RESPONSE OF STRAWBERRY GERMPLASM TO GIBBERELLIC ACID CONCENTRATIONS

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RESPONSE OF STRAWBERRY GERMPLASM TO GIBBERELLIC ACID CONCENTRATIONS

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All praises are due to Allah Who kindly enables the author to complete the present work

DEDICATED
TO
MY BELOVED TEACHER
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CERTIFICATE

This is to certify that the thesis entitled **"Response of Strawberry Germplasm (*fragaria x ananassa*) to gibberellic acid concentrations"** *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* ***Md. Jakir Hossan, Registration No. 04-1489****, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

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ABSTRACT

Response of gibberellic acid on the growth quality and yield of three strawberry germplasm was studied at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka during the period from October, 2010 to April, 2011. The experiment consisted of two factors, Factor A: Germplasm viz.V_1; SG-1, V_2; RABI-3 and V3; SG-3 and Factor B: Different concentrations of GA_3 viz. G_0; control (fresh water) G_1; 50ppm, G_2; 75ppm, G_3; 100ppm. Maximum number of fruits (26/plant), average fruit weight (14.63g) and maximum yield (379.80g /plant) was found in V_1 whereas the minimum result of above parameter was recorded in V_2. Maximum number of fruits (25/plant) and average fruit weight (13.21g) and maximum yield (336.60g) was in G_2. Maximum brix percentage was recorded from V_1 and G_2. For combined effect single fruit weight, yield per plant (419.70g), and brix percentage (5.17) was highest from treatment combination of V_1G_2. So, it may be concluded that V_1 with G_2 showed the best performance.

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro-Ecological Zone
ANOVA	Analysis of variance
cv.	Cultivar
cm	Centimeter
CRD	Complete Randomized Design
DAT	Days After Transplanting
DBI	Days After Bud Initiation
DMRT	Duncan's Multiple Range Test
DAT	Days After Transplanting
DMRT	Duncan's Multiple Range Test
et al.	And others
GA_3	Gibberellic Acid
g	Gram
HORT	Horticulture
LSD	Least Significance Difference
ppm	Parts Per Million
Res.	Research
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
Viz.	Namely
^{o}C	Degree Celsius
%	Percentage
@	At the rate of
Sci.	Science

CHAPTER I

INTRODUCTION

CHAPTER- I
INTRODUCTION

Strawberry (*Fragaria x ananassa* Duch.) is a natural hybrid of *Fragaria chiloensis* L.P. Mill. and *Fragaria virginiana* Duch. Strawberries have traditionally been a popular delicious fruit for its flavor, taste, fresh use, freezing and processing and are highly valued as dessert fruit. The plant comprises a shorten stem or crown from which arises leaves, runners, roots, auxiliary crowns and inflorescences (Maas, 1998; Bowling, 2000 and Darnell *et al*., 2003). A strawberry plant is often handled as a biennial, so that the maiden is removed after the new crop of plantlets is established, even though the plant can form fruits on the mother plant for a number of years. June Bearing strawberries produce a single, large crop per year during a 2 - 3 week period in the spring. There are basically 3 types of strawberry plants to choose from: June bearing, ever bearing and day neutral. June bearers are the traditionally grown plants, producing a single flush of flowers and many runners. They are classified into early, mid-season and late varieties. The largest fruits are generally produced from June bearing varieties. Ever bearing strawberries produce two to three harvests of fruit intermittently during the spring, summer and fall. Ever bearing plants do not send out many runners. Day neutral strawberries will produce fruit throughout the growing season.

Strawberries are native to most of the northern hemisphere, including Europe & Britain. The garden (modern) strawberry is simply a hybrid of North and South American varieties. The cultivated strawberry is an octoploid (2n = 56), and thought to be an autopolyploid. The leaves typically have three leaflets that means trifoliate.

Flowering in strawberry greatly influenced by environmental condition particularly temperature and day length (Maas 1998). Flowers and fruits are produced on a stalk that emerges from an axillary bud. Each flower is subtended by bracts and has five or more green sepals, five separate white petals, numerous stamens, and a domed receptacle (called a torus) that bears an indefinite number of pistils. The pistil (ovary plus style and stigma) develops into a one-seeded, dry fruit, called an achene.

Strawberries have been introduced in Bangladesh recently and getting popularity and cultivate in very small scale. Different regions of Bangladesh are suitable to cultivate strawberry in terms of photoperiod, temperature and humidity. It is the time to research for improving strawberries varieties which are cultivated in our environment. Since it is adaptable strawberry has an expand culture in the world. On the other hand since fruits can be obtained early in the seasons where there is no fresh fruit in the market its marketability is high. Another important aspect is that it can bring back the investment in a short period therefore it is suitable for farming. Apart from these, the incomes per unit area are high in strawberry cultures. Due to all these advantages in production and marketing strawberry area is gradually increasing in Bangladesh. To meet the increasing demand in our local market traders import large amount of strawberry from different foreign country.

In Bangladesh it can be grown everywhere during the month of October to April. Strawberry cultivation was successful in different zone of our country. However, our farmers are new in this field for successful commercial strawberry production. In addition, due to lack of suitable variety and knowledge of intercultural operation which is sustainable in our environment farmers are facing some sorts of problem. The rich sources of modern agricultural innovation are so far to our farmers. Horticulture farm of Sher-e-Bangla Agricultural University have started research work on strawberry through foliar application of different growth regulators to enhance production and quality. Foliar application of GA_3 has been successfully proved the

increased strawberry production in recent modern agricultural world. Gibberellins (GA_3) are probably the most studied hormones with regard to their effects on strawberry, and are associated with promotion of vegetative growth. Most of the studies involving GA are based on the plant response to exogenous applications. (Guttridge and Thompson, 1959; Guttridge, 1985). Gibberellic Acid-3 (GA_3) is a naturally occurring plant growth regulator. GA-3 occurs naturally in the seeds of many species and is produced commercially by growing *Gibberella fujikuroi* fungus cultures in vats, then extracting and purifying the GA-3. Moreover, foliar application of gibberellic acid with optimum concentration increase the yield production compared to traditional farming. Three germplasm were used in this research work to evaluate the effect of gibberellic acid concentration. Gibberellic acid is widely used for different crops and there is some positive effect on different crops that has been used as reference in this experiment. Three different concentration of gibberellic acid were used in this experiment.

Considering the above mentioned fact this study was conducted to find out the optimum concentration of gibberellic acid on the structure of the strawberry plant and response of different concentration on root induction, increasing leaf numbers, flower number as well as weight of total fruit production. Therefore, the aim of this study was be to produce high quality strawberry of different germplasm.

Therefore in this aspect several objectives may be outline as follows:

i. To evaluate suitable variety of strawberry.
ii. To find out the effect of gibberellic acid on different germplasm.
iii. To find out the effective recommended concentration of GA_3 .

CHAPTER II

LITERATURE REVIEW

CHAPTER II

LITERATURE REVIEW

Strawberry (*Fragaria* X *annanasa*) is one of the most popular fruit in the world. Strawberry plants are commercially obtained through vegetative propagation of mother plants, which produce daughter or runner plants currently used by strawberry growers for fruit production. Considering the world production area, around 10 billion quality strawberry transplants are required every year. It is new fruit crops in Bangladesh but with the increasing demand the production area is increasing day by day but no information is available under climatic conditions of Bangladesh. Nevertheless, some of the important and informative works so far been done abroad in these aspects have been presented below-

2.1 Literatures on the varietal characteristics

Strawberry is an herbaceous perennial plant, which can be grown as an annual or perennial crop under commercial cultivation. The plant comprises a shorten stem or crown from which arises leaves, runners, roots, auxiliary crowns and inflorescences (Maas, 1998 ; Bowling 2000 and Darnell *et al*., 2003).

Strawberry flowers are produced on a modified stem which is terminated by the primary flowers. Further stems can arise from main stem to produce secondary flowers from which tertiary flowers arise (Morgan, 2006). According to Morgan (2006), the final size and shape of the berry dependent on the number of achenes formed, which is determined by pollination and fertilization at the time of blooming. Cell division ceases relatively soon after flower opening, usually within 6 to 9 days and cell enlargement is then responsible for fruit growth. Enlargement normally takes 28 to 30 days but is temperature dependent and can vary with many weeks.

According to their photoperiodic response, strawberries are classified into three types: short day (SD) or June-bearing plants (in the northern hemisphere) which initiate flower buds under short days; long day or ever bearing plants which initiate flower buds under long days; and day neutral plants that are relatively insensitive to day length for flowering (Bowling, 2000 and Darnell *et al*., 2003).

Bitencourt De Souza *et al*. (1999) showed that strawberries are extremely perishable fruit with a short postharvest life mainly due to their soft texture and high sensitivity to fungal infection.

Fruit develops a fully red stage within 30 to 40 days after anthesis, depending on cultivar and environment (Perkins- Veaze, 1995; Wills et al., 1998).

Strawberry is an aggregate fruit and not a true fruit, in that the edible portion is the enlarged receptacle, which has many one-seeded fruit or achenes (a combination of seed and ovary tissue) located on the outer surface (Perkins-veazie,1995). Perkins-veazie (1995) reported that Strawberry fruit is non-climacteric and ripens rapidly. Strawberry fruit develop into fully ripe stage within 30-40 days after anthesis depending on cultivar and environment. He also reported SSC (Soluble Solid Content) in strawberry vary from 4-11% depending on cultivar and environment.

2.2 Literatures on the different growth chemicals

Growth hormones are key pieces in the control of several processes in the life cycle of strawberry plants. This section analyzes the effects of major hormones, such as gibberellins, auxins (4-Chloro phenoxy acetic acid), Nitrobenzene 20% w/w etc.

Fabiana Csukasi et al., (2011) conducted an experiment to observe gibberellins biosynthesis and signaling during development of the strawberry receptacle. The result indicated enlargement of receptacle cells during strawberry (*Fragaria* × *ananassa*) fruit development is a critical

factor determining fruit size, with the increase in cell expansion being one of the most important physiological processes regulated by the phytohormone gibberellins (GA) studied the role of GA during strawberry fruit development by analyzing the endogenous content of bioactive GAs and the expression of key components of GA signaling and metabolism. Bioactive GA_1, GA_3 and GA_4 were monitored during fruit development, with the content of GA_4 being extremely high in the receptacle, peaking at the white stage of development.

Exogenous GA promotes stolon formation in strawberry plants. Exogenous GA is absorbed through the leaves and translocated to axillary buds. If this occurs under long days more axillaries buds develop into stolon than under short photoperiods (Porlingis and Boynton, 1961). Therefore, higher amounts of GA are needed to accomplish a significant promotion of stolon during short photoperiods (Blatt and Crouse, 1970; Tafazoli and Vince-Prue, 1978). Additionally, Kender *et al.* (1971) reported that plants in a vegetative stage are more responsive to exogenous GA in terms of number of runners than plants in a flowering stage. The effects of GA on stolon production are cultivar related, some cultivars being less sensitive than others. This may be related to stolon formation potential (Singh *et al.*, 1960; Porlingis and Boynton, 1961b; Kender *et al.*, 1971; Franciosi *et al.*, 1980) and/or the level of endogenous GA's (Barritt, 1974).

Stolon promotion by applied GA has been reported in SD, DN, and LD cultivars (Moore and Scott, 1965; Dennis and Bennett, 1966; Dennis and Bennett, 1969; Braun and Kender, 1985; Dale *et al.*, 1996). Besides runner number, increases in runner length (Leshem and Koller, 1966), number of side branches on stolons (Singh *et al.*, 1960) and number of daughter plants (Moore and Scott, 1965; Dennis and Bennett, 1966; Dennis and Bennett, 1969; Franciosi *et al.*, 1980; Choma and Himelrick, 1984) have been reported. The number of daughter plants is determined by the number of stolons formed by the mother plant, by the number of stolon side branches, and by the number of

daughter plants formed on each stolon series (Barritt, 1974). Stolon formation *in vitro* was also enhanced by addition of GA to the growing media (Waithaka *et al.*, 1980).

Main axis (crown, stem) length increases with applied GA. This has been reported in cultivated strawberry *F. x ananassa* Duch. (Foster and Janick, 1969) as well as in wild strawberry *Duchesnea indica* (Guttridge and Thompson, 1964). Crown length increased with increasing concentrations of GA (Singh *et al.*, 1960; Porlingis and Boynton, 1961b) independently of photoperiod; however, the longer the photoperiod, the greater the effect from applied GA (Tafazoli and Vince-Prue, 1978). The promotion of crown elongation by applied GA was cultivar related (Weidman and Stang, 1983). Crown elongation may be so pronounced that plants lose their typical rosette habit (Guttridge, 1985). Curiously, crown elongation was not accompanied by an increase in crown dry weight (Weidman and Stang, 1983). Furthermore, crown diameter (Dale *et al.*, 1996) and number of lateral branches were not affected by GA applications (Biaiñ and Guitman, 1978Waithaka and Dana, 1978; Braun and Kender, 1985).

