EFFECT OF GRAFTING AND CULTIVARS ON THE GROWTH AND YIELD OF TOMATO

A THESIS
BY
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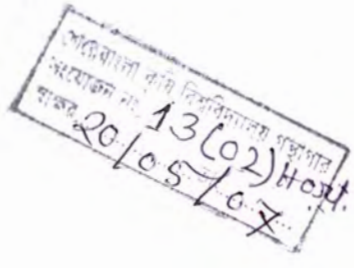

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A Thesis

Submitted to the Department of Horticulture & Postharvest Technology
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JUNE 2006

CERTIFICATE

This is to certify that theis entitled, **"Effect of Ggrafting And Cultivars on the Growth and Yield of Tomato"** submitted to the Faculty of Horticulture & Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka. In partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in Horticulture, embodies the result of a piece of *bona fide* research work caried out by **Romana Afroz Mina** Registration No.**23860/00135** under my supervision and guidance. No part of the thesis has been submitted for any other degree of diploma.

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

Dated:
Dhaka, Bangladesh.

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Dr. Md. Nazrul Islam
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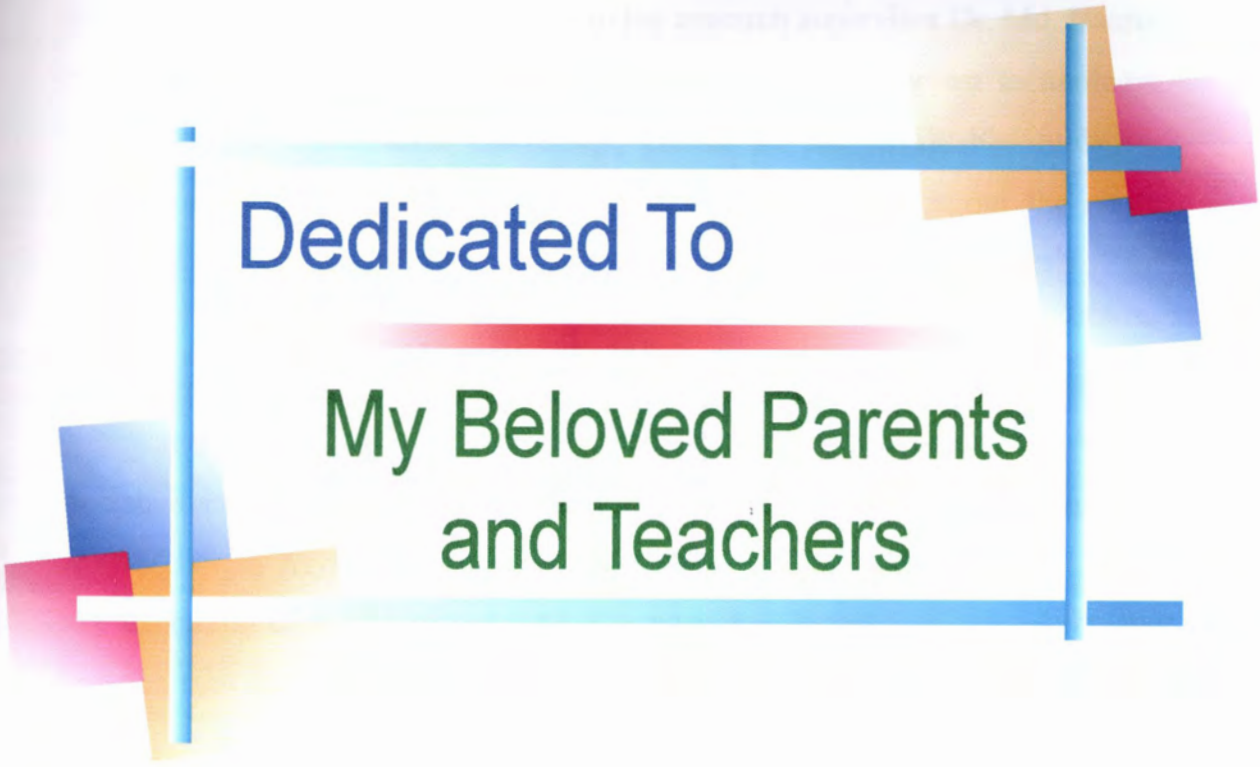
Dedicated To
My Beloved Parents
and Teachers

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Summer, 2006 The Author

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

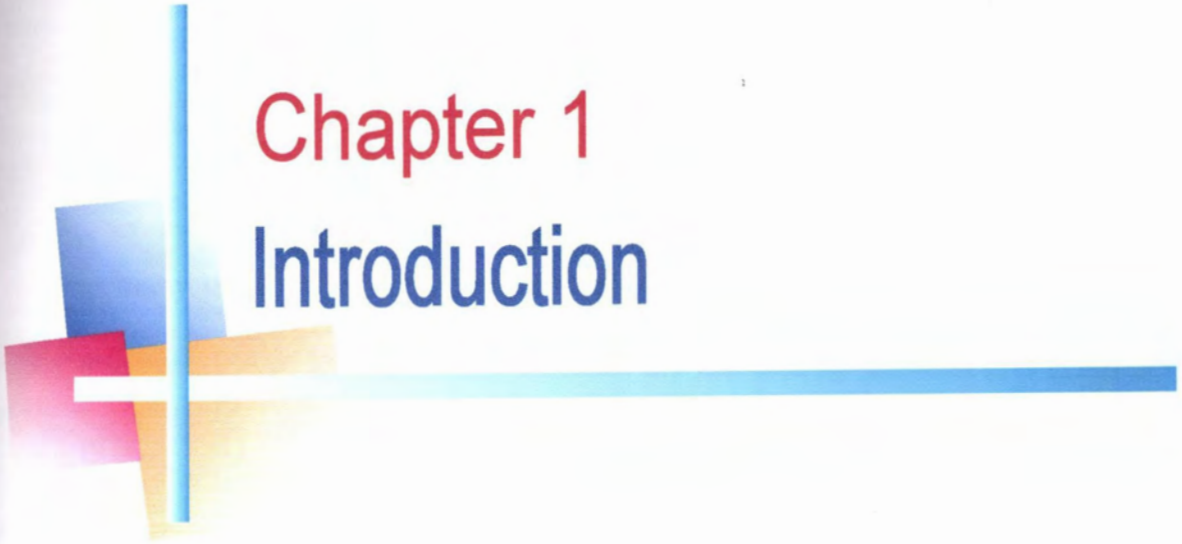
LIST OF APPENDICES

ABBREVIATINS AND ACRONYMS

AVRDC	= Asian Vegetables Research and Development Centre
BADC	= Bangladesh Agricultural Development Corporation
BARC	= Bangladesh Agricultural Research Council
BARI	= Bangladesh Agricultural Research Institute
BAU	= Bangladesh Agricultural University
BSMRAU	= Bangabandhu Sheikh Mujibur Rahman Agricultural University.
cm	= Centimeter
CV.	= Cultivar
et al.	= and others
ed.	= edited
Ed.	= Edition
g	= Gram
HRC	= Horticulture Research Centre
Kg	= Kilogram
M	= Meter
mg	= Milligram
mm	= Millimeter
^{0}C	= Degree Celsius
RCBD	= Randomized Complete Block Design
RH	= Relative Humidity
SAVERNET	= South Asia Vegerables Research Network
SAU	= Sher-E-Bangla Agricultural University
Sq. m	= Square meter
t	= Ton
t/ha	= Ton per hectare
TSS	= Total Soluble Solids
TYLCV	= Tomato Yellow Leaf Curl Virus
TMV	= Tomato Mosaic Virus
Vr.	= Variety
Viz.	= Namely

ABSTRACT

The study was conducted at Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur to study the effect of grafting among three tomato varieties for producing wilt free tomato. The treatments of the experiment consisted of three tomato varieties viz. BARI Tomato-3, BARI Tomato-4 and BARI Tomato-6 and rootstock *Solanum sisymbriifolium.* Tomato varieties had significant influence on grafting success, days to 50% flowering, plant height, days to harvest, fruit characters, bacterial wilt, virus, plant mortality and yield contributing characters. The result of the experiment further revealed that maximum grafting success (46.79%) number of fruit (26.06), yield per plant (1.73 kg) and yield per hectare (76.36 ton) was obtained from the variety BARI Tomato-6.Grafting had significant influence on the above mentioned parameters including incidence of bacterial wilt. The highest harvesting duration (76 days), no wilt incidence and higher yield (64.32 ton/ha) were recorded when tomato plant was grafted. Grafted tomato plants had maximum harvest duration (76.22 days), no wilt incidence and produced higher yield. (64.32 ton / ha) When the combined effect of varieties and rootstock were taken into consideration, highest yield (79.74 ton/ha) was obtained from graft BARI Tomato-6. But BARI Tomato-3 had also highest yield (78.21 ton/ha) and early harvest when it was grafted. Therefore, it may be recommended that tomato varieties may be grafted on resistant wild *Solanum* rootstocks for controlling bacterial wilt and getting higher yield.



Chapter 1

Introduction

CHAPTER – 1

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is one of the most popular and nutritious vegetables in Bangladesh. It has diversified uses like salad, stew, juice, sauce and pickles (Chowdhury, 1979). Tomato ranks the top position among the world's list of vegetables production (Rashid, 1999). It has demand for multipurpose uses both at home and in industries.

Tomato is mainly produced in winter season in Bangladesh. Usually, it is sown in October-November and harvesting is mostly done from the months of January to March (Annon., 1980). Its production is sometimes severely affected due to the attack of an important soil borne pathogen called *Ralstonia solanacearum* and the causal organism of bacterial wilt (Mondal, 1992; Bhuyan and Haque, 1983). The disease causes severe loss in yield of tomatoes in many tropical and sub-tropical countries (Kelman, 1953). In Taiwan, on an average 29% of hybrid tomato varieties are affected by this diseases (Hartmen *et al.*, 1991)

Tomato cultivation in Bangladesh is severely impaired by three important soil-borne pathogens viz. *Pseudomonas solanacearum, Fusarium oxysporum* and *Meloidogyne incognita,* the causal agents of bacterial wilt, fusarium wilt and root-knot nematode, respectively and cause devastating

damage of tomato (Timm and Ameen, 1960: Talukder, 1974). These are also the major limiting factors for tomato production through out the world (Hinata, 1986). Wilt and nematode problems are especially severe in the humid tropics. In some cases 100% of the plant are found to die in kitchen gardens of Bangladesh due to wilt problem (Ali *et al.*, 1994). In Bangladesh root-knot disease may cause as much as 53-62% loss in fruit yield of tomato (Anonymous, 1996).

Hossain *et al.* (1999) reported that incidence of bacterial wilt ranged from 3.33 to 36.76% in tomato. The bacterium has a wide range of host and the extent of crop damage due to bacterial wilt varies greatly depending upon the bacterial strain, host variety and geographical region. It has been found that the problem of this disease is common in high lands which are not flooded and are under continuous cultivation of solanaceous crops without crop rotation. In case of tomato, this acute problem occurs commonly in kitchen gardens, which are usually not-flooded. It has been observed that due to the incidence of wilt in some cases 100% of the tomato plants have died in kitchen gardens of Bangladesh Agricultural Research Institute, Gazipur and Bangladesh Agricultural University, Mymensingh (Ali, 1993).

