RESPONSE OF TOMATO GRAFTED ON BRINJAL ROOTSTOCK FOR GROWTH, YIELD AND QUALITY

by

Ms.Nimbalkar Rajashree Subhash

(Reg. No. 019/308)

A Thesis submitted to the

MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI -413 722, DIST - AHMEDNAGAR
MAHARASHTRA, INDIA.

In partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE (HORTICULTURE)

in

VEGETABLE SCIENCE

DEPARTMENT OF HORTICULTURE

POST GRADUATE INSTITUTE

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2021

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part
there of has not been submitted
by me or other person to any
other University or Institute
for a Degree or Diploma

Place : MPKV., Rahuri (Nimbalkar R.S)

Date : / / 2021

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CERTIFICATE

This is to certify that the thesis entitled. **"RESPONSE OF TOMATO GRAFTED ON BRINJAL ROOTSTOCK FOR GROWTH, YIELD AND QUALITY."** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) in partial fulfilment of the requirement for the award of the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **VEGETABLE SCIENCE**, embodies the result of a piece of bonafide research work carried out by **Ms. NIMBALKAR RAJASHREE SUBHASH** under my guidance and supervision and that no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

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Place : MPKV., Rahuri **(P. N. Rasal)**

Date : / / 2021

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"Gratitude is the most exquisite form of memory"

I think it is the matter of pleasure to glance back and evoke the way one traverse, the days of hard work and perseverance.

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Place: M.P.K.V., Rahuri

Date: / /2021 *(Nimbalkar R.S.)*

CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF PLATES

LIST OF ABBREVATIONS AND SYMBOLS

%	: Percent
@	: At the rate
Anon	: Anonymous
^{o}C	: Degree Celsius
/	: Per
C.D.	: Critical difference
cm	: Centimeter
cv.	: Cultivar
cm^2	: Centimeter square
d.f.	: Degree of freedom
DAG	: Days after grafting
DAT	: Days after transplanting
et al.	: et alli (and others)
etc.	: Electra, Etcetra
Fig.	: Figure
g	: Gram
ha	: Hectare
i.e.	: That is
kg	: Kilo gram
m^2	: meter square
mg	: Milligram
mm	: Millimeter
mMT	: Million metric ton
R.H.	: Relative Humidity
NS	: Non-significant
S.D.	: Standard deviation
SE	: Standard error
Sr. No.	: Serial Number
SIG	: Significant
t	: Tonne
viz.,	: Videlicet (Namely)

ABSTRACT

"RESPONSE OF TOMATO GRAFTED ON BRINJAL ROOTSTOCK FOR GROWTH, YIELD AND QUALITY"

BY

NIMBALKAR RAJASHREE SUBHASH

A Candidate for the degree

of

MASTER OF SEIENCE (HORTICULTURE)

in

VEGETABLE SCIENCE

Post Graduate Institute

Mahatma Phule Krishi Vidyapeeth, Rahuri- 413 722

2021

Research Guide	**:**	**Dr. D.B. Kshirsagar**
Department	**:**	**Horticulture**

The present investigation was undertaken during rabi-2019-20 with an objective to study the compatibility of different tomato varieties grafted on brinjal rootstock and to study the growth, yield and quality parameters of different tomato varieties grafted on brinjal rootstock. The experimental material consisted of two rootstocks and three scions in a Randomized Block Design (RBD) having nine treatment and three replications. Brinjal rootstocks were used *Solanum torvum* and RHRB-06 and scions used Phule Raja, Phule Kesari and NS 501 of tomato hybrids and varieties.

Grafting success rate (%) was found out by number of plants alive to the total number of plants grafted multiplied by hundred and expressed in percentage. Results revealed that grafting success rate ranging from (83.65-89.96). Maximum success rate was observed in Phule Raja grafted on *Solanum torvum* (89.96 %).

Among all the treatments Phule Raja grafted on *Solanum torvum* recorded significantly highest plant height (123.80 cm), maximum number of branches (5.37), whereas lowest plant height (75.33 cm), minimum number of branches (4.20) were recorded in self rooted (non-grafted) Phule Kesari plants. NS 501 grafted on RHRB-06 recorded lowest number of days (25.33) for 50% flowering also lowest number of days (71) for first harvest, whereas self-rooted (non-grafted) Phule Kesari recorded maximum number of days (29.33) for 50% flowering also maximum number of days (74.00) for first harvest. Hence results revealed that grafting had significantly influenced growth parameters than control (non-grafted).

Among all the treatments, Phule Raja grafted on *Solanum torvum* recorded significantly maximum number of fruits per plant (34.06), fruit weight (79.30 g), equatorial diameter (5.16 cm), fruit yield/plant (2.70 kg), fruit yield/plot (86.47 kg) and yield/ hectare (66.72 t/ha). Whereas minimum number of fruits (27.73), fruit weight (73.03 g), equatorial diameter (4.56

cm), fruit yield/plant (2.01 kg), yield per/plot (64.61 kg) and yield/ hectare (49.84 t/ha) were recorded in self rooted (non-grafted) Phule Kesari plants.

It is concluded that Phule Raja grafted on *Solanum torvum* was found suitable for better growth and yield as it recorded maximum plant height, number of branches, average fruit weight, number of fruits per plant, yield/plant, yield/plot and yield/ hectare. From the above points it can be concluded that tomato scion 'Phule Raja' was found highly compatible with brinjal rootstock '*Solanum torvum*'.

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.), is solanaceous fruit vegetable having chromosome number of 2n=2x=24. It is originated as wild form in Peru and Mexico in Central and Southern America. In early days, it was known as ‘Golden apple’ in Italy and as ‘Love apple’ in France. Mostly tomatoes consumed straightly as a raw vegetable or combined with other various food items such as paste and diverse sorts of juice, soups and sauces. Tomato extensively grown in most used vegetable and defiantly the most prominent garden plant. (Chadha, 2014).

Tomatoes are the most widely consumed vegetables over worldwide. Globally tomato is grown in area of 5.03 million hectares, production of 180.77 MT and productivity of 35.93 tonnes per hectare. (Anon. 2019-20a). In India, it is an important vegetable crop with a production of 190.07 lakh tonnes and productivity of 24.33 tonnes per hectare (Anon.2019-20b). After China, India is the world's second-largest tomato grower. It is grown in nearly all parts of India including States like Uttar Pradesh, Orissa, Karnataka, Andhra Pradesh, Maharashtra, Madhya Pradesh and Assam. Andhra Pradesh has highest productivity with 44.50MT/ha. Tomatoes are grown on around 45.50 thousand hectares in Maharashtra, with production of 1086.56 thousand tonnes. Productivity of Maharashtra is 23.88 MT/ha (Anon.2018). In Maharashtra, it is grown in Nashik, Pune, Solapur, Sangli, Satara, Ahmednagar and Nagpur districts.

Tomato is good source of caratenoids, Vitamin C and Pro-vitamin A with a good antioxidant potential including lycopene, ascorbic acid, phenolics, flavanoids and Vitamin E. Because of its attractive appearance and nutritive value, in many countries it is considered as ‘Poor man’s orange’. The total sugar content is 2.5% in ripe fruit, total ascorbic acid content ranges from 16 to 65 mg/100 g of fruit weight, while overall amino acid content ranges from 100 to 350 mg/100 g of fruit weight. The pigment lycopene is responsible for the tomato's red colour and it is 20-50 mg/100 g in edible portion. Tomato is most versatile vegetable with wide usages in culinary traditions. It ranks first among the processed vegetables. It is consumed fresh as well as utilized in the manufacture of wide ranges of processed products such as puree, paste, ketchup, sauce, soup and canned whole fruits. One of the key problems of tomato is poor fruit set and development which is directly related to high temperature. Although, tomato is warm season crop the optimum temperature for tomato production is 21°C and 25°C with an average monthly maximum temperature of 27°C.

To meet the demands of ever-increasing consumers, increased production and product quality are required. Abiotic and biotic stresses are also significant restrictions in tomato production. For dealing with this biotic and abiotic stresses chemical methods are also available.

But chemicals may have detrimental effects not only on the consumer health but also on the farmer himself (Sen *et al*., 2018). Hence there is urgent need to develop an alternate method to overcome this problems. One alternative approach is grafting. Grafting is a process in which the shoot portions of two separate plants of the same or different species are physically linked together and then grown as one plant. Vegetable grafting is considered an innovative and advanced technique with an increasing demand by farmers, in the Mediterranean area. Grafting is becoming highly popular in Greece, especially in southern sides, where the ratio of production area using grafted plants to the total production area, amounts to almost 90-100% for early cropping watermelons, 40-50% for melons under low tunnels, 5-10% for cucumbers and 2-3% for tomato and eggplant. In contrast, in Northern Greece, the cultivation of grafted fruit bearing vegetables is rare. (Traka- Mavrona *et al*., 2000).

During Roman times Artistoteles and Theophrastus referred to the use of grafting, fruit trees were grafted mostly. Letter of St. Paul to the Romans refers to the grafting of the Olive tree (*Olea europaea* L.) is best example found at that time (Hartmann *et al*., 2002). Grafting was applied mainly to the tree crops, though Chinese growers were grafting marrows (*Cucurbita moschata* Duch) on to marrows (auto grafting) from the 5th Century AD and the Koreans from the 17th Century, so as to produce big marrows or pumpkins, which were used to store rice.

In vegetable grafting history, the first reference to hetero grafting (*i.e*., the grafting of two different species) concerned the grafting of watermelon (*Citrullus lanatus*) on to marrows at the beginning of the 1920s by Japanese growers. After that from the early1930s, Korean and Japanese growers applied grafting commercially to watermelons on Lagenaria (*Lagenaria siceraria* standl.) rootstocks (Lee 1994). First time eggplant was grafted on *Solanum integrifolium* Poir. during the 1950s, followed by tomato during 1960s. Grafting has been commercially applied to watermelons, cucumbers (*Cucumis sativus*), melons (*Cucumis melo* L.), tomatoes, eggplants and peppers (*Capsicum annuum* L.) from 1960-1970 (Oda 1995).

Grafting of commercial cultivars (scions) on selected tolerant rootstocks could be advantageous method for producing tomato at suboptimal conditions. (Krumbein,2013). Union of two or more pieces of living plant tissue, which are forced to develop vascular connection and grow as a single plant, is known as grafting. (Edelstein and Koren, 2015). The main advantage of grafted plant is the root system is stronger and more efficient in uptake of water and nutrients which indirectly improves yield. (Edelstein *et al*., 2017; Savvas *et al*., 2010; Schwarz *et al*., 2010). It aids in the reduction of production losses caused by environmental stresses like excess of temperature and radiation in the late cropping season use of suitable rootstocks through grafting provides an alternative strategy. (Schwarz *et al*., 2010).

Vegetable grafting has emerged as a potential and viable alternative to traditional breeding strategies for developing resistance to biotic and abiotic stressors, which are somewhat slow (Bahadur *et al*., 2015). It allows some genetic variants of specific species to be transferred, phenotype of scion is influenced by rootstock characteristics. The genetic potential of various rootstocks in vegetable crops have proven to be a better alternative to chemical sterilants to combating many soil borne diseases. Higher physiological activities like lipoxygenase activity, antioxidant content, membrane selectivity, osmotic adjustment, development of adventitious roots and arenchymatous tissues in plants grafted on prospective rootstock provide broad insight into the mechanism of stress response and grafting is being advocated as a way to offset the negative effects of climate change on vegetable crop output and quality

Compatibility is higher in intraspecific rootstock/ scion grafting than with interspecific grafting (Black *et al*., 2003). Intraspecific grafting is a good alternative to increase resistance to various environmental stresses such as flood, drought, cold, heat and biotic stresses such as disease, insect and nematode. When environmental pressures exceed the benefit that intraspecific grafting alone may provide, interspecific grafting may be useful to enhance rootstock variability.

To check rootstock compatibility is a challenge hence to choose a suitable rootstock for interspecific grafting trials, first look for a relative with unique environmental resistances, and then test for rootstock compatibility. Interspecific grafting may increases production of tomatoes, but with sensitivity limits their production in tropical regions.

There are several conflicting reports whether grafting effects are advantageous or disadvantageous regarding the changes in fruit quality (Davis *et al*.,2008; Lee *et al*., 2010). However there is limited information regarding plant growth parameters, yield and fruit quality of hybrid tomato when grafted on eggplant rootstock.

Therefore it is important to check the **“Response of tomato grafted on brinjal rootstock for growth, yield and quality”.** Hence, current experiment is planned and executed with following objectives:

1] To study the compatibility of different tomato varieties grafted on brinjal rootstock.

2] To study the growth, yield and quality parameters of different tomato varieties grafted on brinjal rootstock.

2. REVIEW OF LITERATURE

The purpose of this chapter is to review the literature for studies on 'Response of tomato grafted on brinjal rootstock for growth, yield and quality.

2.1 Rootstock and scion parameters

2.2 Observation of grafted plant

2.3 Growth parameters

2.4 Yield parameters

2.5 Percent Disease incidence

2.1 Rootstock and Scion Parameters

2.1.1 Days taken for germination

Black *et al*. (2003) studied grafting tomatoes for production in hot- wet season and reported that most fresh market tomato lines germinate in two to three days.

Dhivya (2013) reported that days taken to germination by wild *Solanum* species was ranged from 8.60 to 15.20. The results revealed that *Solanum incanum* took less time (8.60 days) to germinate followed by *Solanum sisymbrifolium* (10.43 days) but *Solanum torvum* took long time (15.20 days) to germinate.

Sharma *et al*. (2019) conducted experiment on evaluation of rootstocks for biotic stress management in tomato under protected conditions and reported that tomato seedlings emerged in 15-20 days at 21-24°C, Brinjal in 25-30 days at 26-28°C while Chilli and Local Pumpkin at 24-30°C took 35-40 days and pumpkin completed germination in 7-8 days.

2.1.2 Days taken to reach grafting stage

Mohammed *et al.* (2009) reported that 18 days after sowing scion seeds, grafting was performed using the tube grafting technique.

Mohamed *et al.* (2012) compared the growth, production, and fruit quality of grafted and non-grafted cherry tomato plants in protected cultivation and came to the conclusion that grafting was performed 25 days after sowing, when seedlings have developed 3-4 true leaves.

Bahadur *et al.* (2015) stated that grafting was carried out using four to five weeks old seedlings of eggplant as rootstocks and three to four weeks tomato seedlings as scions.

Pilli *et al.* (2018) stated that grafting was carried out at 2-3 leaf stage (20-25 days) of scion seedlings and 3-4 leaf stage (55-60 days) of rootstock.

Shipepe and Msogoya (2018) reported that grafting was performed in a palm leaf-thatched grafting house when rootstock and scion seedlings were 42 and 21 days old, respectively.

Hossain *et al.* (2019) studied influence of rootstocks on yield and quality of summer tomato cv. 'BARI-Tomato-4' and stated that tube grafting was employed for 30 day old tomato scion seedlings and 4 day old rootstock seedlings, according to the study.

Sharma *et al*. (2019) evaluated that the rootstock and scion compatibility studies in tomato under protected conditions and reported that tomato seedlings attain grafting stage in 15-20 days after sowing.

2.1.3 Girth of rootstock and scion (mm) at collar region at the time of grafting

Rivard (2006) reported that the grafting method 'hole insertion' was utilized to graft tomato on eggplant, melon or cucumber, so that the scion diameter was less than the diameter of the rootstock used for grafting.

Nirmal (2017) recorded that girth of 21 days old seedling was 2.04 mm and 25 days old seedling was 3.02 mm.

Surve (2019) studied the effect of age of rootstock and scion on success, survival and growth of brinjal grafts and found that highest girth at collar region was measured in 30 days of scion and rootstock.

2.1.4 Number of leaves on scion and rootstock at the time of grafting

Khah (2011) reported that aubergine seedlings were grafted by hand, applying the splice grafting method when the scion had 2 true leaves and the rootstock 2.5-3 true leaves.

Kumar *et al*. (2015) stated that for grafting rootstock used with four to five leaf stage and scion used with 4 leaf stage.

Zeist (2017) stated that grafting was done24 days after emergence of scion seedlings when seedling had 3-4 leaves in tomato.