Experiments were conducted by Sharma and Singh (2009) to observe the effects of foliar application of gibberellic acid on vegetative growth, flowering, fruiting and various disorders in 'Chandler' strawberry. GA_3 (75 ppm) was applied to the strawberry plants either during mid-November (at fruit bud differentiation stage), or mid-February (pre-flowering stage) or at both times. Fruit under control were sprayed with tap water only. Observations were recorded on vegetative attributes like crown height, crown spread, petiole length, leaf number, leaf area; flowering and fruit set, fruit size; production of albino, malformed and button berries, total yield and marketable fruit yield and quality parameters, like juice content, TSS, ascorbic acid contents, acidity etc. Results indicated that GA_3 (75 ppm) spray either during mid-November or mid-February or at both times has favorably influenced all vegetative attributes

of ‘Chandler’ strawberry over control. Similarly, fruit set was increased, and production of malformed and button berries was reduced, but albinism remained unaffected. Although individual berry weight was reduced slightly, but fruit number, total as well as marketable yield was increased tremendously over control with no adverse effect on fruit quality parameters. In all, spraying GA_3 both during mid-November and mid-February was much more effective in achieving the desirable results than single application of GA_3 either during mid-November or mid-February.

To study the effect of ethrel (ethephon), GA_3 and uniconazole on strawberry plants an experiment was carried out by El-Shabasi *et al*., (2008). The results indicated that GA_3 application increased plant petiole.GA_3, ethrel and uniconazole increased total carbohydrate percentage in the foliage of strawberry plants. GA_3 at 10 ppm or ethrel at 250 ppm increased the number of flowers and total yield. TSS was not affected by growth regulators.

An experiment was conducted in December, 2002 by G. Paroussi *at el*., to see the effect of gibberellic acid (GA_3) on the vegetative growth, flowering characteristics and yield of three strawberry cultivars, the June bearing ‘Camarosa’ and ‘Laguna’ and the day neutral ‘Seascape’, was investigated, under heated and unheated greenhouse conditions and under short (10 h) and long (16 h) photoperiod. Young plants, potted in mid-November, were kept outdoors for 1 month, and then sprayed once with GA_3 (0, 50, 200 mg/l) and placed under the different environmental conditions. GA_3 application increased petiole length and leaf area of the strawberry plants in most treatments. It reduced the time needed for inflorescence emergence, accelerated flowering and increased the number of flower buds and open flowers in most growing conditions, the effect being greater on ‘Seascape’ compared to the other cultivars. GA_3 at the lower concentration (50 mg/l) did not affect total marketable yield, whereas at 200 mg/l, combined with long photoperiod, it increased the percentage of aborted flowers plus malformed fruits, resulting in a significant decrease in total marketable yield.

An experiment was conducted by Martínez *et al.,* (1994) to see the effect of GA_3 on postharvest ripening in strawberry fruit was evaluated through different biochemical parameters. Strawberry slices at different ripening stages were incubated with GA_3. A significant decrease on respiratory activity depending on GA_3 concentration was obtained. Also GA_3 was applied to whole and deachened fruit at white and green ripening stages. Results show that GA_3 has an inhibitory effect on strawberry fruit ripening, evidenced by a decrease in the respiratory activity and a delay in anthocyanin synthesis and chlorophylls degradation.

This trial was carried out by Miranda-Stalder *et al.,* (1990) in order to verify the effect of growth regulators on the yield and morphological features of strawberry *(Fragaria x. ananassa)*'Sequóia'. The tested products were the Gibberellic acid (30ppm), naphtaleneacetic acid (30ppm) and the biostimulants Ergostin (30ppm) and Atonik(Sodium nitrophenolate,98%TC) (30ppm). Three weekly applications of 10ppm were started just after plants entered the blooming stage. Results showed that there was no significant difference among treatments on the morphological aspects. However GA3 sprayed plants showed a different conformation. Treatments did not affect significantly average yield, total yield, not fruit classification (diameter and height). GA3 showed a tendency to increase the number of strawberry fruits. There was a significant interaction between number and size of strawberry fruits and the period of harvest for all treatments. Atonik increased fruit soluble sugar content (Brix index).

Michele *et al*., (1984) showed that field grown day-neutral, June-bearing and ever bearing strawberry cultivars responded similarly to GA_3 in most cases. GA_3 stimulated daughter-plant production in ‘Hecker’ and suppressed it in ‘Guardian’ (June). Fifty mg/l GA_3 increased initial runner production of all cultivars, while both 50 and 100 mg/l GA_3 increased fruit yield the year following treatment. In greenhouse studies, GA_3 initially increased leaf

number, petiole length and runner production, but the effects diminished with time. Phthalimide at 1000 mg/l was most effective in increasing leaf number.

Tafazoli and Vince-prue (1978) conducted an experiment to observe the application of GA_3 in aqueous solution to leaves or flowers of hermaphrodite cultivars of strawberry, Redgauntlet and Rabunda, prevented growth of the receptacle despite hand pollination. This inhibitory effect occurred only when GA_3 was applied prior to anthesis. Although viable pollen was produced and germinated to grow down the styles of treated plants, no seeds were formed. Receptacle growth failed underneath the unfertilized carpels, but the basal region devoid of carpels enlarged and ripened. Effect of GA_3 was the same *in vivo* and for flowers grown *in vitro*. ABA and BAP also inhibited growth of pollinated flowers *in vitro*, but neither substance stimulated growth of the base of the receptacle. 2-NOA stimulated receptacle growth of pollinated flowers but did not overcome the inhibitory effect of GA_3. Removal of fertile carpels 9 days after pollination prevented further receptacle growth. GA_3 treatment of the bare receptacle re-started growth but was less effective than 2-NOA.

Applications of GA_3 increase petiole length even under short days, mimicking the effect of long photoperiods on petiole growth (Porlingis and Boynton, 1961; Guttridge and Thompson, 1964; Kender *et al.*, 1971; Tafazoli and Vince-Prue, 1978; Tehranifar and Battey, 1997).

However, repeated applications of GA_3, or one GA_3 spray in warm conditions, may cause excessive elongation of the fleshy receptacle, bringing about fruit size reduction and/or fruit malformation (Porlingis and Boynton, 1961; Turner, 1963; Jonkers, 1965; Castro *et al.*, 1976; Tehranifar and Battey, 1997).

Time required for fruit set, fruit maturity, mean fruit weight and fruit yield/plant were affected by different concentration and in 2% concentration both fruit set and maturity were earlier (AVRDC, 1997).

Lopez-Galarza *et al.* (1989) noted earlier fruit production after treating short day cultivars with GA_3, without affecting other parameters such as total yield, fruit weight, firmness, brix percentage and acidity.

Gibberellins (GA_3) are probably the most studied hormones with regard to their effects on strawberry, and are associated with promotion of vegetative growth. Most studies involving GA are based on the plant response to exogenous applications. (Guttridge and Thompson, 1959; Guttridge, 1985).

Furthermore, the higher the concentration of applied GA, the faster the growth rate of the petiole (Porlingis and Boynton, 1961b; Choma and Himelrick, 1984). Leaf expansion and number of leaves also increase with GA applications (Waithaka *et al.*, 1978).

Some researchers reported increased flower number following GA_3 sprays, but in many cases all of the flowers aborted (Porlingis and Boynton,1961; Guttridge, 1985; Jonkers, 1965).

Castro *et al*. (1976) and Smith (1960) observed an increase in early and total fruit production in short day plants treated with three applications of GA_3 at low dose. The time between GA application and flowering was significantly decreased when SD plants were treated with GA_3 under short days (Smith *et al*., 1961; Jonkers, 1965).

Early fruit production due to GA_3 sprays was attributed to an acceleration of ripening, which was associated with the concentration of GA_3 in the spray. Therefore, within a limited range of GA_3 concentrations, the higher the concentration, the earlier the harvest (Turner, 1963).

Moore and Hough (1962) reported that auxin levels in the apex of strawberry plants grown under conditions inductive for flowering decreased after 15 inductive cycles, but the levels rapidly recovered immediately after the decrease. The authors considered this fluctuation as a consequence rather than a cause of floral induction. They also observed leaf growth reduction during short days but they detected no association between leaf growth and auxin level. Nevertheless, they concluded that there was a photoperiodic control of auxin levels in SD strawberries.

Guttridge and Thompson (1959) reported that petiole growth induced by GA_3 application is due to increases in both the number and the length of epidermal cells.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

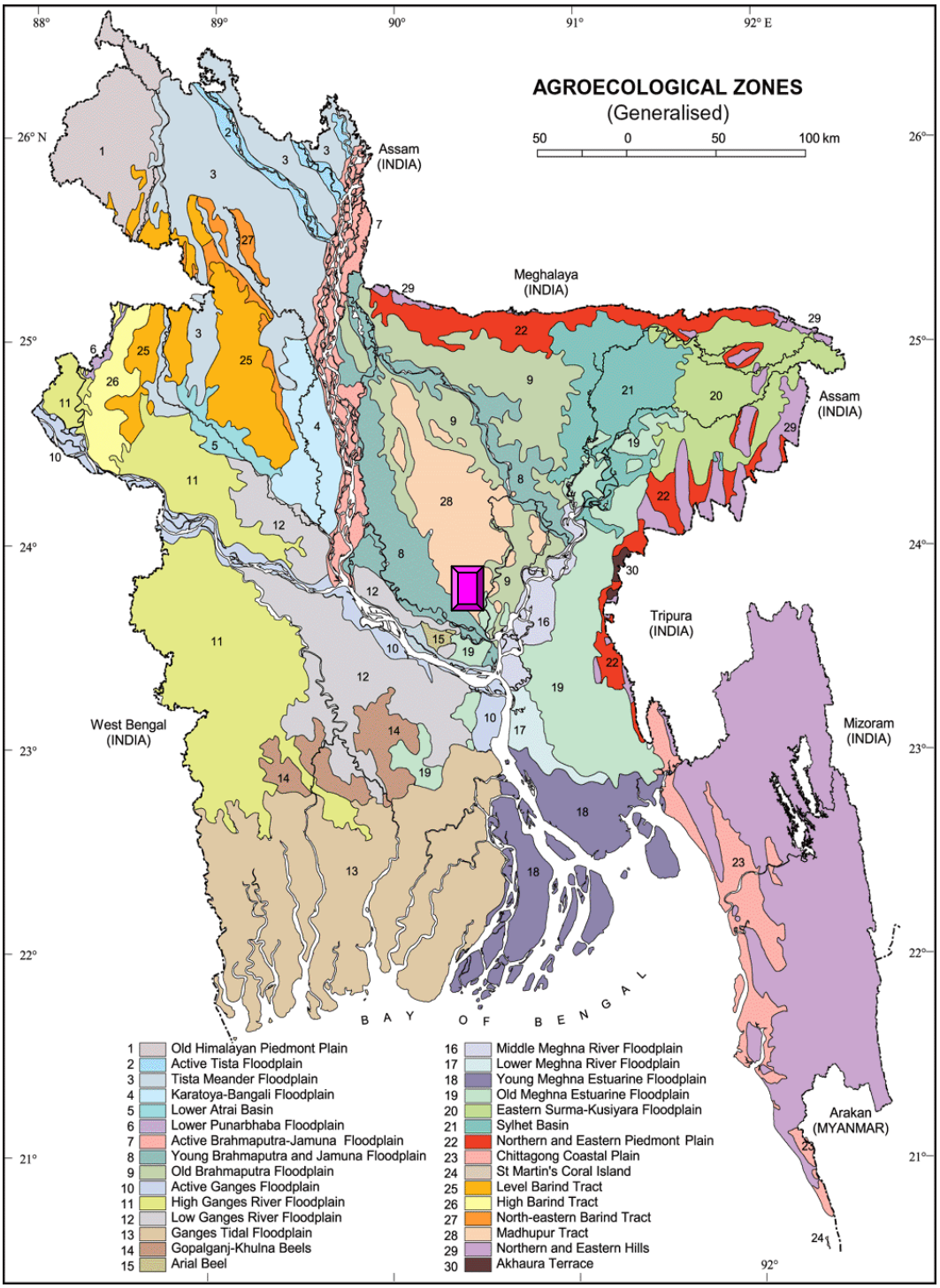
This chapter has been described the materials and methods that were used in execution the experiment.

3.1 Experimental site: The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, during the period from October, 2010 to April, 2011. Location of the site is 23º 74´N latitude and 90º 35´E longitude with an elevation of 8.2 meter from sea level (Anonymous, 1981).

