transplanting to head formation	Fresh weight of stem (g)	Dry weight of stem (g)
Effect of planting time			
T_1	35.90 b	58.17 c	8.15 b
T_2	35.88 b	60.09 a	8.40 a
T_3	36.94 a	58.68 b	8.21 b
$LSD_{0.05}$	0.09275	0.1629	0.0928
Effect of GA_3			
G_0	39.98 a	51.79 d	7.38 c
G_1	35.04 c	57.19 c	8.03 b
G_2	32.70 d	65.06 a	8.98 a
G_3	37.24 b	61.87 b	8.62 a
$LSD_{0.05}$	0.6514	1.752	0.465
Combained effect of planting time and GA_3			
T_1G_0	36.48 bc	51.03 f	7.27 e
T_1G_1	34.27 d	56.03 e	7.88 cd
T_1G_2	37.64 b	61.07 c	8.52 ab
T_1G_3	39.52 a	64.55 ab	8.92 a
T_2G_0	32.34 e	52.91 f	7.56 de
T_2G_1	34.64 d	58.87 d	8.24 bc
T_2G_2	32.16 e	62.69 bc	8.72 ab
T_2G_3	40.04 a	65.90 a	9.08 a
T_3G_0	40.37 a	51.43 f	7.31 e
T_3G_1	36.20 c	56.69 e	7.95 cd
T_3G_2	37.61 b	61.87 c	8.62 ab
T_3G_3	33.60 d	64.73 a	8.94 a
$LSD_{0.05}$	1.128	1.863	0.5052
CV (%)	8.37	10.26	11.39

T_1= 5 November T_2= 20 November T_3= 5 December
G_0= Control G_1= 75 ppm GA_3 G_2= 95 ppm GA_3 G_3= 115 ppm GA_3

4.7 Thickness of head

Different levels of planting time showed significant variation on thickness of head of cabbage (Appendix VIII and Table 5). Results showed that the highest thickness of head of cabbage **(**13.30 cm**)** was obtained from T_2 (20 November) whereas the lowest thickness of head of cabbage (12.56 cm) was obtained from T_3 (5 December).

Different concentrations of gibberellic acid showed the significant variation on diameter of head of cabbage (Appendix VIII and Table 5). Results revealed that the highest diameter of head of cabbage **(**14.21 cm**)** was recorded from G_2 (95 ppm GA_3) where the lowest diameter of head of cabbage (11.42 cm) was recorded from G_0 (Control). The present finding was conformity with the results of Lendve *et al*. (2010), they stated that the thickness of head on cabbage increase with the application of certain levels of GA_3.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences on thickness of head of cabbage (Appendix VIII and Table 5). The highest thickness of head of cabbage (14.55 cm) was obtained from T_2G_2 which was statistically identical toT_1G_2 (14.14 cm) and T_3G_2 (13.95 cm). The lowest thickness of head of cabbage (10.81 cm) was obtained from T_3G_0 which was statistically similar to T_1G_0 (11.57 cm) and T_2G_0 (11.89 cm).

4.8 Diameter of head

Different levels of planting time demonstrated significant variation on diameter of head of cabbage (Appendix VIII). Results indicated that **t**he highest diameter of head of cabbage **(**12.06 cm**)** was recorded from T_2 (20 November) and the lowest diameter of head of cabbage (11.46 cm) was found from T_3. Khan *et al*. (2015) observed that head diameter decreased with delayed planting.

Significant variation was recorded on diameter of head of cabbage due to different concentrations of gibberellic acid (Appendix VIII). Results revealed that the highest diameter of head of cabbage **(**13.02 cm**)** was recorded from G_2 (95 ppm GA_3) where the lowest thickness of head of cabbage (10.48 cm) was recorded from G_0. The result obtained from G_1 (75 ppm GA_3) gave intermediate result considering highest and lowest thickness of head of cabbage. An earlier another experiment, Patil *et al*. (1987) were noticed the maximum head diameter with GA_3 at 50 ppm. Roy and Nasiruddin (2011) obtained the highest diameter (23.81 cm) of cabbage head with the application of 50 ppm GA_3 where the lowest diameter (17.89 cm) of cabbage head was found in control (0 ppm GA_3)(Table 5). Similar trend results was also found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the head diameter (18.88 cm) than control.

Combined effect of different concentrations of planting time and gibberellic acid showed significant differences for diameter of head of cabbage (Appendix VIII and Table 5). The highest diameter of head of cabbage (13.44 cm) was obtained from T_2G_2 followed by T_1G_2 and T_3G_2 where the lowest diameter of head of cabbage (10.14 cm) was recorded fromT_3G_0 whereas statistically similar with T_1G_0 (10.50 cm) and T_2G_0 (10.80 cm).

4.9 Dry matter content of head

Different levels of planting time explained significant variation dry matter content of head of cabbage (Appendix VIII). Results showed that the highest dry matter content of head of cabbage **(**11.20 %**)** was recorded from T_2 (20 November) which was statistically similar to T_1 (11.17%) whereas the lowest fresh dry matter content of head of cabbage (10.88%) was recorded from T_3 (5 December)(Table 5).

Significant variation was observed or dry matter content of head due to application of different concentrations of gibberellic acid (Appendix VIII). However **t**he highest dry matter content of head of cabbage **(**11.89 %**)** was recorded from G_2 (95

Table 5. Effect of planting time and gibberellic acid (GA_3) on thickness of head, diameter of head and dry matter content of head.

Treatment	Thickness of head (cm)	Diameter of head (cm)	Dry matter content of head (%)
Effect of planting time			
T_1	12.98 b	11.75 b	11.17 a
T_2	13.30 a	12.06 a	11.20 a
T_3	12.56 c	11.46 c	10.88 b
$LSD_{0.05}$	0.1104	0.1312	0.1002
Effect of GA_3			
G_0	11.42 d	10.48 d	9.98 c
G_1	13.47 b	12.13 b	11.60 a
G_2	14.21 a	13.02 a	11.89 a
G_3	12.68 c	11.39 c	10.86 b
$LSD_{0.05}$	0.5608	0.3272	0.3286
Combained effect of planting time and GA_3			
T_1G_0	11.57 g	10.50 ij	10.00 fg
T_1G_1	13.51 bc	12.13 de	11.93 ab
T_1G_2	14.14 ab	12.96 b	11.99 ab
T_1G_3	12.71 de	11.40 fg	10.89 de
T_2G_0	11.89 fg	10.80 hi	10.16 fg
T_2G_1	13.81 b	12.30 cd	11.17 cd
T_2G_2	14.55 a	13.44 a	12.16 a
T_2G_3	12.95 c-e	11.68 ef	11.19 cd
T_3G_0	10.81 h	10.14 j	9.79 g
T_3G_1	13.09 cd	11.94 de	11.69 ab
T_3G_2	13.95 ab	12.66 bc	11.53 bc
T_3G_3	12.39 ef	11.09 gh	10.49 ef
$LSD_{0.05}$	0.6082	0.4759	0.4699
CV (%)	8.54	7.83	9.28