Surve (2019) reported that the highest leaves were observed in 30 days old scion and rootstock, according to the study.

2.2 Observation of Grafted Plant

2.2.1 Days taken for graft healing

Martinez-Ballesta *et al*. (2010) studied physiological aspects of rootstock- scion interactions and reported that 8 days were required for graft union.

Petran and Hoover (2014) reported that with 'Celebrity' scion grafted on *Solanum torvum* rootstock required highest days taken to graft union (12.3 days)

Fan *et al*. (2015) studied the process of graft union formation in tomato using the Scanning Electron Microscopy (SEM) and paraffin sectioning technique and reported that many interconnected structures appeared after 8 DAG and vascular bundle bridge appeared after 11 DAG. He observed that in managed environment 7-14 days were required for graft union.

Rathod (2017) reported that considerable variation between the treatments for days taken to graft healing, however minimum days (4.00) required for graft healing was noted in grafting combination M-9 x *Solanum torvum* and Lalitha x *Solanum torvum.*

Miles and Crow (2017) reported that scion and rootstock establish vascular connection at approximately 4-7 days, it takes at least 10-14 days from grafting for the graft union to fully heal.

Surve (2019) studied on the effect of age of rootstock and scion on success, survival and growth of brinjal grafts and reported that average 7.6 to 8.2 days were required for graft union. In these T_1 requires less number of days (7.6) whereas T_6 requires highest number of days (8.2).

2.2.2 Days taken to attain transplanting

Blestos and Olympios (2008) studied rootstock and grafting of tomatoes, peppers and eggplants for soil borne disease resistance, improved yield and quality and stated that the grafted seedlings are ready for transplanting to the greenhouse or field conditions 35-37 days after sowing.

Mohammed *et al*. (2009) reported that after four weeks from grafting grafted and control tomato plants were transplanted to a glass house.

Mohamed *et al*. (2012) studied comparative growth, production and fruit quality of grafted and non-grafted cherry tomato and found that grafted plants and non-grafted plants were transplanted to a green house after three weeks from grafting.

Nkansanh *et al.* (2013) stated that grafted plants were transplanted to the field after 16 days from grafting.

Hossain *et al*. (2019) studied influence of rootstocks on yield and quality of summer tomato cv. 'BARI- Tomato-4' and stated that, the plants were ready to transplant in the field after 3 weeks of grafting

2.2.3 Graft success (%)

Bletsos *et al*. (2003) observed that the percentage of graft success of cv. Tsakoniki on *Solanum torvum* was 84.4% and 80.8% in 1998 and 1999 respectively, while on *Solanum sisymbrifolium* graft success was 77.2% and 74.8% in brinjal.

Nina and Joze (2004) observed that the survival rate of tomato transplants grafted on 'Beaufort' and 'PG 3' rootstocks using the cleft grafting method was 100% with cv. 'Monroe' and 92 to 93% with cv. 'Belle' whereas, with the tube grafting method, the survival rate was 79 to 92% with cv. 'Monroe' and 88% with cv. 'Belle'.

Rashid *et al*. (2004) reported that grafting of tomato on cultivated or wild *Solanum* rootstocks was highly compatible and 95% grafting success was achieved.

Mohammed *et al*.(2009) concluded that using tube grafting method, success percentage of grafting Cecilia F1 scion on either of Beaufort or He-man rootstocks was 99% whereas the success percentage of grafting Cecilia scion on Syrian tomato rootstock was 98%.

Gisbert *et al*. (2011) recorded that 98%, 100%, 90%, 100%, and 100% graft success were recorded in self- grafted cv. 'Black Beauty', Black Beauty on *Solanum torvum*, Black Beauty on

Solanum macrocarpum, Black Beauty on *Solanum incanum*× *Solanum melongena* and Black Beauty on *Solanum melongena* × *Solanum aethiopicum* respectively.

Nkansanh *et al*. (2013) reported that 'Tropimech' tomato cultivar grafted on green eggplant cultivar recorded 96.07% graft success.

Kumar *et al*. (2017) concluded that graft compatibility of Pusa Hybrid-6 on *Solanum torvum* had maximum survival rate (67.5%) while *Solanum xanthocarpum* grafted with Pusa Shyamala (30%) recorded lowest survival rate.

Rathod (2017) concluded that graft success was about 85 to 87% which might be due to favourable condition provided in healing chamber *i.e.* Relative Humidity 85-90% and a temperature range of 21 to 32º C with 50 Lux light under the low tunnel or graft chamber.

Soe *et al*. (2018) studied effects of different rootstocks on plant growth, development, yield of grafted tomato and reported that local type rootstocks of brinjal, tomato and hot pepper are suitable for tomato production and grafting success rate is over 70% *i.e.* tomato on eggplant (87.3%), tomato on tomato (80.3%), tomato on hot pepper (70.7%).

Priyanka *et al*. (2019) reported that *Solanum torvum* with PKM-1 recorded significantly highest graft success (95%) other than six rootstocks are used, whereas LE102 with PKM-1 had least graft success (9.34%).

Singh *et al*. (2019) recorded that maximum graft success (96.33%) observed in treatment Sona NTH 2829+ Navkiran and minimum graft success (93.66%) was observed in Punjab Varkha Bahar-4 + Navkiran.

Sharma *et al*. (2019) studied rootstock and scion compatibility studies in tomato under protected conditions in two seasons and reported that in first season plants grafted on rootstock Hawaii-7998 showed higher success rate (97.33%) also in second season 18 plants grafted on rootstock Hawaii-7998 showed higher success rate (96.67%). In rootstock PI-201232, AVPP0205 and Local Pumpkin no grafting success rate (0%) was recorded.

Rinku *et al*. (2020) reported that percentage of graft success of King Chilli scion on Mem and Moni Jolokia rootstock was 80% and 75% respectively.

2.3. Growth Parameter

2.3.1 Plant height (cm)

Bletos *et al*. (2003) observed that seedlings of eggplant cv. 'Tsakoniki' when grafted on *Solanum torvum* recorded a mean plant height of 124 cm and 116 cm during 1998 and 1999 respectively.

Khah (2005) reported that grafted plants have higher plant height as well as higher fresh and dry weight of stems.

Davis *et al*. (2006) recorded that height of watermelon plant cv. 'SF800' when grafted on 'Gourd' was 430.8 cm, on 'Squash' was 418.5 cm and under control 430.8 cm.

Khah *et al.* (2006) observed that in tomato cv. 'Big Red' grafted onto rootstock 'Primavera' measured maximum plant height of 48.44 cm, 91.88 cm and 106.38 cm at 30,60 and 96 DAT whereas, the minimum plant height (38 cm) was observed in self grafted cv. 'Big Red' at 30 DAT and in control (80.31 cm and 94.19 cm) at 60 DAT and 96 DAT respectively in greenhouse. Further, in open field cv. 'Big Red' grafted onto rootstock 'Heman' recorded the maximum plant height of 53.75 cm, 67.7 cm and 75.13 cm whereas, the lowest height was recorded on rootstock 'Primavera' 46.44 cm, 62.50cm and 69.13cm at 34, 89 and 130 DAT respectively in open field.

Colla *et al.* (2008) reported that grafted plants were 29 and 28% taller than control for 'Edo' and 'Lux' cultivars, respectively.

Mohammed *et al*. (2009) reported that insignificant variation in plant height occurs due to grafting in tomatoes up to 45 DAT.

Bekhradi *et al*. (2011) observed that when watermelon cv. 'Charleston Gray' was grafted on 'Ferro' recorded the highest main stem length (4.98m) whereas, the lowest plant height was recorded (3.40 m) in control.

Mohamed *et al*. (2012) concluded that highest length of main stem (265.67 cm and 241.8 cm) in watermelon cv. 'Aswan F1' grafted on rootstock '6000F1' and 'Aswan F1' on 'Tetsukabuto F1' in 2010 and 2011 respectively whereas, the lowest plant height was recorded in control (135.17 cm and 195 cm).

Petropoulos *et al*. (2012) reported the highest plant height (15.7 cm and 14.2 cm) when 'Sugar Baby' grafted onto 'Rootstock 841 F1' whereas, the minimum height was recorded in control (5.1 cm and 7.6 cm) at 34 days after grafting at 8 °C and 16 °C in watermelon respectively.

Nkansanh *et al*. (2013) revealed that height of plant was affected significantly by grafting in two seasons. Grafted tomatoes had higher plant height (50.3cm) compared to non-grafted (47.3cm).

Johnson *et al*. (2014) observed that the greater height of plant (246.79 cm) was recorded when eggplant cv. 'Epic' grafted onto 'Beaufort'.

Sayed *et al*. (2014) concluded that when cucumber cv. 'Haddy' grafted on the rootstock 'Ferro' recorded average plant height of 69.33 cm, 67.67 cm and 196.50 cm in summer planting whereas 51.00 cm, 118.30 cm and 163.0 cm in winter planting at 30,60 and 90 days respectively.

Kumar *et al*. (2016) recorded the highest plant height (87.64 cm) was measured in grafted 'Surati Ravaiya Pink' (84.12 cm) whereas, lowest plant height (77.71 cm) was recorded in control self-rooted 'Surati Ravaiya Purple'.

Kumar *et al*. (2017) observed that maximum plant height recorded in Pusa Shyamala grafted on *Solanum torvum* (54.87 cm) and lowest observed in non-grafted plants 'Mahyco-9'. Whereas, minimum plant height (70.80 cm) was recorded in self-rooted 'Lalitha' in brinjal.

Rathod (2017) concluded that plant height (91.47 cm) was maximum in grafted 'Mahyco-9' grafted brinjal plants, while minimum plant height (70.80 cm) was observed in self-rooted 'Lalitha' in brinjal.

Abd El-Wasim mona *et al*. (2018) studied on the effect of grafting eggplant on solanaceous rootstocks and observed that maximum height (1.77 m) of plant in treatment where *Solanum torvum* used as rootstock while minimum (0.82 m) observed in treatment where *Lycopersicon esculentum* (cv. Super strain – VFN) used as a rootstock.

Soe *et al*. (2018) noted that at 20 Days After Grafting (DAG), the height of all non- grafted tomato plants was considerably higher than all grafted tomatoes. Starting from 40 DAG, plants on eggplant rootstock were significantly taller than non-grafted and other rootstocks. At harvest, the plants on eggplant rootstock were the tallest (79 cm), followed by tomato rootstock (74 cm), hot pepper rootstock (71 cm) and non-grafted tomato(67 cm).

Latifah *et al*. (2018) studied economic analysis, growth and yield of grafting tomato varieties for *solanum torvum* as a rootstock and reported that growth of grafted plants was smaller than control plants at 2 WAT. At 4 WAT the height of control plants were still increasing than grafted plants. He stated that growth of plant height at the beginning of plant growth which is connected with *Solanum torvum* experiences obstacle because of process of healing and at the end of observation there is no significant differences between tomatoes.

Priyanka *et al*. (2019) reported that commercial cv. PKM-1 observed maximum plant height (29.94 cm) than the grafted plants as time taken for the healing of grafts increased growth period.

Hossain *et al*. (2019) reported that height of grafted and non- grafted plants showed significant variation at different days after transplanting.

Surve (2019) studied on the effect of age of rootstock and scion on success, survival and growth of brinjal grafts and concluded that at 120 days after transplanting higher (78.13 cm) height was observed in 30 days scion and rootstock while lowest (56.58 cm) plant height was noted in control plants under open field condition.

Rinku *et al*. (2020) reported that plant height was significantly affected by grafting than the control one.

2.3.2 Number of branches

Salehi- Mohammadi *et al*. (2009) reported that more number of branches were observed in grafted plant than non-grafted plants.

Bekhradi *et al*. (2011) evaluated the effect of three cucurbit rootstocks on vegetative and yield of 'Charleston Gray' when grafted onto *Cucurbita pepo* recorded the highest number of laterals (10.96) and the lowest number of laterals (8.42) was recorded under control.

Mohamed *et al*. (2012) reported the higher laterals (24.17) of watermelon cv. 'Aswan F1' grafted on rootstock '6000 F1' and on 'Tetsukabuto F1' recorded about (23.00) laterals in 2010 and 2011 respectively.

Rathod (2017) observed that at 90 DAT grafted 'Lalitha' recorded the maximum number of branches (13.07) followed by grafted 'Mahyco-9' (11.87) whereas, minimum number of branches (8.20) was recorded in self-rooted 'Sharpova'.

Surve (2019) reported that at 120 DAT maximum (15.13) number of branches were recorded in T_9 (30 days scion and rootstock) whereas minimum number of branches (8.40) was recorded in control.

Hossain *et al*. (2019) stated that the branches per plant ranged from 3.4 to 3.6 in which Treatment T_1 had maximum number of branches (3.6) while other two had same value (3.4).

Rinku *et al*. (2020) reported that two grafts *i.e*., King Chilli on Mem and Moni Jolokia were not much difference in terms of main and secondary branches per plant.

2.3.3 Days to 50% flowering

Nkansanh *et al*. (2013) reported there were considerable difference in days to 50% flowering. Grafted tomatoes require minimum number of days for 50% flowering than non-grafted plants.

Ndereyimana *et al*. (2013) observed lowest number of days to 50% flowering (31.50 and 16.50 days) in eggplant (*Solanum melongena* L.) grafts under different spacing and fertigation levels.

Kumar *et al*. (2016) revealed the grafted plants of Surati Ravaiya pink expressed significant advantage (37.80 days) over non-grafted plants (42.00 days) for early flowering. However, grafted plants of Surati Ravaiya purple denotes considerable difference to days to first blossoming and had earlier in flowering by more than 5 days comparing with its non-grafted plants.

Kumar *et al*. (2017) recorded the non-grafted plants were bloomed (34.62 days) in advance than grafted ones. However, late flowering were observed in Pusa Hybrid-6 an grafted on *Solanum xanthocarpum* (46.37 days) followed by Pusa Shyamala grafted on *Solanum khasianum* (44.37 days).

Rathod (2017) recorded that average of 43 to 48 days were recorded for 50% flowering after transplanting whereas, 'Lalitha' grafted and own rooted took the lowest number of days (43.33) and 'Arka Anand' took the highest number of days.

Kumar *et al*. (2019) showed the grafted plants significantly earliest in flowering taking 38.60 and 34.53 days in Surati Ravaiya Pink and Surati Ravaiya Purple, respectively compared to their counter parts (43.07 and 39.67 days).

2.3.4 Days to first harvest

Nkansanh *et al*. (2013) reported that days to first harvest was significantly affected by grafting. Grafted plants requires minimum (58) days for first harvest whereas non-grafted plants requires (64) days.

Ibrahim *et al*. (2014) stated that grafting of 'Faridah' tomato plants onto 'Unifort' hastens fruit formation as compared to non-grafted tomato plants.

Assinapol *et al*. (2017) reported that early harvest was observed in main crop of grafted brinal plants that is 44.38 and 45.44 days and the reason for which spacing didn't affect significantly on the first harvesting could be that, at initial stage up to the harvest, there was no competition for space among different spacing levels.

Soe *et al*. (2018) reported that number of days taken to first harvesting was significantly affected by the use of rootstock. In grafted tomato on brinjal rootstock, the first harvesting occurred early (85 days) followed by hot pepper rootstock (88 days) and rootstock of tomato (90 days) and in non-grafted tomato plants (96 days).

Kekan (2018) stated that days necessary for first harvest in cultivar Bandhtiware local seedlings were 81.67 days.

Surve (2019) reported that for first harvesting under open field conditions days varied non-significantly in range of 75.67 to 78.33 with mean of 76.83 days.

2.4 Yield Parameters

2.4.1 Average fruit weight

Khah *et al*. (2006) evaluated that total fruit weight of BH and BP (grafted plants) were 12.8 and 11.1% which was higher than non-grafted plants.

Turhan *et al*. (2011) concluded that fruits of grafted plants possess significantly higher fruit weight than non-grafted plants.

Mohamed *et al*. (2012) reported that among both scions of cherry tomato, non-significant result was founded for fruit weight in grafted plants against non-grafted plants.