There are two traditional methods of controlling the soil-borne diseases: i) Soil sterilization by chemicals, which are very expensive and not practical, and ii) Use of resistant varieties, which are not available (Ali *et al.*, 1994). Recently, some summer tomato varieties have been developed by BARI which are reported to be resistant or tolerant to bacterial wilt. But it has been observed that the resistance is location specific. The location specificity may be due to the diversity of the stains of pathogen, environments (temperature, soil property, or inoculums density etc.) and their interaction (Jaw, 1998).

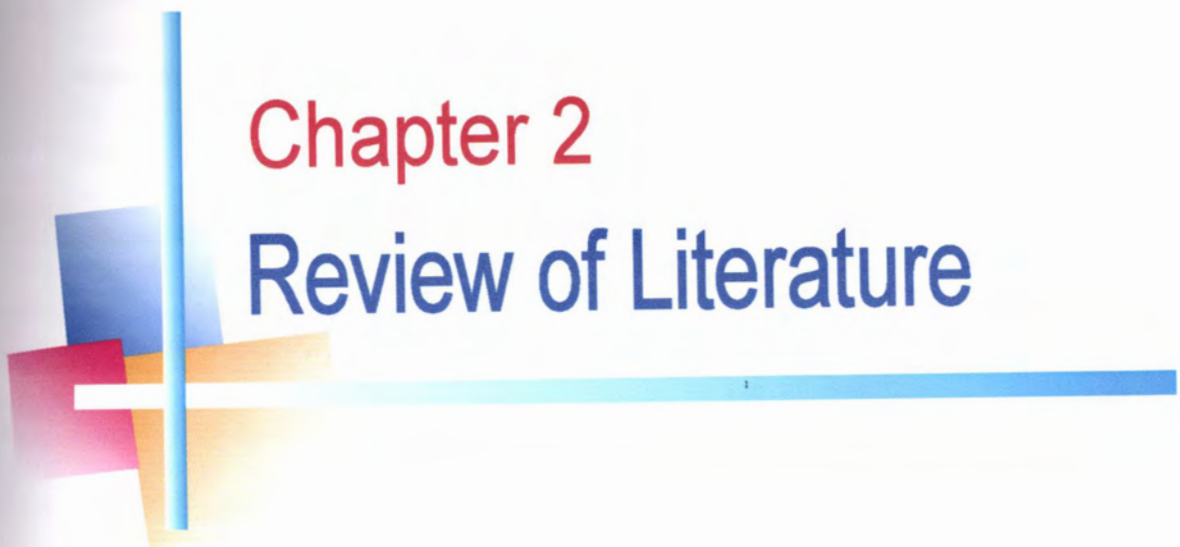
To avoid the problems of soil-borne diseases, grafting of tomato and eggplant on the resistant rootstocks as an alternative, is being practiced in Puerto Rico (Purseglove, 1974) and in Japan (Matsuzoe *et al.*, 1990; Ali et *al.*, 1990a). Japanese growers have been using these technique since 1930s. In 1990 about 95% of Japanese commercial growers have been reported to grow grafted eggplants.

Under the socio-economic condition of Bangladesh, grafting of tomato on resistant wild *Solanum* may be effective technique for the places where wilt problems are acute. It may also be very much effective for the early production of tomato, so, it is urgently necessary to strengthen grafting technology to find out suitable disease resistant rootstock of those which are highly graft

compatible and to observe yield performance of grafted plants under Bangladesh conditions.

Considering the above facts, the present study was undertaken with the following objectives.

1. To find out the grafting success of tomato cultivars
2. To study the performance of grafted plants against bacterial wilt and their growth yield.
3. To find out the suitable cultivar for successfull grafting technique and better yield.



Chapter 2
Review of Literature

CHAPTER – 2

REVIEW OF LITERATURE

Tomato is an important vegetable for its worldwide demand. Numerous experiments have been conducted in various parts of the world to study the grafting success and suitability of some vegetables like tomato, brinjal, watermelon and different rootstocks to control the prevalence of soil borne disease, particularly wilt disease. Some of the relevant literatures related to present research are reviewed here.

A study was conducted on bacterial wilt in sick bed to assess the reaction of rootstocks of wild *Solanum* spp. and cultivated eggplant variety against bacterial wilt. *Solanum torvum*, *S. sisymbriifolium*, *S. melongena* (Var. Khotkhotia long) and *S. melongena* (Var Sufala) showed 0.00, 0.00, 19.44 and 100.00% wilt incidence, respectively (Rashid *et al.*, 2000).

Mayne (1999) stated that tomato grafted on vigorous rootstocks and cultivated under tunnel was economic for high quality and yield due to longer harvesting period.

Huang *et al.* (1999) conducted an experiment to select rootstock of tomato resistant to different soil borne diseases. Eighty two accessions of tomato were artificially inoculated with *F. Oxysporum,* the causal organism of Fusarium wilt and evaluated under field conditions. Two rootstocks were selected as disease resistant by pedigree selection, which had good grafting affinity, high disease resistance to Fusariurn wilt and tomato southern bacterial wilt (*R. solanacearum*) Different scions were grafted on to that rootstock and it showed disease resistance, improved quality and yield was increased from 18.95 to 50.00%.

Hossain *et al.* (1999) stated that *Solanum torvum* and *S. sisymbriifolium* were identified as resistant to bacterial] wilt. It was also mentioned that between these two species; *S. torvum* was more suitable for grafting as it contains few numbers of spines on leaves and stems compared to *S. sisymbriifolium.*

In 1997-98, a study was carried out in France to investigate the effects of grafting using Japanese method on growth, crop yield and quality of tomato. The grafted plants were cultivated under protected condition using same stem densities as for non-grafted plants. Over eight weeks of harvesting, good yield and fruit size were obtained from the grafted plants as compared to non-grafted ones (Mazollier, 1999).

Nishiura *et al.* (1999a) reported that an automatic grafted seedling production system has been developed on the basis of the "Plug-in- method" which was a new grafting method based on physiological principles. It was also found that the new process performed 90% successful grafting with a processing speed of 1.4 times compared to manual grafting.

Nishiura *et al.* (1999b) reported a method for detecting effective vascular systems by using 3-D image construction to study graft union between scion and rootstock. First it was used to detect the vessel tubes of a non-grafted tomato seedling to improve its effectiveness and then applied to grafted seedlings. The 3-D images clearly distinguished vessels at the graft union.

An investigation was carried out by Wadano *et al.* (1999) on changes of ascorbic acid level after grafting of tomato seedling. It was found that the content of ascorbic acid was increased gradually over 2 days compared to control. The ascorbate peroxides showed constant activity. So the increase of ascorbic acid may be due to its requirement to occur in the graft wound.

Wang *et al.* (1998) indicated that sowing date, seedling stage and grafting method (approach grafting, whip grafting, cut grafting or scarf joint)

influenced grafting success in tomatoes. It was also observed that success in cut grafting and scarf joint grafting were 87.69 and 88.95% respectively.

A study was carried out in green house to assess the effect of soil steaming and grafted plants in a soil infected with corky root. It was reported that grafted tomato gave 65% increased yield. Tomatoes from grafted plants had higher mineral salt contents but had slightly lower dry matter. But grafting had no influence on vitamin C content. It was also found that soil steaming improved the yield of non-grafted plants by 48%, while increasing plant vigor, but did not reduce the infection rate, by corky root (Granges *et* a]. 1998).

Alam *et al.* (1995) found the lowest borer infested fruits in grafted plants and significantly higher yield was obtained from these plants compared to normal ones. *Solanum. torvum*, *S. sisymbriifolium* and *S. amphidiploids* were used as rootstock by the investigators.

Ali *et al.* (1994) reported that grafting of eggplant on resistant wild *solanum* rootstocks have been used by Japanese growers since 1930s. It was also mentioned that in 1990, about 95% of Japanese commercial eggplant growers reported to use grafting on eggplants. It was further stated that Japanese scientists employed grafting technique for tomato production during

1950s to avoid soil borne diseases. But the technique was not so popular because of hollow fruit production without enough edible pulp.

Bacterial wilt of solanaceous plants was first observed in 1890 and its causal organism *Pseudomonas solanacearum* E-F Smith was first described by Smith (1896). The pathogen causes severe disease in chili, eggplant, potato, tomato and other solanaceous vegetables resulting in severe yield reduction (Rao *et al.* 1976, Gigard *et al.* 1993).

In Bangladesh five species of wild *Solanum* were evaluated for their resistance to root knot nematode (*Melodogyne incognita*) and their susceptibility was graded on the development of gall and nematode in root systems. It was observed that *S. sisymbriifolium* was found as resistant, *S. indicum* and *S. suranthense* as susceptible an *S. integrifolium S. insanum* as highly susceptible. The compatibility of cultivated eggplant varieties for grafting on *S. sisymbriifolium* was studied and it was found to be an effective rootstock for grafting with susceptible eggplant to reduce the severity of root knot disease (Islam, 1992).

Ali *et al.* (1992 a) developed amphidiploids through in vitro treatment of shoot tip and nodal explants of sterile inter specific hybrids between *S. melongena* and *S. intergrifolium* with 0.05% Colchicine. They found that seed

grown from amphidiploids seedlings were resistant to two of the five most virulent strains of wilt caused by bacteria.

Ali *et al.* (1992 b) evaluated resistance of eggplant, its wild relatives, inter specific *Solanum* Hybrids and amphidiploids to *M. cognita* through inoculation of seedlings of grafted and non-grafted plants. Immunity or high resistance in *S. Khasianum, S. torvum* and *S. toxicarium* was observed. It was further observed that small swellings were formed in S. *sisymbriifolium*, their hybrids and *amphidiploids* and *S. indicum* failed to show resistance against the root knot nematode and *Solanum mammosum* and *S. surattense* were highly susceptible to *M. incognita*.

In China, Lu *et al.* (1992) reported that grafting of the main local tomato cultivars with wild one gave 100% control of tomato bacterial wilt. Further, by 120.9; 80.5 and 78.6% when three wild rootstocks (Ch-2-26, Ch-2-25 and Ch-2-21) were used in tomato grafting.

Ali (1991) indicated that direct use of the *Solanum* sp. as rootstock has many problems like slow growth of seedling, poor post grafting affinity, susceptible to high or low temperature and poor economic yield of scion etc.

Matsuzoe *et al.* (1990) observed that the yield and quality of tomato fruits of grafted plants on the amphidiploid rootstocks were equivalent to or higher than those of non-grafted plants.

In 1988, tomato shoots were grafted on wild eggplant. It was found that the grafted tomato plants produced excellent quality fruit without hollowness (Ali, 1991). From that observation it was hypothesized that the genetic background of the modern tomato varieties might be responsible for non-hollowness. On the basis of that research, tomato grafting has been used commercially in Japan since 1991 to escape soil borne diseases.