3.2 Climatic condition: The experimental site was situated in the subtropical Climatic zone, characterized by heavy rainfall during the months from April to September and scanty rainfall during the rest of the year (Rabi season). Details of weather data in respect of maximum and minimum temperature (°C), relative humidity (%) and rainfall (cm) during the study period were collected from the Bangladesh Meteorological Department (climate division), Agargaon, Dhaka-1207 (Appendix- I).

3.3 Planting materials: The seedlings of SG-1, SG-2 & Rabi 3 were collected from USA, Japan and Bangladesh respectively. In case of each germplasm (SG-1, SG-2 & Rabi 3) only one seedling was collected from the mentioned countries then multiplied in SAU Horticultural farm

3.4 Treatments of the experiment: This experiment was conducted to find out the influence of varietals performance and gibberellic acid chemicals on strawberry production. There were two factors in this experiment. They were as follows:


AGROECOLOGICAL ZONES
(Generalised)
50 0 50 100 km
88°
89°
90°
91°
92° E
26° N
25°
24°
23°
22°
21°
Assam (INDIA)
Meghalaya (INDIA)
Tripura (INDIA)
Mizoram (INDIA)
West Bengal (INDIA)
Arakan (MYANMAR)
B A Y O F B E N G A L
1 Old Himalayan Piedmont Plain
2 Active Tista Floodplain
3 Tista Meander Floodplain
4 Karatoya-Bangali Floodplain
5 Lower Atrai Basin
6 Lower Punarbhaba Floodplain
7 Active Brahmaputra-Jamuna Floodplain
8 Young Brahmaputra and Jamuna Floodplain
9 Old Brahmaputra Floodplain
10 Active Ganges Floodplain
11 High Ganges River Floodplain
12 Low Ganges River Floodplain
13 Ganges Tidal Floodplain
14 Gopalganj-Khulna Beels
15 Arial Beel
16 Middle Meghna River Floodplain
17 Lower Meghna River Floodplain
18 Young Meghna Estuarine Floodplain
19 Old Meghna Estuarine Floodplain
20 Eastern Surma-Kusiyara Floodplain
21 Sylhet Basin
22 Northern and Eastern Piedmont Plain
23 Chittagong Coastal Plain
24 St Martin's Coral Island
25 Level Barind Tract
26 High Barind Tract
27 North-eastern Barind Tract
28 Madhupur Tract
29 Northern and Eastern Hills
30 Akhaura Terrace

Factor A: Variety

In the experiment three different varieties were used

i. V_1; SG-01
ii. V_2 ; RABI-3
iii. V_3; SG-03

Factor B: Gibberellic acid

Three different concentrations of GA_3 were used

- G_0; control (fresh water)
- G_1; 50ppm GA_3
- G_2; 75ppmGA_3
- G_3; 100ppm GA_3

3.5 GA3 concentration and application methods

- 50 ppm GA_3(50ppm GA_3 /1 L water)
- 75 ppm GA_3 (75ppm GA_3 /1 L water)
- 100 ppm GA_3 (100ppm GA_3 /1 L water)

Application of GA3 was started from 40 days after transplanting the seedlings and applied 3 times with 15 days intervals.

3.6 Pot preparation: Loamy soils were used for pot preparation. Soil and cow dung were mixed and pot were filled 7 days before transplanting. Only trace amount chemical fertilizers were added to the Pot as it increases the growth of the plant. Pots were filled on 5th October 2010. The weeds and stubbles were completely removed from the soil.

3.7 Design and layout of the experiment: Two-factor experiment was laid out in the Complete Randomized Design (CRD) with three replications. In the experiment 36 pots were used. The size of the each pot was 25 cm (10 inches) in diameter and 20 cm (8 inches) in height.

3.8 Cultivation technology

3.8.1 Transplanting of seedlings: Seedlings were transplanted in such a way that the crown does not go much under the soil or does not remain in shallow. On an average runners were planted at 7 cm depth in pot on 12th October, 2010. Total numbers of Pots were used in 36 and 12 from the each germplasm.

3.8.2 Tagging of plants: Plants were tagged on 17th October, 2010 using laminating card.

3.8.3 Weeding: Weeding was done in all the Pots and when required to keep the plant free from weeds.

3.8.4 Irrigation: Frequency of watering depended upon the moisture status of the soil. However, water logging was avoided, as it is harmful to plants.

3.8.5 Protection: During fruit ripening time the Pot were covered with net to protect the fruit from bird, squirrel and rat**.**

3.8.6 Disease and pest control: Pest can be a major factor limiting Strawberry production. Experimental crop was infected by grey mold during the flowering stage. Disease was controlled by spraying Diathene M-45. Fungicide was sprayed two times at 15 days interval. Crop was also attacked by leaf feeder during the growing stage and flowering stage. The larvae were controlled by Pyrithrum @ 1.5 ml/l. The insecticides were sprayed one time after 7 days of planting of suckers.

3.8.7 Harvesting of fruits: Fruits were harvested from 5th January, 2011 when the fruit reached at harvesting stage. In harvesting period the fruits turn red in color with waxy layer.

3.9 Parameters: Data were collected in respect of the following parameters from each pot.

a) Plant height(cm)
b) Crown length(cm)
c) Leaf number per plant
d) Leaf area(cm^2)
e) Number of runner per plant
f) Length of runner
g) Days to flower bud Initiation
h) Days to flowering
i) Days to fruit harvesting from flowering
j) No of flower bud per plant
k) No of flower per plant
l) No of fruit per plant
m) Yield per plant
n) Individual fruit weight
o) Brix percentage
p) Fruit length(cm)
q) Diameter of fruit(cm)

3.10 Data Collection

3.10.1 Measurement of plant height, crown length:

Plant height and crown length of each plant was measured in cm by using meter scale and the mean was calculated.

3.10.2 Number of leaves, flower buds, flowers and fruits per plant: Number of leaves, flower buds, flowers and fruits per plant was recorded by counting all the leaves and flower bud, flowers and fruits from each plant of each pot and the mean was calculated.

3.10.3 Leaf area measurement: Leaf area was measured by using CL-202 Leaf Area meter and expressed in $cm^{2.}$ For leaf area measurement the mature leaf were collected from each plant. The leaf areas were measured by destructive method.

3.10.4 Days to flower initiation, flowering, fruiting and fruit harvesting: Days to inflorescence initiation, flowering, fruiting and fruit ripening was counted from the date of transplanting.

3.10.5 Measurement of brix percentage: The Brix percentage was measured by portable refractometer (ERMA, Tokyo-Japan). To measure the Brix percentage whole fruits were smashed and collected the juice. The brisk percentages of fruits were measured at 20^0C the readings were corrected by using temperature correction table.

3.10.6 Measurement of fruit weight: Every fruit weight was obtained with the help of electric balance. The total fruit weight of each pot was obtained by addition the weight of total fruit and average fruit weight was obtained from divided the total fruit weight by total number of fruit.

3.10.7 Fruit length and diameter measurement: Fruit Length, Diameter and Pedicel Diameter were measured by Digital Caliper -515 (DC- 515).

3.11 Statistical analysis: Collected data for various characters were statistically analyzed using MSTAT computer package programme. Mean for all the treatments were calculated and the analysis of variance for each of the characters were performed by F (Variance ratio) test. Differences between treatments were evaluated by Duncan's Multiple Range (DMRT) test (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

Present experiment was conducted to determine the response of GA_3 on different germplasm of strawberry have been presented and discussed in this chapter. Some of the data have been expressed in table(s) and others in figure(s) for each of discussion, comprehension and understanding. A summary of the analysis of variances in respect of all the parameters have been shown on Appendices. Results are presented under the following heads.

4.1 Plant Height (cm)

Significant difference in plant height was found due to germplasm performance and GA_3 individually (Appendix II). There was a gradual increasing trend of plant height at different days after transplanting. Highest plant height (28cm) was obtained from SG-1(V_1) and lowest plant height (26cm) was obtained from RABI-3 at 73 DAT (Fig.1).This result indicate that the plant height of different strawberry genotype is not same and this character was genetically controlled.

Plant height of strawberry showed statistically significant differences for the application of GA_3 at 45, 52, 59, 66 and 73 DAT (Appendix II**).** Fig.2 represents a gradual increasing trend of plant height with days after transplanting for different concentration of gibberellic acid application**.** Highest plant height (31.44cm) was recorded from G_2 (75ppm) treated plant and smallest plant height (17.22cm) was found in G_0 (control) treatment at 73 DAT **(**Fig.2**)**. There was no significant variation in terms of plant height between G_2 (31.40cm) and G_3 (31.00cm) treated plant at 73 DAT. As GA_3 increases cell elongation so plant height increases. El-Shabasi et al., (2008) reported that GA_3 application increased petiole length. The plant height depends on the leaf length, as the stem (crown) of strawberry is smaller than the leaf. So when the petiole length increases, the plant height also

increases. The similar result was also founded by Prolings and Boynton,(1961); Guttridge and Thompson,(1964).Shittu and Adeleke (1999) reported that plant height was optimum with the application of 75ppm-100ppm GA_3 with other levels of application.

When combined effect of germplasm and growth regulators was showed significant variation **(**Appendix II**).** It was observed that tallest (29.67cm) plant was produced by V_3G_2 and lowest (19.67cm) plant was obtained from V_1G_0 treatment at 73 DAT (Table 1).

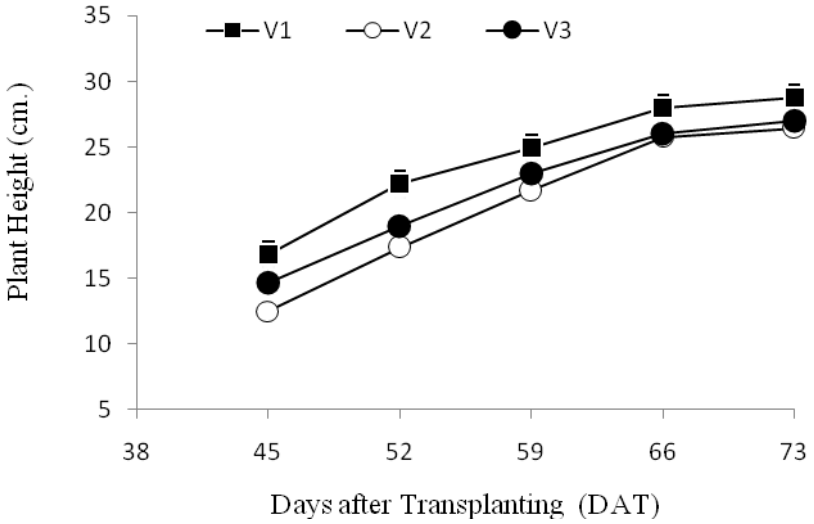


Fig.1. Effect of varietal performance on plant height at different days after transplanting of strawberry germplasm (V_1; SG-1, V_2; RABI-3 and V_3; SG-3)

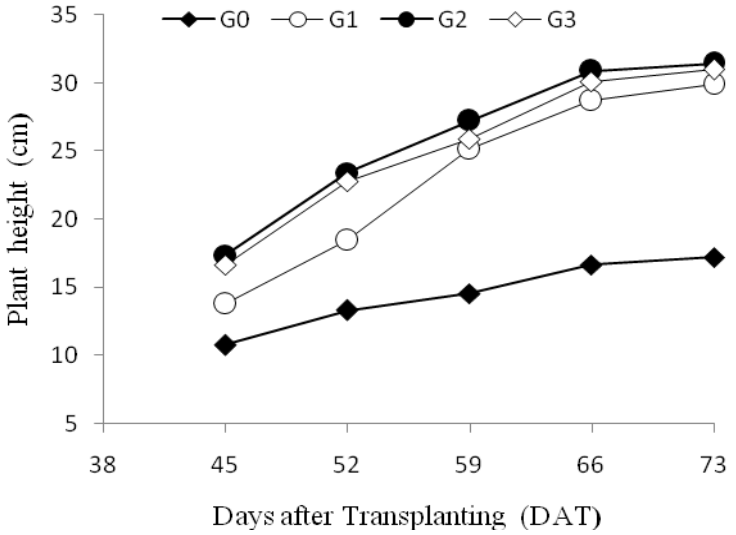


Fig.2. Effect of gibberellic acid on plant height at different days after transplanting of strawberry germplasm (G_0; Control, G_1; 50 ppm GA_3, G2; 75 ppm GA_3, G_3; 100 ppm GA_3

Table 1. Interaction effect of germplasm and gibberellic acid on plant height at different days after transplanting of strawberry [x]

Treatment [y]	Days after transplanting (DAT)									
	45		52		59		66		73	
V_1G_0	11.33	cd	15.00	d	17.33	e	19.00	e	19.67	e
V_1G_1	17.33	a	24.33	a	29.00	ab	31.33	ab	33.00	ab
V_1G_2	19.50	a	23.67	ab	27.33	abc	31.67	ab	31.67	abc
V_1G_3	19.00	a	25.67	a	26.00	bc	30.00	bc	30.67	abcd
V_2G_0	10.67	cd	12.33	e	13.00	f	15.33	f	16.00	f
V_2G_1	12.00	bcd	15.00	d	22.00	d	28.33	cd	29.33	bcd
V_2G_2	14.33	b	21.33	c	24.67	cd	28.00	cd	28.67	cd
V_2G_3	13.00	bc	20.67	c	27.00	abc	31.33	ab	31.67	abc
V_3G_0	10.33	d	12.67	e	13.33	f	15.67	f	16.00	f
V_3G_1	12.00	bcd	16.00	d	24.33	cd	26.33	d	27.33	d
V_3G_2	18.33	a	25.33	a	29.67	a	33.00	a	34.00	a
V_3G_3	18.00	a	22.00	bc	24.67	cd	29.00	bcd	30.67	abcd
$LSD_{(0.05)}$	2.30		2.211		2.972		15.67		3.323	
CV(%)	9.29		6.73		7.6		15.67		7.2	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-3 and V_3 ; SG-3; G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3

4.2 Leaf Number

Significant difference in leaf number was found due to varietals performance and different concentration of GA_3 individually (Appendix II). Maximum leaf number (11.67) per plant was observed from V_1 and minimum number of leaves (9.75) was observed from V_2 treatment at 73 DAT (Fig. 3).