Voutsela *et al*. (2012) observed that mean fruit weight was higher for P2, P5 and P6 combinations respectively 62.6 g, 61.0 g, 59.8 g and lowest fruit weight was observed on P1 combination (50.9 g).

Nkansanh *et al*. (2013) reported that grafting significantly affects average weight of fruit. Grafted plants had highest fruit weight than non-grafted.

Rahmatian *et al*. (2014) evaluated that 'synda' tomato plants compared with grafted onto 'Kingkong' rootstock, average fruit weight significantly increases 11%.

Ibrahim *et al*. (2014) studied growth, yield, quality and grafted tomato plants water use efficiency and reported that average fruit weight in non-grafted tomato plants (Faridah) were lower than the grafted tomato plants 'Faridah' onto 'Unifort' rootstock.

Ahmed (2014) observed that grafted tomato fruits had comparatively high average fruit weight than non-grafted tomato fruits.

Kumar *et al*. (2016) noted maximum weight of fruit was in grafted Surati Ravaiya Pink (73.56 g) followed by non-grafted Surati Ravaiya Pink (73.35 g). Whereas, lowest weight of fruit was measured in non-grafted Surati Ravaiya Purple (68.57 g).

Kumar *et al*. (2017) observed that average weight of individual fruits were highest in grafted plants of *Solanum torvum* with Pusa Shyamala (64.25 g) and lowest obtained in control plants.

Hoza *et al*. (2017) recorded the maximum weight (400.04 g) of fruit was in graft combination cv. Classic F1 x V4 and lowest average fruit weight (375.03 g) was in cv. Classic F1 x V5. However, grafting combination cv. Black Pear F1 x V7 was recorded highest average fruit (417.59 g) and lowest average fruit weight (384.76 g) was noted in cv. Black Pear F1 x V8.

Rathod (2017) revealed the grafted Sharpova (T_3) recorded the highest average fruit weight (260.00 g) per fruit followed by self-rooted Sharpova (T_6) (233.33 g). However, the minimum weight of fruit was recorded in self-rooted Arka Anand (T_7) (91.33 g).

Soe *et al*. (2018) recorded that highest weight of fruit was recorded in the grafted tomato on eggplant rootstock (62 g) followed by tomato rootstock (60 g) and hot pepper rootstock (55 g) whereas lowest fruit weight was observed on non-grafted tomato (48 g).

Hossain *et al*. (2019) evaluated the maximum weight of individual fruit was measured on grafted plants in T_1 (57.88 g) and the least in non-grafted plants in T_0 (44.84 g).

Sharma *et al*. (2019) evaluated the rootstock and scion compatibility studies in Tomato under protected conditions and reported the highest fruit weight (average) was recorded on plants grafted on rootstock Green Gourd (91.50 g) followed by Palam Pride (87.25 g), Arka Keshav (85.34 g), Palam Pink (81.88 g) and VI-45376 (80.33 g). Non-grafted plants recorded 24.06 % less fruit weight in comparison to grafted ones.

Singh *et al*. (2019) recorded the average fruit weight of tomato was maximum (57.30 g) in V2+B (Sona NTH 2829+Navkiran) treatment followed by (49.24 g) in V3+B treatment. While, low fruit weight (41.15 g) was reported in non-grafted V1 (Punjab Varkha Bahar-4) treatment combination.

Rinku *et al*. (2020) stated that there was no considerable differences between fruit length, width and individual fruit weight.

2.4.2 Polar diameter

Kumar *et al*. (2016) noted the highest fruit length in grafted Surati Ravaiya Pink (8.26 cm) followed by non-grafted Surati Ravaiya Pink (8.18 cm). Whereas, lowest recorded in grafted Surati Ravaiya Purple (6.77 cm).

Rathod (2017) reported that the highest length of fruit was noted in grafted Mahyco-9 (T_1) (23.33 cm) followed by self-rooted Mahyco-9 (T_4) (20.70 cm) and the minimum fruit length was noted in self-rooted Lalitha (T_5) (8.17 cm).

Hossain *et al*. (2019) reported that length of fruit i.e. polar diameter was found maximum in grafted plants (44.13 mm) while minimum (41.51 mm) was observed in the non-grafted plants.

Singh *et al*. (2019) observed the highest value of fruit length (4.15 cm) was recorded in grafting combination Heemshikhar+Navkiran treatment which is at par with grafting combination Punjab Varkha Bahar-4+Navkiran treatment (3.94 cm).Whereas, lowest fruit length (3.09 cm) was found in non-grafted treatments Punjab Varkha Bahar-4.

Sabatino *et al.* (2020) evaluated the quality parameters of eggplant cv.'Madonna' under protected cultivation and the results explained that the greater fruit length was reported in self-grafted cv. Madonna (18.10 cm). However, Madonna grafted on tomato rootstock Optifort recorded lowest fruit length (14.94 cm).

2.4.3 Equatorial diameter

Balliu and Vuksani (2008) concluded that the fruit diameters of plants which is grafted and grown under saline conditions was more reduced compared with non-grafted plants and whereas no difference of fruit diameter in absence of NaCl.

Johnson *et al*. (2014) concluded that highest fruit diameter (9.7 cm) was recorded when eggplant cv. 'Epic' grafted on to 'Beaufort' whereas, the lowest fruit diameter (8.07 cm) was recorded onto rootstock '*Solanum aethiopicum'*.

Kumar *et al*. (2016) reported that 'Indra' grafted on to rootstock 'Pant C-1' gave highest diameter of fruit (7.29 cm) then 'Indra' on 'Surajmukhi' 7.31 cm.

Rathod (2017) concluded that grafted 'Sharpova' recorded maximum fruit diameter of around (7.00 cm) followed by self-rooted 'Sharpova' (5.33 cm) and least (3.27 cm) was recorded in self- rooted 'Arka Anand'.

Soe *et al*. (2018) reported that grafted tomato on eggplant rootstocks had maximum fruit diameter (4.5 cm) and non-grafted tomato had minimum diameter (4.3 cm).

Shipepe and Msogoya (2018) evaluated that grafting reduced fruit diameter for all eggplant/ Assila and EG 190/ Monica graft combinations.

Hossain *et al*. (2019) evaluated that diameter of fruit *i.e*. Equitorial diameter was found maximum in grafted plants (47.23mm) while minimum diameter (45.15mm) was found in non-grafted plants.

Kumar *et al*. (2019) recorded maximum fruit diameter in grafted 'Surati Ravaiya Purple' (7.62cm) followed by self-rooted 'Surati Ravaiya Pink' (7.56 cm) whereas minimum fruit diameter (6.00 cm) was recorded in control.

Singh *et al*. (2019) noted that the highest diameter of fruit was observed in grafting combination Sona NTH 2829+Navkiran treatment (5.15 cm) trailed by Punjab Varkha Bahar-4+Navkiran treatment combination as (4.71 cm) and (4.34 cm) in Heemshikhar + Navkiran treatment. Whereas, non- grafted variety Sona NTH 2829 treatment resulted in the lowest fruit diameter (3.93 cm) of tomato fruit.

2.4.4 Fruit Shape

Lee (1994) investigated cultivation of grafted vegetables: Current status, grafting methods, and benefits and stated that fruit shapes are greatly influenced by the rootstocks.

Davis *et al*. (2008) studied grafting effects on vegetable quality and stated that fruit shape was greatly affected by grafting.

Turhan *et al*. (2011) reported that due to vigorous rootstock grafted plants usually showed increased increased uptake of water and minerals when compared to self-rooted plants but does not affected the shape of fruits as it is controlled by genotype of scion but not the genotype of rootstock.

2.4.5 Pericarp thickness

Negi (2016) stated that rootstocks, grafting methods and scions affected pericarp thickness significantly. Maximum pericarp thickness (7.31 mm) was recorded in fruits from plants grafted on rootstock Kufri Himalini. Grafting methods affected the pericarp thickness significantly. Tongue grafting resulted in thickest pericarp thickness (7.22 mm), followed by cleft grafting which recorded 7.03 mm pericarp thickness. Similarly, scions affected the pericarp thickness significantly. Plants grafted using GS-600 as scion recorded maximum (7.41 mm) pericarp thickness. There were no considerable differences between non-grafted plants (control) and other treatment combinations.

Kumar *et al.* (2017) concluded that rootstocks affected the pericarp thickness of the grafted tomato plants. The treatment VI034845+Avatar recorded maximum pericarp thickness (4.16 mm).

Papadaki *et al.* (2017) studied effectiveness of seven commercial rootstocks against verticillium wilt and their effects on growth, production, and quality of tomato fruit and stated that none of the rootstocks had any significant effect on pericarp thickness of fruit.

Sharma (2019) concluded that maximum pericarp thickness in plants grafted on rootstock Palam Pride (6.60 mm) followed by Back Attack (6.26 mm), Hawaii-7998 (6.24 mm) and Hawaii-7996 (6.22 mm). Thus, grafted plants excelled superiority and had 15.45% more pericarp thickness than non-grafted ones.

2.4.5 Number of fruits per plant

Blestos *et al*. (2003) revealed the seedlings of Tsakoniki when grafted on *Solanum torvum* Swartz found maximum fruits per plant (20.3) and minimum number (6.70) of fruit per plant were noted in non-grafted seedlings of Tsakoniki in fumigated soil. When Tsakoniki seedlings were grafted on *Solanum torvum* in infected soil, the highest amount (18.0) of fruit was seen and least numbers (6.30) of fruit per plant were noted in non-grafted seedlings of Tsakoniki.

Khah (2005) stated that grafted plants Rima (*Solanum melongena* L.) onto Heman (*Lycopersicon hirsutum*) produces 34% and 43.3% more fruits than control.

Leonardi and Giuffrida (2006) observed that when Beaufort rootstock was used, it was discovered that the number of fruits per plant increased roughly by 30%.

Balliu and Vuksani (2008) reported that average numbers of fruit in each plant in tomato was not influenced by grafting but slightly influenced by NaCl concentration.

Gisbert *et al*. (2011) recorded the average numbers of fruit per plant ranged between 4.0 and 12.0 when using the *S. habrochaites* (SH1) and *S. melongena* (SM1) rootstocks and the non-grafted control Cristal (F1) had a mean of 7.6 fruits per plant. While, the self-grafted Cristal (F1) it was 8.8 fruits per plant.

Turhan *et al*. (2011) investigated the effect of grafting on different rootstocks on tomato fruits yield and quality and noted that highest fruits per plant was in cv. Beril grafted onto Beaufort (6.02) followed by cv. Swanson grafted onto Beaufort (5.57). Whereas, least numbers of fruit per plant (4.64) was observed in non-grafted cv. Swanson.

Mohamed *et al*. (2012) observed that total fruit number per plant were increased significantly by grafting of ‘Catalena’ onto ‘Beaufort’ and increase was 11.42%.

Nkansanh *et al*. (2013) stated that average numbers of fruit/ plant was highest on grafted plants (16) and lowest on non-grafted plants (11).

Rahmatian *et al*. (2014) evaluated that ‘synda’ plants compared with those grafted onto ‘King Kong’ rootstock number of fruits significantly increases 17.8%.

Ibrahim (2014) reported that highest number of fruits per plant were found in grafted tomato plants ‘Faridah’ onto ‘Unifort’ rootstock than non-grafted tomato plants.

Sabatino *et al.* (2016) reported the number of marketable fruits per m^2 differed significantly among landraces, with the greatest number obtained for L4 (Sicilia) (30.3) and the lowest for L3 (Marsala) (10.4) by using *Solanum torvum* as rootstock.

Hoza *et al*. (2017) studied on response of different grafted eggplants in protected culture and reported maximum numbers of fruits per plant were in the Classic F1 grafted on L23Band Torpedo has formed over 10 fruit per plant and grafted on L1S produced 9.76 fruits. Very good results had obtained in plants grafted on tomato rootstock Kaiser F1, with 9.49 fruits.

Kumar *et al*. (2017) concluded that plants grafted onto *Solanum torvum* gave highest number of fruits compared to non-grafted plants.

Rathod (2017) reported the grafted Mahyco-9 (T_1) noted highest amount of fruits per plant (39.33) followed by grafted Lalitha (T_2) (32.67) and least amount of fruits (12.67) were recorded in self-rooted Sharpova (T_6).

Soe *et al*. (2018) observed that the number of fruits of grafted tomato was significantly higher than non-grafted tomato. Among this, grafted tomato on eggplant rootstock resulted in highest fruits per plant (91) and least fruits per plant observed on non-grafted tomato (62).

Kumar *et al*. (2019) reported that maximum numbers of fruits per plant were in grafted Surati Ravaiya Purple (35.25) followed by non-grafted Surati Ravaiya Purple (25.57). Whereas, minimum numbers of fruits per plant recorded in non-grafted Surati Ravaiya Pink (13.40).

Sharma *et al*. (2019) found that the scion variety GS-600 grafted on rootstock Green Gourd produced most fruits per plant (23.67) followed by *Solanum torvum* (21.67), Arka Keshav (21.17) and VI-47335 (21.17). Whereas, non-grafted plants recorded 32.40% less number of marketable fruits than grafted.

Rinku *et al*. (2020) reported that after four months of grafting, the quantity of fruits on grafted plants increased.

2.4.6 Fruit yield per plant

Leonardi and Giuffrida (2006) concluded that other than remaining treatments, tomato plants grafted on Beaufort rootstock had the highest yield of about 30%.

Davis *et al*. (2008) reported that poor yields recorded when tomato scions are grafted on non-vigorous rootstock.

Gisbert *et al*. (2011) observed that maximum yield was noted in graft of Black Beauty x (*Solanum incanum*× *S. melongena*) (6.90 kg) in each plant followed by Black Beauty x (*S. melongena*× *S. aethiopicum*) (6.40 kg) and Black Beauty x *Solanum torvum* (6.40 kg). However, the lowest yield per plant was noted (3.40 kg) in cv. Black Beauty grafted on *S. macrocarpum.*

Turhan *et al*. (2011) studied on effects of grafting on different rootstocks on tomato fruit yield and quality. They found maximum yield was in graft combination Yeni Talya x Beaufort (6.77 kg/ plant). Whereas lowest fruit yield was recorded in non-grafted cv. Beril (4.46 kg/plant).

Mohamed *et al*. (2012) studied comparative growth and yield of grafted and non-grafted (control) cherry tomato plants and reported that total yield of grafted plants onto ‘Maxifort’

increases by 3.8% whereas yield decreases by 20.67% in the plants grafted onto '43437 F1' as compared to non-grafted plants.

Voutsela *et al*. (2012) observed effect of grafting of five various rootstocks on plant growth and yield of tomato plants and reported that grafted plants had higher total yield than self-rooted *i.e*., non-grafted plants.

Rahmatian *et al*. (2014) evaluated that 'Synda' tomato plants compared with those who grafted onto 'Kingkong' rootstock, yield of tomato increases 27%.

Ibrahim *et al*. (2014) concluded that total fruit yield was higher by 11.90-12.41% in grafted tomato plants than non-grafted tomato plants.

Kumar *et al*. (2016) noted the maximum yield(g) per plant was in grafted Surati Ravaiya Purple (2482.68 g) followed by non-grafted Surati Ravaiya Purple (1762.37 g). Whereas, least yield(g) per plant was recorded in non-grafted Surati Ravaiya Pink (1003.49 g).

Kumar *et al*. (2017) reported that grafted plants onto *Solanum torvum* had higher yield (1.323 kg/plant) and lowest observed in control (non-grafted) plants (0.5666 kg).

Hoza *et al*. (2017) reported that highest average production (kg/plant) was in graft combination cv. Classic F1 × L23B (4.27 kg) followed by cv. Classic F1 x Torpedo (4.10 kg) and lowest average production (kg/plant) was in un-grafted cv. Classic F1 (2.46 kg). However, in graft combination cv. Black Pear F1 x Kaiser F1 was recorded highest (4.15 kg) average yield (kg/plant) followed by Black Pearl F1 × Torpedo (4.00 kg) and least average yield (kg/plant) was noted in un-grafted cv. Black Pear (2.59 kg).