An integrated control of *Ralstionia solanacearum* was conducted by Iizuka *et al.* (1988) who reported that the most effective treatments to control bacterial wilt involved the application of fungicides (Chloropicrin) and the use of grafting on rootstocks with resistance to bacterial wilt.

Hinata (1986) mentioned that the bacterial wilt Fusarium wilt and nematodes are the major factors limiting tomato production through out the world. It was reported that root-knot nematode infection is indicated by gall formation in root system and ultimately weakened the plant. As a result the growth and yield are affected. Nematode infection facilitates easy entries of the wilt causing organisms like bacteria and fungi.

Four cultivars of greenhouse tomatoes grafted on resistant rootstocks KNVF against *Pyrenochaeta lycopersici* or *Meloidogyne* spp. produced 30-50% higher yields than non-grafted control plants (Pirog, 1986)

Reboul (1981) worked on scions of tomato cvs. susceptible to *Pseudomonas solanacearum* (including Mighty Boy, Floradel and Better Boy) were grafted on eggplant as rootstock, Plant on eggplant rootstocks yielded 54. 5t/ha whereas non-grafted plants yielded only 16.5 t/ha.

Reboul (1979) evaluated tomato cvs. N 52, N 63, Fandango, Flamingo, Better Boy and Floradel which yielded well both in cool and hot seasons. Grafting on eggplant was recommended on soil infected with *Pseudomonas solancearum*.

Pudelski *et al.* (1978) worked on seven tomato cvs. Which were grafted on the rootstock type KNIVT, and observed increased yield in all cvs. ranging from the highest increment of 110.7% over the control. Grafting on KNVF rootstocks also improved fruit composition. Disease incidence on grafted plants was significantly lower.

Gindrat *et al.* (1977) reported that grafting the susceptible cvs. Montfavet 63-5, Rise, Vilmorin 186-73, Harold and Luca on hybrid rootstock KNVF (F. hybrid with a *Lycopersicon hitrutum* parent) gave a 600% increase

in yield compared to the non-grafted control (Susceptible to *Fusarium Oxysporumf.* sp. *lycopersici* race 1). Grafting was considered a satisfactory method of disease control.

Cheng *et al.* (1976) worked on scions of the tomato cv. Farmers No. I were grafted on rootstocks of *Solanum melongena* (a local eggplant cv.), *S. wrightii* (a perennial tree) or a local tomato cv. all resistant to bacterial wilt (*Pseudomonas solanacearum*). The grafting was successful and no graft died from wilt.

Lum *et al.* (1976) observed that *Pseudomonas solanacearum*, the major limiting factor of large-scale tomato growing in Malaysian lowlands, can be successfully overcome when tomato scions are grafted on selected resistant eggplant rootstocks. Grafts were highly compatible for perfect union. Using local cvs. "Flitam", "Bulat" or "Sabah" as rootstocks, wilt incidence was consistently reduced to below 10% in fields where nongrafted cvs. suffered total loss.

Rajendra *et al.* (1975) observed the effects of grafting tomato scions on eggplant and *Solanum torvum* rootstocks. The percentage of successful grafts was greater in the former combination and flowering was profuse.

Purseglove (1974) mentioned that some of the wild *Solanum* sp. are being used directly as rootstock of eggplant or can be used as breeding materials to exploit resistance.

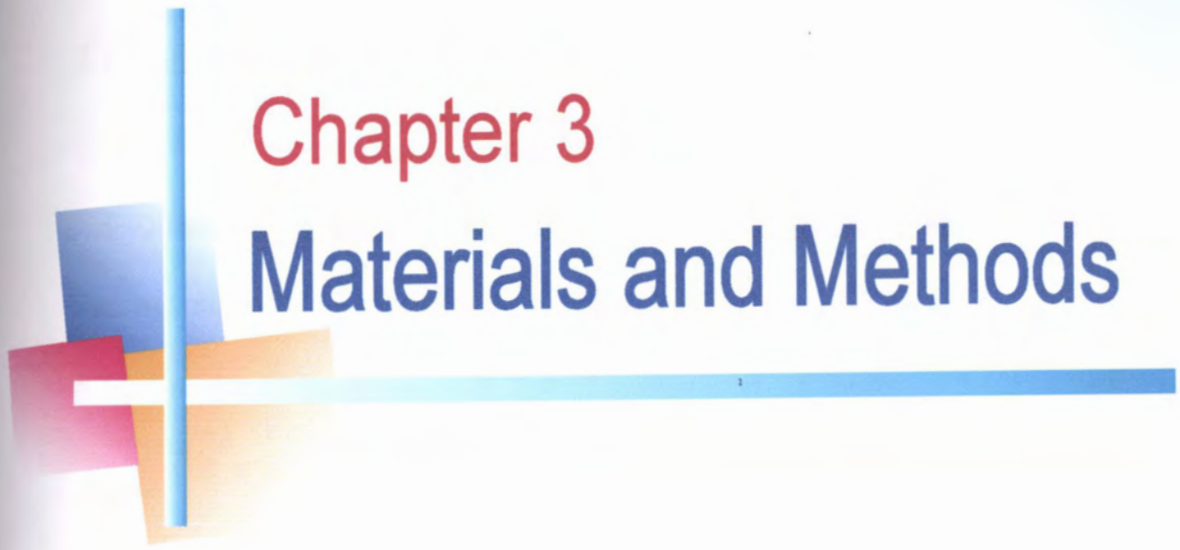
Felix (1973) stated that in greenhouse and field trials, tomato scions tongue grafted on *Solanum torvum* rootstock were resistant to the attack of *Pseudomonas solanacearum* and *Meloidogyne* sp. whereas non-grafted plants were highly susceptible. The field establishment of grafted seedlings was also more successful than that of non-grafted plants.

In tomato, grafting was being practiced where there was severe problems of soil borne disease found in 3 resistant varieties introduced into Japan. OTB-2 was best for using as stock in grafting for controlling *Fusrium oxysporum, F. lycopersici* and *Pseudomonas solanacearum*. Cleft grafting was recommended, with stock at the 5 leaf stage and the scion at the 3 leaf stage (Okuda *et al*., 1972).

In several experiments, it was noticed that heritable changes of scion might be due to somatic mutation probably caused by the effects of root stocks and thereby heritable changes through grafting had been reported by Baldin (1952); Bohme (1954), Sumarskaja (1958); Vnuckova (1962); Hirata (1980).

Kress (1961) reported that tomato could be grafted on eggplant and it had some practical implication to breeders. It was further reported that there was some reduction in size of fruit and *S. torvum* could be successfully used as a root stock to produce plants resistant to root diseases.

It is therefore, revealed from the above review that bacterial wilt and root knot nematode cause severe damage to tomato. Tomato varieties released by BARI are particularly susceptible to these diseases. However, few wild *Solanum* species were found to be resistant to soil borne disease. Grafting of tomato varieties on resistant *Solanum* spp. has been suggested to have higher yield, to extend the fruiting period avoiding soil borne diseases especially bacterial wilt problem.



Chapter 3

Materials and Methods

CHAPTER – 3

MATERIALS AND METHODS

The present research work was carried out at the Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the period from October 2004 to April 2005 to study the effect of grafting on the yield of tomato. This chapter deals with the materials and methods in conducting the experiment.

3.1 Soil:

The land was medium high with good drainage facilities. The soil of the experimental area belongs to the Gray Terrace Soil Tract. The texture of the soil was silt loam having pH 6.4 with an organic matter content of 1.88%.

3.2 Climate:

The area is characterized by hot and humid climate. The average rainfall of the locality during the experiment was 5.83 mm. The average minimum and maximum temperatures were 17.82^{0}C and 29.08^{0}C respectively. The average relative humidity was 72.5% during October 2004 to April 2005.

3.3 Materials :

Bangladesh Agricultural Research Institute (BARI), Joydebpur developed three tomato varieties namely BARI Tomato-3, BARI Tomato-4,

and BARI Tomato-6. These three tomato varieties were used as scion and *Solanum sisymbriifolium* were considered as rootstock.

3.4 Treatment:

The factorial RCBD experiment consisted of two factors that are represented as below:

3.4.1 Factor – A: Tomato varieties

BARI Tomato-3, designated as V_1

BARI Tomato-4, designated as V_2

BARI Tomato-6, designated as V_3

3.4.2 Factor – B: Grafting

No grafting designated as G_0

Tomato grafting designated as G_1

3.5 Design and layout:

The two-factor experiment was laid out in randomized complete block design with three replications. A block consisted of 18 unit plots each receiving a treatment combination of the experiment. Treatment combinations of the experiment were assigned randomly in block. The number of plant per unit plot was 20. The size of unit plot was 4 x $1m^2$.

3.6 Seedling raising:

3.6.1 Raising of rootstock seedling:

Seeds of rootstock (*S. sisymbriifolium*) were sown directly in the seedbed on 2nd October 2004. Seedlings at 2-3 true leaf stage were transplanted individually in polyethylene bag (9 cm in diameter) containing a mixture of 3 parts well-decomposed cow dung and 1 part soil.

The rootstock seedlings of *S. sisymbriifolium* (Plate 1) were ready for grafting on 8th December 2004 when four to six fully opened leaves were developed and the plants were 8 to 10 cm tall.

Plate 1. Seedlings of rootstock (*S. sisymbriifolium*) for grafting

3.6.2 Raising of scion seedling:

Seeds of tomato (var, BARI Tomato-3, BARI Tomato-4 and BARI Tomato-6) were sown directly in the seedbed on 10th November, 2004.

The scion seedlings (plate 2) were ready for grafting when they were 5-8 cm in height with 4-5 leaves. Adjustment was made with sowing date of scion and stock so that the seedlings were ready for grafting at the same time. Watering, mulching, weeding and shading were done as and when necessary.

Plate 2. Seedlings of scion ready for grafting

(1) BARI Tomato-3 (2) BARI Tomato-4 (3) BARI Tomato-6

3.7 Procedure for grafting

3.7.1 Rootstock preparation

- Rootstock in polyethylene bag was held tightly between knees.
- The top of the rootstock was removed by a sharp horizontal cut using a razor blade retaining 1-3 leaves with the stock plant.
- A vertical cut of about 1 cm depth was made so that the tip of the rootstock become two equal parts.
- Slightly open and wide slit was made to facilitate the insertion of scion.

3.7.2 Scion Preparation

- Four to five cm long shoot with growing point from the scion seedling was cut with the help of a sharp razor blade.
- Lower leaves were removed from the scion to reduce transpiration. The first slanting cut about one cm long on the basal end of the scion was made.
- A similar cut to the opposite side at the basal end was made such that a 'V' or 'wedge' shape was formed at the base of the scion.