When the plants treated with different concentration of GA_3 maximum leaf number was produced over control as it increase the plant height. At 73 DAT, the maximum (11.11) number of leaves per plant was recorded from G_2 (75ppm) which was statistical similar to G_1 and G_3 treatment. Lowest leaf number (9.56) was obtained from control (Fig. 4). Leaf number had the greatest positive direct effect on fruit yield .Waithika *et al*.(1978) also reported that leaf number also increase with the increasing certain concentration of Gibberellic acid .

When combined effect of germplasm and foliar application was considered, it was observed that maximum leaves number (13.67/plant) were produced by V_1 treated with 75ppm GA_3 and minimum leaves number (9.33/plant) were obtained from V_2G_0 treatment **(**Table 2**).** However, the number of leaves were statistical identical with the treatment combination of V_2G_2, V_2G_3 and V_2G_o at 73 DAT.

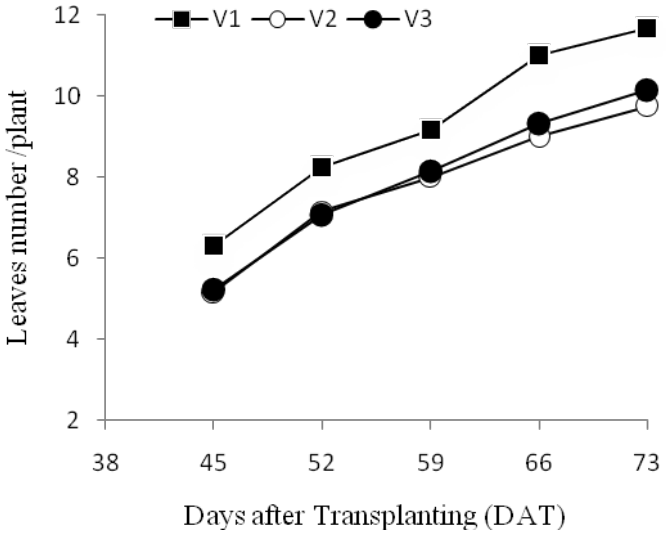


Fig.3 Effect of varietal performance on leaves number at different days after transplanting of strawberry germplasm (V_1; SG-1, V_2; RABI-3 and V_3; SG-3)

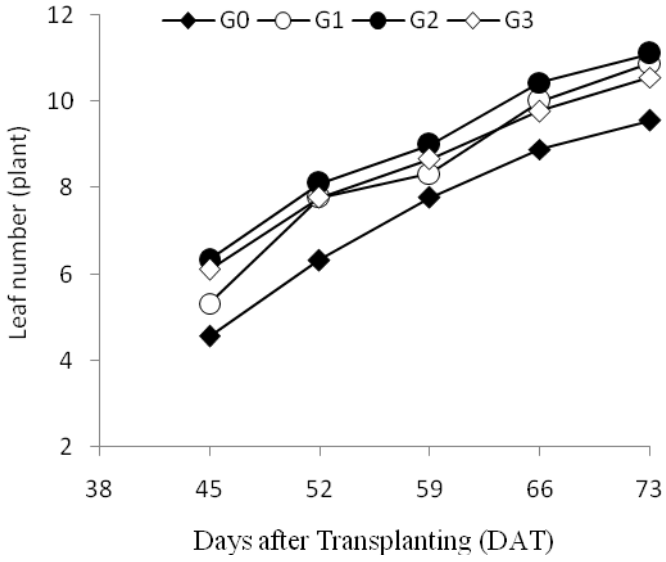


Fig.4 Effect of gibberellic acid on leaf number at different days after transplanting of strawberry germplasm (G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3)

Table 2. Interaction effect of germplasm and gibberellic acid on number of leaves/plant at different days after transplanting of strawberry [x]

Treatment [y]	Days after transplanting (DAT)									
	45		52		59		66		73	
V_1G_0	5.00	cd	6.67	fgh	8.00	cd	9.67	cd	10.00	c
V_1G_1	6.00	b	8.00	cd	8.00	cd	11.00	b	11.67	b
V_1G_2	7.33	a	9.33	a	10.00	ab	12.33	a	13.33	a
V_1G_3	7.00	a	9.00	ab	10.67	a	11.00	b	11.67	b
V_2G_0	4.33	d	6.00	h	7.67	d	8.33	d	9.33	c
V_2G_1	5.00	cd	8.33	bc	9.00	bc	10.00	bc	10.33	bc
V_2G_2	5.67	bc	7.33	def	8.00	cd	9.00	cd	9.67	c
V_2G_3	5.67	bc	7.00	efg	7.33	d	8.67	cd	9.67	c
V_3G_0	4.33	d	6.33	gh	7.67	d	8.67	cd	9.33	c
V_3G_1	5.00	cd	7.00	efg	8.00	cd	9.00	cd	10.67	bc
V_3G_2	6.00	b	7.67	cde	9.00	bc	10.00	bc	10.33	bc
V_3G_3	5.67	bc	7.33	def	8.00	cd	9.67	cd	10.33	bc
$LSD_{(0.05)}$	0.649		0.742		1.013		1.192		1.257	
CV(%)	7.31		5.88		7.12		7.23		7.08	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-3 and V_3; SG-03, G_0; Control, G_1; 50 ppm GA_3, G_2 ; 75 ppm GA_3, G_3; 100 ppm GA_3

4.3 Leaf areas (cm^2)

Strawberry leaf areas showed significant variation with three germplasm (Appendix III). Leaf area showed a gradual increasing trend at 45, 52, 59, 66 and 73, DAT (Fig. 5). At 73 DAT the maximum leaf area per plant (69.79cm^2) was recorded from V_1 germplasm whereas, at the same DAT the minimum leaf area (50.42cm^2) was observed from V_2 germplasm. V_2 and V_3 showed statistical identical in terms of leaf area at 73 DAT. Fig. 5 represents that SG-1 produced maximum area of leaf among germplasm.

Foliar application of GA_3 showed a statistically significant variation at 45, 52, 59, 66 and 73, DAT (Appendix III). Foliar feeding showed increasing trends of leaf area at 45, 52, 59, 66 and 73, DAT (Fig. 6). Maximum (64.54 cm^2) leaf area was recorded in G_2.On the other hand the minimum (50.26cm^2) leaf area was recorded from G_0 at 73 DAT. This finding is in agreement with the reports of Paroussi *et al*., (2002) and Sharma *et.al.*, (2009).

Combine effect of germplasm with foliar application of GA_3 was found to be significant (Appendix III). Leaf area varied from 80.46 cm^2 to 39.61cm^2 due to interaction effect between germplasm and GA_3 application. Among the combined effect the maximum (80.46cm^2) leaf area was recorded from combination of V_1G_3 and the minimum (39.87) leaf area was obtained from V_2G_0 (Table 3).

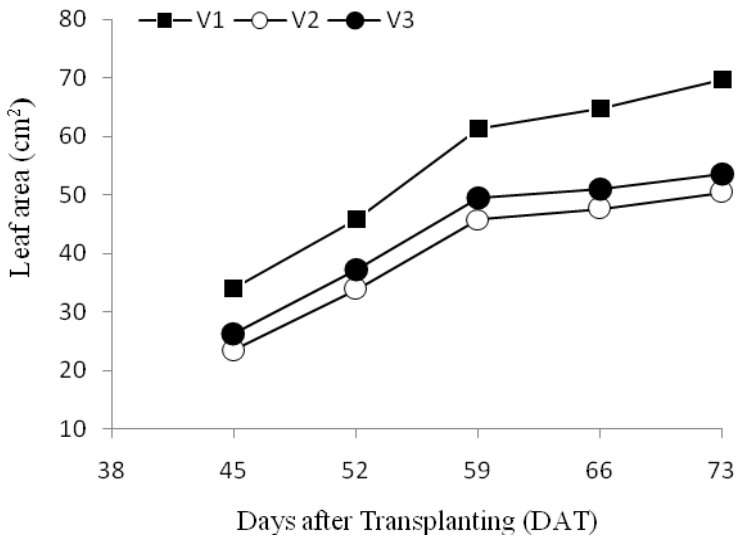


Fig. 5 Effect of varietal performance on leaf area at different days after transplanting of strawberry germplasm (V_1; SG-1,V_2; RABI-3 and V_3; SG-3)

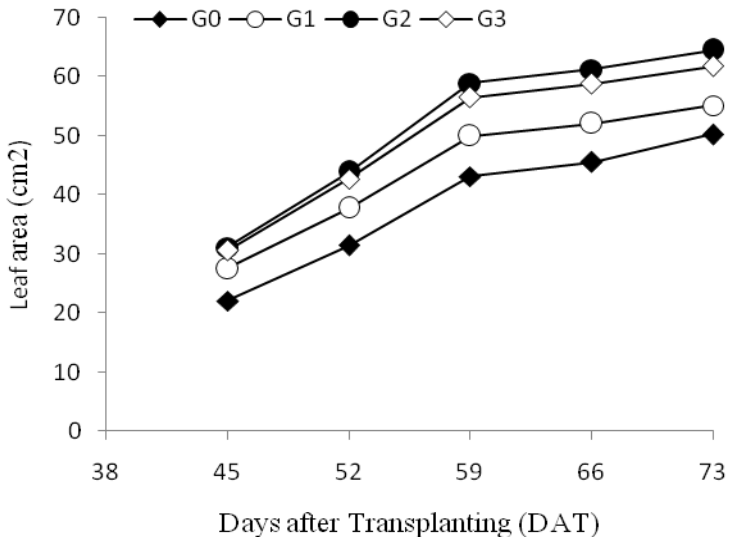


Fig.6 Effect of gibberellic acid on leaf area at different days after transplanting of strawberry germplasm (G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3

Table 3. Interaction effect of germplasm and gibberellic acid on leaf area at different days after transplanting of strawberry [x]

Treatment [y]	Days after transplanting (DAT)									
	45		52		59		66		73	
V_1G_0	29.59	bcd	39.28	c	52.59	de	55.6	cde	61.91	bcd
V_1G_1	40.93	a	49.96	ab	63.98	abc	67.21	ab	71.61	ab
V_1G_2	27.43	cde	40.09	c	56.13	bcd	60.94	bcd	65.18	bcd
V_1G_3	37.61	ab	54.02	a	72.05	a	74.88	a	80.46	a
V_2G_0	20.71	ef	26.94	e	35.53	g	36.81	g	39.87	f
V_2G_1	22.25	def	35.65	cd	49.88	def	51.17	def	54.26	de
V_2G_2	30.8	bc	42.28	bc	54.69	cd	56.93	bcd	59.51	bcde
V_2G_3	19.61	ef	30.24	de	43.07	efg	45.62	efg	48.04	ef
V_3G_0	15.91	f	28.01	de	41.24	fg	44.41	fg	48.99	ef
V_3G_1	19.32	ef	27.64	de	35.97	g	38.05	g	39.61	f
V_3G_2	35.09	abc	49.16	ab	66.01	ab	65.97	abc	68.93	bc
V_3G_3	34.52	abc	43.89	bc	54.4	cd	55.86	cde	57.03	cde
$LSD_{(0.05)}$	7.85		7.61		10.04		10.06		10.98	
CV(%)	16.76		11.6		11.43		10.96		11.24	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

y V1; SG-1, V2; RABI-3 and V3; SG-03, G0; Control, G1; 50 ppm GA3, G2; 75 ppm GA3, G3; 100 ppm GA3

4.4 Number of Runner/plant

As evident from (Appendix IV**)** number of runner was different from V_1, V_2 and V_3 germplasm. Maximum number of runner/plant (3.92) was recorded from V_1 and the minimum (3.17) number of runner/plant was obtained from V_2 at 73 DAT (Fig. 7).