Rathod (2017) showed the grafted plants of Mahyco-9 (T_1) was recorded the highest yield per plant (4.23 kg) followed by grafted Lalitha (T_2) (3.97 kg) and the lowest yield (2.73 kg/ plant) was recorded in self-rooted Lalitha (T_5)

Quamruzzaman *et al*. (2018) reported the maximum weight of fruit in grafted treatment T_6 (3.34 kg/ plant), T_1 (3.31 kg/ plant), T_4 (3.15 kg/plant) and fruit weight was lowest in T_8 (1.39 kg/ plant).

Abd El- Wasim mona *et al.* (2018) studied on the effect of grafting eggplant onto certain solanaceous rootstocks and observed that higher yield (3.860 kg/ plant) in treatment where *Solanum torvum* used as rootstock while minimum (1.010 kg/ plant) observed in treatment where *Lycopersicon esculentum* (cv. Super strain –VFN) used as a rootstock.

Shipepe and Msogoya (2018) concluded that grafting impacted negatively on marketable yield of tomato cv. Assila, EG 190/Monica in comparison to ungrafted controls due to limited plant growth of graft combinations.

Soe *et al*. (2018) reported that total yield per plant was highest in grafted tomato on eggplant rootstock (5071.4 g) followed by tomato rootstock (3894.3 g) and lowest was observed on non-grafted tomato (2491.7 g).

Semiz and Suarez (2019) recorded that higher fruit yield observed in 'Maxifort' an eggplant cultivar grafted on *Solanum torvum* relative to non-grafted plants in all salinity treatments.

Sharma *et al*. (2019) showed that plants grafted on rootstock Green Gourd resulted in maximum yield per plant (2.16 kg) after that Palam Pride (1.92 kg), Arka Keshav (1.80 kg) and VI-45376 (1.78 kg). Grafted plants produced 48.61% more yield than non-grafted.

2.4.7 Fruit yield per hectare

Besri (2003) stated that 15-20% of yield increases for the grafted tomatoes even only half of plants were planted.

Khah *et al*. (2006) reported that during first harvest grafted plants had low yield compared to self-rooted plants, but during second harvest grafted plants had high yield than non-grafted plants.

Gisbert *et al*. (2011) concluded that Black Beauty x (*Solanum incanum*× *S. melongena*) (8.6 kg/m^2) grafting combination noted highest yield followed by Black Beauty x (*S. melongena*× *S. aethiopicum*) (8.0 kg/m^2) and Black Beauty x *Solanum torvum* (7.7 kg/m^2). However, the lowest yield (kg/m^2) was noted (3.2 kg/m^2) in cv. Black Beauty grafted on to *S. macrocarpum.*

Moncanda *et al.* (2013) showed the highest marketable yield (kg/m^2) was reported in grafting combination (5.58 kg/m^2) Longo x *Solanum torvum* and lowest yield was noted in graft combination (2.57 kg/m^2) Birgah x *Solanum torvum.*

Nkansanh *et al*. (2013) reported that grafted tomatoes on eggplant rootstocks had highest yield (18.7 t/ha) than non-grafted control plants (15.7t/ha).

Bogoescu and Doltu (2015) reported the mean yield of grafted eggplant was 122.4 t/ha. Whereas, at the non-grafted eggplants was registered only a yield of 98.8 t/ha. Among the (rootstock x scion) combinations, the best results were recorded for grafting (Emperador x Sharapova).

Kumar *et al*. (2016) reported that highest yield per hectare (t) was in grafted Surati Ravaiya Purple (45.44 t/ha) followed by non-grafted Surati Ravaiya Purple (32.54 t/ha). While, lower yield/ha (t) was recorded in non-grafted Surati Ravaiya Pink (18.56 t/ha).

Rathod (2017) observed among the treatments, grafted Mahyco-9 ($T_{1)}$ recorded significantly highest yield per hectare (58.67 t/ha) followed by grafted Lalitha (T_2) (54.12 t/ha) and the lowest yield was recorded (37.33 t/ha) in self-rooted Lalitha (T_3).

Quamruzzaman *et al*. (2018) recorded the highest yield (36.77 t/ha) was measured in T_6 (BARI Begun-8 x BARI Hybrid Begun-4) treatment and the lowest yield (12.37 t/ha) was registered from T_{26} (non-grafted BARI Begun-9).

Hossain *et al*. (2019) recorded that total yield per hectare had highest in grafted plants (60.87 t/ha) whereas lowest in non-grafted plants (40.06 t/ha).

Kumar *et al*. (2019) noted that grafting combination Surati Ravaiya Purple x *Solanum torvum* produced the maximum marketable yield per hectare (t) (45.24 t/ha) followed by non-grafted (control) Surati Ravaiya Purple (32.04 t/ha). Whereas, lowest yield per hectare (t) was observed in non-grafted Surati Ravaiya Pink (18.13 t/ha).

Sabatino *et al.* (2020) concluded the Birgah grafted on to *Solanum torvum* (48.4 t/ha) noted highest marketable yield followed by Birgah grafted on to *Solanum macrocarpon* (40.1 t/ha). Whereas, lowest yield was recorded in non-grafted Birgah (36.5 t/ha).

2.5 Disease Incidence

2.5.1 Fusarium wilt

Lee and Oda (2003) reported that Fig leaf gourd (*Cucurbita ficifolia*) is a popular rootstock for cucumber sinceit shows excellent resistance to fusarium wilt.

Miguel (2004) concluded that rootstock ‘Shintoza’ is mostly preferred in spain because of its effectiveness against all races of fusarium.

Gousset *et al*. (2005) stated that *Solanum torvum* rootstock conferred resistance to *Fusarium oxysporum* sp. *Melongenae* limits fusarium wilt incidence in brinjal scions.

Sakata *et al*. (2008) reported that grafting of cucumbers becomes popular in Japan when *Fusarium oxysporum* sp.*cucumerinum* resistance was combined with rootstocks that enhances yield and reduce stress tolerance.

Rivard and Louws (2008) observed that ‘German Johsan’ heirloom tomatoes had 0% fusarium wilt incidence in infested soils when grafted onto resistant CRA 66 or Hawaii 7996 tomato rootstock, compared to 79% incidence on non-grafted control plants.

Louws *et al*. (2010) reported that hybrid squashes are widely used as melon rootstock because these are highly resistant to fusarium wilt and tolerant to verticillium wilt.

Pardeep *et al*. (2015) concluded that grafting is used to stop and minimizes soil borne diseases such as fusarium wilt in cucurbitaceous crops and bacterial wilt in solanaceous crops.

Latifah *et al*. (2018) concluded that various varieties of tomatoes as scions were grafted onto *Solanum torvum* rootstock proved to have more resistance to fusarium wilt attacks than control (non-grafted). At 2 WAT, varieties of Cervo, Karina and Timoy were able to suppress fusarium wilt attack by 85%, 93%, and 99% compared to control and at 8 WAT could suppressed to 74%, 99% compared to controls.

3. MATERIAL AND METHODS

The information pertaining to the material used and methodology followed as per the experiment details during present investigation entitled “Response of Tomato grafted on Brinjal rootstock for growth, yield and quality” are explained in this chapter.

3.1 Material

The seeds of brinjal rootstock were obtained from Senior Vegetable Breeder, All India Co-ordinated Research Project on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth Rahuri while the seeds of tomato varieties were obtained from Tomato Improvement Scheme, Mahatma Phule Krishi Vidyapeeth, Rahuri. The three tomato varieties and hybrids Phule Raja, Phule Kesari, NS 501 were used as scion whereas *Solanum torvum* and RHRB-06 were used as rootstock.

3.1.1 Location

The field experiment was conducted at Tomato Improvement Scheme, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri. Dist.- Ahmednagar. State- Maharashtra. India 413722 during year 2019-20 in Rabi season.

3.1.2 Climate

Rahuri situated at about 525 m above the mean sea level. Which is comes under arid and tropical region and having temperature range 7.30^{0}C to 39.30^{0}C with 65% relative humidity. The average day length is of 8 hours and 30 minutes. Annual rainfall varies from 307 to 619 mm and the average rainfall is about 475 mm. The most of the rainfall is received through South-West monsoon.

3.1.3 Description of Varieties

1) Phule Raja

The hybrid was released in the year 2006. Plants have indeterminate growth habit, stout fruit, oval round with thick pericarp, orange red fruits, moderately resistance to viral diseases. The average productivity is 55-60 t/ha.

2) Phule Kesari

The variety was released in the year 2017. Plants have determinate growth habit, developed for local fresh market, medium round, orange fruits. Rich in β-Carotene (5.93 mg/100g) content. Tolerant to thrips, white-fly, leaf curl and spotted wilt virus. The average productivity is 50t/ha.

3) NS 501 (F1 Hybrid)

The hybrid was released by Namdhari Seeds Pvt. Ltd. This is suitable for tropics with tolerance to bacterial wilt and Tomato Leaf Curl Viral diseases(TLCV). The determinate plants are vigorous with good foliage cover with high yields. The top quality

uniform fruits are square round , 80-90g, very firm and attractive glossy red having strong consumer preference.

3.2.1 Experimental Details

Crop	**:**	**Tomato**
Rootstocks	**:**	1) *Solanum torvum*
		2) *Solanum melongena* cv. RHRB-06
Scions	**:**	1) Phule Raja
		2) Phule Kesari
		3) NS 501
Number of treatments	**:**	9
Replications	**:**	3
Design	**:**	RBD (Randomized Block Design)
Grafting time	**:**	January -2020
Method of grafting	**:**	Splice grafting
Plot size	**:**	3.60 × 3.60 m
Spacing	**:**	90 × 45 cm
Number of plants/plot	**:**	32

3.2.2 Treatment details:

Treatments	Treatment details
T_1	Phule Raja grafted on *Solanum torvum*
T_2	Phule Kesari grafted on *Solanum torvum*
T_3	NS 501 grafted on *Solanum torvum*
T_4	Phule Raja grafted on RHRB- 06
T_5	Phule Kesari grafted on RHRB- 06
T_6	NS 501 grafted on RHRB- 06
T_7	Control (without grafting) Phule Raja
T_8	Control (without grafting) Phule Kesari
T_9	Control (without grafting) NS 501

3.3 Detail Cultivation of Practices

3.3.1 Seed sowing

Seeds of both rootstock as well as scion were sown in protrays containing sterilized cocopeat to avoid the problem of uneven germination. The seeds of rootstock were sown 4 weeks before the scion seeds.

3.3.2 Seedling raising and grafting

Seedlings of various age treatment wise were raised carefully. Drenching treatment applied whenever necessary for proper growth of seedlings.

Grafting: Splice grafting method was carried out when scion and rootstock seedling attained their respective height and girth. 1.6 mm silicon grafting clips were used for grafting. Grafted plants were placed in healing chamber to ensure high grafting success. They were kept in healing chambers with a relative humidity 85-90% and 28-32°C temperature for ten to twelve days to allow graft union.

R I	R II	R III
T_1	T_3	T_5
T_2	T_4	T_6
T_3	T_5	T_7
T_4	T_6	T_8
T_5	T_7	T_9
T_6	T_8	T_1
T_7	T_9	T_2
T_8	T_1	T_3
T_9	T_2	T_4

Fig. Plan of layout of the experiment

Design	**:**	**Randomized Block Design**
Replications	**:**	**3**
Treatments	**:**	**9**
Spacing	**:**	**90×45 cm**
Plot size	**:**	**3.60×3.60 m**

3.3.3. Transplanting

The grafted seedlings were transplanted in the main plot 20 days after grafting, when the grafts were at 3-4 true leaf stage. Grafted plants were planted to find its effect on growth, yield and quality.

3.4 Observation Recorded

Five plants per treatment per replication were selected randomly for recording observation.

3.4.1 Rootstock and Scion Parameters

3.4.1.1 Days taken for germination

The observation was recorded at everyday by visual observation and average days taken for germination were expressed.

3.4.1.2 Days taken to reach grafting stage

It was recorded based on number of leaves and days required to reach correct stage of grafting.

3.4.1.3 Girth of rootstock and scion (mm) at collar region at the time of grafting

The replication wise stem diameter of rootstock at collar region was measured by digital Vernier Caliper Scale at the time of grafting and multiplied it with π value (3.14), which is girth value.

3.4.1.4 Number of leaves on rootstock and scion at the time of grafting

At the time of grafting, leaves on the rootstock and scion seedlings were counted replication wise.

3.4.2 Observation of Grafted Plant

3.4.2.1 Days taken to graft healing

After 5 days of grafting, the average number of days required to graft heal was noted by removing the silicon grafting clip.

3.4.2.2 Days taken to attain transplanting

The observation was recorded by counting day required for transplanting from grafting and mean days required for days taken to attain transplanting was worked out.

3.4.2.3 Graft success (%)

The observation was recorded at 7^{th}, 14^{th} and 21^{th} days after grafting. It was calculated by number of plants alive to the total number of plants grafted multiplied by hundred and expressed in percentage.

3.4.3 Growth Parameters

3.4.3.1 Plant height (cm)

. The height of the plant was measured in centimeters from base of the plant to the growing tip of the plant. The measurements were recorded during the last harvest The

observations were taken at the time of last harvest. The readings were taken from the tagged plants and average was worked out and expressed in centimeters.

3.4.3.2 Number of branches

At the time of the last harvest, the number of branches on each plant was noted. The number of branches on each of the five plants was counted, and the average number of branches per plant was calculated.

3.4.3.3 Days to 50% flowering

The date on which 50% of the plants in the net plot showed the flowering was noted. The days from the transplanting to the date of 50% flowering were noted and mentioned as days for 50% flowering.

3.4.3.4 Days to first harvest

Number of days necessary for first harvesting from the date of transplantation was recorded in each treatment.

3.4.4 Yield Parameters

3.4.4.1 Average fruit weight (g)

The weight of five fruits were measured in grams and average was worked out.

3.4.4.2 Polar diameter (cm)

Polar diameter of five selected fruits were measured by using vernier caliper and expressed in centimeter.

3.4.4.3Equatorial diameter (cm)

Equatorial diameter of five selected fruits were measured by using vernier calliper and expressed in centimeters.

3.4.4.4 Fruit shape

The earlier selected fruits were cut longitudinally and shape was recorded by visual observation.

3.4.4.5 Pericarp thickness (cm)

Pericarp thickness of five selected fruits was measured by using vernier calliper and expressed in centimeters.

3.4.4.6 Number of fruit / plant

The number of fruit per plant was counted by taking five plants per treatment and then average was worked out.

3.4.4.7 Yield / plant (kg)

The total yield per plant was determined at each harvest by weighing the total quantity of fruits produced by each plant and expressed it in kilograms.

3.4.4.8 Yield / plot (kg)

The weight of fruits of all harvestings from each plot was summed up to workout yield per plot in kilograms.

3.4.4.9 Yield / hectare (t)

The yield per plot was multiplied by ha factor to workout total yield (t/ha).

3.5 Percent of Disease Incidence

3.5.1 Fusarium wilt (%)

$$\text{The Percent Disease Incidence (PDI)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

3.6 Statistical analysis

The data gathered in this study was analyzed by using the appropriate procedure to the Randomized Block Design as explained by Panse and Sukhatme (1985). The critical difference at 5 per cent level of probability was used for comparing treatments.

4. RESULT AND DISCUSSION

The present study titled as “Response of tomato grafted on brinjal rootstock for growth, yield and quality” was conducted at the Tomato Improvement Scheme, Mahatma Phule Krishi Vidyapeeth Rahuri in 2019-20 during rabi season. The findings are given in this chapter with tables under suitable headings and subheadings.

4.1 Rootstock and Scion Parameters

4.1.1 Days taken for germination

NS-501 took least days (4.75) for germination among all rootstocks and scions for germination which was at par with Phule Kesari (5.50) and followed by RHRB-06 (5.75) and Phule Raja (6.25). However *Solanum torvum* took maximum days (28.00) for germination. Significant differences were recorded for days taken for germination (Table 4.1).