3.7.3 Making the graft and nursing:

- The wedge of the scion was inserted into the slit portion of the rootstock is such a way that the cut surface of both scion and rootstock made contact and fitted gently (plate 3).
- To make the joint tight and strong a plastic clip was used.
- After grafting, water was sprayed on the scion using a hand sprayer.
- Grafted plants were put in a small tunnel covered with a sheet of polyethylene and a black sheet of curtain under the polyethylene cover so that high humidity can be maintained and no sunlight can directly enter into the tunnel. When there was no rain the tunnel was kept uncovered at night but covered again during the day time. Water was sprayed on the grafted plants 3-4 times a day for a period of 7-10 days.
- Polyethylene sheet was removed from the top of the tunnel after above mentioned times keeping the black cover for another few days until the graft union was established. After 10-12 days the scion started to grow. Emerged twig from the rootstock was removed immediately (plate 3).

For better success tunnel was prepared in a shady place and grafting was done in the afternoon.

Plate 3. Grafting procedure of tomato on rootstock (contimned)

(a) Insertion of "V" shaped end of the scion into the vertical cut of the rootstock and attaching a grafting clip;

(b) Grafted tomato seedling on a rootstock attached with a grafting clip;

(c) Spraying water on the grafted seedling;

(d) Grafted seedling in a shade house covered with a sheet of polyethylene and a black curtain.

3.8 Land preparation:

Selected land was opened on 23rd December 2004. The land was prepared by ploughing and cross ploughing followed by laddering. The weeds and stubbles were removed and the land was prepared through addition of the basal doses of manures and fertilizers. Finally, the plots were raised up to 30 cm from the ground level and 1m in width and 20m in length raised beds were prepared having 30cm space in between two beds for providing irrigation and cultural operations.

3.9 Dose of manure and fertilizers and their methods of application:

Manure and fertilizers were applied uniformly in all the experimental plots as per following doses:

Manure/Fertilizer	Dose/ha	Dose/Plot
Well decomposed cowdung	10t	4 kg
Urea	550 kg	220gm
TSP	450 kg	180 gm
MP	250 kg	100gm
Gypsum	120 kg	40gm

The whole amount of cowdung and TSP were applied as basal dose during land preparation. Urea and MP were applied as side dressing in two equal splits at 21 and 35 days after transplanting.

3.10 Transplanting and establishment of seedlings

Seedlings were transplanted in the main field after three weeks of grafting on 27th December 2004. Non-grafted seedlings (control) of similar age were also transplanted in the field on the same date.

Grafted seedlings were watered 3-4 hours before transplanting in the main field. Before transplanting undesired emerging shoots and twigs of stocks (below grafted point) were removed. During transplanting the polythylene bag was cut and removed with care to keep the soil intact with the root system of the rootstock plant. A spacing of 60 x 40 cm was used. Irrigation was provided after transplanting of seedlings.

3.11 Staking and pruning practices:

Plants were supported by 'A' shaped bamboo stick to keep the branch upright. The plants were pruned twice 21 and 35 days after transplanting respectively.

3.12 Weeding and mulching:

Weeding and mulching were done as and when necessary to keep the plot free from weeds.

3.13 Irrigation:

The plants were initially irrigated by watering can and as they grew older flood irrigation was provided whenever required.

3.14 Pest and disease control

White flies were controlled by spraying Bimecron 50 EC @ 2ml/L at 15 days interval as suggested by Khurshed *et al.* (1987). There was no other major insects pests found in the crop and the bacterial wilt affected plant whenever found was uprooted and destroyed.

3.15 Harvesting

Time to harvest was counted from the date of transplanting (27^{th} December) to the date it was harvested (2^{nd} March to 20^{th} April 2005).

3.16 Data collection:

Data were recorded on the following parameters from the sample plants to assess the result. The sampling was done randomly. The plants in the outer two rows and at the extreme end of the middle rows were excluded during randomization. Ten plants were randomly selected from each plot. The data on following parameters were recorded.

i) Grafting success (%): Percent success of grafting was determined 15 days after grafting when the scion started growing on the rootstock. Healthy and well established scions were counted as successful grafts.

ii) Mortality (%)

iii) Plant height (cm)

iv) Days to 50% flowering

v) Duration of harvesting (days)

vi) Fruit length (cm)

vii) Fruit diameter (cm)

viii) No of fruits / plant

ix) Single fruit weight (gm)

x) Bacterial wilt incidence

xi) Virus infestation.

xii) TSS (%)

xiii) Yield / plant (kg)

xiv) Yield / ha (ton)

Chapter 4

Result and Discussion

CHAPTER – 4

RESULT AND DISCUSSION

The present experiment was conducted to investigate the performance of three tomato varieties on grafting success on growth, wilt incidence, quality of fruits and yield of tomato. The results obtained from the study have been presented and discussed in this chapter.

4.1 Grafting success:

The results of the experiment indicated that grafting success was significantly influenced by different varieties. The maximum success (46.79%) was found in the variety BARI Tomato-6 and the minimum success (44.99%) in BARI Tomato-4 (Table 1). Grafting success obtained from BARI Toamto-3 and BARI Tomato-6 were statistically identical.

When grafting was made with different tomato varieties on rootstocks of *Solanum* spp., success of grafting varied widely. The effect of rootstock on the grafting success was found significant (Table 1).

The combined effect of varieties and grafting on grafting success was also found significant. The results in this regard have been presented in (Fig.1). It was revealed from the results that the highest grafting success (93.59%) was recorded from the treatment combination of BARI Tomato-6 followed by

BARI Toamto-3 grafted with *S. sisymbriifolium* (92.21%) which was statistically identical. The lowest degree of grafting success (89.99%) was obtained from the variety BARI Tomato-4 grafted on same rootstock. Chadha *et al.* (1992) observed 60-93% success of grafting when tomato was grafted with *Solanum sisymbriifolium* which is similar with the results of the present study.

Table 1. Main effect of variety on grafting success of tomato.

Treatment	Grafting Success (%)
V_1	46.10ab
V_2	44.99b
V_3	46.79a
LSD 0.05	1.48
CV%	2.51

In parenthesis transformed data have been presented.

V_1 = BARI Tomato-3, V_2 = BARI Tomato-4, V_3= BARI Tomato-6 ,

4.2 Mortality

The results of main effect of scion on rootstock for mortality have been presented in (Table 2). The Mortality percentage were found significant among the tomato varieties. Under study BARI Tomato-3 showed highest (8.55%) mortality percentage and BARI Tomato - 4 showed lowest (5.10%) mortality percentage.

When grafting was made among the varieties significant variation was found (Table 2). The grafted tomato plants suffered minimal mortality (0.21%) from the Bacterial wilt disease.On the other hand, the non-grafted tomato plants suffered 14% mortality from bacterial disease.

As regards combined effect significant variation was found among the different treatment combinations in respect of mortality (Fig.-2). The maximum mortality percentage (17.00%) was observed from BARI Tomato-3 while the minimum (0.10%) was observed from non-grafting BARI Tomato-3.

Table 2. Main effect of variety and grafting on mortality of tomato.

Treatment	Mortality (%)
V_1	8.55a
V_2	5.10c
V_3	7.66b
LSD 0.05	0.672
CV%	7.35
G_0	14.00a
G_1	0.21b
LSD 0.05	0.95
CV%	7.35

In parenthesis transformed data have been presented.

V_1 = BARI Tomato-3 , V_2 = BARI Tomato-4, V_3= BARI Tomato-6 ,

G_0= Control

G_1= Grafting

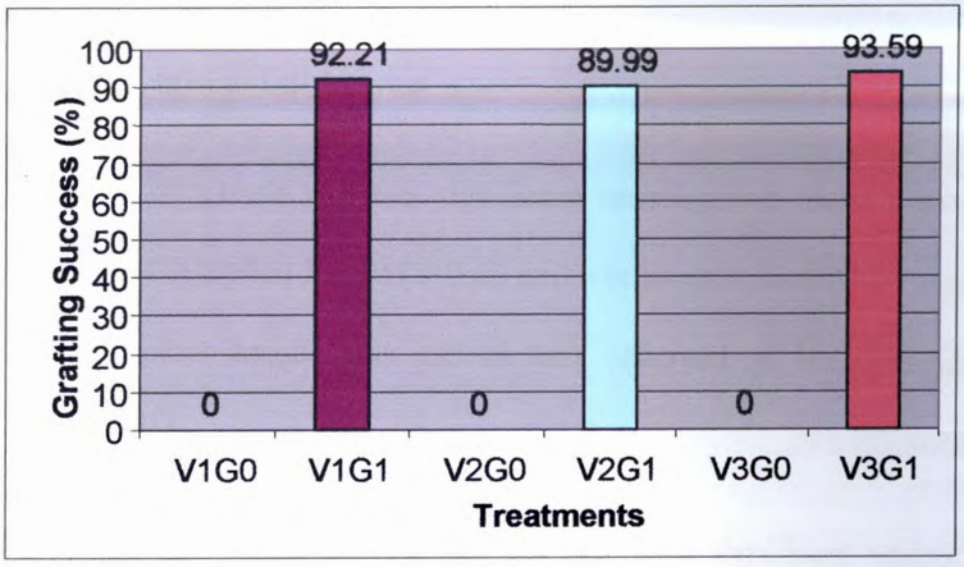


Fig. 1. Combined effect of variety and grafting on grafting success of tomato

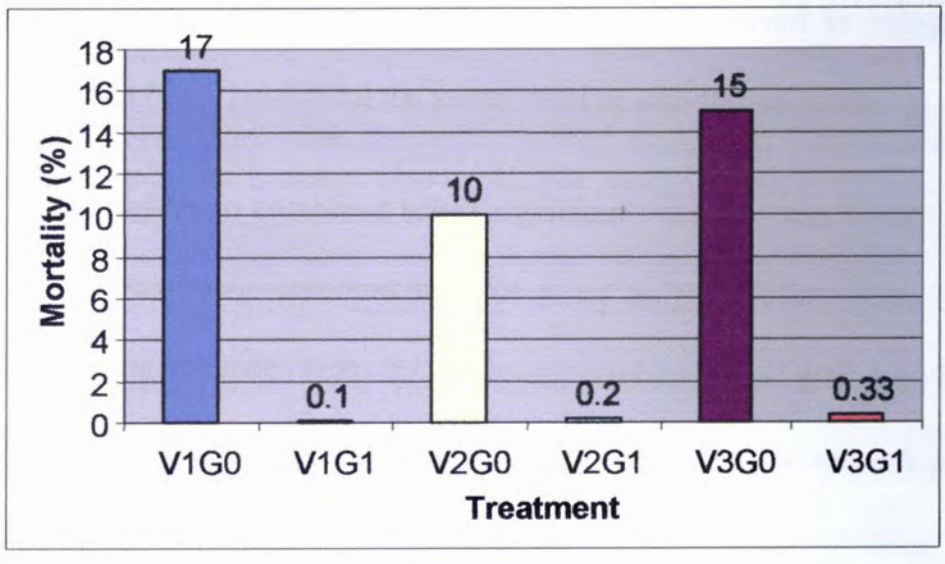


Fig. 2. Combined effect of variety and grafting on mortality of tomato

In parenthesis transformed data have been presented

V_1 G_0= Non-grafting BARI Tomato-3
V_1 G_1= Grafting BARI Tomato-3
V_2 G_0= Non-grafting BARI Tomato-4
V_2 G_1= Grafting BARI Tomato-4
V_3 G_0= Non-grafting BARI Tomato-6
V_3 G_1= Grafting BARI Tomato- 6

4.3 Plant height at last harvest

In case of tomato varieties significant variation was found among the varieties. The tallest plant height (110.45 cm) was recorded in BARI Tomato-4. The shortest plant height was (95.06 cm) observed in BARI Tomato-3 (Table-3).