Foliar application of GA_3 on the number of runner/plant was also found to be significant (Appendix IV). Maximum number of runner (4.00/plant) was obtained from the plant treated with G_2 treatment and the minimum number of runner (3.00/plant) was recorded from G_0 treatment at 73 DAT (Fig. 8). However in G_1, G_2 and G_3 treatment the number of runner was almost statistical similar in each case at 73 DAT. These figures were 3.67, 4.00 and 3.78 respectively. Similar opinion was also put forwarded by Vijaya and Subhan (1997).

Interaction between variety and foliar application of GA_3 on number of runner was found to be significant (Appendix IV). Maximum number of runner (4.33/plant) was obtained from V_2G_2 treatment, while the minimum number of runner (2.67/plant) was obtained from V_2G_0 treatment (Table 2).However, there were no significance difference in terms of number of runner between 66 DAT and 73DAT.

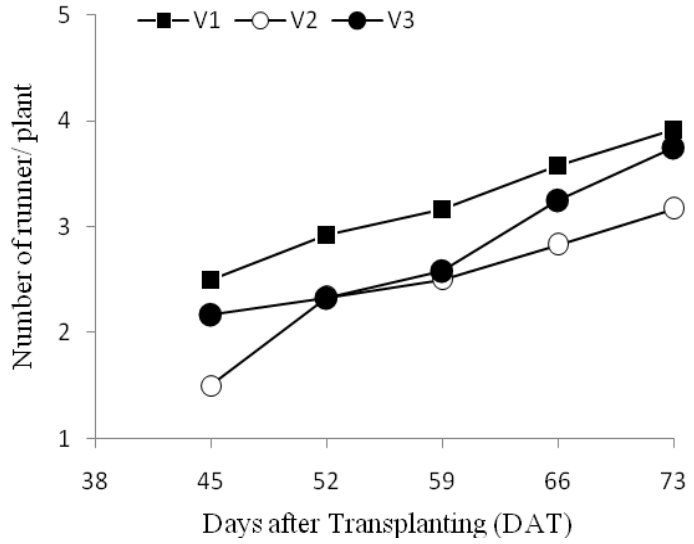


Fig:7 Effect of varietal performance on number of runner at different days after transplanting of strawberry germplasm (V_1; SG-1, V_2; RABI-3 and V_3; SG-3)

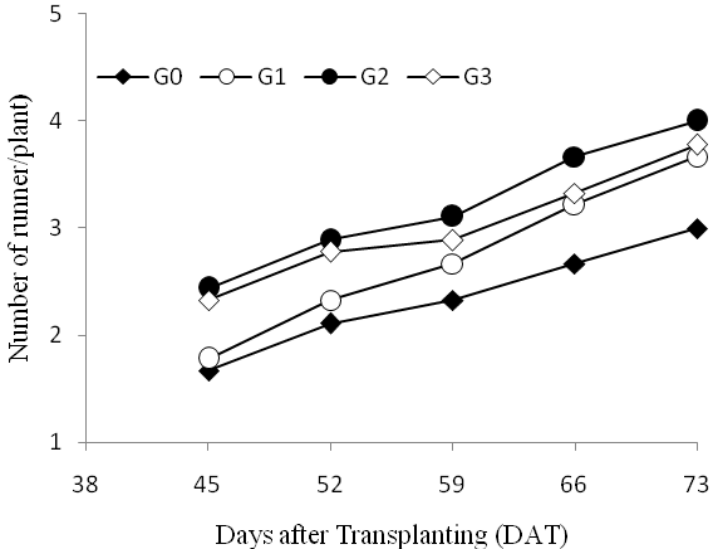


Fig.8 Effect of gibberellic acid on runner number at different days after transplanting of strawberry germplasm (G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3)

Table 4. Interaction effect of germplasm and gibberellic acid on number of runner/plant at different days after transplanting of strawberry [x]

Treatment [y]	Days after transplanting (DAT)									
	45		52		59		66		73	
V_1G_0	2.00	b	2.33	bc	2.67	bcd	3.00	bcd	3.33	bcd
V_1G_1	2.00	b	2.67	bc	3.00	abc	3.67	ab	4.00	ab
V_1G_2	3.00	a	3.00	ab	3.33	ab	4.00	a	4.33	a
V_1G_3	3.00	a	3.67	a	3.67	a	3.67	ab	4.00	ab
V_2G_0	1.00	c	2.00	c	2.00	d	2.33	d	2.67	d
V_2G_1	1.00	c	2.00	c	2.33	cd	2.67	cd	3.00	cd
V_2G_2	2.00	b	2.67	bc	3.00	abc	3.33	abc	3.67	abc
V_2G_3	2.00	b	2.67	bc	2.67	bcd	3.00	bcd	3.33	bcd
V_3G_0	2.00	b	2.00	c	2.33	cd	2.67	cd	3.00	cd
V_3G_1	2.33	b	2.33	bc	2.67	bcd	3.33	abc	4.00	ab
V_3G_2	2.33	b	3.00	ab	3.00	abc	3.67	ab	4.00	ab
V_3G_3	2.00	b	2.00	c	2.33	cd	3.33	abc	4.00	ab
$LSD_{(0.05)}$	0.339		0.689		0.794		0.842		0.628	
CV(%)	11.4		16.15		17.14		15.52		10.32	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-3 and V_3; SG-03; G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3

4.5 Length of Runner/plant (cm)

There was significant variation in respect of length of runner was obtained due to the effect of variety and GA_3 individually (Appendix V). Length of runner showed a gradual increasing trend at 45, 52, 59, 66, and 73 DAT (Fig. 9). Longest length of runner (32.95 cm) was recorded V_1 and the smallest (30.50 cm) was recorded from V_2. It was observed that the length of runner was statistical similar between V_1 and V_3 at 73 DAT.

Plant treated with of GA_3 showed a significant variation on the length of runner (Appendix V). Longest (33.41 cm) length of runner was found in G_2 treatment which also statistically similar to G_1 and G_3 treatment (33.28 cm and 32.17 respectively) and the smallest length of runner (28.67cm) was found in G_0 (Fig. 10).

Combine effect of variety and GA_3 was found to be significant in terms of runner length (Appendix V). It was recorded that the longest runner (35.80 cm) was produced by V_1G_2 treatment combination which was statistically almost similar with V_1G_1 treatment (35.17 cm). Lowest (27.61 cm) length of runner was found in V_1G_0 (Table 5).

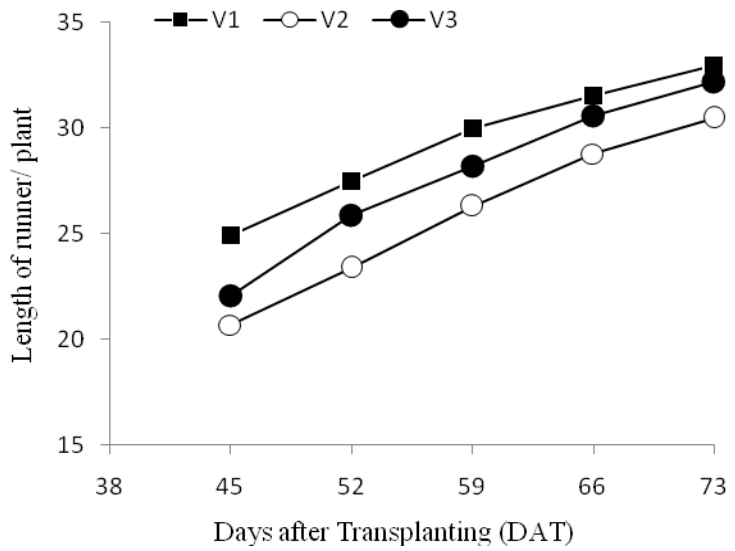


Fig.9 Effect of varietal performance on runner length at different days after transplanting of strawberry germplasm (V_1; SG-1, V_2; RABI-3 and V_3; SG-3)

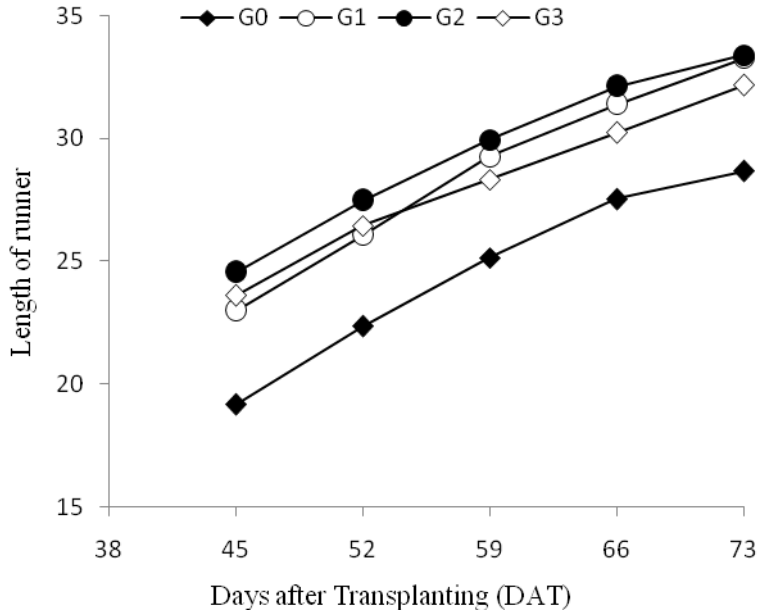


Fig.10 Effect of gibberellic acid on length of runner at different days after transplanting of strawberry germplasm (G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3)

Table 5. Interaction effect of germplasm and gibberellic acid on length of runner at different days after transplanting of strawberry [x]

Treatment [y]	Days after transplanting (DAT)									
	45		52		59		66		73	
V_1G_0	20.50	e	23.22	d	25.78	c	26.55	d	27.61	f
V_1G_1	25.07	ab	27.11	bc	30.83	ab	33.47	a	35.80	a
V_1G_2	27.22	a	30.17	a	32.47	a	34.17	a	35.17	a
V_1G_3	26.93	a	29.40	ab	30.89	ab	32.07	ab	33.22	abc
V_2G_0	16.33	f	19.87	e	23.73	d	27.63	d	28.50	ef
V_2G_1	21.00	de	23.67	d	27.17	c	29.43	bcd	31.22	cde
V_2G_2	22.93	bcd	25.00	cd	27.13	c	28.90	cd	30.40	cdef
V_2G_3	22.50	cde	25.11	cd	27.27	c	29.22	bcd	31.87	bcd
V_3G_0	20.67	de	24.00	d	25.91	c	28.44	cd	29.89	def
V_3G_1	22.83	bcd	27.44	bc	29.83	b	31.23	abc	32.83	abcd
V_3G_2	23.44	bc	27.24	bc	30.29	b	33.33	a	34.67	ab
V_3G_3	21.33	cde	24.87	cd	26.87	c	29.47	bcd	31.42	cde
$LSD_{(0.05)}$	2.071		2.304		1.941		2.770		2.895	
CV(%)	5.45		5.34		8.09		5.42		6.39	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-3 and V_3 ; SG-03; G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3

4.6 Number of Stolon/ Plant

There was no significant variation among germplasm in terms of number of stolon (Appendix VI**)**. Number of stolon showed a gradual increasing tendency at 45, 52, 66, 73 DAT (Fig.11). At 73 DAT the maximum number of stolon per plant (2.67) was recorded from V_1 and the minimum number of stolon per plant (2.08) was observed from V_2.

Foliar Application of GA_3 showed statistical similar in each dose of GA_3 application over control in terms number of stolon (Appendix VI). Foliar application of GA_3 showed increasing trends of number of stolon at 45, 52, 59, 66 and 73 DAT (Fig. 11). Maximum number of stolon (2.89) was recorded in G_2 and minimum number of stolon (1.78) was recorded from G_0 at 73 DAT. This finding is an agreement with the report of Singh *et al.*, 1960.