T_1= 5 November T_2= 20 November T_3= 5 December
G_0= Control G_1= 75 ppm GA_3 G_2= 95 ppm GA_3 G_3= 115 ppm GA_3

ppm GA_3) which statistically similar to G_1 (11.60%). The lowest dry matter content of head of cabbage (9.98 %) was recorded from G_0 (Table 5). Chauhan *et al*. (2009) agreed to the findings of the present study.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences for dry matter content of head of cabbage (Appendix VIII and Table 5). The highest dry matter content of head of cabbage (12.16 %) was obtained from T_2G_2 which was statistically similar with T_1G_2 (11.99 %), T_1G_1 (11.93 %) and T_3G_1 (11.69 %). The lowest dry matter content of head of cabbage (9.79 %) was recorded from T_3G_0 which was statistically similar withT_1G_0 (10.00 %) and T_2G_0 (10.16 %).

4.10 Gross weight of head plant^{-1}

Different levels of planting time showed significant variation on gross weight of head plant^{-1} of cabbage (Appendix IX and Table 6). The highest gross weight of head plant^{-1}of cabbage **(**1523.00 g**)** was recorded from T_2 (20 November) where as the lowest gross weight of head plant^{-1}of cabbage (1441.00 g) was recorded from T_3 (5 December). Singh *et al.* (2015) recorded the highest yield per plant from earlier plantation. Khatun *et al*. (2012) found different transplanting dates showed significant influence on the yield and yield contributing characters of broccoli. They observed that weight of curd plant^{-1} (319.11 g), were decreased with delay in transplanting.

Significant variation was recorded on gross weight of head plant^{-1} of cabbage due to different concentrations of gibberellic acid (Appendix IX and Table 6). However, the highest gross weight of head plant^{-1}**(**1662.00 g**)** was recorded from G_2 (95 ppm GA_3) wheras the lowest gross weight of head plant^{-1}(1311.00) was recorded from G_0. Similar results was also found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the whole plant weight (2.44 kg) than control.

Due to combined effect of different concentrations of gibberellic acid and planting time showed significant differences on gross weight of head plant^{-1} of cabbage (Appendix IX and Table 6). The highest gross weight of head plant^{-1} of cabbage (1713.00 g) was obtained from T_2G_2.The lowest gross weight of head plant^{-1} 1281.00 g) was recorded from T_3G_0 followed by T_1G_0 (1301.00 g) and T_2G_0 (1349.00 g).

4.11 Gross yield plot^{-1}

Due to use of different levels of planting time showed significant variation on gross yield plot^{-1} of cabbage (Appendix IX). Results indicated that **t**he highest gross yield plot^{-1} of cabbage **(**17.49 kg**)** was recorded from T_2 (20 November) where the lowest gross yield plot^{-1} of cabbage (16.27 kg) was found from T_3 (5 December) (Table 6). Singh *et al.* (2015) recorded the highest yield per plot over later date of planting. Khatun *et al*. (2012) also found different transplanting dates showed significant influence on the yield and they observed that curd yield plot^{-1} (7.83 kg) and were decreased with delay in transplanting.

Different concentrations of gibberellic acid showed the significant variation for gross yield plot^{-1} of cabbage (Appendix IX). Results revealed that the highest gross yield plot^{-1} of cabbage **(**19.16 kg**)** was recorded from G_2 (95 ppm GA_3) whereas the lowest gross yield plot^{-1} of cabbage (14.95 kg) was recorded from G_0(Table 6). Similar results was also found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the head yield (51.26 t/ha) than control.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences for gross yield plot^{-1} of cabbage (Appendix IX and Table 6). The highest gross yield plot^{-1} of cabbage (19.78 kg) was obtained from T_2G_2 which was statistically identical to T_1G_2 (19.16 kg).The lowest gross yield plot^{-1} of cabbage (14.60 kg) was recorded from T_3G_0 which was statistically similar to T_1G_0 (14.84 kg).

4.12 Gross yield ha^{-1}

Different levels of planting time demonstrated significant variation for gross yield ha^{-1} of cabbage (Appendix IX and Table 6). Results indicated that **t**he highest gross yield ha^{-1} of cabbage **(**60.73 t/ha**)** was recorded from T_2 (20 November) and the lowest gross yield ha^{-1} of cabbage (57.35 t/ha) was recorded from T_3 (5 December).. Khan *et al*. (2015) observed that head yield decreased with delayed planting. Khatun *et al*. (2012) also found different transplanting dates showed significant influence on the yield and yield contributing characters of broccoli. They observed that curd yield ha^{-1} (13.04 t/ha) was decreased with delay in transplanting.

Different concentrations of gibberellic acid showed significant variation on gross yield ha^{-1} of cabbage (Appendix IX and Table 6). Results showed that **t**he highest gross yield ha^{-1} of cabbage **(**66.54 t/ha**)** was recorded from G_2 (95 ppm GA_3).The lowest gross yield ha^{-1} of cabbage (51.91 t/ha) was recorded from G_0 (control). Yadav *et al*. (2000) observed the highest yield (494.78 q/ha) with 2 sprays of gibberellic acid at 100 ppm.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences for gross yield ha^{-1} of cabbage (Appendix IX and Table 6). The highest gross yield ha^{-1} of cabbage (68.68 t/ha) was obtained fromT_2G_2).The lowest gross yield ha^{-1} of cabbage (50.52 t/ha) was recorded from T_3G_0 which was statistically similar to T_1G_0 (51.68 t/ha).

4.13 Marketable yield $plant^{-1}$

Different levels of planting time showed significant variation for marketable yield $plant^{-1}$of cabbage (Appendix X and Table 6). Results showed that the highest marketable yield $plant^{-1}$**(**1179.00 g**)** was recorded from T_2 (20 November) where the lowest marketable yield $plant^{-1}$ (1103.00 g) was recorded from T_3 (5 December) which was statistically similar to T_1 (5 November). Singh *et al.* (2015)

Table 6. Effect of planting time and gibberellic acid (GA_3) on yield of cabbage.