The non-grafted and grafted plants showed a significant variation in plant height (Table-3). Tallest plant (103.07 cm) was observed in grafted plants. The shortest plant height (100.25 cm) was observed in non-grafted plants. Ibrahim (1996) observed the same result in non-grafted plants.

With regards to combined effect significant variation was found among the different treatment combinations for plant height. Tallest plant height (112.30 cm) was recorded from the treatment combination of graft with BARI Tomato-4 and the shortest plant was observed (92.89cm) from non-grafted BARI tomato 4 (Fig. 3).

4.4 Days to 50% flowering

The results on main effect of scion on rootstock for days to 50% flowering have been presented in Table-3. Among the tomato varieties under study BARI Tomato-4 and BARI Tomato-6 took 47 days and 48 days

respectively for 50% flowering. But BARI Tomato-3 took 51 days for the same.

When grafting was made among the varieties significant variation was found (Table-3). As evident from the results, it was found that non-grafted plants took minimum time (46 days after plantation) for 50% flowering. On the other hand, the grafted plants took 53 days for 50% flowering.

In case of combined effect significant variation was found among the different treatment combination for 50% flowering (Fig - 4).

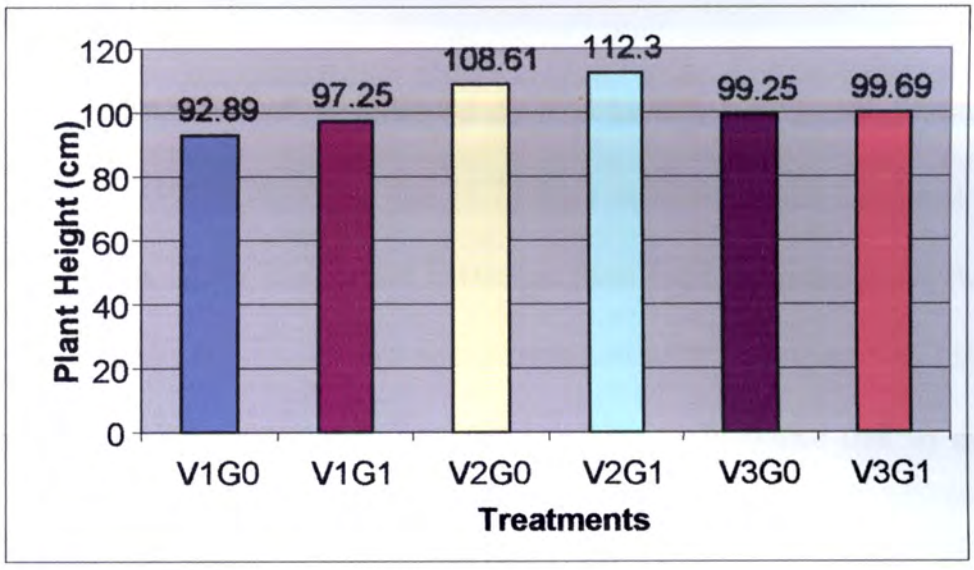


Fig. 3. Combined effect of variety and grafting on plant height of tomato

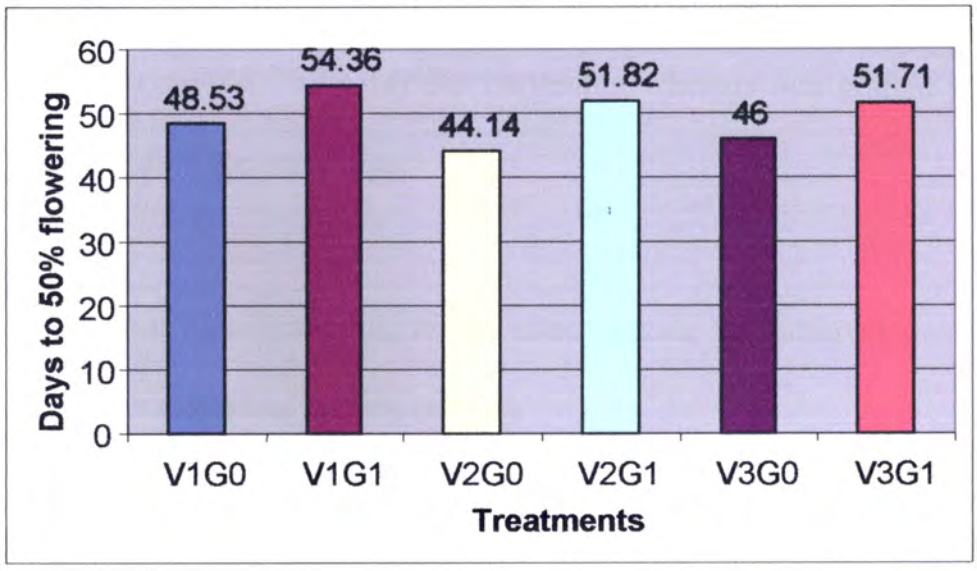


Fig. 4. Combined effect of variety and grafting on flowering of tomato.

In parenthesis transformed data have been presented

V_1 G_0= Non-grafting BARI Tomato-3
V_1 G_1= Grafting BARI Tomato-3
V_2 G_0= Non-grafting BARI Tomato-4
V_2 G_1= Grafting BARI Tomato-4
V_3 G_0= Non-grafting BARI Tomato-6
V_3 G_1= Grafting BARI Tomato- 6

4.5 Days to harvest

The main effect of varieties on days to harvest was found significant (Table 3). The results indicated that 79.74 days were needed to harvest BARI Tomato-6 where as the fruits were harvested from BARI Tomato-3 and BARI Tomato-4 at 68.67 and 71.18 days after planting of seedling respectively (Table 1). Among the varieties BARI Tomato- 6 had the inheritance trait to delay flowering and fruiting.

It was revealed from the result (Table 3) that the duration of fruit harvest was significantly longer in grafted plants than those of non-grafted plants. The grafted plants required 76.22 day for harvesting whereas non grafted plants required 70.17 days for harvesting.

There was significant interaction effect among the different treatment combinations in respect of harvest (Fig. 5).

Generally grafted plants had a tendency of delay in flowering, fruit set and harvesting compared to non grafted plants. This might be due to the transplanting shocks during grafting. Matasuzoe *et al.* (1990) and Ali (1994) also reported the same observation.

Table 3. Main effect of variety and grafting on plant height, flowering and days to harvest of tomato.

Treatment	Plant height at last harvest (cm)	Days to 50% flowering	Days to harvest
V_1	95.06c	51.44a	68.67c
V_2	110.45a	47.48b	71.18b
V_3	99.47b	48.85b	79.74a
LSD 0.05	2.77	1.77	2.35
CV%	2.12	2.79	2.5
G_0	100.25b	46.23b	70.17b
G_1	103.07a	52.63a	76.22a
LSD 0.05	3.92	2.51	3.33
CV%	2.12	2.79	2.5

In parenthesis transformed data have been presented.

V_1 = BARI Tomato-3, V_2 = BARI Tomato-4, V_3= BARI Tomato-6 , G_0= Control G_1= Grafting.

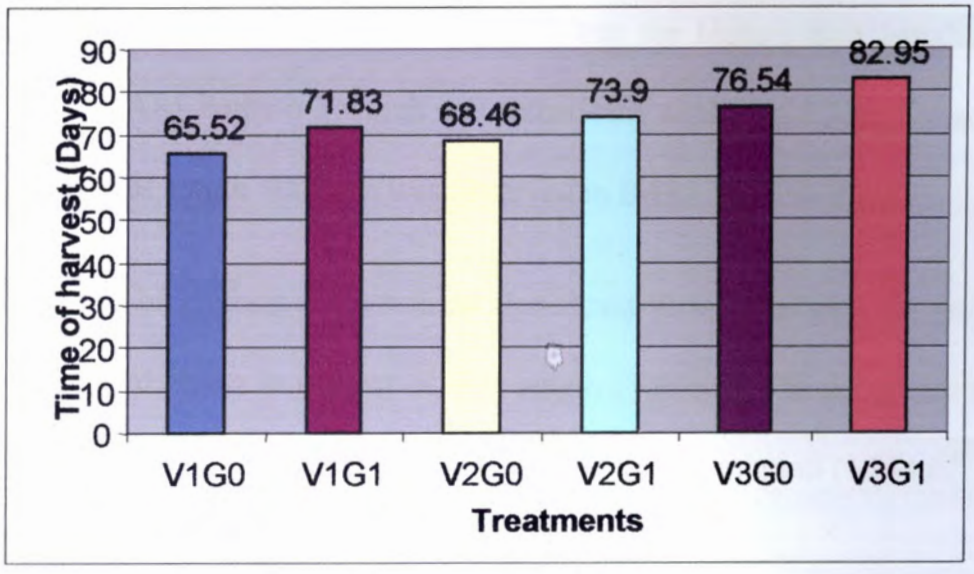


Fig. 5. Combined effect of variety and grafting on time of harvest of tomato

In parenthesis transformed data have been presented

V_1 G_0= Non-grafting BARI Tomato-3
V_1 G_1= Grafting BARI Tomato-3
V_2 G_0= Non-grafting BARI Tomato-4
V_2 G_1= Grafting BARI Tomato-4
V_3 G_0= Non-grafting BARI Tomato-6
V_3 G_1= Grafting BARI Tomato- 6

4.6 Fruit length

In case of main effect of varieties on fruit length significant variation was found. (Table-4). The results indicated that the highest fruit length was observed in BARI Tomato-3 which was statistically similar in BARI Tomato-6. The lowest fruit length 4.02 cm was observed to BARI Tomato- 4.

In case of grafting there was no significant variation among the grafted and non grafted plants in respect of fruit length (Table-4.) The maximum fruit length (4.93 cm) was obtained from grafted while the minimum (4.84 cm) was recorded from non grafted plants.

As regards combined effect, significant variation was found among the different treatment combinations for fruit length (Table-5). The highest fruit length was 5.41 cm found from grafting with BARI Tomato–3 and the lowest 3.88 cm showed in non grafting BARI Tomato-4.

4.7 Fruit diameter

Significant difference in fruit diameter among the tomato varieties was recorded (Table 4). BARI Tomato-6 showed highest fruit diameter 5.74 cm and BARI Tomato- 4 showed the lowest fruit diameter 3.30 cm.

Significant variation was found among the grafted and non-grafted plants in case of fruit diameter. The maximum fruit diameter 4.83 cm was found from grafted plant while the minimum 4.58 cm was obtained from non grafted plant (Table-4).