Combine effect of variety with foliar application of GA_3 was found to be variation (Appendix VI). Maximum number of stolon (3.33) was produced by the treatment combination of V_1G_2 and the minimum number of stolon (1.67) was obtained from V_1G_0 and V_2G_O (Table 3**).** However it was recorded that the number of stolon produced by the V_2G_2, V_2G_3 and V_3G_3 treatment were statistical similar.

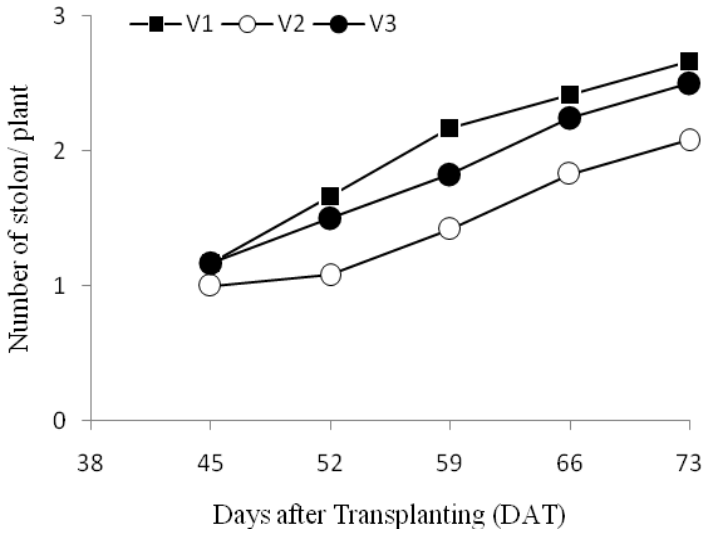


Fig.11 Effect of varietal performance on number of stolon at different days after transplanting of strawberry germplasm (V_1; SG-$_1$, V_2; RABI-3 and V_3; SG-3)

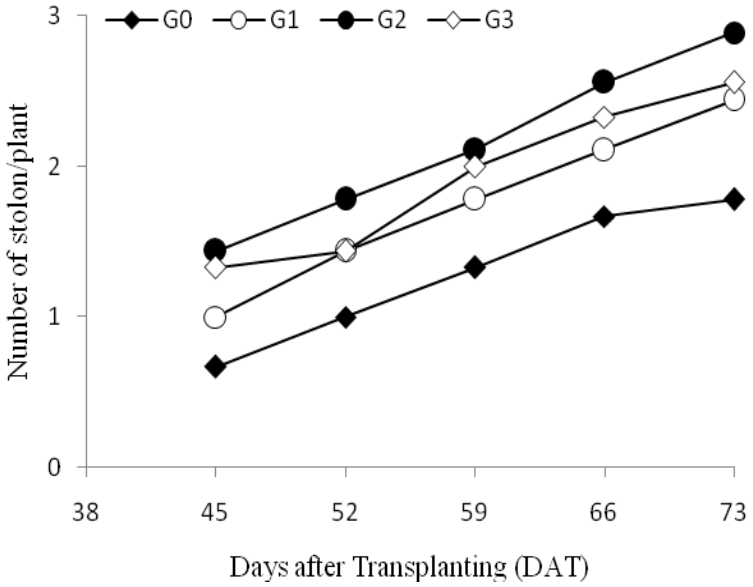


Fig.12 Effect of gibberellic acid on number of stolon at different days after transplanting of strawberry germplasm (G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3)

Table 6. Interaction effect of germplasm and gibberellic acid on Number of stolon/plant at different days after transplanting of strawberry [x]

Treatment [y]	Days after transplanting (DAT)									
	45		52		59		66		73	
V_1G_0	1.00	abc	1.33	abc	1.67	bcd	1.67	cd	1.67	d
V_1G_1	1.00	abc	1.67	ab	2.00	abc	2.33	abc	2.67	abc
V_1G_2	1.33	ab	2.00	a	2.33	abc	2.67	ab	3.33	a
V_1G_3	1.33	ab	1.67	ab	2.67	a	3.00	a	3.00	ab
V_2G_0	0.33	c	0.67	c	1.00	d	1.33	d	1.67	d
V_2G_1	1.00	abc	1.00	bc	1.33	cd	1.67	cd	2.00	cd
V_2G_2	1.33	ab	1.33	abc	1.67	bcd	2.33	abc	2.33	bcd
V_2G_3	1.33	ab	1.33	abc	1.67	bcd	2.00	bcd	2.33	bcd
V_3G_0	0.67	bc	1.00	bc	1.33	cd	2.00	bcd	2.00	cd
V_3G_1	1.00	abc	1.67	ab	2.00	abc	2.33	abc	2.67	abc
V_3G_2	1.67	a	2.00	a	2.33	abc	2.67	ab	3.00	ab
V_3G_3	1.33	ab	1.33	abc	1.67	bcd	2.00	bcd	2.33	bcd
$LSD_{(0.05)}$	0.79		0.794		0.843		0.794		0.794	
CV(%)	12.43		16.28		17.69		11.76		9.51	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-3 and V_3; SG-03; G_0; Control, G_1; 50 ppm GA_3, G_2; 75 ppm GA_3, G_3; 100 ppm GA_3

4.7 Crown height (cm)

There was significant variation in respect of crown height obtained due to the effect of germplasm and GA_3 individually and varied from 9.75cm to 11.00cm before flowering. Longest crown height (11.00cm) was recorded from V_2 which was statistical similar with V_1 and the smallest (9.75cm) was recorded from V_2 **(**Table 7).

Plant treated with GA_3 crown height was also found to be significant (Appendix VII). Largest (13.78 cm) height of crown was found in G_3 treatment which also statistically similar with G_1 and G_2 treatment (11.89 cm and 13.00cm respectively) and the smallest height of crown (3.89cm) was found in G_0 (Table 8). Prolingis and Boynton(1961) reported that higher the concentration of applied GA_3 , the faster the growth rate of stem(petiole). So the longest crown height (13.78cm) was found G_3 treatment.

Combine effect of the germplasm and GA_3 was found to be significant in crown height (Appendix VII). It was recorded that longest (17.67cm) height of crown was produced by V_2G_3 while it was shortest (2.67) in V_1G_0 (Table 9).

4.8 Days to flower bud initiation

There was significant variation in terms of days to bud initiation of strawberry germplasm (Appendix VII). Maximum days (88.50) needed to bud initiation was recorded from V_2 whereas the minimum days (81.33) needed for bud initiation was recorded from V_3. So SG-3(V_3) is the earliest germplasm compared to other two germplasm. (Table 7).

Application of GA_3 showed significant variation to bud initiation of strawberry. Maximum days to bud initiation (96.5 days) was recorded from G_0. Again the minimum days (77.00) was obtained from G_2 (Table 8**)**. Higher dose of GA_3 increases the time for flower bud initiation. However optimum concentration of GA_3 reduces the time for bud initiation. Similar opinion also put forwarded by Paroussi *et al*., (2002).

Interaction between germplasm and GA_3 on flower bud initiation was found to be significant (Appendix VII). Maximum days (95.00) was recorded from V_1G_0 and minimum days (71.00) was recorded from V_3G_2 (Table 9).

4.9 Days to flowering from transplanting

Significant variation was found for days required flowering from seedling transplanting. And days from flower initiation from flower bud (6-7days) were almost same in all strawberry germplasm. However, different varieties exhibited variation in respect of days for flowering from runner transplanting due to different strawberry germplasm. (Appendix VII). V_2 variety took maximum time (96.50 days) from runner transplanting to flower bloom than V_3 (88.42 days) (Table 7).

Foliar application of GA_3 on days for flower bud initiation to flower bloom and runner transplanting to flowering was also found to be statistically significant (Appendix VII). The maximum day (95.56) was recorded from G_0 treatment and minimum day (77.00) was recorded from G_2 treatment from runner transplanting to flower bloom. This also means GA_3 hasten flower bloom. Paroussi *et al.,(*2002) reported that GA_3 reduced the time need for inflorescence emergence.

Interaction between germplasm and GA_3 on runner transplanting to flower bloom was found to be significant (Appendix VII). Maximum day (105.00) was recorded from V_2G_0 and a minimum day (77.33) was recorded from V_3G_2 (Table 9).

4.10 Days to fruit harvesting from flowering

There was significant variation in terms of fruit harvesting from flowering (Appendix VII). Maximum days (32.92) needed to fruit harvesting from flowering was recorded from V_2 whereas the minimum days (25.42) needed fruit harvesting from flowering was recorded from V_1 (Table 7).

Foliar application of GA_3 showed significant variation on fruit harvesting from flowering of strawberry. Maximum days to fruit harvesting (32.56) was recorded from G_o. Again the minimum days (25.33) was obtained from G_2 which is statistical similar with G_1 and G_3 (Table 8**).**

Interaction between germplasm and foliar application of GA3 on fruit harvesting from flowering was found to be significant (Appendix VII). Maximum days (39.00) was recorded from V_2G_0 and minimum days (24.00) was recorded from V_1G_2 which was statistically similar with V_1G_3 and V_3G_3 (Table 9).

4.11 Number of flower bud per plant

Number of flowers bud per plant of strawberry germplasm showed statistically significant variations (Appendix VII). Maximum (30.42/plant) number of flower buds was recorded from V_3 which was closely followed (29.25/plant) by V_1, while the minimum (23.08/plant) number of flowers bud per plant was recorded from V_2 .(Table 7**)** This results shows that SB-3 has potentiality to bear highest number of flower bud.

Application of different concentration of GA_3 differs significantly on number of flowers bud per plant (Appendix VII**).** Maximum (30/plant) number of flowers bud per plant was recorded from G_2 which was closely followed (28.22, 28.78) with G_1 and G_3 and the minimum (23.33) number of flowers bud per plant was recorded from G_0 (Table 8). These findings supported by the findings of Tafazoli
and Vince-Prue (1978) and they reported that 50-75ppm GA_3 increased number of flower bud with similar statistical difference.

Combined effect of GA_3 and different germplasm showed statistically significant differences on number of flowers bud per plant (Appendix VII). Maximum (34.67/plant) number of flowers bud per plant was recorded from V_3G_2 and V_2G_0 gave the minimum (21.00) number of flowers bud per plant (Table 9)**.**

4.12 Number of flower per plant

Number of flowers per plant was significantly varied with the germplasm of strawberry (Appendix VII). Maximum (29.33/ plant) number of flower was recorded from V_3 which was statistical identical to V_1 while minimum (20.92/plant) number of flower was recorded from V_2 (Table 7).

Foliar application of GA_3 significantly influenced the production of flower per plant (Appendix VII). Maximum (28.67/plant) number of flowers per plant was recorded from G_2 which was closely followed (27.33) with G_3 and the minimum (21.11) number of flowers per plant was recorded from G_0 (Table 8). Similar opinion was also put forwarded by Tafazoli and Vince-Prue (1978).

Combine effect of varietal performance and foliar application of GA_3 was found to be significant in terms of number flower per plant (Appendix VII). Maximum (33.67/plant) number of flower per plant was recorded fromV_3G_2 and minimum (18.33 / plant) number of flower per plant was recorded from V_2G_0 (Table 9).