Treatment	Gross weight of head plant^{-1} (g)	Gross yield plot^{-1} (kg)	Gross yield ha^{-1} (ton)	Marketable yield plant^{-1} (g)	Marketable yield plot^{-1} (kg)
Effect of planting time					
T_1	1474.00 b	16.91 b	58.70 b	1136.00 b	13.63 b
T_2	1523.00 a	17.49 a	60.73 a	1179.00 a	14.15 a
T_3	1441.00 c	16.27 c	57.35 c	1103.00 c	13.24 c
$LSD_{0.05}$	2.093	0.1874	0.1735	2.133	0.1391
Effect of GA_3					
G_0	1311.00 d	14.95 d	51.91 d	989.00 d	11.87 d
G_1	1534.00 b	17.29 b	61.20 b	1182.00 b	14.18 b
G_2	1662.00 a	19.16 a	66.54 a	1315.00 a	15.78 a
G_3	1411.00 c	16.15 c	56.07 c	1071.00 c	12.85 c
$LSD_{0.05}$	2.621	0.4878	0.6745	2.824	0.3330
Combained effect of planting time and GA_3					
T_1G_0	1301.00 k	14.84 g	51.68 h	981.00 k	10.90 ij
T_1G_1	1523.00 e	17.50 d	60.77 d	1176.00 e	14.11 de
T_1G_2	1662.00 b	19.16 ab	66.52 b	1317.00 b	15.80 b
T_1G_3	1409.00 h	16.13 ef	56.02 ef	1070.00 h	12.84 hi
T_2G_0	1349.00 j	15.41 fg	53.52 g	1019.00 j	11.08 i
T_2G_1	1584.00 d	18.23 cd	63.31 c	1232.00 d	14.78 cd
T_2G_2	1713.00 a	19.78 a	68.68 a	1363.00 a	17.10 a
T_2G_3	1443.00 g	16.54 e	57.43 e	1099.00 g	13.19 fg
T_3G_0	1281.00 *l*	14.60 g	50.52 h	966.00 *l*	10.69 j
T_3G_1	1494.00 f	16.14 ef	59.52 d	1138.00 f	13.66 ef
T_3G_2	1611.00 c	18.56 bc	64.43 c	1263.00 c	15.16 bc
T_3G_3	1379.00 i	15.77 ef	54.77 fg	1043.00 i	12.96 gh
$LSD_{0.05}$	4.540	0.8450	1.732	4.892	0.5767
CV (%)	8.33	10.27	9.67	9.74	12.32

T_1= 5 November T_2= 20 November T_3= 5 December
G_0= Control G_1= 75 ppm GA_3 G_2= 95 ppm GA_3 G_3= 115 ppm GA_3

recorded the highest yield per plant from earlier plantation. Khatun *et al*. (2012) also found different transplanting dates showed significant influence on the yield and yield contributing characters of broccoli. They observed that weight of curd plant^{-1} (319.11g), were decreased with delay in transplanting.

Significant variation was recorded marketable yield plant^{-1}of cabbage due to different concentrations of GA_3 (Appendix X and Table 6). Results revealed that the highest marketable yield plant^{-1}(1315.00 g) was recorded from G_2 (95 ppm GA_3) and the lowest marketable yield plant^{-1}of cabbage (989.00 g) was found from G_0 (Control). Similar results was also found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the head weight (1.73 kg) than control.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences on marketable yield plant^{-1} of cabbage (Appendix X and Table 6). The highest marketable yield plant^{-1}of cabbage (1363.00 g) was obtained from T_2G_2.The lowest marketable yield plant^{-1} (966.00 g) was found from T_3G_0.

4.14 Marketable yield plot^{-1}

Marketable yield plot^{-1}of cabbage was significantly influenced by different levels of planting time (Appendix X and Table 6). **T**he highest marketable yield plot^{-1}of cabbage **(**14.15 kg**)** was obtained from T_2 (20 November) and the lowest marketable yield plot^{-1}of cabbage (13.24 kg) was found from T_3 (5 December). Singh *et al.* (2015) recorded the highest yield per plot over later date of planting. Khatun *et al*. (2012) also found different transplanting dates showed significant influence on the yield and they observed that curd yield plot^{-1} (7.83 kg) and were decreased with delay in transplanting.

Different concentrations of gibberellic acid showed the significant variation on marketable yield plot^{-1} of cabbage (Appendix X and Table 6). However, the

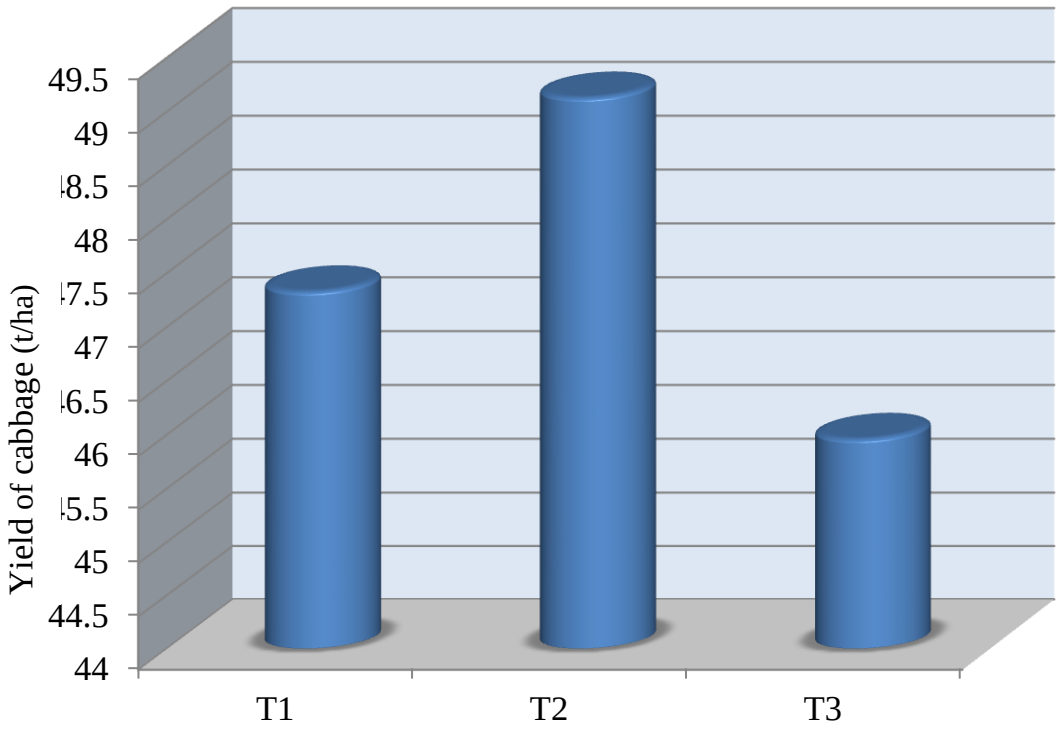
highest marketable yield plot^{-1} of cabbage **(**15.78 kg**)** was obtained from G_2 (95 ppm GA_3) whereas the lowest marketable yield plot^{-1} of cabbage (11.87 kg) was obtained from G_0 (Control). Similar trends results was found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the head yield (51.26 t/ha) than control.