In case of combined effect significant variation was found among the different treatment combinations for fruit diameter (Table-5). The maximum fruit diameter 5.78 cm was recorded from grafting BARI Tomato-6 and the minimum 3.02 cm was found from non grafting BARI Tomato-4.

4.8 Fruits per plant

The number of fruits per plant of different varieties exhibited significant variation (Table 4). The maximum number of fruit (26.06) was obtained from BARI Tomato-6. The lowest number of fruits per plant (21.10) was recorded from BARI Tomato-4.

The maximum number of fruit (24.34) was harvested from grafted plants whereas minimum number (22.67) was obtained from non-grafted tomato plants (Table 4). Similar results were also obtained by Kader *et al.* (1967) who reported that grafting increased the total number of fruits by 28 to 58%.

The results on combined effect of varieties and rootstock in this respect were found significant (Table-5). The maximum number of fruit per plant 26.15 was obtained from grafting BARI Tomato-6 while the minimum 19.88 was found from non grafting BARI Tomato-4.

4.9 Individual fruit weight

The variation in individual fruit weight was found significant in different tomato varieties. The maximum fruit weight (68.84gm) was recorded in BARI Tomato-3. The lowest fruit weight (33.70 gm) was obtained from BARI Tomato-4 (Table-4). This difference was probably due to genetic potentialities of the varieties.

Table 4. Main effect of variety and grafting on fruit characters on the yield of tomato.

Treatment	Fruit length (cm)	Fruit diameter (cm)	Number of fruits / plant	Individual fruit weight (g)	TSS (%) (Total Soluble Solids)
V_1	5.38a	5.08b	23.35b	68.84a	4.25b
V_2	4.02b	3.30c	21.10c	33.70c	4.57a
V_3	5.24a	5.74a	26.06a	66.75b	4.32ab
LSD 0.05	0.32	0.29	1.02	8.973	0.26
CV%	5.08	4.89	3.39	12.74	4.61
G_0	4.84	4.58	22.67b	55.22b	4.26
G_1	4.92	4.83	24.34a	57.63	4.49
LSD 0.05	0.45	0.41	1.44	1.34	0.368
CV%	5.08	4.89	3.39	12.74	4.61

In parenthesis transformed data have been presented.

V_1 = BARI Tomato-3, V_2 = BARI Tomato-4, V_3= BARI Tomato-6

G_0= Control (non-grafting), G_1= Grafting.

There was no significant difference among the grafted and non-grafted plants. The highest fruit weight (57.63 gm) was found in grafted plants. It was revealed that heavier fruits were produced from grafted plants compared to non-grafted plants. Since the fruits produced from grafted plants contained higher dry matter than that of non-grafted. Hence, single fruit weight was increased proportionally.

The result of combined effect indicated significant response of individual fruit weight. The largest fruit weight (70.39 gm) was obtained from the treatment combination of BARI Tomato-3 grafted on *S. sisymbriifolium.* While the lowest fruit weight was found in non grafted plants (Table-5)

4.10 Total soluble solids (TSS)

The results of main effect of varieties were found significant. The highest TSS (4.57%) was recorded from BARI Tomato-4 which was statistically similar to BARI Tomato-6 (Table-4).

There was no significant difference between grafted and non-grafted plant (Table-4)

The result of combined effect showed significant influence on TSS (Table-5). There was significant variation between all the treatments. The maximum TSS 4.62 was recorded from grafting BARI Tomao-4 while the minimum was recorded from non grafting BARI Tomato-3.

In overall observation it was found that grafted plants were high yielder than non-grafted plants when tomato plants was grafted on *S. sisymbriifolium.* The present study is in support of the views of Mastodon. *et al.* (1990) and Ali (1993) who got wilt free and the higher fruit yield in tomato when grafted on *S. sisymbriifolium* root stock.

Table 5. Combined effect of variety and grafting on fruit characters of tomato.

Treatment	Fruit length (cm)	Fruit diameter (cm)	Fruits / plant (no)	Individual fruit weight (g)	TSS (%) (Total Soluble Solids)
V_1G_0	5.35a	5.01b	22.14c	67.28b	4.06b
V_1G_1	5.41a	5.14b	24.57b	70.39a	4.44ab
V_2G_0	3.88b	3.02d	19.88d	32.55e	4.52a
V_2G_1	4.16b	3.58c	22.31c	34.85d	4.62a
V_3G_0	5.29a	5.71a	25.98ab	65.16c	4.22ab
V_3G_1	5.2a	5.78a	26.15a	67.64b	4.41ab
LSD at 0.05%	0.45	0.41	1.45	12.69	0.36
CV (%)	5.08	4.89	3.39	12.74	4.61

In parenthesis transformed data have been presented

V_1 $G_{0=}$ Non-grafting BARI Tomato-3

V_1 $G_{1=}$ Grafting BARI Tomato-3

V_2 $G_{0=}$ Non-grafting BARI Tomato-4

V_2 $G_{1=}$ Grafting BARI Tomato-4

V_3 $G_{0=}$ Non-grafting BARI Tomato-6 V_3 $G_{2=}$ Grafting BARI Tomato- 6

4.11 Yield per plant

There was significant variation in yield per plant due to varietals influence. The maximum yield per plant (1.73 kg) was recorded from BARI Tomato– 6. The lowest yield (0.71 kg) was obtained from BARI Tomato -4 (Table– 6).This finding was in agreement with the findings of Hosain(2000) who got the lowest yield while working with BARI Tomato – 4 .

The main effect of rootstocks on yield per plant revealed that there was significant variation among the different treatments (Table 6). The higher yield (1.42 kg) was observed when BARI Tomato 6 was grafted and the lowest yield (1.28 kg) was obtained from non-grafted plants. In general, the yield obtained from grafted plants was found higher than that of the non-grafted plants.

The interaction effect between varieties and grafting was found significant. The result presented in Fig-6 showed that due to combined effect of varieties and rootstocks, the highest yield (1.76 kg) was obtained from BARI Tomato – 6 in grafting condition while the lowest yield (0.64 kg) was recorded in BARI Tomato – 4 in control condition.

4.12 Yield per hectare

The yield of tomato per hectare was significantly influenced by the main effect of varieties used. When the yield of tomato per plot was converted into yield per hectare, BARI Tomato-6 produced the highest yield 76.36 ton/ha which was statistically similar to BARI Tomato-3.. The lowest yield was obtained from BARI Tomato-4 (Table-6). It might be due to genetic potentialities of the varieties studied.

The results of main effect of rootstocks revealed that the total yield per hectare was influenced by rootstock with significant variation. Grafted tomato plant gave the highest yield (64.32 t/ha) and the lowest yield (59.14 t/ha) was recorded in non-grafted plants. Kill and Jaksch (1998) showed that yield increases 15-35% in grafted plant compared to the yield of tomato plants without grafting.

The combined effect on yield per hectare indicated that BARI Tomato – 6 gave the highest yield (79.74 t/ha) when grafted and the lowest yield (72.98 t/ha) was received from the same variety without grafting. Maximum yield (35.02 t/ha) was obtained from the grafted plants while the lowest yield (30.91 t/ha) was noted from non-grafted plants (Fig. 7).

Table 6. Main effect of variety and grafting on the yield of tomato.

Treatment	Yield Per Plant (kg)	Yield per ha(ton)
V_1	1.61b	75.87a
V_2	0.71c	32.97b
V_3	1.73a	76.36a
LSD 0.05	0.07	5.62
CV%	4.33	7.08
G_0	1.28b	59.14b
G_1	1.42a	64.32a
LSD 0.05	0.057	7.95
CV%	4.33	7.08

In parenthesis transformed data have been presented.

V_1 = BARI Tomato-3, V_2 = BARI Tomato-4, V3= BARI Tomato-6

G_0= Control, G_1= Grafting.

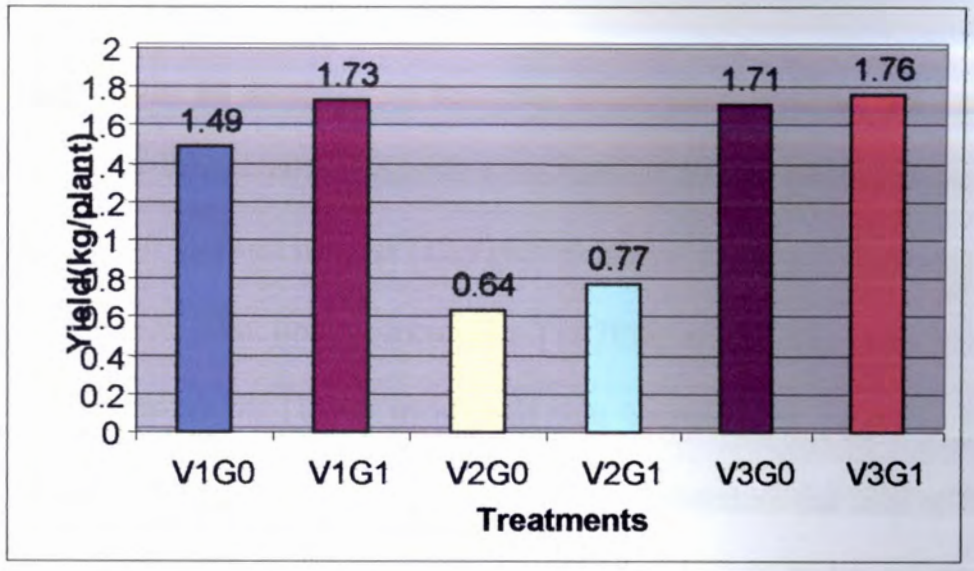


Fig. 6 Combined effect of variety and grafting on yield (per plant) of tomato.

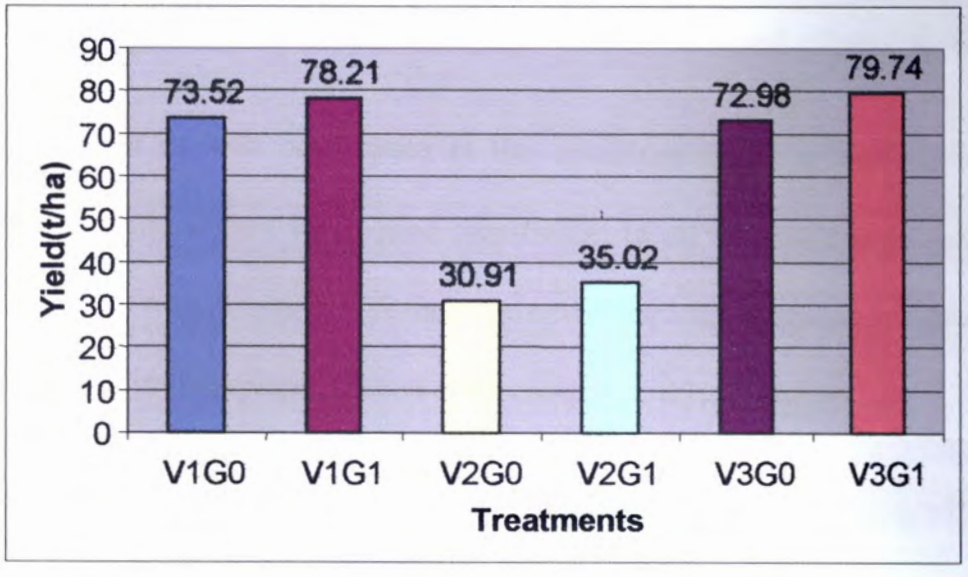


Fig. 7 Combined effect of variety and grafting on yield (per hectare) of tomato.

In parenthesis transformed data have been presented

V_1 G_0= Non-grafting BARI Tomato-3
V_1 G_1= Grafting BARI Tomato-3
V_2 G_0= Non-grafting BARI Tomato-4
V_2 G_1= Grafting BARI Tomato-4
V_3 G_0= Non-grafting BARI Tomato-6
V_3 G_1= Grafting BARI Tomato- 6

4.13 Bacterial wilt incidence

The results on incidence of bacterial wilt revealed that varieties varied significantly in this respect. Regarding the rate of disease (wilt) occurence, BARI Tomato-6 showed highest (17.93%) incidence which was followed by BARI Tomato-3. The lowest incidence (12.78%) was found from BARI Tomato-4/. Boro *et al.* (1996) mentioned that bacterial wilt incidence was significantly correlated with soil temperature, air temperature and total rainfall but relative humidity had no influence on bacterial wilt incidence which endorsed the justification of the present work. *Solanum sisymbriifolium* was completely resistant, even not a single grafted plant was found affected by wilt.

The rate of wilt occurrence in the combined effect of varieties and rootstocks in this regard was found significant. In all treatment combination tomato grafted with *S. sisymbriifolium* showed complete resistance to bacterial wilt while non grafted plant showed different degree of wilt occurrence.

The result on grafting on the incidence of wilt has been shown in Fig. 9. The highest percentage of wilt incidence (31.53%) was found in non-grafted condition. Hossain *et al.* (1999) reported that incidence of bacterial wilt occurred from 3.33 to 36.76% in tomato in non-grafted condition. This finding agreed with the results of the present investigation. No wilt incidence was found when grafting was made with *S. sisymbriifolium.* Similar opinion was

also put forward by Ali (1991) when tomato was grafted with *S. torvum* and *S. sisymbriifolium* rootstocks. In another investigation same comments were made by Mondal *et al.* (1991) when *S. sisymbriifolium* were considered as rootstock in controlling bacterial wilt.

4.14 Virus infestation

The result on the appearance of virus infestation in both grafted and non-grafted plants are presented in table-7.

The main effect of varieties on virus infestation was found significant (Fig. 8). The results indicated that BARI Toamto-4 showed highest (19.90%) virus infestation and BARI Tomato-3 showed lowest (16.26%) virus infestation.

Virus infestation was higher (30.81%) in non-grafted plants as compared to grafted ones. Plants grafted on *Solanum sisymbriifolium* showed better performance against virus infestation.

The result on combined effect indicated significant response of virus infestation. Grafted plants showed less virus disease like symptoms compared to the non-grafted ones as wild *Solanum* species are probably resistant to the viruses present in the soil. Akanda (1994) reported that the wild *Solanum* spp.

used as rootstock of tomato and eggplant in controlling wilt diseases caused by bacteria and fungi may also be resistant to the viruses occuring soil (eg. TMV / T_0MV; T_0RSV,/TRSV, etc.) Moreover, the wild species may have bio-active chemical substances which can resist the viruses and ultimately reduce the incidence of the virus diseases of the crop.

Reduced disease incidence in grafted plants as compared to non-grafted ones was also reported by Lum *et al.* (1976), Mochizuki *et al.* (1976b) Reboul (1979), Peregrine *et al. (1992),* Ali *et al.* (1994). Ibrahim (1996).

Table 7. Combined effect of variety and grafting on the bacterial wilt incidence and virus infestation of tomato.

Treatment	Bacterial wilt (%)	Virus infestation (%)
V_1G_0	33.16b	26.71c
V_1G_1	0.00d	5.80d
V_2G_0	25.56c	36.46a
V_2G_1	0.00d	3.33e
V_3G_0	35.87a	29.24b
V_3G_1	0.00d	6.47d
LSD at 0.05%	3.71	1.25
CV (%)	9.47	3.84

In parenthesis transformed data have been presented

V_1 G_0= Non-grafting BARI Tomato-3, V_1 G_1= Grafting BARI Tomato-3

V_2 G_0= Non-grafting BARI Tomato- 4, V_2 G_1= Grafting BARI Tomato-4

V_3 G_0= Non-grafting BARI Tomato-6 , V_3 G_1= Grafting BARI Tomato-6

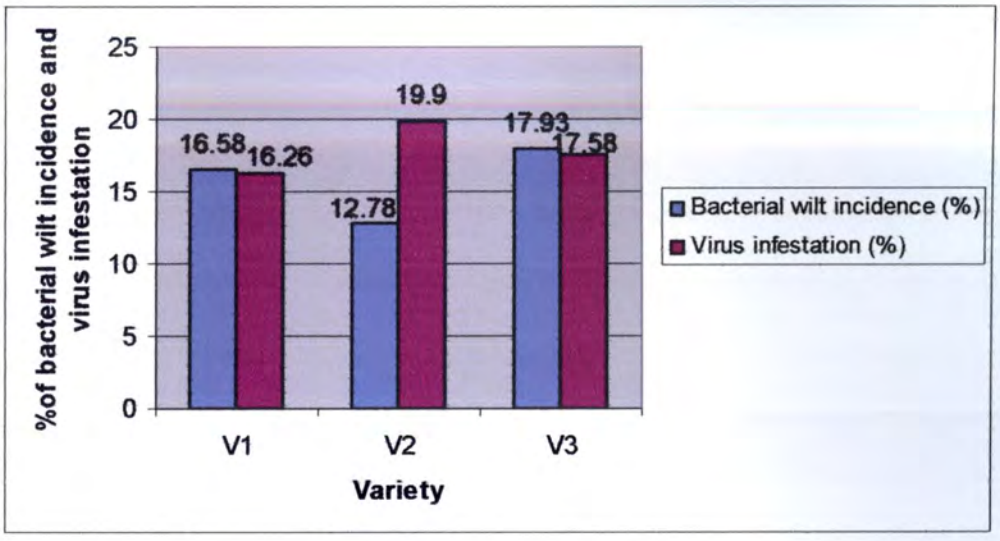


Fig. 8 Main effect of variety on the Bacterial wilt incidence and Virus infestation of tomato.

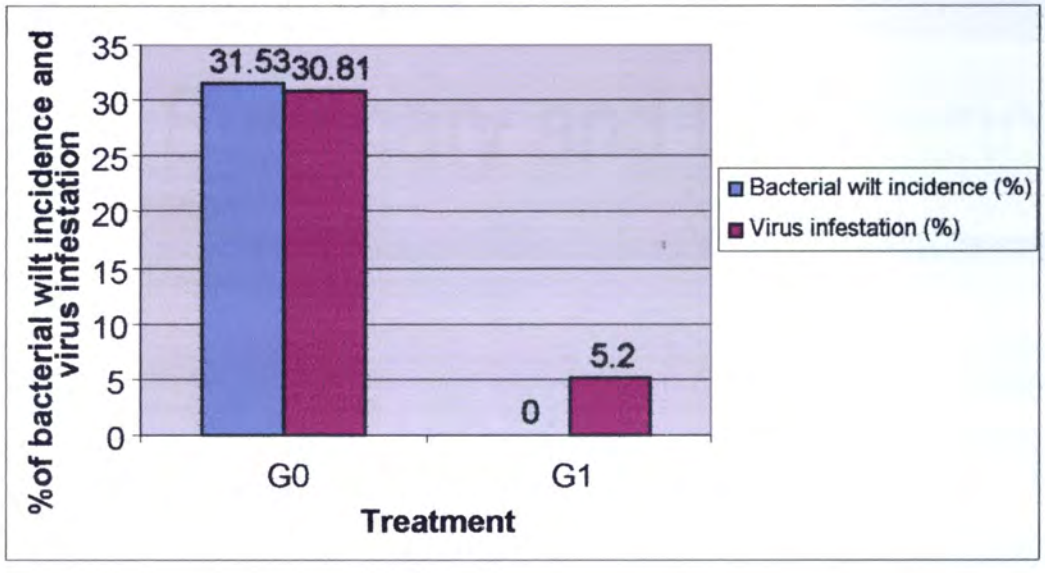
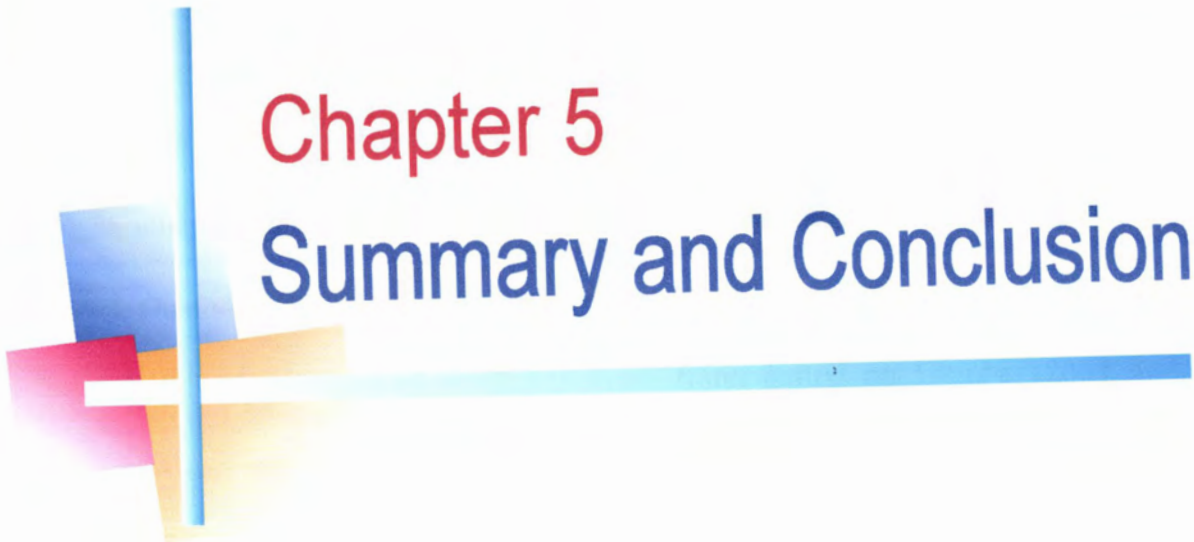


Fig. 9 Main effect of grafting on the Bacterial wilt incidence and Virus infestation of tomato.

In parenthesis transformed data have been presented

V_1= BARI Tomato-3
V_2= BARI Tomato-4
V_3= BARI Tomato-6

G_0= Control (non grafting)
G_1= Grafting



Chapter 5

Summary and Conclusion

CHAPTER – 5

SUMMARY AND CONCLUSION

The present study was conducted at the Horticulture Research Centre, BARI, Gazipur during the period from October 2004 to April 2005 to study the performance of three tomato varieties grafted on *Solanum sisymbriifolium* rootstock. The treatment of the experiment consisted of all possible combinations of three tomato varieties viz. BARI Tomato-3, BARI Tomato-4, and BARI Tomato-6 and control where no grafting was done. The experiment was laid out in RCBD factorial with three replications. In this study seedlings of rootstock and scion were raised and grafting was done at the rootstock. Grafted and non-grafted seedlings were transplanted on October 2004 and harvesting was done up to April 2005. Data on different parameters were recorded and statistically analyzed.

The effect of different varieties on grafting success was found significant. The highest percentage of grafting success was obtained using BARI Tomato- 6 (46.79%) and BARI Tomato-3 (46.10%). The poorest success was observed in BARI Tomato-4. Considering the combined effect of tomato varieties BARI Tomato 6 and 3, grafting with *S. sisymbriifolium* rootstock showed highest grafting success. The grafted tomato plants suffered minimal

mortality (0.21%) from the bacterial wilt disease. On the other hand, the non-grafted tomato plants suffered 14% morality from bacterial disease.

In case of days to 50% flowering it was found that non-grafted plants bloomed earlier than grafted ones. The days to first harvest was started earlier in the variety BARI Tomato-4 (68.67 days). In the grafted plants harvest was delayed by 8-10 days compared to non-grafted plants. This might be due to the transplanting shocks during grafting.

The highest fruit length was found in BARI Tomato-3 (5.38 cm) followed by BARI Tomato-6 and the lowest fruit length was observed in BARI Tomato-4 (4.02 cm). The highest fruit length was found in grafted plants. Highest fruit diameter was found in BARI Tomato-6 (5.74 cm) and BARI Tomato-4 (3.30 cm) showed the lowest fruit diameter. The highest fruits diameter was found in grafted plants. The maximum number of fruit per plant was obtained from BARI Tomato-6 (26.06) and the minimum number of fruit per plant was obtained from BARI Tomato-4 (21.10). The maximum number of fruit per plant was harvested from grafted plants than that of non-grafted plant. The maximum individual fruit weight was recorded in BARI Tomato-3 (68.84 gm) and minimum fruit weight was 33.70 gm. The highest fruit weight was found in grafted plants. Since the fruits were produced from grafted plants these contained higher dry matter than that of non-grafted plant.

The fruit yield and yield contributing characters were evaluated. The highest number of fruits per plant and yield per hectare was obtained from grafted plants and the lowest were received from non-grafted plants. Among the tomato varieties BARI Tomato-6 and BARI Tomato-3. produced maximum yield when same variety was grafted on *S. sisymbriifolium* which differed significantly from the plants of control treatment.

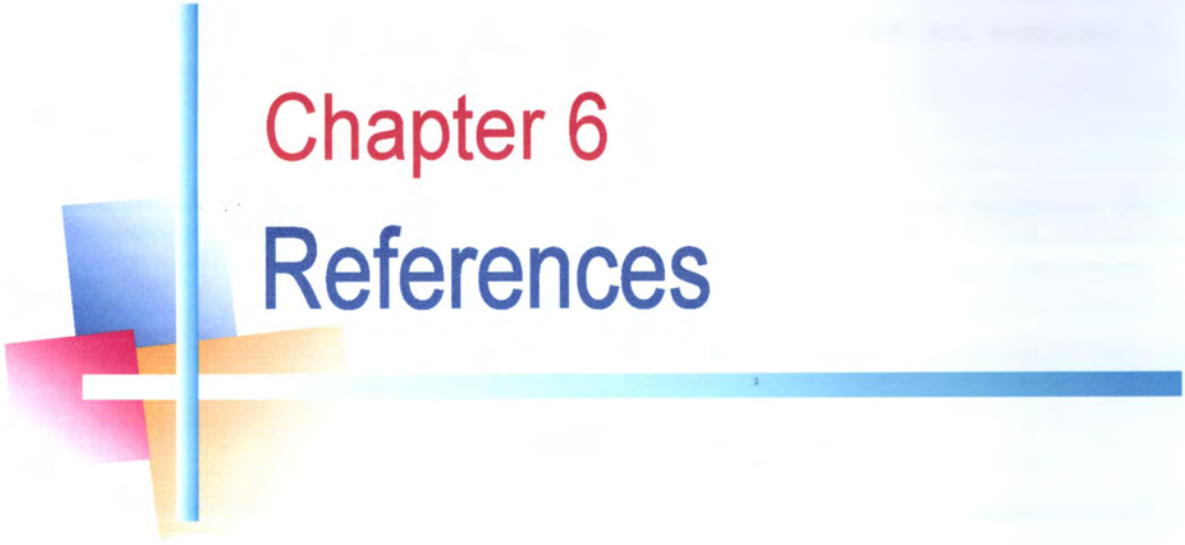
The reaction of grafted and non-grafted plants against bacterial wilt was tested in field condition. The tomato plants grafted on *S. sisymbriifolium* showed complete resistance against bacterial wilt irrespective of tomato varieties whereas non-grafted plants showed vulnerability against this disease at different level. Higher percentage of wilt incidence was recorded in BARI Tomato-6 (17.93%) followed by BARI Tomato-3 (16.58%) and the lowest in BARI Tomato 4 (12.78%). In case of combined effect, non-grafted plants suffered more from wilt incidence.

BARI Tomato-4 (19.90%) showed higher percentage of virus infestation and the lowest percentage of virus infestation was recorded in BARI Tomato-3 (16.26%). Virus infestation was higher in non-grafted plants as compared to grafted plants. Complete yield was loss of a plant due to virus and wilt diseases but it was found to be minimum in non-grafted plants. As a result grafting increased fruit yield per unit area.

Nutritional composition was studied in respect of TSS. The higher percentage of total acid was obtained from grafted plants compared to non-grafted plants resulting in higher yield.

Conclusion :

In case of grafting, the grafted plant showed higher fruit length, fruit diameter, days to harvest, fruit per plant and yield per plant compare to non grafted planted . The grafted plants showed resistance to bacterial wilt in field conditions. The grafted plants had prolonged harvesting period and gave higher yield **BARI** Tomato-3 harvested 11^{th} days earlier than BARI Tomato -6 and others characters such as grafting success, mortality, fruit length, indicidual furit weight was the best compare to other cultivates Amoung the Tomato cultivars BARI tomato -3 can be treated as the best cultivar that can be grown through grafting technique



Chapter 6
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CHAPTER – 6

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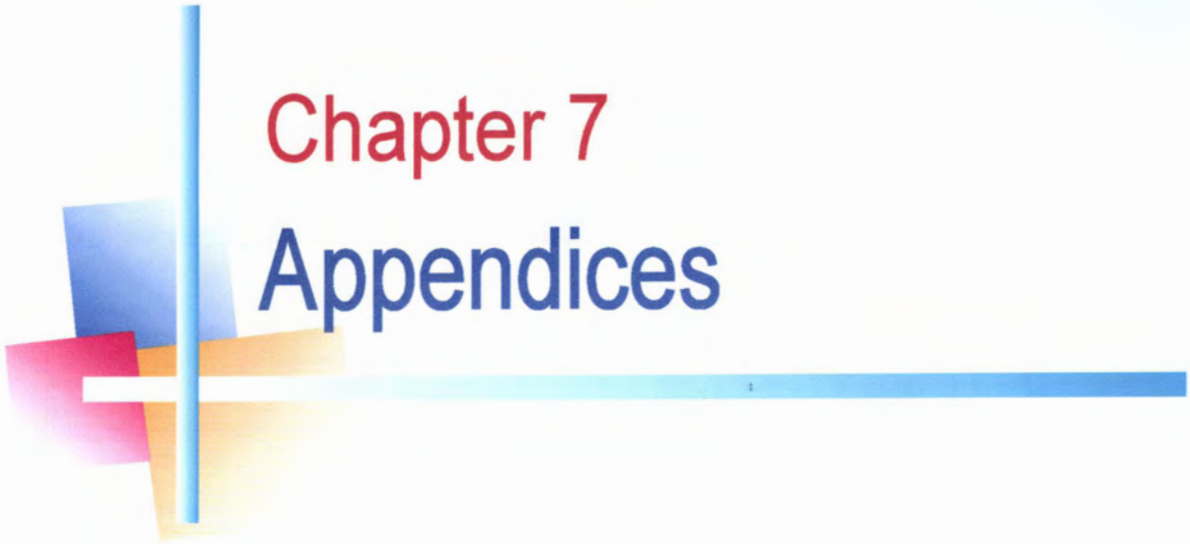

Chapter 7

Appendices

CHAPTER – 7

APPENDICES

Appendix 1: Analysis of variance on the grafting success, mortality, plant height, flowering duration of harvest, fruit length, fruit diameter, no. of fruit, single fruit weight yield, wilt incidence, virus infestation.

Source of variation	Degree of freedom	Grafting success (%)	Mortality (%)	Plant height (cm)	Days to 50% flowering	Days to harvest	Fruit length	Fruit diameter
Replication	2	5.996	1.721	21.640	40.463	30.905	0.586	0.419
Variety (A)	2	4.958**	19.271**	377.08**	19.465**	202.114**	3.373**	9.581**
Grafting (B)	1	38034.65**	855.601**	35.927**	184.384**	164.832**	0.32	0.291
Interaction (A x B)	2	4.958**	19.771**	6.583**	1.836**	0.425**	0.056	0.102
Error	10	1.33	0.273	4.645	1.90	3.362	0.062	0.053

** = Significant at 5% level of probability

NS= Not significant

Appendix 1. (Contd.)

Source of variation	Degree of freedom	Fruit per plant	Individual fruit weight (gm)	TSS (%)	Yield per plant (Kg)	Yield per ha (ton)	Bacterial wilt (%)	Virus infestation (%)
Replication	2	32.234	168.056	0.324	0.219	797.347	10.654	5.205
Variety (A)	2	37.130**	2008.102**	0.170**	1.878**	3723.201**	42.864**	19.955**
Grafting (B)	1	12.650**	3.873**	0.227**	0.091**	121.057**	4474.579**	2950.656**
Interaction (A x B)	2	2.531**	39.647**	0.029**	0.013**	2.901**	42.864**	65.039**
Error	10	0.635	48.654	0.041	0.003	19.121	2.230	0.479

** = Significant at 5% level of probability

NS= Not significant

Appendix 2. Monthly average temperature gelative humiclity and rainfall of experimental field during the period from October 2004 to march, and 2005.

Month	Air temperature (^{0}C)			Hymidity (%)	Rainfall (mm)
	Maximum	Minimum	Average		
October 04	31.45	23.12	27.28	75.25	17.4
November 04	29.60	17.68	23.63	68.5	0.00
December 04	27.14	14.93	21.03	73.41	0.00
January 05	24.91	13.02	18.96	72.87	0.08
February 05	29.15	16.96	23.06	69.07	0.01
March 05	32.24	21.22	26.73	76.16	17.52

Source: Meterological station, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.