Table 7. Growth habit of different strawberry germplasm [x]

Treatment [y]	Crown height(cm)	Days to flower bud initiation	Days to flowering	Number of flower bud/plant	Number of flower	Days to fruit harvesting
V_1	11.00 a	88.17 a	96.00 a	29.25 a	27.42 a	25.42 b
V_2	11.17 a	88.50 a	95.50 a	23.08 b	20.92 b	30.92 a
V_3	9.75 a	81.83 a	88.42 a	30.42 a	29.33 a	26.83 ab
$LSD_{(0.05)}$	6.917	16.530	16.100	2.171	2.420	4.535

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

y V_1; SG-1, V_2; RABI-3 and V_3; SG-3

Table 8. Effect of different gibberellic acid concentration on the growth habit of different strawberry germplasm [x]

Treatment [y]	Crown height(cm)	Days to flower bud initiation	Days to flowering	Number of flower bud/plant	Number of flower	Days to fruit harvesting
G_0	3.89 b	95.56 a	103.30 a	23.33 b	21.11 b	32.56 a
G_1	11.89 a	87.00 ab	93.78 ab	28.22 a	26.44 a	27.44 b
G_2	13.00 a	77.00 b	85.00 b	30.00 a	28.67 a	25.33 b
G_3	13.78 a	84.00 ab	91.11 ab	28.78 a	27.33 a	25.56 b
$LSD_{(0.05)}$	6.917	16.530	16.100	2.171	2.420	4.535
CV(%)	38.400	11.330	10.190	4.650	5.520	9.660

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] G_0; Control, G_1; 50 ppm GA3, G_2; 75 ppm GA3, G_3; 100 ppm GA3

Table 9. Combined effect of germplasm performance and gibberellic acid concentration on the growth habit of strawberry [x]

Treatment [y]	Crown height(cm)		Days to flower bud initiation		Days to flowering		Number of flower bud/plant		Number of flower		Days to fruit harvesting	
V_1G_0	5.67	bcd	95.00	a	103.00	a	24.33	c	22.00	c	27.00	bcd
V_1G_1	13.33	ab	91.00	ab	99.00	ab	29.67	b	28.00	b	26.67	bcd
V_1G_2	13.33	ab	81.00	abc	90.00	abc	31.00	b	29.00	b	24.00	d
V_1G_3	11.67	ab	85.67	abc	92.00	abc	32.00	b	30.67	b	24.00	d
V_2G_0	2.67	d	97.00	a	105.00	a	21.33	d	18.33	d	39.00	a
V_2G_1	12.00	ab	94.67	a	101.00	a	24.00	c	21.33	c	30.00	bc
V_2G_2	12.33	ab	80.67	abc	87.67	abc	23.67	c	22.33	c	26.67	bcd
V_2G_3	17.67	a	81.67	abc	88.33	abc	23.33	cd	21.67	c	28.00	bcd
V_3G_0	3.34	cd	94.67	a	102.00	a	24.33	c	23.00	c	31.67	b
V_3G_1	10.33	abc	75.33	bc	81.33	bc	31.00	b	30.00	b	25.67	cd
V_3G_2	13.33	ab	71.00	c	77.33	c	34.67	a	33.67	a	25.33	cd
V_3G_3	12.00	ab	86.33	abc	93.00	abc	31.67	b	30.67	b	24.67	d
$LSD_{(0.05)}$	6.917		16.530		16.100		2.171		2.420		4.535	
CV(%)	38.400		11.330		10.190		4.650		5.520		9.660	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-03 and V_3; SB-03; G_0; Control, G_1; 50 ppm GA3, G_2; 75 ppm GA3, G_3; 100 ppm GA3

4.13 Number of fruits per plant

Number of fruits per plant was statistically varied with the germplasm of strawberry (Appendix VIII). Maximum (26.67/ plant) number of fruit was recorded from V_1 which was statistically similar with V_3 while minimum (18.50 / plant) number of fruit was recorded from V_2 (Table 10).

Different germplasm for the application of different concentration of GA_3 was also recorded in variation for the number of fruits per plant of strawberry (Appendix VIII). The maximum (25.89) number of fruits per plant was recorded from G_2 which was closely followed (18.11) by G_1 and G3, while the minimum (19.56) number of fruits per plant was recorded from G_0 (control).(Table 11). Similar trend was also put forwarded by Miranda-stalder *et al*., (1990).

Combined effect of GA_3 regulators and germplasm showed statistically significant differences on number of fruits per plant (Appendix VIII). Maximum (30.33) number of fruits per plant was recorded from V_1G_2 which was statistically similar with V_3G_1 and V_2G_0 (control) gave the minimum (16.33) number of fruits per plant (Table 12).

4.14 Yield per plant (g)

Yield per plant of strawberry showed statistically significant variations for the germplasm characteristics (Appendix VIII). Total fruit weight (379.80g) per plant was recorded maximum from SG-01, while the minimum (194.10gm) fruit weight per plant was recorded from V_2 followed by SG-03 (350.90) under the present trial (Table 10).

Yield per plant varied significantly due to the application of GA_3 (Appendix VIII). Maximum (336.60gm) yield per plant was recorded from G_2 and the minimum (249.90gm) yield per plant was recorded under control condition (Table 11).

Repeated applications of GA_3, or one GA_3 spray in warm conditions, may cause excessive elongation of the fleshy receptacle, bringing about fruit size reduction and/or fruit malformation (Porlingis and Boynton, 1961b; Turner, 1963; Jonkers, 1965; Castro *et al*., 1976; Tehranifar and Battey, 1997.

Combined effect of growth regulators and germplasm showed statistically significant differences on yield per plant (Appendix VIII). Maximum (419.70g) yield per plant was recorded from V_1G_2 and V_2G_O (control) gave the minimum (176.50g) yield per plant (Table 12).

4.15 Fruit length (mm)

Length of fruit significantly varied with the germplasm (Appendix VIII). Longest fruit (31.57mm) was recorded from V_1 and shortest (28.64mm) fruit was recorded from V_2 (Table 10).

Foliar application of GA_3 significantly influenced the length of fruit (Appendix VIII).The fruit length was highest (32.69mm) in G_2 while the shortest (28.26mm) length of the fruit was recorded from G_o (Table 11).

Combine effect of germplasm performance and application of GA_3 was found to be significant in terms of length of fruit (Appendix VIII). It was founded hat longest (34.41mm) fruit was found in V_1G_2 while the shortest (24.17mm) fruit was found in V_2G_0 (Table 12).

4.16 Diameter of fruit (mm)

The diameter of fruit influenced significantly with the germplasm (Appendix VIII). The maximum average diameter (24.57mm) was recorded from V_1 which was statistically similar with V_3 and lowest diameter (21.10mm) fruit was recorded from V_2 (Table10).

Foliar application of different concentration GA_3 significantly influenced the diameter of fruit (Appendix VIII).The fruit diameter was maximum (25.00mm) in G_2 which was statistically similar with G_1 while the lowest (21.84mm) diameter of the fruit was recorded from G_0 (Table11).

Combine effect of germplasm performance and foliar application of GA_3 was found to be significant in terms of diameter of fruit (Appendix VIII). It was founded hat maximum diameter (28.01mm) fruit was found in V_IG_2 while the minimum diameter (18.47mm) fruit was found in V_2G_0 (Table12).

4.17 Average fruit weight (g)

Average fruit of strawberry showed statistically significant variations for the germplasm characteristics. Average fruit weight was maximum (14.63) in V_1 and minimum average fruit weight (10.55g) was recorded from V_3 (Table10).
Average fruit weight varied significantly due to the application of different concentration of GA_3. The maximum average fruit weight (13.21g) was recorded from G_2 and the minimum (12.32g) was recorded under control condition (Table 11).

Combined effect of GA_3 and germplasm showed statistically significant differences on average fruit weight. The maximum average fruit weight (15.37g) was recorded from V_1G_2 and V_2G_o (control) gave the minimum (10.27g) average fruit weight (Table 3).

4.18 Brix percentage

Different germplasm of this research work exhibited no significant variation in respects of brix percentage of Strawberry (Appendix VIII). V_1 and V_3 germplasms showed statistically similar variation in terms of brix percentage. The brix percentage (4.07) was lowest in V_2 (Table10).

Percentage of brix varied due to the application of different concentration of GA_3 (Appendix VIII). Maximum percentage of brix (4.67) was recorded from G_2 which was statistically similar with G_1 and the minimum (4.42) was recorded under control condition (Table 2). Perkins-Veazie (1995) reported that SSC (soluble solid content) of strawberry fruits vary from 4-11% depending on cultivars and environment (Table 11).

Combined effect of growth regulators and germplasm showed statistically differences on brix percentage (Appendix VIII). Maximum brix percentage (5.17) was observed from the treatment combination of V_1G_1 and V_2G_O (control) gave the minimum (3.60) brix percentage (Table12).

Table 10. Varietal performance of different strawberry germplasm related to fruit quality [x]

Treatment[y]	Numbers of fruit/plant	yield (g)/plant	Fruit length(mm)	Diameter of fruit(mm)	Average fruit weight(g)	%Brix
V_1	26.67 a	379.80 a	31.57 a	24.57 a	14.63 a	4.96 a
V_2	18.50 b	194.10 b	28.64 ab	21.10 b	10.55 b	4.07 b
V_3	25.75 a	350.90 a	30.39 b	24.22 a	13.17 a	4.83 a
$LSD_{(0.05)}$	2.338	32.750	1.933	1.702	1.636	0.215

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-3 and V_3; SG-3

Table 11. Effect of different concentration of GA_3 on strawberry germplasm related to fruit quality [x]

Treatment [y]	Numbers of fruit/plant	Yield(g)/plant	Fruit length(mm)	Diameter of fruit(mm)	Average fruit weight(g)	%Brix
G_0	19.56 b	248.90 b	28.26 b	21.84 c	12.32 b	4.42 a
G_1	24.11 a	319.60 a	31.06 ab	23.93 a	13.02 a	4.61 b
G_2	25.89 a	336.60 a	32.69 a	25.00 a	13.21 a	4.67 b
G_3	25.00 a	327.90 a	28.79 b	23.62 b	12.57 b	4.78 a
$LSD_{(0.05)}$	2.338	32.750	2.232	1.965	1.636	0.248
CV(%)	5.840	7.560	9.620	8.560	7.740	5.520

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] G_0 ; Control, G_1; 50 ppm GA3, G_2; 75 ppm GA3, G_3; 100 ppm GA3

Table 12. Interaction effect of varietal performance of different strawberry germplasm related to fruit strawberry [x]

Treatment [y]	Numbers of fruit/plant		Total fruit weight(g)/plant		Fruit length(mm)		Diameter of fruit(mm)		Average fruit weight(g)		%Brix	
V_1G_0	21.33	c	293.30	d	34.12	a	26.55	ab	13.80	abc	4.80	ab
V_1G_1	26.33	b	401.30	b	32.11	ab	26.29	abc	15.30	ab	4.83	a
V_1G_2	30.33	a	419.70	a	34.41	a	28.01	a	15.37	a	5.17	a
V_1G_3	28.00	ab	405.00	c	28.76	bc	24.96	abc	14.03	abc	5.00	d
V_2G_0	16.33	e	176.50	e	24.17	de	18.47	e	10.27	e	3.60	d
V_2G_1	18.67	de	189.70	d	28.83	bc	20.52	de	10.83	de	3.83	c
V_2G_2	19.67	cd	207.00	d	32.37	ab	22.90	bcd	10.57	e	4.33	bc
V_2G_3	19.33	cd	203.00	de	29.20	bc	22.52	cd	10.53	e	4.50	ab
V_3G_0	21.00	cd	276.00	de	26.49	cd	20.51	de	13.07	c	4.83	ab
V_3G_1	27.33	a	368.00	d	32.25	ab	24.98	abc	13.50	bc	4.83	ab
V_3G_2	28.00	ab	383.00	ab	31.29	ab	24.09	bcd	13.70	abc	4.83	ab
V_3G_3	26.33	b	375.70	c	28.42	bc	23.37	bcd	12.40	cd	4.83	ab
$LSD_{(0.05)}$	2.338		32.750		3.866		3.404		1.636		0.430	
CV(%)	5.840		7.560		7.600		8.560		7.740		5.520	

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1; SG-1, V_2; RABI-03 and V_3; SB-03; G_0 ; Control, G_1; 50 ppm GA3, G_2; 75 ppm GA3, G_3; 100 ppm GA3

CHAPTER V

SUMMARY AND CONCLUSION

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SUMMARY AND CONCLUSION

An experiment was conducted at Horticulture research firm, Sher-e-Bangla Agricultural University farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from October 2010 to April 2011. The Objective of the study was to determine the response of gibberellic acid to three different germplasm of strawberry on the growth yield and quality attributes. Experiment included three germplasm viz. V_1; SG-1, V_2; RABI 3, V_3: SG-03 & and different concentration of gibberellic acid viz. G_0; Fresh water, G_1; 50ppm GA_3, G_2; 75ppm GA_3 and G_3; 100ppm GA_3. Two factorial experiment was laid out in Complete Randomized Design (CRD) with three Replications. Size of the each pot was 25 cm × 20 cm. Runners were planted on 12th October, 2010. Data were taken on the basis of different parameters time to time.

In order to maximize the better production of strawberry through foliar application of gibberellic acid with different concentration a research was conducted to investigate the growth and yield of strawberry. Data were taken for different parameters from the entire period of experiment.

Regarding the germplasm characteristic tallest plant (28cm) was recorded by V_1, while lowest plant (26cm) was recorded from V_2. In the foliar application of GA_3, highest plant height (31.44cm) was recorded from G_2 and minimum plant height (17.22cm) was recorded from G_0. In combined effect of germplasm and foliar application of GA_3 highest plant height (29.67cm) was recorded from V_3G_2 and minimum plant height (19.67cm) was recorded from V_1G_0.

Regarding the leaf number maximum (11.67) was recorded by V_1 while minimum (9.75) was recorded from V_2. In the foliar application of GA_3, maximum leaf number (11.11) was recorded from G_2 and minimum leaf number (9.56) was recorded from G_0. In combined effect, maximum leaf

number (13.67) was recorded from V_1G_2 and minimum leaf number (9.33) was recorded from V_2G_0.