Combined effect of different concentrations of gibberellic acid and planting time showed significant differences on marketable yield plot^{-1} of cabbage (Appendix X and Table 6). The highest marketable yield plot^{-1} of cabbage (17.10 kg) was obtained from T_2G_2 which was statistically identical to T_1G_2 (15.80 kg). The lowest marketable yield plot^{-1} of cabbage (10.69 kg) was recorded from T_3G_0 which was statistically similar to T_1G_0 (10.90 kg).

4.15 Marketable yield ha^{-1}

Due to use of different levels of planting time showed significant effect on marketable yield ha^{-1} of cabbage (Appendix X). **T**he highest marketable yield ha^{-1}of cabbage **(**49.13 t/ha**)** was found from T_2 (20 November) whereas the lowest marketable yield ha^{-1}of cabbage (45.96 t/ha) was found from T_3 (5 December) (Fig. 8). Kryuchkov and Suddenko (1991) reported that late sowing reduced the head development. Hasan *et al*. (2003) revealed that cabbage cultivation is more profitable in pre-rabi period and least profitable (actually negative profitable) in the late-rabi period. Khan *et al*. (2015) observed that head yield decreased with delayed planting. Khatun *et al*. (2012) also found different transplanting dates showed significant influence on the yield and yield contributing characters of broccoli. They observed that curd yield ha^{-1} (13.04 ton) was decreased with delay in transplanting.

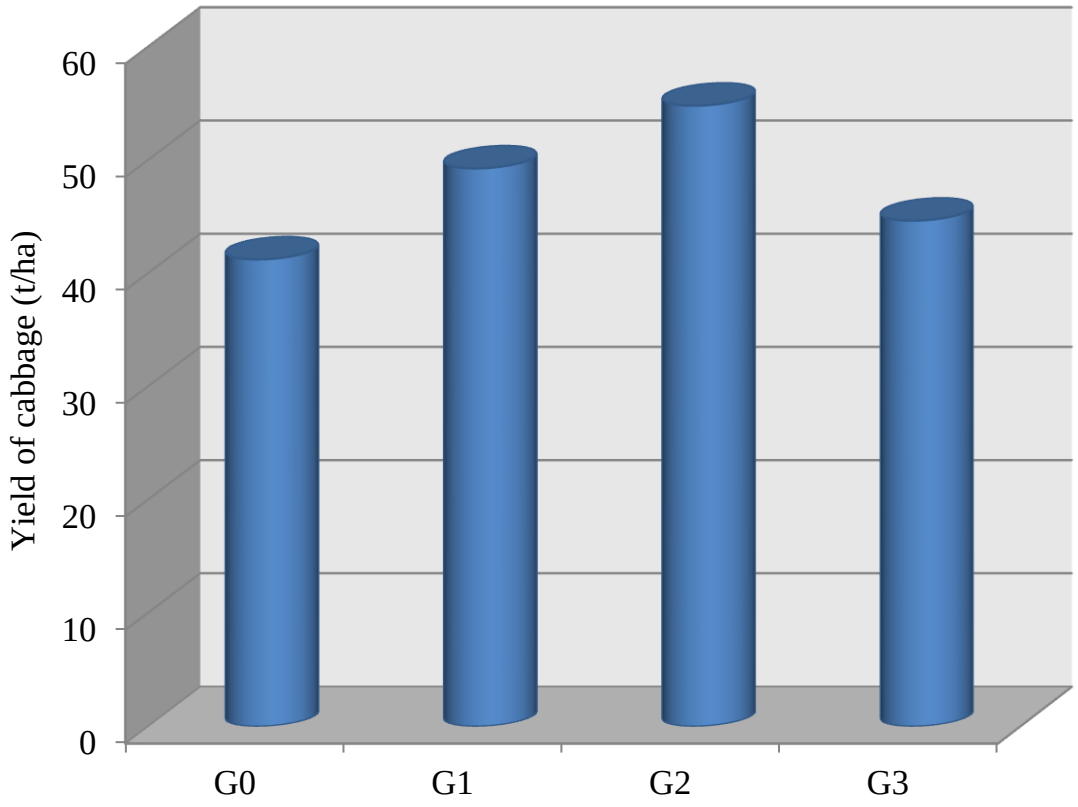
Due to application of different concentrations of gibberellic acid had significant variation on marketable yield $ha^{-1}$of cabbage (Appendix X). However the highest marketable yield $ha^{-1}$of cabbage (54.79 t/ha) was found from G_2 (95 ppm GA_3) and the lowest marketable yield $ha^{-1}$of cabbage (41.21 t/ha) was found from G_0 (control)(Fig. 9). Yadav *et al*. (2000) observed the highest yield (494.78 q/ha) with 2 sprays of gibberellic acid at 100 ppm. Similar results was also found by Chaurasiy *et al*. (2014). They noticed that GA_3 60 ppm significantly increased the head yield (51.26 t/ha) than control.



T_1= 5 November; T_2= 20 November; T_3= 5 December

Fig. 8. Effect of planting time on yield of cabbage.

Due to combined effect of different levels of planting time and GA_3 showed significant differences on marketable yield ha^{-1} of cabbage (Appendix X).The highest marketable yield ha^{-1} of cabbage (59.35 t/ha) was found from T_2G_2 whereas the lowest marketable yield ha^{-1} of cabbage (37.12 t/ha) was found from T_3G_0 (Fig.10).



G_0 = Control, G_1 = 75ppm GA_3 , G_2 = 95ppm GA_3 , G_3 = 115ppm GA_3

Fig. 9. Effect of gibberellic acid (GA_3)on yield of cabbage.

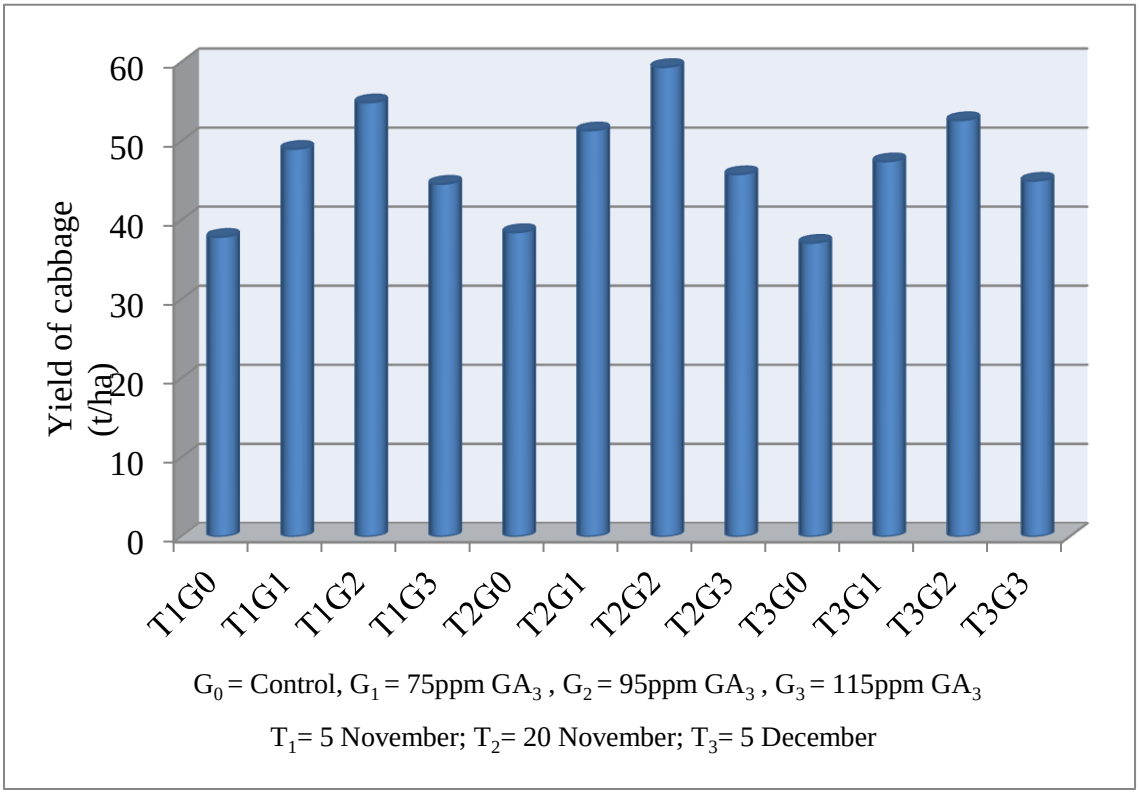


Fig. 10. Combined effect of planting time and gibberellic acid (GA_3) on yield of cabbage.

4.16 Performance on economic return

4.16.1 Cost of production

Due to effect of different treatment combinations showed major differences in terms of cost of production of cabbage (Appendix XI Table 7). The highest cost of production of cabbage (170,547.00 Tk/ha) was obtained from T_1G_3, T_2G_3 and T_3G_3 and the second highest cost of production of cabbage (168,862.00 Tk/ha) was obtained from T_1G_2, T_2G_2 and T_3G_2. The lowest cost of production of cabbage (161,559.00 Tk/ha) was recorded from T_1G_0, T_2G_0 and T_3G_0 where the second lowest cost of production (167,177.00 Tk/ha) was obtained from T_1G_1, T_2G_1 and T_3G_1.

4.16.2 Gross return

In case of gross return, different treatment combination showed considerable gross return of cabbage (Appendix XI and Table 7). The highest gross return of cabbage (433255.00 Tk/ha) was obtained from T_2G_2 where the second and third highest gross return of cabbage (400624.00 and 384199.00 Tk/ha respectively) was obtained from T_1G_2 and T_3G_2 respectively. The lowest gross return of cabbage (270976.00 Tk/ha) was recorded from T_3G_0 and the second and third lowest gross return of cabbage (276451.00 and 280758.00 Tk/ha respectively) was found fromT_1G_0 and T_2G_0 respectively.

4.16.3 Net return

Different treatment combinations showed large differences in terms of net return from cabbage (Appendix XI and Table 7). The highest net return of cabbage (264,393.00 Tk/ha) was obtained from T_2G_2 where the second and third highest net return of cabbage (231,762.00 and 215,337.00 Tk/ha, respectively) was obtained from T_1G_2 and T_3G_2 respectively. The lowest net return of cabbage (109,417.00 Tk/ha) was recorded from T_3G_0 and the second and third lowest net return of cabbage (114,892.00 and 119,199.00 Tk/ha, respectively) was found from T_1G_0, T_2G_0 respectively.

4.16.4 Benefit cost ratio (BCR)

Different treatment combination showed imperative differences on benefit cost ratio of cabbage production (Appendix XI and Table 7). Results indicated that the highest benefit cost ratio of cabbage (2.57) was obtained from T_2G_2 where the lowest benefit cost ratio (1.68) was found from T_3G_0. The results also obtained from T_1G_2, T_2G_1, T_3G_2, T_1G_1 and T_3G_1 also gave promising results in terms of BCR but lower than the highest results.

Table 7. Cost and return of cabbage cultivation as influenced by different levels of planting time and GA_3.

Treatment	Cost of production (Tk/ha)	Yield of cabbage (t/ha)	Gross return (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio
T_1G_0	161,559	37.87	276451	114,892	1.71
T_1G_1	167,177	49.00	357700	190,523	2.14
T_1G_2	168,862	54.88	400624	231,762	2.37
T_1G_3	170,547	44.58	325434	154,887	1.91
T_2G_0	161,559	38.46	280758	119,199	1.74
T_2G_1	167,177	51.33	374709	207,532	2.24
T_2G_2	168,862	59.35	433255	264,393	2.57
T_2G_3	170,547	45.79	334267	163,720	1.96
T_3G_0	161,559	37.12	270976	109,417	1.68
T_3G_1	167,177	47.42	346166	178,989	2.07
T_3G_2	168,862	52.63	384199	215,337	2.28
T_3G_3	170,547	44.97	328281	157,734	1.92

T_1= 5 November T_2= 20 November T_3= 5 December
G_0= Control G_1= 75 ppm GA_3 G_2= 95 ppm GA_3 G_3= 115 ppm GA_3

Rate of cabbage: 7300 Tk/ton
Gross return = Total yield (t/ha) × Tk. 7,300
Net return = Gross return - Total cost of production

Benefit Cost Ratio (BCR) = Gross return/Total cost of production

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted in the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka during the period from October 2013 to March 2014 to find out the effect of planting time and gibberellic acid on the growth and yield of cabbage. The variety of cabbage was Atlas-70 and it was used as a test crop in the experiment. The experiment consisted of two factors: Factor A: Planting time (three levels) such as - T_1= 5 Nov ; T_2= 20 Nov and T_3= 5 Dec and Factor B: Gibberellic acid - GA_3 (four levels) such as- G_0= 0 ppm GA_3 (control); G_1= 75 ppm GA_3; G_2= 95 ppm GA_3 and G_3= 115 ppm GA_3. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on different growth, yield parameters and yield were recorded and analyzed statistically.

Planting time had significant effect on different growth, yield and yield contributing characters of cabbage. Results revealed that the tallest plant (23.54, 31.95, 42.64 and 45.62 cm at 30, 45, 60 DAT and at harvest respectively), the highest number of leaves plant^{-1} (9.27, 11.82, 15.87 and 17.91 at 30, 45, 60 DAT and at harvest respectively), spread of plant (19.42, 32.78, 48.25 and 53.09 cm at 30, 45, 60 DAT and at harvest, respectively), fresh weight of stem of cabbage (60.09 g), dry weight of stem of cabbage (8.40 g), thickness of head of cabbage (13.30 cm), diameter of head of cabbage (12.06 cm), dry matter content of head (11.20 %) gross weight of head plant^{-1} of cabbage (1523.00 g), gross yield plot^{-1} of cabbage (17.49 kg), gross yield ha^{-1} of cabbage (60.73 t/ha), marketable yield plant^{-1} (1179.00 g), marketable yield plot^{-1} of cabbage (14.15 kg) and marketable yield ha^{-1} of cabbage (49.13 t/ha) was recorded from T_2 (20 November). Again, the shortest plant (30.63, 40.96 and 44.24 cm at 45, 60 DAT and at harvest respectively) was recorded from T_1 (5 November). But the lowest number of

leaves plant^{-1} (9.02, 11.05, 14.68 and 16.64 at 30, 45, 60 DAT and at harvest respectively), spread of plant (18.23, 31.08, 46.05 and 50.97 cm at 30, 60 DAT and at harvest respectively), thickness of head (12.56 cm), diameter of head (11.46 cm), dry matter content of head (10.88 %), gross weight of head plant^{-1} (1441.00 g), gross yield plot^{-1} (16.27 kg), gross yield ha^{-1} (57.35 t/ha), marketable yield plant^{-1} (1103.00 g), marketable yield plot^{-1} (13.24 kg) and marketable yield ha^{-1} of cabbage (45.96 t/ha) was recorded from T_3 (5 December). The lowest days to head formation (35.88 days) was recorded from T_2 (20 November) where the lowest fresh weight of stem (58.17 g) and dry weight of stem (8.15 g) was recorded from T_1 (5 November).

Significant variation was recorded with GA_3 on different growth, yield and yield contributing characters of cabbage. Results indicated that the tallest plant (23.81, 33.32, 45.00 and 48.05 cm at 30, 45, 60 DAT and at harvest, respectively), highest number of leaves plant^{-1} (10.10, 12.95, 17.27 and 19.45 at 30, 45, 60 DAT and at harvest, respectively), fresh weight of stem of cabbage (65.06 g) and dry weight of stem of cabbage (8.98 g) were obtained from G_3 (115 ppm GA_3). But the highest spread of plant (21.22, 52.53, 35.82 and 57.24 cm at 30, 45, 60 DAT and at harvest, respectively), diameter of head (13.02 cm), thickness of head (14.21 cm), dry matter content of head (11.89 %), gross weight of head plant^{-1} (1662.00 g), gross yield plot^{-1} (19.16 kg), gross yield ha^{-1} (66.54 t/ha), marketable yield plant^{-1} (1315.00 g), marketable yield plot^{1} (15.78 kg) and marketable yield ha^{-1} (54.79 t/ha) of cabbage were recorded from G_2 (95 ppm GA_3).

On the other hand, the shortest plant (21.98, 28.80, 37.88 and 41.92 cm at 30, 45, 60 DAT and at harvest, respectively), lowest number of leaves plant^{-1} (8.60, 10.28, 13.57 and 15.30 at 30, 45, 60 DAT and at harvest respectively), spread of plant (16.17, 28.13, 42.20 and 47.25 cm at 30, 45, 60 DAT and at harvest respectively), fresh weight of stem (51.79 g), dry weight of stem (7.38 g), diameter of head (10.48 cm), thickness of head (11.42 cm), dry matter content of head (9.98

%), gross weight of head plant^{-1} (1311.00), gross yield plot^{-1} (14.95 kg), gross yield ha^{-1} (51.91 t/ha), marketable yield plant^{-1} (989.00 g), marketable yield plot^{-1} (11.87 kg) and marketable yield ha^{-1} (41.21 t/ha) of cabbage were found from G_0 (control).

Combined effect of planting time and GA_3 had significant effect on different growth, yield and yield contributing characters of cabbage. Results pointed out that the tallest plant (23.97, 34.15, 46.59 and 49.86 cm at 30, 45, 60 DAT and at harvest respectively), number of leaves plant^{-1} (10.73, 13.85, 18.47 and 20.68 at 30, 45, 60 DAT and at harvest respectively), fresh weight of stem of cabbage (65.90 g) and dry weight of stem of cabbage (9.08 g) were obtained from T_2G_3. Again, the highest days to head formation of cabbage (40.37 days) was obtained from T_3G_0. But the highest spread of plant (10.73, 37.17, 18.47 and 20.68 cm at 30, 45, 60 DAT and at harvest respectively), thickness of head of cabbage (14.55 cm), diameter of head of cabbage (13.44 cm), dry matter content of head (12.16 %), gross weight of head plant^{-1} (1713.00 g), gross yield plot^{-1} (19.78 kg), gross yield ha^{-1} (68.68 t/ha), marketable yield plant^{-1} (1363.00 g), marketable yield plot^{-1} (16.36 kg) and marketable yield ha^{-1} (59.35 t/ha) were obtained from T_2G_2.

On the contrary, the shortest plant (27.70, 35.63 and 41.90 cm at 45, 60 DAT and at harvest respectively) was found in T_1G_0 where the lowest number of leaves plant^{-1} (10.15, 13.07 and 14.75 at 45, 60 DAT and at harvest respectively) , spread of plant (15.64, 27.32, 41.11and 46.21 cm at 30, 45, 60 DAT and at harvest respectively), the lowest thickness of head (10.81 cm), diameter of head (10.14 cm), dry matter content of head (9.79 %), gross weight of head plant^{-1} (1281.00 g), gross yield plot^{-1} (14.60 kg), gross yield ha^{-1} (53.52 t/ha), marketable yield plant^{-1} (966.00 g), marketable yield plot^{-1} (11.59 kg) and marketable yield ha^{-1} (37.12 t/ha) were found from T_3G_0. . But, the lowest fresh weight of stem (51.03 g) and dry weight of stem (7.27 g) were found from T_1G_0.

In terms of economic performance, the highest gross return (433255.00 Tk/ha) and net return (264,393.00 Tk/ha) of cabbage were obtained from T_2G_2 where the lowest gross return (270976.00 Tk/ha) and net return (109,417.00 Tk/ha) of cabbage were recorded from T_3G_0. The highest benefit cost ratio (2.57) was noted from the combination of T_2G_2 and the lowest benefit cost ratio (1.68) was obtained from T_3G_0. From economic point of view, it is apparent from the above results that the combination of T_2G_2 was better than rest of the combination.

Conclusion

Among the combination of different levels of planting time and gibberellic acid; planting time at 20 November with 95 ppm GA_3 induced superior growth, yield contributing characters and yield of cabbage as well as highest economic return.

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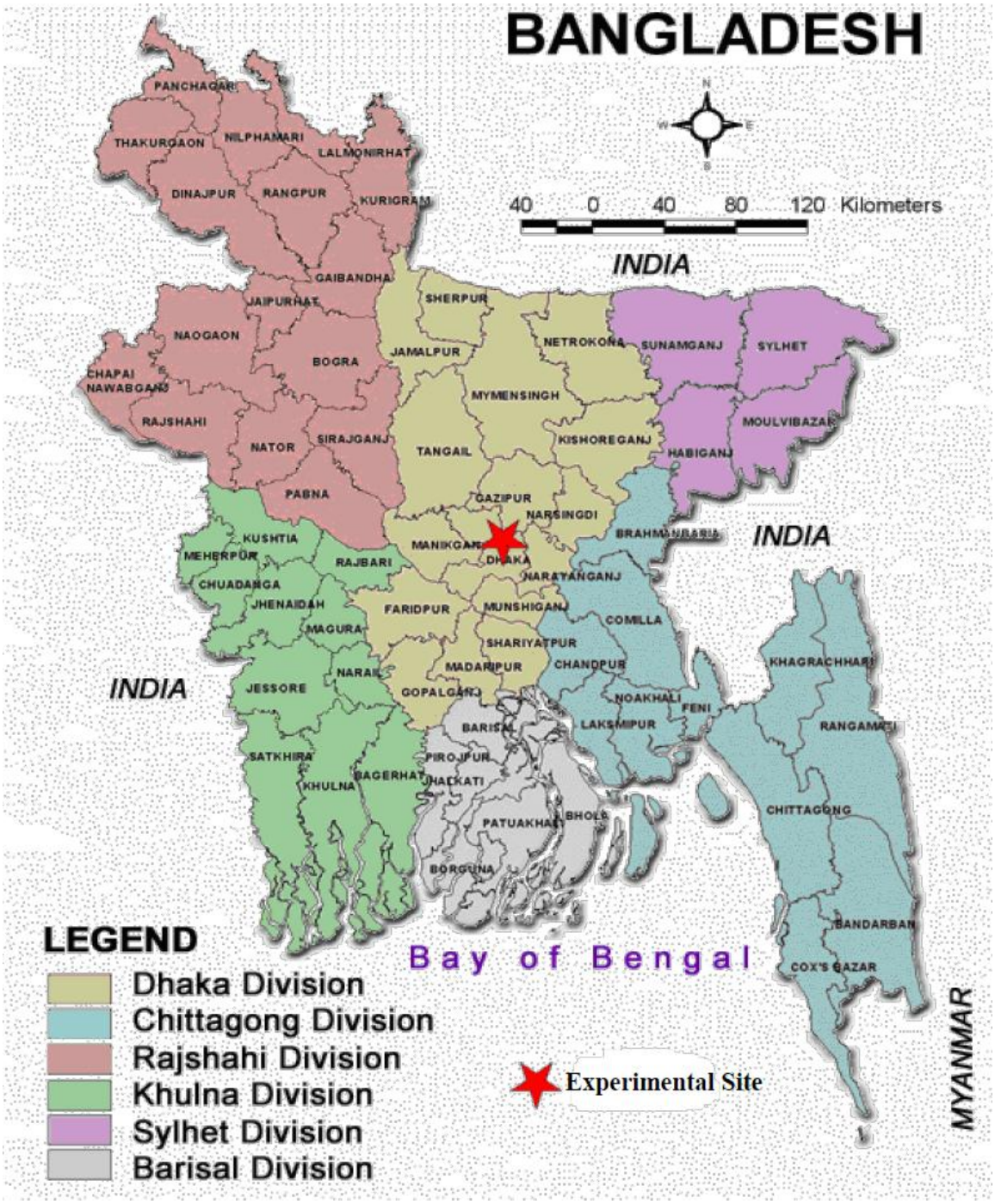
APPENDICES

Appendix I. Map showing the experimental site under study.



Appendix II. Monthly records of Temperature, Rainfall, and Relative humidity of the experiment site during the period from October 2013 to February 2014.

Year	Month	Air Temperature (^{0}c)			Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Maximum	Minimum	Mean			
2013	November	28.5	17.9	23.2	68.5	0.0	233.2
	December	27.6	15.2	21.4	71.6	0.0	210.5
2014	January	24.6	13.5	19.1	66.5	3.0	194.1
	February	27.5	18.6	23.1	60.0	2.0	221.5

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. The mechanical and chemical characteristics of soil of the experimental site as observed prior to experimentation.

Particle size constitution:

Sand	:	40 %
Silt	:	40 %
Clay	:	20 %
Texture	:	Loamy

Chemical composition:

Constituents	:	0-15 cm depth
P^H	:	6.4
Total N (%)	:	0.07
Available P (µ gm/gm)	:	18.49
Exchangeable K (meq)	:	0.07
Available S (µ gm/gm)	:	20.82
Available Fe (µ gm/gm)	:	229
Available Zn (µ gm/gm)	:	4.48
Available Mg (µ gm/gm)	:	0.825
Available Na (µ gm/gm)	:	0.32
Available B (µ gm/gm)	:	0.94
Organic matter (%)	:	1.4

Source: Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

Appendix IV. Analysis of variance of the data on plant height of cabbage.

Source of variation	Degrees of freedom	Mean square of plant height			
		30 DAT	45 DAT	60 DAT	At harvest
Replication	2	3.68	0.50	2.97	2.50
Factor A	2	7.28**	4.80*	9.44*	5.88**
Factor B	3	5.58*	9.51*	7.44*	8.52*
AB	6	1.62**	1.28**	3.26**	1.21**
Error	22	1.141	2.017	2.773	2.016

Appendix V. Analysis of variance of the data on number of leaves plant^{-1} of cabbage.

Source of variation	Degrees of freedom	Mean square of number of leaves plant^{-1}			
		30 DAT	45 DAT	60 DAT	At harvest
Replication	2	1.08	1.06	2.08	2.05
Factor A	2	0.19**	4.38*	4.28**	4.88*
Factor B	3	4.09*	9.27*	12.68*	18.27*
AB	6	1.76*	1.18**	0.49**	1.45**
Error	22	1.371	1.082	2.197	1.336

Appendix VI. Analysis of variance of the data on spread of plant of cabbage.

Source of variation	Degrees of freedom	Spread of plant (cm)			
		30 DAT	45 DAT	60 DAT	At harvest
Replication	2	2.40	2.42	5.467	3.46
Factor A	2	4.43*	11.44*	14.48*	13.47*
Factor B	3	41.85*	16.47*	16.68*	15.44*
AB	6	0.34**	1.27*	1.27**	3.29*
Error	22	1.115	2.283	1.138	2.314

Appendix VII. Analysis of variance of the data on yield contributing parameters of cabbage showing days from transplanting to head formation, fresh weight of stem and dry weight of stem.

Source of variation	Degrees of freedom	Days from transplanting to head formation	Fresh weight of stem (g)	Dry weight of stem (g)
Replication	2	1.92	5.32	5.37
Factor A	2	4.48*	11.90*	3.21*
Factor B	3	26.84*	30.70*	4.43*
AB	6	8.79*	3.46**	2.09*
Error	22	1.444	3.211	1.226

Appendix VIII. Analysis of variance of the data on yield contributing parameters of cabbage showing thickness of head, diameter of head and dry matter content of head.

Source of variation	Degrees of freedom	Thickness of head (cm)	Diameter of head (cm)	Dry matter content of head (%)
Replication	2	3.44	1.27	0.14
Factor A	2	1.65**	1.07*	1.39**
Factor B	3	12.80*	10.48*	6.54*
AB	6	6.06*	2.06*	2.28*
Error	22	0.392	1.116	1.037

Appendix IX. Analysis of variance of the data on yield of cabbage showing Fresh weight of whole plant, Gross yield plot^{-1} and Gross yield ha^{-1}.

Source of variation	Degrees of freedom	Gross weight of head plant^{-1}	Gross yield plot^{-1} (kg)	Gross yield ha^{-1} (ton)
Replication	2	23.58	4.45	2.86
Factor A	2	202.08*	14.55*	17.69*
Factor B	3	208.29*	8.95*	17.00*
AB	6	31.26*	6.32*	5.58*
Error	22	7.189	2.292	4.363

Appendix X. Analysis of variance of the data on yield parameters of cabbage showing Fresh weight of head plant^{-1}, Marketable yield plot^{-1} and Marketable yield ha^{-1}.

Source of variation	Degrees of freedom	Marketable yield plant^{-1} (g)	Marketable yield plot^{-1} (kg)	Marketable yield ha^{-1} (ton)
Replication	2	4.04	1.34	4.11
Factor A	2	34.81*	2.47*	30.06*
Factor B	3	361.86*	25.79*	31.90*
AB	6	7.57*	4.07**	5.88*
Error	22	2.476	1.162	2.266

Appendix XI. Production cost of cabbage per hectare.

A. Input cost (Tk./ha)

Treatment combination	Labour cost	Ploughing cost	Seed cost	Irrigation cost	GA_3 cost	Manure and fertilizers				Insecticide /pesticides	Sub-total (A)
						Cowdung	Urea	TSP	MOP		
T_1G_0	30,000	18,000	8000	12,000	0	12,000	4,800	5,500	4,000	9,500	103,800
T_1G_1	32,000	18,000	8000	12,000	3000	12,000	4,800	5,500	4,000	9,500	108,800
T_1G_2	32,000	18,000	8000	12,000	4500	12,000	4,800	5,500	4,000	9,500	110,300
T_1G_3	32,000	18,000	8000	12,000	6000	12,000	4,800	5,500	4,000	9,500	111,800
T_2G_0	30,000	18,000	8000	12,000	0	12,000	4,800	5,500	4,000	9,500	103,800
T_2G_1	32,000	18,000	8000	12,000	3,000	12,000	4,800	5,500	4,000	9,500	108,800
T_2G_2	32,000	18,000	8000	12,000	4,500	12,000	4,800	5,500	4,000	9,500	110,300
T_2G_3	32,000	18,000	8000	12,000	6,000	12,000	4,800	5,500	4,000	9,500	111,800
T_3G_0	30,000	18,000	8000	12,000	0	12,000	4,800	5,500	4,000	9,500	103,800
T_3G_1	32,000	18,000	8000	12,000	3,000	12,000	4,800	5,500	4,000	9,500	108,800
T_3G_2	32,000	18,000	8000	12,000	4,500	12,000	4,800	5,500	4,000	9,500	110,300
T_3G_3	32,000	18,000	8000	12,000	6,000	12,000	4,800	5,500	4,000	9,500	111,800

Appendix IX. Production cost of cabbage per hectare (cont'd).

B. Overhead cost (Tk./ha)

Treatment combination	Cost of lease of land (Tk.14% of value of land cost/year)	Miscellaneous cost (Tk. 5% of the input cost	Interest on running capital for 6 months (Tk. 14% of cost/year)	Sub-total (Tk.) (B)	Total cost of production (Tk./ha) [Input cost (A) + overhead cost (B)]
T_1G_0	42,000	5,190	10,569	57,759	161,559
T_1G_1	42,000	5,440	10,937	58,377	167,177
T_1G_2	42,000	5,515	11,047	58,562	168,862
T_1G_3	42,000	5,590	11,157	58,747	170,547
T_2G_0	42,000	5,190	10,569	57,759	161,559
T_2G_1	42,000	5,440	10,937	58,377	167,177
T_2G_2	42,000	5,515	11,047	58,562	168,862
T_2G_3	42,000	5,590	11,157	58,747	170,547
T_3G_0	42,000	5,190	10,569	57,759	161,559
T_3G_1	42,000	5,440	10,937	58,377	167,177
T_3G_2	42,000	5,515	11,047	58,562	168,862
T_3G_3	42,000	5,590	11,157	58,747	170,547

Rate of Cowdung = 1200 TK/ton
Rate of Urea = 16 Tk/kg
Rate of TSP = 22 Tk/kg
Rate of MoP = 20 Tk/kg
Labor cost = Tk 400/day/head
Required seed 160gm/ha; Rate = 50000 Tk/kg

PLATES

Plate 1: Photograph showing raising of seedling in the seed bed.

Plate 2: Photograph showing general view of experimental plot at growth stage.

Plate 3: Distal view of the experimental plot of cabbage.

Plate 4: Closure view of the experimental plot of cabbage.