Hybrid variety NS-501 resulted in early germination. *Solanum torvum* took maximum days for germination. Some of *Solanum* species were having slow germination process around 30 days that may be species character. *Solanum torvum* is a wild species which is having hard seed coat and prolonged seed dormancy that result in poor, erratic and slow germination. This result was in agreement with Gisbert *et al*. (2011). Dhivya (2013) reported that *Solanum torvum* took long time to germinate. Further Kumar *et al*. (2016) specified that *Solanum torvum* is a highly vigorous relative of eggplant but its low, irregular and inconsistent germination due to long dormancy in seeds limits practicability as rootstock.

4.1.2 Days taken to reach grafting stage

Significant differences were required for days taken to reach grafting stage among all rootstocks and scions (Table 4.1). NS -501 took less number of days (24.5) from germination to reach grafting stage whereas, *Solanum torvum* recorded maximum (58.5) number of days from germination to reach grafting.

Fastest germination exhibited by NS-501 obviously resulted in minimum number of days to reach the grafting stage. *Solanum torvum* having slow germination process resulted in maximum number of days to reach the grafting stage. This results are agreement with Bahadur *et al*. (2015), Pilli *et al*.(2018) and Shipepe and Msogoya (2018) respectively.

Table 4.1 Days taken for germination, taken to reach grafting stage in rootstock and scion seeds

Rootstock/ Scion	Days taken for germination	Days taken to reach grafting stage
Solanum torvum	28.00	58.50
RHRB-06	5.75	29.00
Phule Raja	6.25	25.50
Phule Kesari	5.50	25.00
NS-501	4.75	24.50
S.E. (m) ±	0.30	0.30
CD at 5%	0.92	0.94

Note: Number of replications: 04

Table 4.2 Girth of rootstock and scion (mm) at collar region and number of leaves on rootstock and scion at the time of grafting.

Rootstock/ Scion	Girth of rootstock/ scion at the time of grafting (mm)	Number of leaves on rootstock/ scion at the time of grafting
Solanum torvum	9.48	4.63
RHRB-06	9.34	5.72
Phule Raja	9.35	4.34
Phule Kesari	8.58	4.05
NS-501	9.32	3.94
S.E. (m) ±	0.09	0.05
CD at 5%	0.28	0.15

Note: Number of replications:04

4.1.3 Girth of rootstock and scion at collar region (mm) at the time of grafting

Girth of rootstock and scion at collar region is an important parameter which decides graft union combination and further decides health and growth of graft in field.

The data in Table 4.2 revealed that the girth of the rootstock and scion at the collar region. Significantly maximum girth of rootstock was observed in *Solanum torvum* (9.48 mm) and maximum girth of scion was observed in Phule Raja (9.35 mm). The minimum girth of rootstock was recorded in RHRB-06 (9.34 mm) however minimum girth of scion was recorded in Phule Kesari (8.58 mm) at collar region at the time of grafting.

These observations were recorded at the time of grafting. Due to increase in age of seedlings the girth of seedlings was also increased. This result is in similar with results reported by Rivard (2006), Surve (2019) and Nirmal (2017). Rivard (2006) reported that the scion diameter was less than diameter of rootstock used for grafting. Nirmal (2017) revealed that girth of 21 day old seedlings was 2.04 mm and 25 day old seedlings was 3.02 mm. Surve (2019) observed that girth of rootstock was 1.46 mm to 3.15 mm at 30 days after germination in brinjal.

4.1.4 Number of leaves on rootstock and scion at the time of grafting

The data pertaining to number of leaves on scion and rootstock at the time of grafting are presented in Table 4.2 which indicates that number of leaves on both rootstock and scion varied significantly. Significantly maximum number of leaves on scion (4.34) was recorded in Phule Raja whereas maximum number of leaves on rootstock (5.72) was observed in RHRB-06 at the grafting time. Significantly minimum number of leaves on scion (3.94) was recorded in NS 501, whereas minimum number of leaves on rootstock (4.63) was recorded in *Solanum torvum* at the time of grafting.

These observations were recorded at the time of grafting stage. Due to increase in age of seedling the amount of leaves on both rootstock and scion was also increased. This result is in conformity with results reported by Kumar *et al*. (2015), Surve (2019). Kumar *et al*. (2015) used four to five leaf stage rootstock and four leaf stage scion for brinjal grafting. Surve (2019) reported that number of leaves of both rootstock and scion was more on 30 days old seedlings. Maximum number of leaves on scion (6.53) and rootstock (6.87) observed in T_9 in brinjal before grafting.

4.2 Observations of Grafted Plant

4.2.1 Days taken for graft healing

The data of days taken for graft healing presented in Table 4.3 showed that there was considerable difference in the number of days it took for graft heal between the treatments to days taken for graft healing and it was in range of 6.25 to 7.75 days. Lowest number of days (6.25) was required for graft healing in Phule Kesari grafted on RHRB-06 (T_5), whereas highest number of days (7.75) was required for graft healing in Phule Raja grafted on *Solanum torvum* (T_1).

Days required for graft healing depends on stage of rootstock and scion as well as prevailing atmospheric conditions. According to findings, changes occur during the formation of graft union include the death of cell layers at graft interface, cohesion of scion and rootstock, proliferation of callus cells at the graft interface, and vascular differentiation across the graft interface to establish vascular connectivity.

These results are in conformity with Patron and Hoover (2014), Fan *et al*. (2015) and Surve (2019). Petran and Hoover (2014) reported that 'Celebrity' scion grafted on *Solanum torvum* rootstock required highest days taken to graft union. Fan *et al*. (2015) reported that in managed environment 7-14 days were required for graft union. Surve (2019) reported that average 7.6 to 8.2 days were required for graft union.

4.2.2 Days taken to attain transplanting

The mean data pertaining to days taken to attain transplanting presented in Table 4.3. It shows that there was significant difference among the treatments to days taken for transplanting and it was in the range of 23.25 to 25.75 days. Lowest number of days (23.25) was required for transplanting in Phule Kesari grafted on RHRB-06 (T_5), whereas highest number of days (25.75) was required for transplanting in Phule Raja grafted on *Solanum torvum* (T_1).

After graft healing, for acclimatization grafted seedlings were taken outside the healing chamber and kept under sunlight so as provide hardening prior to transplanting and to reduce transplanting shock. Grafted seedlings took three to four days for complete acclimatization and later they were transplanted.

This result is in accordance with results reported by Mohammed *et al*. (2009), Mohamed *et al*. (2012) and Hossain *et al*. (2019). Mohammed *et al*. (2009) reported that grafted tomato plants were transplanted after four weeks from grafting. Mohamed *et al*. (2012) reported that grafted and non-grafted plants were transplanted to a green house after three weeks from grafting. Hossain *et al*. (2019) reported that the plants were ready to transplanting in the open field after three weeks of grafting

Table 4.3 Days taken for graft healing, to attain transplanting and percent rate of graft success

Tr. No	Treatment details	Days taken for graft healing (DAG)	Days taken to attain transplanting (DAG)	Graft Success (%)
T_1	Phule Raja grafted on *Solanum torvum*	7.75	25.75	89.96
T_2	Phule Kesari grafted on *Solanum torvum*	6.50	25.50	84.07
T_3	NS 501 grafted on *Solanum torvum*	6.75	23.50	88.17
T_4	Phule Raja grafted on RHRB-06	7.25	25.00	83.65
T_5	Phule Kesari grafted on RHRB-06	6.25	23.25	87.21
T_6	NS 501 grafted on RHRB-06	6.75	24.00	85.85
	S.E. (m) ±	0.28	0.36	1.42
	CD at 5%	0.84	1.09	4.28

Note: Number of replications: 4
DAG: Days After Grafting

4.2.3 Graft success (%)

The data presented in Table 4.3 revealed the grafting success of tomato on brinjal rootstock. The results revealed that there was considerable variation between the grafting success and it was in the range of 83.65 % to 89.96 %. Highest grafting success (89.96%) was observed in Phule Raja grafted on *Solanum torvum* (T_1) which was at par with treatment NS 501 grafted on *Solanum torvum* (T_3) (88.17 %), treatment Phule Kesari grafted on RHRB-06 (T_5) (87.21 %) and treatment NS 501 grafted on RHRB-06 (T_6) (85.85 %). The minimum grafting success (83.65 %) was noted in Phule Raja grafted on RHRB-06 (T_4).

Significantly highest grafting success after grafting was recorded in treatment T_1. This might be due to better graft union and favorable conditions provided in the healing chamber. The above results are in similar with Rashid *et al*. (2004), Nkansanh *et al*. (2013) and Soe *et al*. (2018). Rashid *et al*. (2004) reported that grafting of tomato on cultivated or wild *Solanum* rootstocks was highly compatible. Nkansanh *et al*. (2013) reported that 'Tropimech' tomato cultivar grafted on green eggplant cultivar recorded highest grafting success. Soe *et al*. (2018) reported that local type rootstocks of eggplant, tomato and hot pepper are suitable for tomato production and grafting success rate is over 70% *i.e*. tomato on eggplant (87.3%).

4.3 Growth Parameters

4.3.1 Plant height (cm)

The data on effect of brinjal rootstock on tomato regarding plant height in grafted and self-rooted (non-grafted) condition is presented in Table 4.4. Significant differences in plant height were observed (Figure 4.1). At harvest, Phule Raja grafted on *Solanum torvum* (T_1) treatment gave the highest (123.80 cm) plant height among all the treatments which was at par with Phule Raja grafted on RHRB-06 (T_4) (115.00 cm), whereas the lowest plant height (75.33 cm) was recorded in self rooted (non-grafted) Phule Kesari (T_8).

The above findings are consistent with results reported by Nkansanh *et al*. (2013), Soe *et al*. (2018) and Hossain *et al*. (2019). Nkansanh *et al*. (2013) reported that grafted tomato had higher plant height compared to non- grafted plants. Soe *et al*. (2018) reported that at harvest, the plants on eggplant rootstock were tallest compared to non-grafted tomato. Hossain *et al*. (2019) reported that height of grafted and non-grafted plants showed significant variation at different days after transplanting. Also, this result also consistent with the results of Lee (1994) and Ioannou *et al*. (2001) who observed that grafted plants were taller and vigorous than self-rooted once.

Plant height is considered as indicator of plant vigor. In present investigation the significantly highest height of plant was recorded in grafted Phule Raja. Among the three hybrids and varieties Phule Raja have the indeterminate type of growth habit and remaining two hybrids and varieties which are determinate type of growth habit. Might be due to Phule Raja is taller than other hybrids and varieties. *Solanum torvum* is wild eggplant rootstock. It has good root systems which ensured more plant height and vigorous growth, which absorbs more water and nutrients. The rootstock's of vigorous root system is often capable of absorbing nutrients and water more efficiently than self- rooted scion plants.

4.3.2 Number of branches/ plant

The mean data on effect of brinjal rootstock on tomato regarding number of branches per plant in grafted and self-rooted (non- grafted) condition is presented in Table 4.4. Significant differences in number of branches were observed (Figure 4.2). At harvest, Phule Raja grafted on *Solanum torvum* (T_1) recorded the highest branches per plant (5.37) which was at par with Phule Raja grafted on RHRB-06 (T_4) (5.30), whereas the lowest branches per plant (4.20) were observed in self rooted Phule Kesari plants (T_8).

The number of branches per plant is important yield contributing factor in tomato. The present investigation showed that significantly highest numbers of branches were recorded in Phule Raja grafted on *Solanum torvum* than non-grafted plants. It could be owing to strong and deep root system of rootstock which is able to absorb nutrients, minerals and water efficiently causes vigorous growth of plant. The rootstock's vigorous root system aided scion growth,

resulting in greater number of branches in grafted plants (Salehi- Mohammadi *et al*. 2009). Rathod (2017) and Surve (2019) also revealed that maximum branches recorded in grafted plants than non-grafted (control) plants.

Table 4.4 Effect of brinjal rootstock on tomato regarding plant height (cm), number of branches and growth habit in grafted and non-grafted plants

Treatments	Treatment details	Plant height (cm)	Number of branches
T_1	Phule Raja grafted on *Solanum torvum*	123.80	5.37
T_2	Phule Kesari grafted on *Solanum torvum*	77.93	4.40
T_3	NS 501 grafted on *Solanum torvum*	83.33	4.53
T_4	Phule Raja grafted on RHRB-06	115.00	5.30
T_5	Phule Kesari grafted on RHRB-06	76.67	4.33
T_6	NS 501 grafted on RHRB-06	80.00	4.40
T_7	Control (Phule Raja)	103.37	5.17
T_8	Control (Phule Kesari)	75.33	4.20
T_9	Control (NS 501)	78.53	4.40
	S.E. (m) ±	2.95	0.21
	CD at 5%	8.87	0.63

4.3.3 Days to 50% flowering

The mean data pertaining effect of brinjal rootstock on tomato regarding days to 50% flowering in grafted and non- grafted condition is presented in Table 4.5. In days taken for 50% flowering, the difference between the treatments were significant (Figure 4.3).

In present investigation, NS 501 grafted on RHRB-06 (T_6) took the lowest number of days (25.33) for 50 % flowering which was at par with treatment NS 501 grafted on *Solanum torvum* (T_3) (26.33) and self-rooted NS 501 (T_9) (26.00), whereas self-rooted (non- grafted) Phule Kesari (T_8) took the highest number of days (29.33). However, for 50% flowering, all of the treatments took an average of 26 days after transplanting. The above results are in similar with results of Nkansanh *et al*. (2013), Kumar *et al*. (2016) and Kumar *et al*. (2019). Nkansanh *et al*. (2013) reported that grafted tomatoes require minimum number of days for 50% flowering than non-grafted plants. Kumar *et al*. (2016) and Kumar *et al*. (2019) also reported that grafted plants are significantly earliest in flowering than non-grafted plants.

Earliness is major attribute which is measured in terms of days taken to flowering and is preferred for commercial cultivation when high yield is coupled with earliness. The result of this study indicated an early flowering in grafted plant than non-grafted plant. Among three varieties

and hybrids NS 501 is early maturing hybrid; hence it took minimum days for flowering than other varieties. Gisbert *et al*. (2011) revealed that when there is no constraint due to incompatibility and abiotic stress, grafted plants may develop faster, thereby resulting in earliness of the grafted plant.

Table 4.5 Effect of brinjal rootstock on tomato regarding days to 50% flowering and days to first harvest in grafted and non-grafted plants.

Treatments	Treatment details	Days to 50% flowering	Days to first harvest
T_1	Phule Raja grafted on *Solanum torvum*	28.00	73.67
T_2	Phule Kesari grafted on *Solanum torvum*	29.00	73.33
T_3	NS 501 grafted on *Solanum torvum*	26.33	72.00
T_4	Phule Raja grafted on RHRB-06	29.00	74.00
T_5	Phule Kesari grafted on RHRB-06	28.33	73.67
T_6	NS 501 grafted on RHRB-06	25.33	71.00
T_7	Control (Phule Raja)	28.00	73.67
T_8	Control (Phule Kesari)	29.33	74.00
T_9	Control (NS 501)	26.00	72.00
	S.E. (m) ±	0.47	0.62
	CD at 5%	1.41	1.87

4.3.4 Days to first harvest

The mean data pertaining effect of brinjal rootstock on tomato regarding days to first harvest in grafted and non- grafted condition is presented in Table 4.5. In days taken for first harvest, the difference between the treatments were significant (Figure 4.4).

In present investigation, NS 501 grafted onto RHRB-06 (T_6) took lowest number of days (71.00) for first harvest which was at par with treatment (T_3) NS 501 grafted on *Solanum torvum* (72.00) and self-rooted NS 501 (T_9) (72.00), whereas highest number of days (74.00) was recorded in self rooted (non-grafted) Phule Kesari (T_8) plants. However, the first harvesting was done on an average 73 days of all the treatments after transplanting for first harvest. The above results are in accordance with the results of Nkansanh *et al*. (2013) and Soe *et al*. (2018), they reported that in grafted plants days necessary for first harvest compared to non- grafted plants.

Among all the three varieties and hybrids NS 501 is early maturing hybrid. Hence, it's harvesting is earlier as compared to other two varieties. Earliness is considered as important factor for commercial cultivation and in addition to this, grafted plants produce earlier

reproductive development, faster flowering, earlier harvesting compared to non-grafted plants (Soe *et al*. 2018).

4.4 Yield Parameter

4.4.1 Average fruit weight (g)

The mean data pertaining effect of brinjal rootstock on tomato regarding average weight of individual fruit in grafted and self-rooted (non-grafted) condition is presented in Table 4.6. Among all the treatments, Phule Raja grafted on *Solanum torvum* (T_1) produced fruits with higher weight (79.30 g) which was at par with Phule Raja grafted on RHRB-06 (T_4) (78.67 g), whereas the lowest weight of fruit was observed in self rooted Phule Kesari (T_8) (73.03 g). Treatments had significantly effect on average fruit weight of plants (Figure 4.5).

Average fruit weight is a major yield contributing trait. In the present investigation, high values of average weight of fruit were recorded in Phule Raja grafted on *Solanum torvum.* However, other grafted varieties also seem the significantly highest average weight of fruit than the self-rooted. This harmonize with results from other studies they noted positive rootstock-scion interactions on the average fruit weight. Turhan *et al*. (2011), Nkansanh *et al*. (2013), Ahmed (2014), Ibrahim (2014) and Kumar *et al*. (2016) also reported that weight of fruit of grafted plants was found to be greater than non-grafted plants. Soe *et al.* (2018) reported that grafted tomato on eggplant rootstock produced fruit with higher fruit weight comparing to other rootstocks such as tomato, chili and also non-grafted tomato plants. Soe *et al*. (2018) recorded that highest fruit weight was observed in the grafted tomato onto eggplant rootstock, whereas lowest fruit weight was observed on non-grafted tomato. Hossain *et al*. (2019) also reported that maximum weight of individual fruit was measured on plants which are grafted and lowest observed in non-grafted plants.

4.4.2 Polar diameter (cm)

The data on effect of brinjal rootstock on tomato regarding polar diameter of fruit (cm) in grafted and self-rooted (non-grafted) condition is presented in Table 4.6. All the treatments showed significant differences for polar diameter (Figure 4.6). In present investigation, Phule Kesari grafted on *Solanum torvum* (T_2) recorded maximum polar diameter (6.59 cm), which was at par with Phule Kesari grafted on RHRB-06 (T_5) (6.56 cm), whereas minimum polar diameter (5.44 cm) recorded in self rooted Phule Raja plants (T_7).

Polar diameter *i.e*., fruit length is considered as important parameter for quality tomato production. Mostly it is due to varietal character. As fruits of oval fruit variety had maximum polar diameter and fruits of round variety had minimum polar diameter. In present investigation Phule Kesari grafted on *Solanum torvum* recorded maximum polar diameter, might be due to its varietal character as it produces oval fruits. Although, Phule Kesari recorded maximum polar diameter, but other grafted plants also showed maximum polar diameter than its counterparts.

The above result is accordance with results reported by Kumar *et al*. (2016), Rathod (2017) and Hossain *et al*. (2019). They reported that length of fruit was maximum in grafted plants while minimum was observed in the non-grafted plants. This variation could be caused by the grafting effect, which results in variations in nutrient and water uptake.

Table 4.6 Effect of brinjal rootstock on tomato regarding average weight of fruit (g), polar diameter (cm), equatorial diameter (cm) and fruit shape in grafted and non-grafted plants.

Tr. No.	Treatment details	Average fruit weight (g)	Polar diameter (cm)	Equatorial diameter (cm)	Fruit shape
T_1	Phule Raja grafted on *Solanum torvum*	79.30	5.69	5.16	Oval round
T_2	Phule Kesari grafted on *Solanum torvum*	77.33	6.59	4.71	Oval
T_3	NS 501 grafted on *Solanum torvum*	78.25	6.44	4.98	Oval
T_4	Phule Raja grafted on RHRB-06	78.67	5.75	5.00	Oval round
T_5	Phule Kesari grafted on RHRB-06	75.41	6.56	4.57	Oval
T_6	NS 501 grafted on RHRB-06	76.08	6.16	4.98	Oval
T_7	Control (Phule Raja)	76.47	5.44	5.10	Oval round
T_8	Control (Phule Kesari)	73.03	6.34	4.56	Oval
T_9	Control (NS 501)	74.14	6.13	4.83	Oval
	S.E. (m) ±	0.40	0.22	0.13	
	CD at 5%	1.21	0.68	0.39	

4.4.3 Equatorial diameter (cm)

The data on effect of brinjal rootstock on tomato regarding equatorial diameter of fruit (cm) in grafted and self-rooted (non-grafted) condition is presented in Table 4.6. All the treatments showed significant differences for equatorial diameter (Figure 4.7). Among all the treatments, Phule Raja grafted on *Solanum torvum* (T_1) recorded maximum equatorial diameter (5.16 cm), whereas self-rooted (non-grafted) Phule Kesari (T_8) recorded minimum equatorial diameter (4.56 cm).

Equatorial diameter *i.e.,* fruit diameter is considered as important parameter for quality production of tomato. Mostly it is due to varietal character. As fruit of round variety had maximum equatorial diameter and fruits of oval variety had minimum equatorial diameter. In present investigation, Phule Raja grafted on *Solanum torvum* recorded maximum equatorial diameter due to its varietal character as it produces round type fruits while self-rooted Phule

Kesari recorded minimum equatorial diameter due to it produces oval type fruits. Although, Phule Raja recorded maximum equatorial diameter, but other grafted plants also showed maximum equatorial diameter than its counterparts. The above results are in accordance with results reported by Soe *et al*. (2018), Kumar *et al*. (2019). They reported that grafted tomato on eggplant rootstock had maximum fruit diameter compared to non-grafted tomato plants. Hossain *et al*. (2019) reported that equatorial diameter was found maximum in grafted plant as comparing to non-grafted plants

4.4.4 Fruit Shape

There were no changes in fruit shape obtained from grafted plants when compared to the fruits obtained from non-grafted plants. As the trait, shape is predominantly governed by scion genotype and little altered by environmental or cultural factors. Hence, the effect of grafting there upon has been circumstantial and mostly minimal. Due to vigorous rootstock grafted plants usually showed increased increased uptake of water and minerals when compared to self-rooted plants but does not affected the shape of fruits as it is controlled by genotype of scion but not the genotype of rootstock. (Turhan *et al*. 2011).

4.4.5 Pericarp thickness (cm)

The data on effect of brinjal rootstock on tomato regarding pericarp thickness of fruit (cm) in grafted and self-rooted (non- grafted) condition is presented in Table 4.7. All the treatments showed significant differences for pericarp thickness (Figure 4.8). Among all the treatments, Phule Kesari grafted on *Solanum torvum* (T_2) recorded maximum pericarp thickness (0.63 cm), whereas self rooted (non-grafted) NS 501 (T_9) recorded minimum pericarp thickness (0.50 cm).

Pericarp thickness is a major contributing trait to determine fruit firmness. In present investigation, Phule Kesari grafted on *Solanum torvum* recorded maximum pericarp thickness due to its specific varietal character as it has thick pericarp fruits while self-rooted NS 501 recorded minimum pericarp thickness due to it has thin pericarp than other two varieties. Although, Phule Kesari recorded maximum pericarp thickness, but other grafted plants also showed maximum pericarp thickness than its counterparts. The above results are in accordance with results reported by Negi (2016) who reported that rootstocks, grafting methods and scions affected pericarp thickness significantly. Kumar *et al.* (2017) reported that rootstocks affected the pericarp thickness of the grafted tomato plants. Sharma (2019) reported that maximum pericarp thickness observed in grafted plants than non-grafted plants.

Table 4.7 Effect of brinjal rootstock on tomato regarding pericarp thickness (cm) and Number of fruits/plant in grafted and non-grafted plants.

Treatments	Treatment details	Pericarp thickness (cm)	Number of fruits/ plant
T_1	Phule Raja grafted on *Solanum torvum*	0.54	34.06
T_2	Phule Kesari grafted on *Solanum torvum*	0.63	29.25
T_3	NS 501 grafted on *Solanum torvum*	0.51	30.08
T_4	Phule Raja grafted on RHRB-06	0.53	31.86
T_5	Phule Kesari grafted on RHRB-06	0.62	26.24
T_6	NS 501 grafted on RHRB-06	0.51	28.35
T_7	Control (Phule Raja)	0.53	29.17
T_8	Control (Phule Kesari)	0.62	27.73
T_9	Control (NS 501)	0.50	28.23
	S.E. (m) ±	0.09	0.32
	CD at 5%	0.27	0.96

4.4.6 Number of fruit / plant

The mean data pertaining effect of brinjal rootstock on tomato regarding number of fruits per plant in grafted and self-rooted (non-grafted) condition is presented in Table 4.7. Treatments had significantly effect on number of fruits per plant (Figure 4.9).In present investigation, Phule Raja grafted on *Solanum torvum* (T_1) recorded maximum fruits per plant (34.06), whereas minimum number of fruits per plant (27.73) were recorded in self rooted Phule Kesari plants (T_8).

Number of fruits per plant is a major yield contributing factor in tomato. In present investigation, Phule Raja grafted on *Solanum torvum* recorded higher amount of fruits per plant. Favorable climatic conditions, crop duration, varietal characters, vigorous rootstock, compatibility of rootstocks and scion which might be contribute to maximum numbers of fruits per plant. Although, Phule Raja reported higher numbers of fruit per plant, but other grafted plant also showed the greater number of fruits than its counterparts. The above results are in accordance with results reported by Turhan *et al*. (2011), Nkansanh *et al*. (2013), Ibrahim (2014), Kumar *et al*. (2017) and Sharma *et al*. (2019). Turhan *et al*. (2011) reported that the total number of fruits per plant increased by grafting than without grafting of tomato. Nkansanh *et al*. (2013) reported that number of fruits per plant was greater on grafted plants and lowest on non-grafted plants. Kumar *et al*. (2017) reported that plants grafted on *Solanum torvum* gave highest number of fruits per plant compared to non-grafted plants. Shrama *et al*. (2019) also showed

maximum number of fruits per plant in scion variety GS-600 grafted onto rootstock *Solanum torvum*, whereas non grafted plants recorded less number of fruits per plant.

Table 4.8 Effect of brinjal rootstock on tomato regarding yield per plant (kg), yield per plot (kg) and yield per hectare (t) in grafted and non-grafted plants.

Treatments	Treatment details	Yield / plant (kg)	Yield / Plot (kg)	Yield/ ha (t)
T_1	Phule Raja grafted on *Solanum torvum*	2.70	86.47	66.72
T_2	Phule Kesari grafted on *Solanum torvum*	2.26	72.28	55.77
T_3	NS 501 grafted on *Solanum torvum*	2.35	75.23	58.03
T_4	Phule Raja grafted on RHRB-06	2.50	79.99	61.72
T_5	Phule Kesari grafted on RHRB-06	2.03	63.24	48.80
T_6	NS 501 grafted on RHRB-06	2.15	68.79	53.07
T_7	Control (Phule Raja)	2.23	71.23	54.96
T_8	Control (Phule Kesari)	2.01	64.61	49.84
T_9	Control (NS 501)	2.09	66.75	52.01
	S.E. (m) ±	0.03	0.99	0.79
	CD at 5%	0.09	2.97	2.37

4.4.7 Fruit yield/ plant (kg)

The mean data pertaining effect of brinjal rootstock on tomato regarding yield per plant is presented in Table 4.8. Fruit yield of grafted plant was significantly higher than the non-grafted ones (Figure 4.10).

Phule Raja grafted on *Solanum torvum* (T_1) recorded highest yield per plant (2.70 kg), whereas lowest yield per plant (2.01 kg) observed in self rooted (non-grafted) Phule Kesari. In vegetable production, yield is an important factor. In present investigation it was considered that grafting with *Solanum torvum* rootstock significantly affects on yield per plant. Tomato hybrid Phule Raja grafted on *Solanum torvum* reported significantly highest yield per plant. The above results are in accordance with results reported by Turhan *et al*. (2011), Ibrahim *et al*. (2014), Kumar *et al*. (2017) and Soe *et al.* (2018).

They reported that maximum yield was achieved from grafted tomato on eggplant rootstock and minimum yield was achieved from non-grafted tomato. Schwarz *et al*. (2010) also found that eggplant is very effective in water uptake than tomato root systems. The vigorous root system of rootstock is often capable of absorbing water and nutrients more efficiently than scion roots and serves as a good supplier of endogenous plant hormones and also enhanced accumulation of more food reserves to the sink. (Takahashi *et al*. 1981).The difference in yield

response may be due to different growth characteristics of cultivars and different response of grafting, growth period and compatibility of rootstocks and scions.

4.4.8 Yield/ plot (kg)

The mean data pertaining effect of brinjal rootstock on tomato regarding yield per plot is presented in Table 4.8. Treatments showed significant difference for yield per plot. Trends similar to the yield per plant was observed in yield per plot. Phule Raja grafted on *Solanum torvum* (T_1) recorded maximum yield per plot (86.47 kg), whereas minimum yield per plot (63.24 kg) observed in Phule Kesari grafted on RHRB-06 (T_6).

4.4.9 Yield/ ha (t)

The mean data pertaining effect of brinjal rootstock on tomato regarding yield per hectare is presented in Table 4.8. Treatments showed significant difference for yield per hectare. Trends similar to the yield/plant was observed in yield/ha. In present study, Phule Raja grafted on *Solanum torvum* (T_1) recorded highest yield per hectare (66.72 t/ha), whereas lowest yield per hectare (48.80 t/ha) recorded in Phule Kesari grafted on RHRB-06 (T_6).

The above results are in accordance with results reported by Nkansanh *et al*. (2013), Hossain *et al*. (2019), Kumar *et al*. (2019) and Sabatino *et al*. (2020). Nkansanh *et al*. (2013) reported that grafted tomatoes on eggplant rootstock had maximum yield per hectare than non-grafted control plants. Kumar *et al*. (2019) reported that highest yield per hectare was in grafting combination than non-grafted plants. Also Hossain *et al*. (2019) reported that total fruit yield per hectare had highest in grafted plants whereas lowest in non-grafted plants. Sabatino *et al*. (2020) recorded that ‘Birgah’ grafted on *Solanum torvum* noted highest marketable yield compared to non-grafted plants.

4.5 Percent Disease Incidence

4.5.1 Fusarium wilt

The mean data pertaining effect of brinjal rootstock on tomato regarding percent disease is presented in Table 4.9. Treatments showed non-significant differences for incidence of fusarium wilt. In Phule Raja tomato hybrid, fusarium wilt attack was not found either in grafted plants or control plants. Among the hybrids and varieties, NS 501 grafted on *Solanum torvum* able to suppress fusarium wilt attack by 99%, which means *Solanum torvum* rootstock proved more resistance to fusarium wilt.

The above results are in consistent with Gousset *et al*. (2005) and Latifah *et al*. (2018). Gousset *et al*. (2005) stated that *Solanum torvum* rootstock conferred resistance to *Fusarium oxysporum* spp. *lycopersicum* limit fusarium wilt disease in scions. Latifah *et al*. (2018) reported that various varieties of tomatoes as scions were grafted on *Solanum torvum* rootstock proved to have more resistance to fusarium wilt attacks than control (non-grafted)

Table 4.9 Effect of brinjal rootstock on tomato regarding percent fusarium wilt incidence

Treatments	Treatment details	Fusarium wilt (%)
T_1	Phule Raja grafted on *Solanum torvum*	0.00 (2.86)
T_2	Phule Kesari grafted on *Solanum torvum*	1.67 (7.42)
T_3	NS 501 grafted on *Solanum torvum*	0.83 (5.22)
T_4	Phule Raja grafted on RHRB-06	0.00 (2.86)
T_5	Phule Kesari grafted on RHRB-06	1.67 (7.42)
T_6	NS 501 grafted on RHRB-06	2.50 (9.09)
T_7	Control (Phule Raja)	0.00 (2.86)
T_8	Control (Phule Kesari)	0.83 (5.22)
T_9	Control (NS 501)	1.67 (7.42)
	S.E. (m) ±	0.96
	CD at 5%	NS

5. SUMMARY AND CONCLUSIONS

Present investigation entitled “Response of tomato grafted on brinjal rootstock for growth, yield and quality” was carried out at Tomato Improvement Scheme, Department of Horticulture, MPKV Rahuri during rabi 2019-20 with following objectives.

1. To study the compatibility of different tomato varieties grafted on brinjal rootstock.
2. To study the growth, yield and quality parameters of different tomato varieties grafted on brinjal rootstock.

The performance of the grafts was studied and the brief accounts of results are summarized below.

5.1 Rootstock and Scion Parameters

Among both the rootstocks, *Solanum torvum* was recorded maximum days for germination (28.00), days taken to reach grafting stage (58.50), maximum girth of rootstock (9.48 mm) and minimum number of leaves (4.60), whereas RHRB-06 rootstock recorded minimum days for germination (5.75), days taken to reach grafting stage (29.00), minimum girth of rootstock (9.34 mm) and maximum number of leaves (5.80).

Among the hybrids and varieties, NS 501 was recorded minimum days for germination (4.75), days taken to reach grafting stage (24.5) and number of leaves (3.80), whereas Phule Raja recorded maximum days for germination (6.25), days taken to reach grafting stage (25.50), girth of scion (9.35 mm) and number of leaves (4.43).

5.2 Observations of Grafted Plant

Among all the treatments, Phule Raja grafted on *Solanum torvum* recorded maximum days (7.75) for graft healing, days to attain transplanting (25.75) and maximum graft success (89.96), whereas Phule Kesari grafted on RHRB-06 recorded minimum days (6.25) for graft healing, days to attain transplanting (23.25) and graft success (87.21). Phule Raja grafted on RHRB-06 recorded lowest graft success (83.65)

5.3 Growth Parameters

Among all the treatments, Phule Raja grafted on *Solanum torvum* recorded significantly highest plant height (123.80 cm), maximum number of branches (5.37). Whereas, lowest plant height (75.33 cm), minimum number of branches (4.20) were recorded in self rooted (non-grafted) Kesari plants. NS 501 grafted on RHRB-06 recorded lowest number of days (25.33) for 50% flowering also lowest number of days (71) for first harvest, whereas self-rooted (non-grafted) Phule Kesari recorded maximum number of days (29.33) for 50% flowering also maximum number of days (74) for first harvest.

5.4 Yield Parameters

Among all the treatments, Phule Raja grafted on *Solanum torvum* recorded significantly maximum number of fruits per plant (34.06), fruit weight (79.30 g), equatorial diameter (5.16 cm), fruit yield/plant (2.70 kg), fruit yield/plot (86.47 kg) and yield/hectare (66.72 t/ha).

Whereas minimum number of fruits per plant (27.73), fruit weight (73.03 g), equatorial diameter (4.56 cm), yield/plant (2.01 kg) recorded in self rooted (non-grafted) Phule Kesari plants.

Phule Kesari grafted on *Solanum torvum* recorded maximum polar diameter (6.59 cm) and pericarp thickness (6.35 mm), whereas minimum polar diameter (5.44 cm) recorded in self rooted Phule Raja plants.

5.5 Percent Disease Incidence

All the treatments showed non- significant differences for incidence of fusarium wilt.

5.6 Conclusion

- The results revealed that grafting can contribute to significant increase in the production of tomato.
- In present study, minimum days taken for germination, days taken to reach grafting stage, days to 50% flowering and days to first harvest was observed in variety NS 501 as it is early maturing hybrid.. However other growth parameters and yield parameters are maximum observed in Phule Raja hybrid.
- *Solanum torvum* is a vigorous rootstock having a good compatibility with the scion provides the best result in terms of growth and yield parameter. Also, *Solanum torvum* rootstock proved more resistance to fusarium wilt.
- The results showed that there are considerable differences between grafted and non-grafted plants in terms of all parameters measured during the study. Both rootstock *Solanum torvum* and RHRB-06 significantly improved the growth and yield parameters of tomato.
- It is concluded that Phule Raja grafted on *Solanum torvum* was found suitable for better growth and yield as it recorded maximum plant height, number of branches, average fruit weight, number of fruits/plant, yield/plant, yield/plot and yield/hectare. Considering the above points it can be concluded that ‘Phule Raja’ was found highly compatible with brinjal rootstock ‘*Solanum torvum*’.

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7. VITAE

Ms. NIMBALKAR RAJASHREE SUBHASH

MASTER OF SCIENCE(HORTICULTURE)

IN

VEGETABLE SCIENCE

2021

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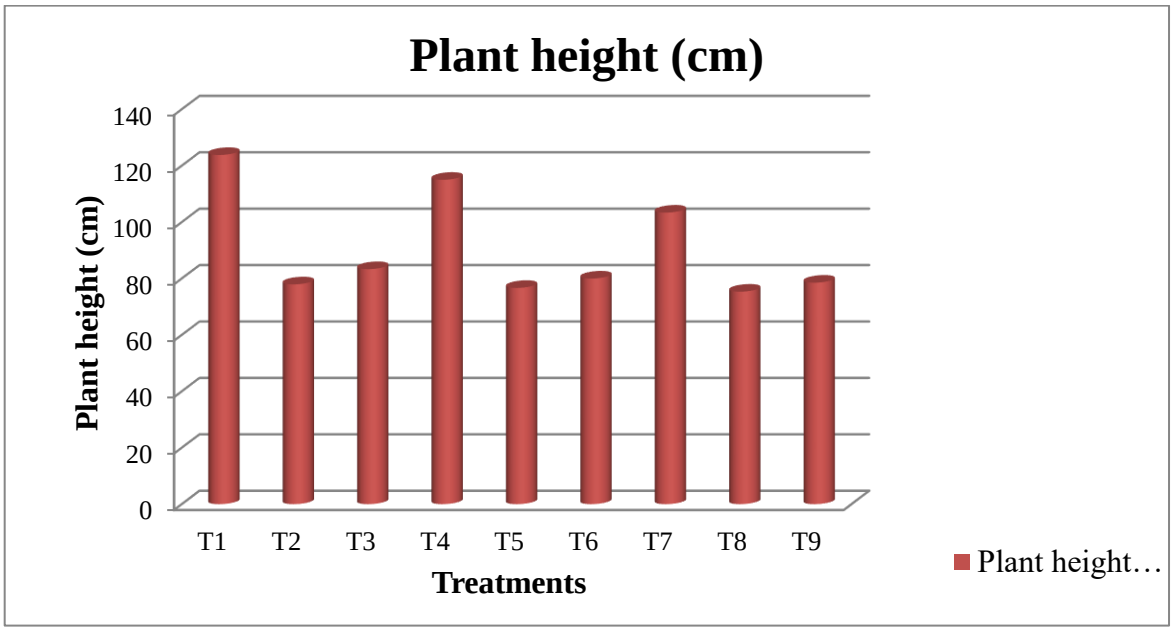

Figure 4.1 Plant heights (cm) of tomato varieties grafted on brinjal rootstock

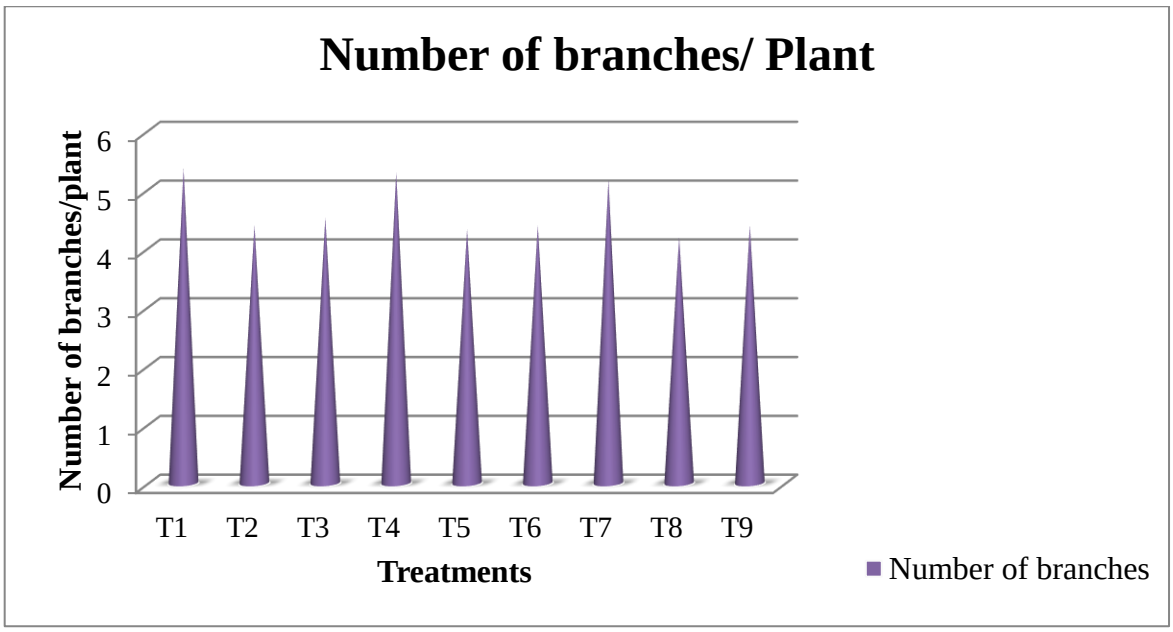

Figure 4.2 Number of branches/ plant of tomato varieties grafted on brinjal rootstock

Treatment details: **T_1**: Phule Raja grafted on *S. torvum*, **T_2:** Phule Kesari grafted on *S. torvum*,**T_3**: NS 501 grafted on *S. torvum* ,**T_4:** Phule Raja grafted on RHRB-06, **T_5**: Phule Kesari grafted on RHRB-06, **T_6**: NS 501 grafted on RHRB-06, **T_7:** Control (without grafting) Phule Raja, **T_8**: Control (without grafting) Phule Kesari, **T_9**: Control (without grafting) NS 501

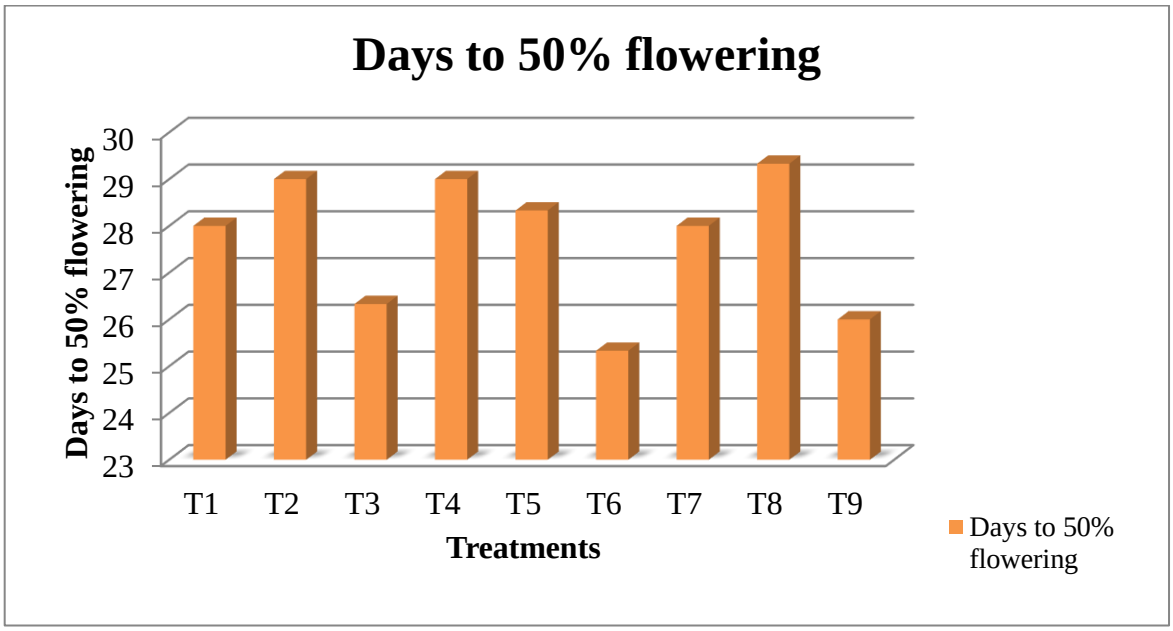

Figure 4.3 Days to 50% flowering in tomato varieties grafted on brinjal rootstock

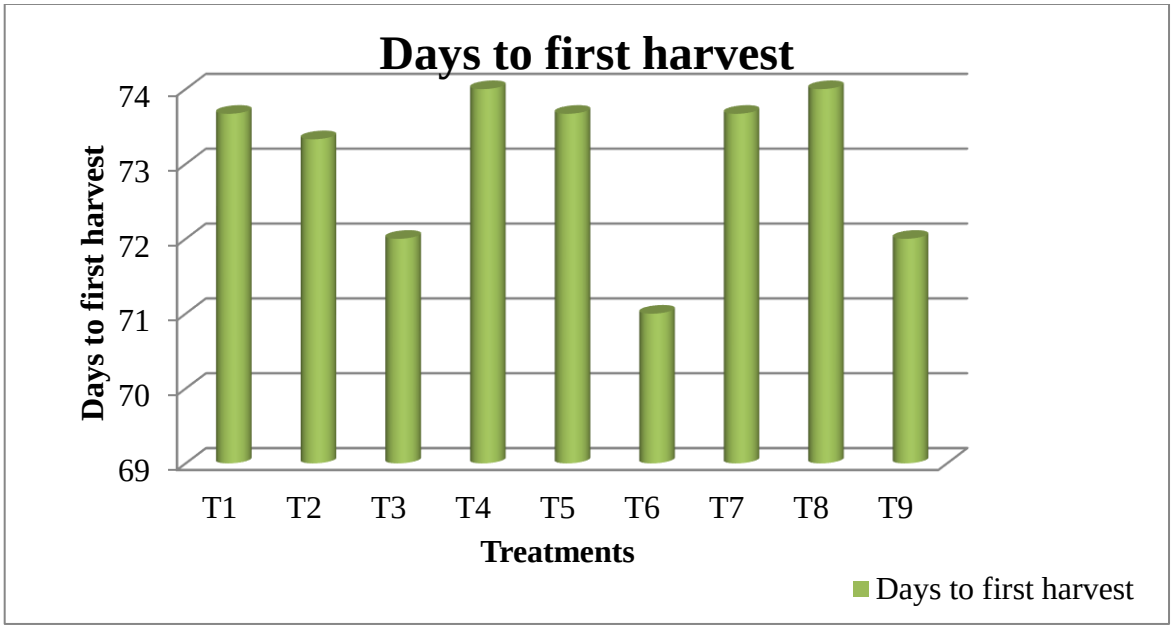

Figure 4.4 Days to first harvest in tomato varieties grafted on brinjal rootstock.

Treatment details: **T_1**: Phule Raja grafted on *S. torvum*, **T_2:** Phule Kesari grafted on *S. torvum*, **T_3**: NS 501 grafted on *S. torvum* ,**T_4:** Phule Raja grafted on RHRB-06,**T_5**: Phule Kesari grafted on RHRB-06, **T_6**: NS 501 grafted on RHRB-06, **T_7:** Control (without grafting) Phule Raja, **T_8**: Control (without grafting) Phule Kesari, **T_9**: Control (without grafting) NS 501

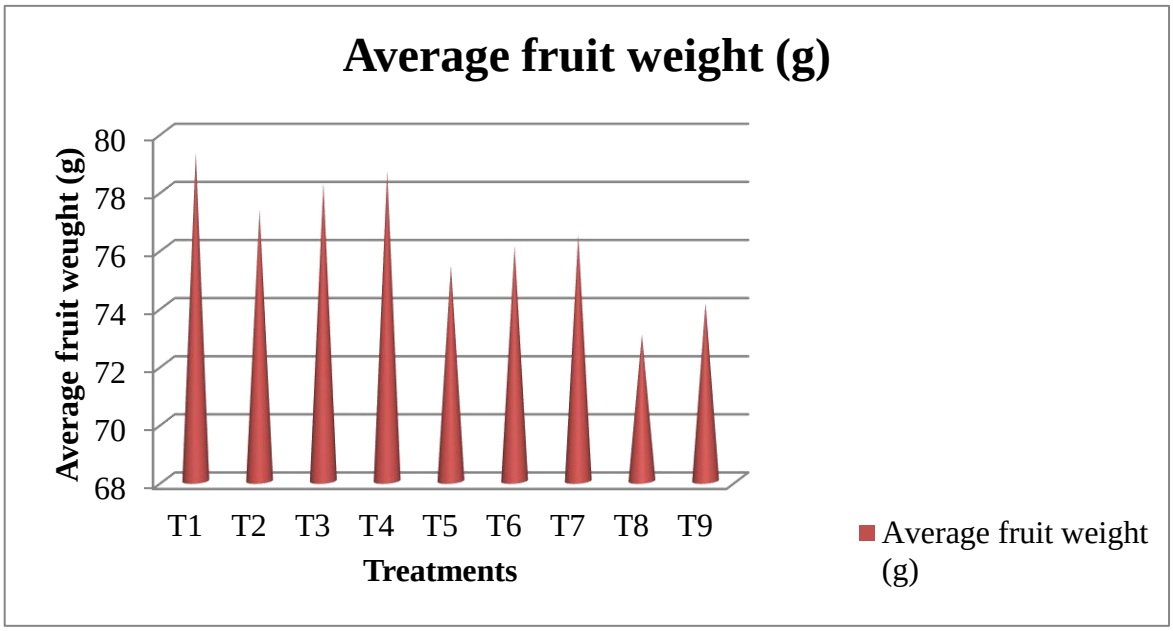

Figure 4.5 Average fruit weight (g) of tomato varieties grafted on brinjal rootstock

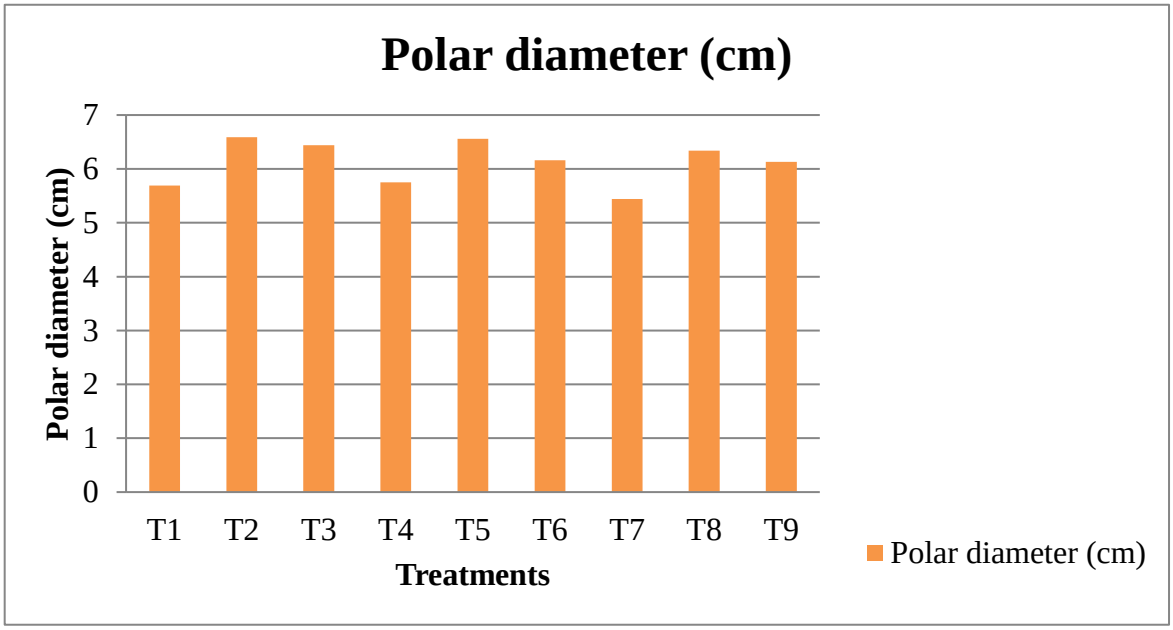

Figure 4.6 Polar diameters (cm) of tomato varieties grafted on brinjal rootstock

Treatment details: **T_1**: Phule Raja grafted on *S. torvum*, **T_2:** Phule Kesari grafted on *S. torvum*, **T_3**: NS 501 grafted on *S. torvum* ,**T_4:** Phule Raja grafted on RHRB-06,**T_5**: Phule Kesari grafted on RHRB-06, **T_6**: NS 501 grafted on RHRB-06, **T_7:** Control (without grafting) Phule Raja, **T_8**: Control (without grafting) Phule Kesari, **T_9**: Control (without grafting) NS 501

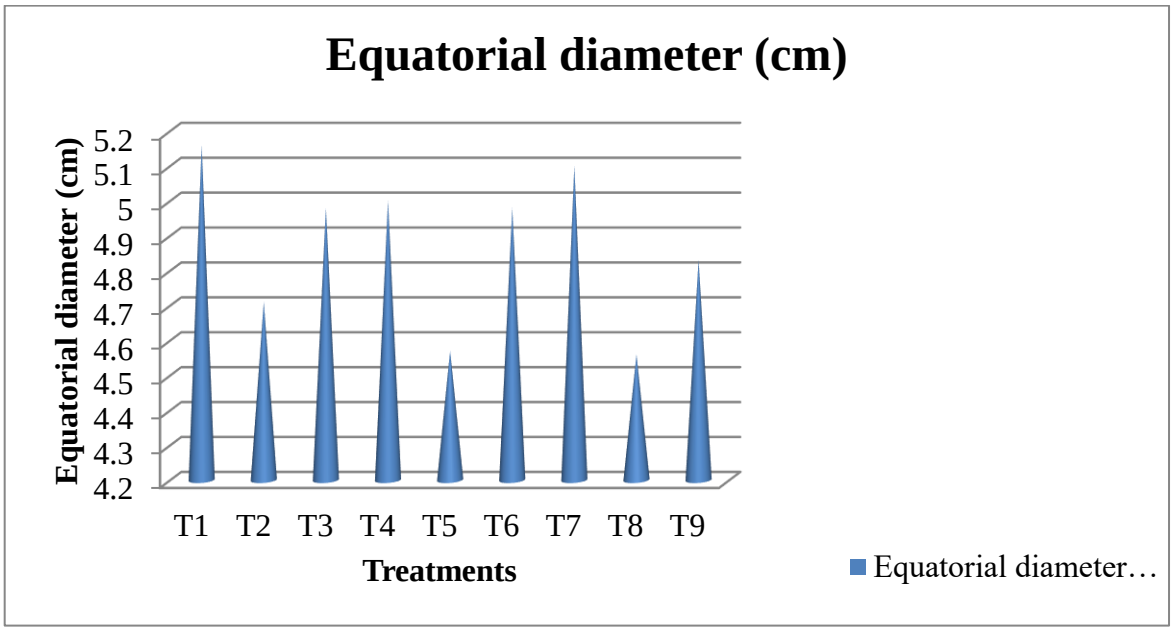

Figure 4.7 Equatorial diameters (cm) of tomato varieties grafted on brinjal rootstock

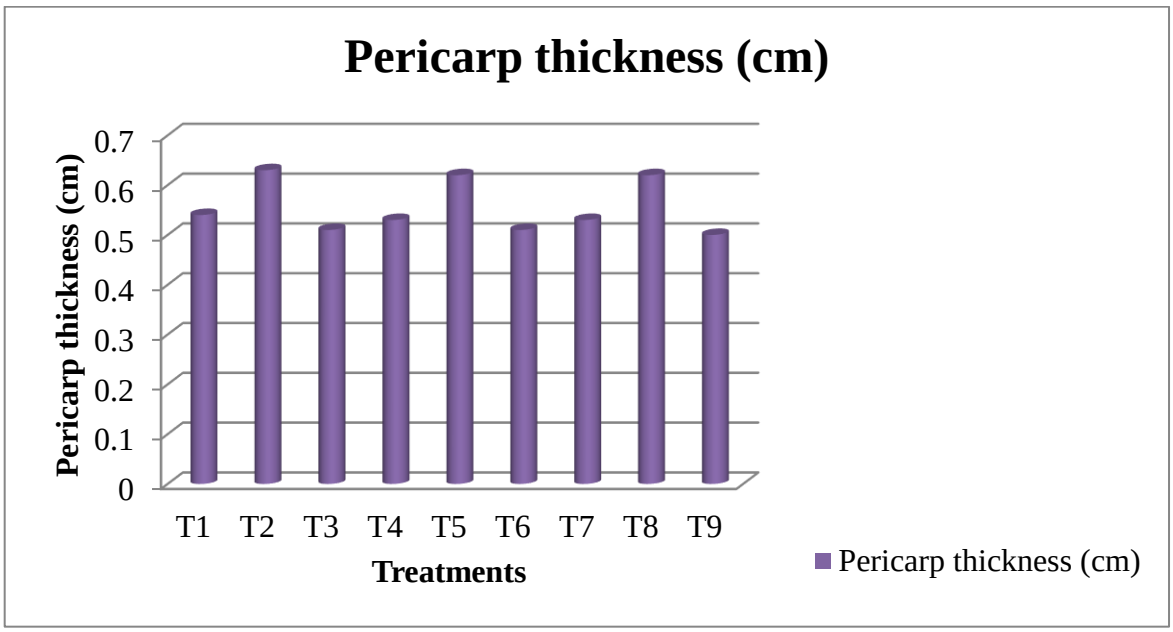

Figure 4.8 Pericarp thicknesses (cm) of tomato varieties grafted on brinjal rootstock

Treatment details: **T_1**: Phule Raja grafted on *S. torvum*, **T_2:** Phule Kesari grafted on *S. torvum*, **T_3**: NS 501 grafted on *S. torvum* ,**T_4:** Phule Raja grafted on RHRB-06,**T_5**: Phule Kesari grafted on RHRB-06, **T_6**: NS 501 grafted on RHRB-06, **T_7:** Control (without grafting) Phule Raja, **T_8**: Control (without grafting) Phule Kesari, **T_9**: Control (without grafting) NS 501

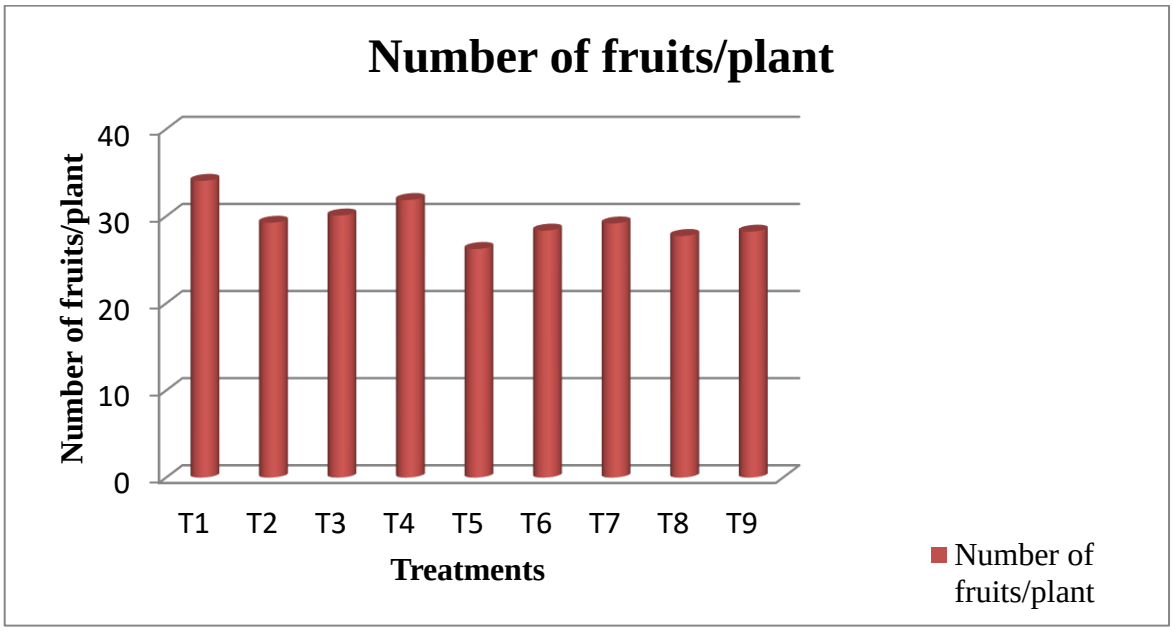

Figure 4.9 Number of fruits/plant of tomato varieties grafted on brinjal rootstock.

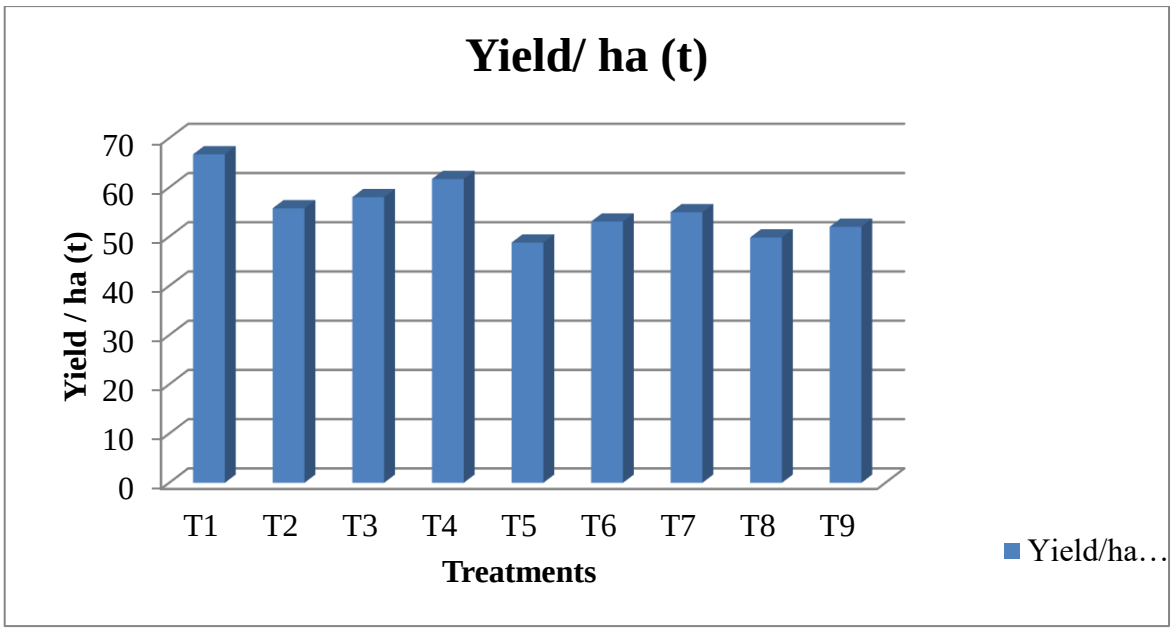

Figure 4.10 Yield/ha (t) of tomato varieties grafted on brinjal rootstock

Treatment details: **T_1**: Phule Raja grafted on *S. torvum*, **T_2:** Phule Kesari grafted on *S. torvum*, **T_3**: NS 501 grafted on *S. torvum* ,**T_4:** Phule Raja grafted on RHRB-06, **T_5**: Phule Kesari grafted on RHRB-06, **T_6**: NS 501 grafted on RHRB-06, **T_7:** Control (without grafting) Phule Raja, **T_8**: Control (without grafting) Phule Kesari, **T_9**: Control (without grafting) NS 501

A. Sowing of seeds

B. Germination of seed

C. Rootstock ready for grafting

D. Scion ready for grafting

E. Cut made on rootstock

F. Cut made on scion

G. Joining of rootstock and scion by using silicon clip

H. Grafted seedlings

I. Grafts in healing chamber

J. Graft union

K. Grafted plants ready for transplanting

L. Transplanting in field

Plate 1. Procedure of grafting (Splice grafting)

T_1: Phule Raja grafted on *S. torvum*

T_2: Phule Kesari grafted on *S. torvum*

T_3: NS 501 grafted on *S. torvum*

T_4: Phule Raja grafted on RHRB-06

T_5: Phule Kesari grafted on RHRB-06

T_6: NS 501 grafted on RHRB-06

Plate 2: Grafted seedlings