Maximum leaf area per plant (69.79cm^2) was recorded from V_1 germplasm whereas, minimum leaf area (50.42cm^2) was observed from V_2. In case of GA_3 application maximum (64.54 cm^2) leaf area was recorded in G_2 while the minimum (50.26cm^2) leaf area was recorded from G_0. Among the combined effect the maximum (80.46cm^2) leaf area was recorded from combination of V_1G_3 and the minimum (39.87) leaf area was obtained from V_2G_0.

Maximum number of runner/plant (3.92) was recorded from V_1 and the minimum (3.17) number of runner/plant was obtained from V_2. Maximum number of runner (4.00/plant) was obtained from the plant treated with G_2 treatment and the minimum number of runner (3.00/plant) was recorded from G_0. Maximum number of runner (4.33/plant) was obtained from V_2G_2, while the minimum number runner (2.67/plant) was obtained from V_2G_0.

Longest length of runner (32.95 cm) was recorded from V_1 and the smallest (30.50cm) was recorded from V_2. Longest (33.41 cm) runner was found in G_2 and the smallest runner (28.67cm) was found in G_0. Combine effect, highest length of runner (35.80cm) was produced by V_1G_2 the lowest (27.61 cm) length of runner was found in V_1G_0.

Maximum number of stolon per plant (2.67) was recorded from V_1 the minimum number of stolon per plant (2.08) was observed from V_2. Maximum number of stolon (2.89) was recorded in G_2 and minimum number of stolon (1.78) was recorded from G_0. Maximum number of stolon (3.33) was produced by the treatment combination of V_1G_2 and the minimum number of stolon (1.67) was obtained from V_1G_0.

Tallest crown height (11.00cm) was recorded from V_2 and the smallest (9.75cm) was recorded from V_3 .When the plant treated with application of GA_3 tallest (13.78 cm) crown was found in G_3 the smallest crown (3.89cm) was found in G_0 .In case of combine effect tallest (17.67cm) crown was produced by V_2G_3 while it was shortest (2.67) in V_1G_0.

Maximum days needed to bud initiation from transplanting was recorded from V_2 (88.50) whereas the minimum (81.33) days needed for bud initiation was recorded from V_3. In case of GA_3 the maximum days to bud initiation (96.5 days) was recorded from G_0 and the minimum days (77.00) was obtained from G_2. While in combined effect maximum days (95.00) was recorded from V_1G_0 and minimum days (71.00) was recorded from V_3G_2 .V_2 variety took maximum time (96.50 days) from runner transplanting to flower bloom than V_3 (88.42 days). Maximum day (95.56) was recorded from G_0 and minimum day (77.00) was recorded from G_2 from runner transplanting to flower bloom. Within interaction between germplasm and foliar application of GA_3 maximum day (105.00) was recorded from V_2G_0 and a minimum day (77.33) was recorded from V_3G_2.

The maximum days required from flowering to fruit harvesting was recorded from V_2 whereas the minimum was recorded from V_1. Foliar application of GA_3 showed significant variation on flowering to fruit harvesting of strawberry. Maximum days for fruit harvesting (32.56) was recorded from G_o. Again the minimum days (25.33) was obtained from G_2. Maximum days (39.00) were recorded from V_2G_0 and minimum days (24.00) were recorded from V_1G_2.

Maximum (30.42/plant) number of flower buds was recorded from V_3 while the minimum (23.08/plant) number of flowers bud per plant was recorded from V_2. In case of GA_3 application the maximum (30/plant) number of flowers buds per plant was recorded from G_2 while minimum (23.33) number of flowers bud

per plant was recorded from G_0. When interaction effect was observed the maximum (34.67/plant) number of flowers bud per plant was recorded from V_3G_2 and V_2G_0 gave the minimum (21.00) number of flowers bud per plant. Maximum (29.33/ plant) number of flower was recorded from V_3 while minimum (20.92 / plant) number of flower was recorded from V_2. Maximum (28.67/plant) number of flowers per plant was recorded from G_2 and minimum (21.11/plant) number of flowers per plant was recorded from G_0. In case of interaction, maximum (33.67/plant) number of flower per plant was recorded fromV_3G_2 and minimum (18.33 / plant) number of flower per plant was recorded from V_2G_0.

Maximum (26.67/ plant) number of fruit was recorded from V_1 while minimum (18.50 / plant) number of fruit was recorded from V_2. The maximum (25.89) number of fruits per plant was recorded from G_2 while the minimum (19.56) number of fruits per plant was recorded from G_0. When interaction was observed, maximum (30.33) number of fruits per plant was recorded from V_1G_2 and V_2G_0 gave the minimum (16.33) number of fruits.

Yield (379.80 gm) per plant was recorded maximum from V_1, while the minimum (194.10gm) was recorded from V_2. In case of GA_3 application the maximum (336.60gm) yield per plant was recorded from G_2 and the minimum (249.90gm) was recorded under control. Maximum (419.70gm) yield per plant was recorded from V_1G_2 and V_2G_O (control) gave the minimum (176.50gm) yield per plant.

Longest fruit (31.57mm) was recorded from V_1 and shortest (28.64mm) fruit was recorded from V_2. The fruit length was highest (32.69mm) in G_2 while the shortest (28.26mm) length of the fruit was recorded from G_o when treated with GA_3. During interaction it was founded that longest (34.41mm) fruit was found in V_2G_2 while the shortest (24.17mm) fruit was found in V_2G_0.

Maximum average diameter (24.57mm) of fruit was recorded from V_1 while the lowest (21.10mm) was recorded from V_2. Fruit diameter was maximum (25.00mm) in G_2 and the lowest (21.84mm) was recorded from G_0.

It was founded that maximum diameter (28.01mm) fruit was found in V_1G_2 while the minimum diameter (18.47mm) fruit was found in $V_2G_{0.}$

The average fruit weight was maximum (14.63gm) in V_1 and was minimum (10.55gm) in $V_{3.}$ In case of GA_3 application, maximum average fruit weight (13.21gm) was recorded from G_2 and the minimum (12.32gm) was recorded under control condition. Maximum average fruit weight (15.37gm) was recorded from V_1G_2 and V_2G_o gave the minimum (10.27gm) average fruit weight under interaction.

Brix percentage was highest in V_1 while the lowest (4.07) was V_2. Maximum percentage of brix (4.67) was recorded from G_2 and the minimum (4.42) was recorded under control condition. Maximum brisk percentage (5.17) was observed from the treatment combination of V_1G_1 and V_2G_0 gave the minimum (3.60) brix percentage.

CONCLUSION

The best vegetative growth (plant height, leaves, runner, and stolon) was found with SG-1. Fruits number, fruit weight, fruit length, and diameter of fruit were also found maximum in SG-1. But the maximum number of flower bud and flower was found in SG-3 and numbers of fruits were less as some flower did not set for fruiting for genetically erosion. Between the concentration of 75ppm GA_3 and 100ppm GA_3 there was no significant difference on vegetative growth and was statistical identical but it differs from other two treatments significantly. Maximum number of flower bud, flower, and fruit was recorded when plants treated with 75ppm GA_3. In case of combined effect maximum fruit number was in SB-1 treated with 75ppm GA3. Similar result was also found from total fruit weight, average fruit weight, fruit length and fruit diameter under this concentration. Considering the above circumstances, it may conclude that SB-01 is the suitable germplasm. Among the gibberellic acid concentrations 75ppm GA_3 performs the best result for yield and quality of harvest product.

Considering the findings of the present experiment, further studies in the following areas may be suggested:

I. Further study is needed for determination of quality attributes of strawberry like nutritive value analysis.
II. Other different parameters like storability, thickness and color of strawberry may be include for further study.

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APPENDICES

APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period from October 2010 to March, 2011

Month	*Air temperature (^{o}C)		*Relative humidity (%)	*Rainfall (mm) (total)
	Maximum	Minimum		
October, 2010	29.18	18.26	81	39
November, 2010	25.82	16.04	78	0
December, 2010	22.4	13.5	74	0
January, 2011	24.5	12.4	68	0
February, 2011	27.1	16.7	67	30
March, 2011	31.4	19.6	54	11

* Monthly average,

* Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1207.

Appendix II. Analysis of variance of the data on plant height at different days after transplanting (DAT) of strawberry

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		45 DAT	52 DAT	59 DAT	66 DAT	73 DAT
Factor A (Germplasm)	2	55.257**	72.333**	32.028**	18.250**	17.694*
Factor B (Gibberellic acid)	3	81.970**	196.333**	305.361**	400.991**	417.296**
Interaction (A×B)	6	8.998**	15.000**	15.472**	12.435**	14.324**
Error	24	1.854	1.722	3.111	2.278	3.889

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix III. Analysis of variance of the data on number of leaves per plant at different days after transplanting (DAT) of strawberry

Source of variation	Degrees of freedom	Mean square				
		Number of leaves/plant at				
		45 DAT	52 DAT	59 DAT	66 DAT	73 DAT
Factor A (Germplasm)	2	5.083**	5.083**	4.778**	13.778**	12.194**
Factor B (Gibberellic acid)	3	5.880**	5.667**	2.444**	3.852**	4.250**
Interaction (A×B)	6	0.957*	1.194**	2.889**	1.185*	1.417*
Error	24	0.167	0.194	0.361	0.500	0.556

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on leaf area at different days after transplanting (DAT) of strawberry

Source of variation	Degrees of freedom	Mean square				
		Leaf area(cm^2) at				
		45 DAT	52 DAT	59 DAT	66 DAT	73 DAT
Factor A (Germplasm)	2	356.801**	464.182**	777.830**	972.329	1292.840**
Factor B (Gibberellic acid)	3	154.754**	289.378**	454.629**	447.026**	376.622**
Interaction (A×B)	6	173.967**	184.665**	263.492**	219.451**	250.936**
Error	24	21.720	20.378	35.521	35.609	42.461

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on number of runner per plant at different days after transplanting (DAT) of strawberry

Source of variation	Degrees of freedom	Mean square				
		Number of runner/plant at				
		45 DAT	52 DAT	59 DAT	66 DAT	73 DAT
Factor A (Germplasm)	2	3.111**	1.361**	1.583**	1.694**	1.861**
Factor B (Gibberellic acid)	3	1.370**	1.213**	0.991**	1.556**	1.667**
Interaction (A×B)	6	0.370**	0.435*	0.913*	0.928*	0.883*
Error	24	0.056	0.167	0.222	0.250	0.139

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on length of runner at different days after transplanting (DAT) of strawberry

Source of variation	Degrees of freedom	Mean square				
		Length of runner at				
		45 DAT	52 DAT	59 DAT	66 DAT	73 DAT
Factor A (Germplasm)	2	56.096**	50.349**	40.333**	23.732**	18.961**
Factor B (Gibberellic acid)	3	49.878**	44.812**	40.946**	36.353**	44.199**
Interaction (A×B)	6	5.697**	5.635*	3.731*	7.569*	8.134*
Error	24	1.511	1.870	1.326	2.701	2.951

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on number of stolon at different days after transplanting (DAT) of strawberry

Source of variation	Degrees of freedom	Mean square				
		Number of stolon at				
		45 DAT	52 DAT	59 DAT	66 DAT	73 DAT
Factor A (Germplasm)	2	0.111	1.083*	1.694**	1.083**	1.083**
Factor B (Gibberellic acid)	3	1.111**	0.917*	1.065**	1.296**	1.954**
Interaction (A×B)	6	0.111	0.983**	0.976*	0.969*	0.731*
Error	24	0.222	0.222	0.250	0.222	0.222

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on growth habit of different strawberry germplasm

Source of variation	Degrees of freedom	Mean square					
		Bearing habit at					
		Crown Height	Days to flower bud initiation	Days to flowering	Number of flowers per plant	Number of fruiting bud per plant	Days to fruit harvesting from flowering
Factor A(Germplasm)	2	23.528**	143.694*	111.583**	144.444**	60.861**	318.778**
Factor B(Gibberellic acid)	3	39.000**	96.546*	68.028*	40.074**	65.519**	182.444*
Interaction (A×B)	6	5.083*	413.546**	373.361**	9.963**	13.491**	472.889**
Error	24	1.861	31.389	22.556	2.611	3.833	46.583

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data on related to fruit quality

Source of variation	Degrees of freedom	Mean square				
		Fruit quality at				
		Fruits per plant	Yeild per plant (g)	Length of fruits	Breadth of fruits	%Brix
Factor A (Germplasm)	2	128.250**	24871.58**	26.042**	60.794**	2.797**
Factor B (Gibberellic acid)	3	19.657**	14019.11**	38.050**	15.521*	0.199*
Interaction (A×B)	6	8.880*	4304.250**	24.867**	15.226**	0.204*
Error	24	4.000	406.917	5.263	4.081	0.065

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability