# CELL COMPATIBILITY ANALYSIS OF POMATO BASED ON SEEDLING AGE AND FERTILIZER TREATMENT

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**DEPARTMENT OF GENETICS AND PLANT BREEDING**
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*A Thesis*
*submitted to the Faculty of Agriculture,*
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# CERTIFICATE

*This is to certify that thesis entitled, "cell compatibility analysis of pomato based on seedling age and fertilizer treatment." submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in GENETICS AND PLANT BREEDING,*** *embodies the result of a piece of bona fide research work carried out by S. M. ANAMUL AREFIN, Registration No. 09-03644 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

***Dated: December, 2015***
***Place: Dhaka, Bangladesh***

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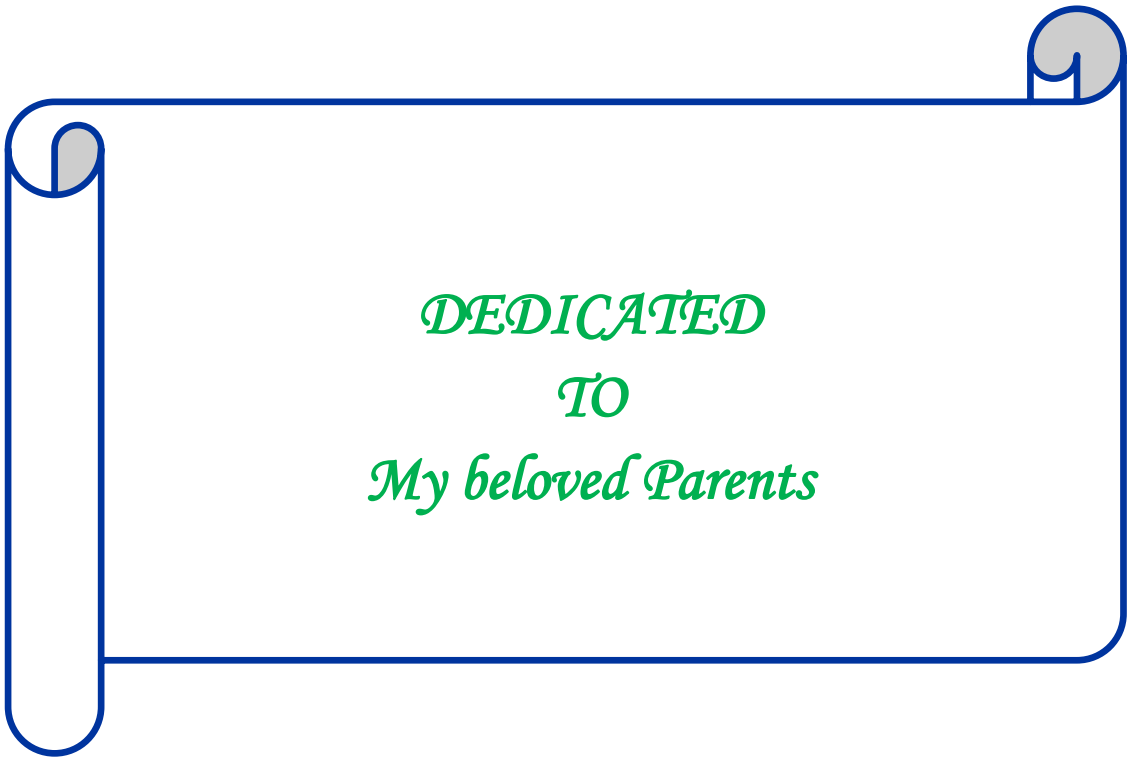
DEDICATED
TO
My beloved Parents

## Some commonly used abbreviations

| Full word | Abbreviations | Full word | Abbreviations |
|---|---|---|---|
| Agro-ecological Zone | AEZ | Meter square | $m^2$ |
| Agricultural | *Agril.* | Millimeter | Mm |
| Agriculture | *Agric.* | Muriate of potash | MP |
| And others | *et al.* | Number | No. |
| Annals | *Ann.* | Percentage | % |
| Applied | *App.* | Plant Genetic Resource Centre | PGRC |
| Application | *Appl.* | Proceeding | Proc. |
| Bangladesh Agricultural Research Council | BARC | Progressive | *Progr.* |
| | | Randomized complete block design | RCBD |
| | | Review | *Rev.* |
| Bangladesh Agricultural Research Institute | BARI | Research / Resource | *Res.* |
| | | Report | *Rpt.* |
| | | Reporter | *Rep.* |
| Bangladesh Bureau of Statistics | BBS | Sher-e-Bangla Agricultural University | SAU |
| Biology | *Biol.* | Serial | *Sl.* |
| Botany | *Bot.* | Science | *Sci.* |
| British Broadcasting | BBC | Society | *Soc.* |
| Centimeter | cm. | Soil Resource Development Institute | SRDI |
| Days after transplanting | DAT | Standard error | SE |
| | | Technology | *Technol.* |
| Edition | *Edn.* | Triple super phosphate | TPS |
| Environment | Environ. | That is | i.e. |
| Etcetera | etc. | Ton | T |
| Evolution | *Ev.* | University | *Univ.* |
| Food and Agricultural Organization | FAO | Vegetable | *Veg.* |
| Gram | g | | |
| Hectare | ha. | | |
| Horticulture | *Hort.* | | |
| International | *Intl.* | | |
| Incorporation | *Inc.* | | |
| Journal | *J.* | | |
| Kilogram | Kg | | |
| Meter | M | | |
| Mean sum square | MSS | | |

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*December, 2015* *The Author*

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# CELL COMPATIBILITY ANALYSIS OF POMATO BASED ON SEEDLING AGE AND FERTILIZER TREATMENT

**BY**

**S. M. ANAMUL AREFIN**

## ABSTRACT

An experiment was conducted at the experimental field of Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka, during November 2014 to April 2015. Cell compatibility of tomato and potato by making pomato plants was evaluated in six grafting combinations (tomato grafted on potato) and laid out in RCBD design with three replications. Three potato (*Solanum tuberosum L.)* and two tomato genotypes (*Solanum lycopersicum L*) were used for grafting in all possible combinations. Two treatments, *viz.* two seedling age of tomato and three fertilizer doses were used to identify best compatible grafting. The compatibility was evaluated through the observation of yield and sixteen yield contributing characters under different treatments. Cleft grafting was used to assess the magnitude of different fertilizers doses effect on different pomato genotype for high yield of tomato and tuber. The analysis of cell compatibility revealed that the pomato G6 (BARI tomato-11 grafted on Asterix) showed the best performance for total tuber yield (13.8 ton/ha) followed by pomato G3 (BARI tomato-2 grafted on Asterix) which showed the total tuber yield 9.27 ton/ha. Both the pomato genotypes for giving high tuber yield were grafted with 25 days old seedling of tomato and the applied fertilizer dose was 390 Kg/ha of urea, 280 Kg/ha of TSP, 312 Kg/ha of MoP, 140 Kg/ha of gypsum and 13000 Kg/ha of cowdung. The pomato G3 also showed the best performance for total tomato yield (41.65 ton/ha) when grafted with same age of seedling of tomato and with the same fertilizer doses as mentioned for total tuber yield. Hence, pomato G3 (BARI tomato-2 grafted on Asterix) could be recommended to the farmers for grafting and cultivation for total yield including both potato and tomato when grafted with young tomato seedling of 25 days old and with the fertilizer dose of 390 Kg/ha of urea, 280 Kg/ha of TSP, 312 Kg/ha of MoP, 140 Kg/ha of gypsum and 13000 Kg/ha of cowdung.

# CHAPTER I
# INTRODUCTION

Potato (*Solanaum tuberosum* L.) is perennial crops under the solaneceous family which species are autotetraploid. Potato is a staple food next to rice and wheat grown almost all over the world. Not only a staple food, but also popular as vegetables as well as main item of preparing various food and confectionary. The yield potential and food value compared to rice and wheat, potato is considered as a promising food crop against world hunger including Bangladesh where food shortage is a chronic feature (Anonymous, 1997). Now a day, potato has emerged as a major food crop in Bangladesh and is being cultivated throughout the country.

Other Solanaceae's crop, Tomato (*Solanum lycopersicum* L.) is a self-pollinated annual crop and one of the most important solanaceous vegetables in the world in terms of production, harvested area and consumption per capita (FAOSTAT, 2005). Tomato species are diploid (2n=2x=24). It has wider adaptability, high yielding potential and suitability for variety of uses in fresh as well as processed food industries (Meena and Bahadur, 2015). In addition to, tomatoes that are eaten directly as raw vegetable or added as ingredient to other food items, a variety of processed products have gained popularity. They contribute significantly to the dietary intake of vitamins A and C as well as essential minerals and nutrients. Tomato ranks the first among all fruits and vegetables as a source of vitamins and minerals (Rick and Chetelat, 1995).

The **"** Pomato" or "Tomtato" is a hybrid or chimera produced by grafting from a tomato plant on to a potato plant, both of which are members of the solanaceae (nightshade) family (David, 2013). Tomatoes grow on the vine, while potatoes grow in the soil from the same plant. The double species closely related, sharing a common basic chromosome no.12. But rather than just the chromosome count, it's the compatibility of the graft union, where the all-important cambium

(growth) cells found under the skin of the potato and tomato shoots need to match up for the graft to work.

Grafting is the process of combining two different plants to create a single one. It requires lots of skill and practice, but has been successfully achieved by providing a clean cut on the two plants and taping the ends together until they heal. The purpose is to combine one plant's qualities of flowering or fruiting with the roots of another that offers vigour and resilience. Most plants need to be grafted within their own genus - such as potatoes and tomatoes - but it is sometimes possible to graft those of a differing makeup. The concept of grafting related potatoes and tomatoes so that both are produced on the same plant was originally developed in 1977 at the Max Planck Institute for Developmental Biology in Tubingen, Germany. The Max Planck Institute for Plant Breeding Research in Koln produced a plant with fruit in 1994 (Renneberg, 2008). As with all grafts, this plant will not occur in nature and cannot be grown from seed, because the two parts of the plant remain genetically separate, and only rely on each other for nourishment and growth. Like most standard types of plant grafting, a small incision is made in the stem of both plants and they are strapped together. The rootstock (potato) acts as a stable and healthy root system and the scions (tomato) are chosen for their fruit, flowers or leaves. The pomatoes should be ready to harvest after about 12 weeks during the summer months; the potatoes should be ready after the tomato leaves begin to die back, normally in early autumn (Anonymous, 2013).

Pomato plants have been seen as a new technology to make food production more efficient, as they maximize the number of crops that can be produced on a piece of land or in a small urban environment like a balcony. This has significant impacts on developing countries like Bangladesh, where farmers can save on space, time and labour without affecting the quality of their produce by growing pomato plants. In addition, grafting can improve resistance to bacteria, viruses and fungi attract a more diverse group of pollinators and provide a strong trunk (Jabr, 2013). Later grafted pomato plants were launched in the United Kingdom

in September 2013 by horticultural mail order company Thompson and Morgan, who sold pre-grafted plants branded as the "TomTato". The Incredible Edible nursery in New Zealand announced a "Double UP Potato Tom" in the same month (Jude, 2013). Thompson and Morgan claimed that was the first time the plant has been produced commercially, and Director Paul Hansord described originating the tomtato idea himself 15 years ago, in the US, when visiting a garden where someone had planted a potato under a tomato (Hall, 2013). Grafting is a difficult process because the tomato and the potato stems have to be the same thickness and Thompson and Morgan trialed the hybrid for several years before selling it. Production and grafting of tomtatoes begins in a specialist laboratory in the Netherlands, before being shipped back to the UK and grown in greenhouses until they are ready to be sold (Wilkes, 2013).

In Bangladesh, pomato or tomtato production is a new technology. Recently in 2013 and 2014, Department of Genetics and Plant Breeding of Sher-e-Bangla Agricultural University, Bangladesh produced pomato by grafting BARI released tomato with local and exotic potato varieties (Jahanara, 2015; Nusrat, 2014). Later, Bangladesh Agricultural Development Corporation (BADC) also has launched a programme on pomato production in two trial areas Comilla and Pabna by taking one potato and three tomato varieties (Anonymous, 2013a).

Compatibility responses are features common to plant morphogenesis. Compatibility is the adjustment or union between the cells of tissues of different plants and sufficiently closes genetic (taxonomic) relationship between stock and scion for a successful graft union (Nelson, 1968). Through this process, the tissues of two plants are combined so they can grow together and able to produce the unique plant. The determination of the best union among different tomato and potato varieties has been conducted in this study with the following objectives:

- To assess the compatibility of cells of two different species, tomato and potato.
- To develop a suitable protocol for getting two crops at a time, tomato and potato from a single plant.
- To evaluate the yield potentiality and efficiency of compatible pomato plants grafted by different seedling age of tomato.
- To evaluate the yield potentiality of compatible pomato plants under different fertilizer treatments.
- To determine the response of grafted genotype × treatment interaction based on yield and yield contributing characters.

# CHAPTER II

# REVIEW OF LITERATURE

Existence of “Pomato” or “Tomtato” plant which is produced by grafting a tomato plant and a potato plant. They yield both potatoes and tomatoes without affecting the quality of the crops. Pomato plant produces tomatoes on the top and potatoes underground. Tomatoes are members of the potato family and are therefore naturally compatible with potatoes. The Tomtato plant is specially grafted by hand for creating this unique double cropping feature. There is no genetic modification in pomato plants, it is a natural, and safe process. Tomato and potato both are well-studied crop species for genetic and cytological analysis. Various resources are available for tomato and potato research now, which can lead to rising in evaluation of tomato and potato biology (Barone *et al*., 2008). Using different genes to examine genetic diversity in these crops (Asamizu and Ezura, 2009; Carelli *et al*., 2006; Martinez *et al*., 2006) have been done in many studies. The amount and nature of variation of tomato and potato plant characters helps the breeder for improving the selection efficiency. Morphological characters include the plant growth type and size, leaf shape, size and arrangement, plant height and fruit morphology i.e. number of fruits per plant, fruit length, fruit diameter, total yield. Literature available concerning to the present study has been presented below.

## 2.1. Origin, domestication and nomenclature of tomato

The tomato (*Solanum lycopersicum* L.) is an edible, often red berry-type fruit of the nightshade family commonly known as a tomato plant (Anonymous, 2014). The tomato is consumed in diverse ways, including raw, as an ingredient in many dishes, sauces, salads, and drinks. The English word tomato comes from the Spanish word, tomate, derived from the Nahuatl (Aztec language) word *tomatl*. It first appeared in print in 1595. The cultivated tomato originated in the Peru-Ecuador-Bolivia area of the South American (Vavilov, 1951).

According to “International Plant Name Index” and “Slow Food ® Upstate”, in 1753, Linnaeus placed the tomato in the genus *Solanum* as *Solanum lycopersicum* and in 1768 Philip Miller moved it to its own genus, naming it *Lycopersicon esculentum*. This name came into wide use, but was in violating of the plant naming rules. Genetic evidence has now shown that Linnaeus was correct to put the tomato in the genus *Solanum*, making *Solanum lycopersicum* the correct name (Peralta *et al*., 2006). Both names, however, will probably be found in the literature for some time.

Tomato is a tropical plant and grown in almost every corner of the world from tropics to within a few degrees of the Arctic Circle. Mexico has been considered the most likely center of domestication of tomato. Italy and Spain are considered secondary centers of diversification (Smith, 1994). Major tomato producing countries are Spain, Brazil, Iran, Mexico, Greece, Russia, China, USA, India, Turkey, Egypt and Italy. It is believed that the tomato was introduced in subcontinent during the British regime. It is adapted to a wide range of climates. In tomato (*Solanum lycopersicum* L.), one cultivated species and 12 wild relatives have been reported (Peralta *et al*., 2006).

### 2.2. Origin, domestication and nomenclature of pomato

The potato (*Solanum tuberosum* L) is a starchy, tuberous crop from the perennial nightshade. The word "potato" may refer either to the plant itself or to the edible tuber (Anonymous, 2016a). In the Andes, where the species is indigenous, there are some other closely related cultivated potato species. Potatoes were introduced outside the Andes region approximately four centuries ago, and have since become an integral part of much of the world's food supply. It is the world's fourth-largest food crop, following maize, wheat, and rice (FAO, 2009). Like many other important crops, potato is a polyploid. Potato actually has a number of ploidy levels, based on a haploid number of 12, ranging from diploid (2n=24) to hexaploid (6n=72), and including triploids, tetraploids, and pentaploids. Cultivated potato varieties are tetraploid (4n=48); many wild

species are diploid but may range up to hexaploid. The tetraploid cultivated potatoes are not diploidized, so that there are four interchangeable genes at each locus (Anonymous, 2016b).

According to Bell (1948) the failure of early potato cultivar to produce seed was due to tuber formation, indicating that early growth of tubers utilizes materials necessary for floral and fruit development. He concluded that preventing the formation tubers promotes the formation of numerous flowers and berries. Growth and development of different plant parts are affected by total assimilate production and partitioning among sink organs. Shoot and tuber growth are considered competing processes. Since the conventional potato propagation rely on seed tubers. Less attention has been given to the effect of flowering and berry set on the growth of potato. Some researchers have studied the effects of flowering and berry formation on vegetative growth and tuber yield but the result are conflicting.

Ahmad (1980), studied that, stolon formation starts at the most basal nodes and progresses acropetally. Tuberization of potato plants is strongly influenced by day length. Induction to tuberize is promoted by short photoperiod (long dark period) and the signal is perceived in the leaves. Under inductive conditions both the young and old leaves are capable of producing the stimulus (Hammes and Beyers, 1973). Research expended through the 1960 to include fertilizer applications, seed degeneration, mulching, planting techniques and storage (Ahamad, 1995). In 1967-1968 the Bangladesh Agricultural Development Corporation (BADC) launched a project for the multiplication and distribution of high quality seed potatoes (Ahamad, 1995). He investigated the pattern of stolon formation in three cultivars and found that about half of the stolon was formed at the most basal node, with roughly 10% of the remaining stolons at each of the next four higher nodes.

According to Cutter (1987) potato tubers are shortened and thickened modified stems that bear scale leaves (cataphylls) each with a bud in its axil. The usual site of tuber formation is a stolon tip. Stolons (rhizomes) are diagravitropic stem

with long internodes and scale leaves. The potato plant is remarkable for its plasticity in organ development (Clowes and MacDonald, 1987). Potatoes have been grown in Bangladesh since at least the 19th century (Anonymous, 1997). By the 1920s, the first commercial production of the crop was established in the country. Agronomic research on potato dates late 1950s when limited variety trials were started by the Bangladesh Agricultural Research Institute (BARI).

Tuber formation can occur on almost every bud of the plant including axillary buds (Ewing, 1985) and inflorescence (Marinus, 1993). They develop as branch from underground nodes and are terminated by a curved apical portion called a hook. It has been reported that stolons formed first normally grow longer, are more likely to branch, and are preferential sites for tuber formation (Lovell and Booth, 1969). According to Gregory (1956) both air and soil temperature are important cool air temperatures favour induction to tuberize and high soil temperature black the expression of the tuberization stimulus on the underground nodes. There is an interaction between temperature and photoperiod. The higher the temperature the shorter the photoperiod require for a given genotype to tuberize. Generally cool temperatures promote tuberization (Booth, 1963), and the high temperature are inhibition for tuberization under both short and long photoperiod, albeit the degree of inhibition is greater under long days (Wheeler *et al*., 1985). The formation of stolon and tubers takes place preferably underground although the tuberization stimulus may be present throughout the plant and affects morphological development (Ewing, 1997). The signal for induction to tuberization is omnipresent and can express itself in all buds. Potato tuberization is a complex process involving anatomical, enzymatic, biochemical and hormonal changes leading to the differentiation of the stolon into a vegetative storage organ the tuber (Fernie and Willmitzer, 2001).

### 2.3. “Pomato” in all over the world

According to Lubbock online Fruit or tuber formation (2002) requires a great deal of a plant's energy, so a pomato plant might get confused as where to direct its energy. A tomato plant is programmed to put energy into large, luscious fruits.

A potato plant is programmed to put its energy into fat, fleshy tubers. So a pomato plant probably would not yield many tomatoes or potatoes, Barter (2013), who is a contributor to BBC Gardener's World, said "many of these plants - created by a technique known as grafting - had been created before but taste had previously been a problem. We're looking at it with real interest because Thompson and Morgan is a really reputable firm with a lot to lose, but I wouldn't rule out that it could be a very valuable plant to them. In the past we've never had any faith in the plants - they've not been very good - but grafting has come on leaps and bounds in recent years".

According to the Director Dr. Paul Hansord (2015), of the Thompson and Morgan Company the plant has been enormously successful. And it's little wonder. Tomatoes and potatoes, from the same greenery it seems almost like magic. But tomatoes are red and potatoes are brown. Yet here they are, together as one has been successfully produced commercially. Tomatoes are members of the potato family and are therefore naturally compatible with potatoes. Each TomTato plant is specially grafted by hand to create this unique double cropping feature. There's no genetic modification - it's an all-natural, and safe (Hansord, 2015). Rather than some freak of nature, or a genetically engineered marvel, it's simply a seedling tomato plant grafted on top of a potato plant, created using a technique similar to that used for years to produce "supertom" tomatoes. Tomato seedlings were used for the top, or scion, part of the plant, and then grafted on to the emerging shoot from a potato tuber to produce the dual purpose plant (Jude, 2013). The Oregon Seed Company reported in 2014 that the plant was developed in the United Kingdom (CBS Seattle Newsletter (2014). The seed company said since potatoes and tomatoes are fairly closely related, they graft well together. It's not genetic engineering. Gardeners can harvest a double crop of red cherry tomatoes and white potatoes from the plant also called a TomTato. According to Springvale Garden Centre (2014) tomatoes belong to the Potato family and so are naturally compatible with them. The idea of grafting a tomato onto a potato to get two vegetables from the one plant is not a new idea. It simply has never

been commercialized before and of course it is a great use of space, especially for people with small gardens or just a patio. As the crop of tomatoes grows and is harvested the Agria potatoes are developing below. Once the tomatoes have finished, simply dig out and harvest the potatoes.

It has been very difficult to achieve a pomato plant because the tomato stem and the potato stem have to be the same thickness for the graft to work. It is a very highly skilled operation. However, on closer inspection the potato is planted in a pot with a tomato planted in the same pot - the plant is one plant and produces no potato foliage. The plants last for one season and by the time the tomatoes are ready for picking, the potatoes can be dug up (BBC News, 2013). If at first it seems like a weird science experiment that just took off, well, it is. Closer inspection, however, shows that the two plants are related. Both are part of the same genus: the tomato is the fruit of the nightshade *Solanum lycopersicum*, while the potato is the crop of the nightshade *Solanum tuberosum*. It was developed in the Netherlands and commercialized in England, yet it's as American as a plant can get. Ketchup 'n' Fries is a plant that's been grafted to bear cherry tomatoes on top and white potatoes beneath the soil, and it's making its way to home gardens in the United States. The plant debuted in the U.S. recently, just in time to catch the attention of Southern California tomato enthusiasts, who typically are scouting now for new varieties to plant in the coming weeks. But as a chimera-like twofer, Ketchup 'n' Fries are garnering the attention of more than just tomato gardeners (The Orange County Register, 2015). In 1915 Burbank wrote about one of his findings that were with herbaceous plants like the potato and tomato the stem may unite at any portion where the cut surfaces come in contact. To make a neat and thoroughly satisfactory graft, however, it is of course desirable to select stems of exactly the same size. The splice graft, elsewhere described, is the best one to use, and if the incisions are made with care, so that the incised surfaces fit accurately together, it is only necessary to tie a piece of cloth about the united stems for a few days until union has taken place. A farm in Kenya has grafted a plant that grows

tomatoes and potatoes on the same stem in a bid to maximise the use of land parcels. The pomato is a result of trials that began two years ago in Kenya's Kiambu Prison farm, inspired by Chinese literature showing tuber and the fruit could be grown on the same plant (Fresh Fruit Portal newsletter, 2015). According to Greene (2013), there's a new wonder plant on the market. Some are calling it the TomTato. Cherry tomatoes grow above ground on the vine while white potatoes grow in the soil all from the same plant. The double crop plant might sound a little bit like mad science, but tomato and potatoes are members of the same plant family, making them really an ideal couple. A plant which produces both potatoes and tomatoes, described as a "veg plot in a pot", has been launched in the UK. The TomTato can grow more than 500 sweet cherry tomatoes while producing white potatoes (Hall, 2013). Some farmers and gardeners have created pomato plants, which grow potatoes underground and tomatoes above ground. Potatoes and tomatoes might seem very different based on appearances, but they both belong to the genus *Solanum* (Jabr, 2013). After a process of trial and error, and with the help of grafting specialists, Thompson & Morgan hit upon a method using a variety of potato that produces the right size shoot.

Careful variations in the temperature at which the tomato and potato arc initially grown are also made to ensure the two plants are a perfect match before being joined together (Mail online news, 2015). We've seen a number of innovations that allow for gardening in small spaces, including a Ferris wheel-like contraption, a mat that shows you where to plant specially-prepared seeds, and a system that lets you grow vertically-stacked veggies in your window. The TomTato, however, is in a league of its own- it's a single plant that produces both tomatoes and potatoes at the same time (Coxworth, 2013).

### 2.4. Crop improvement by grafting

Grafting with detached scions has been practiced for thousands of years. It was in use by the Chinese before 2000 BC, (Cooper and Chapot, 1977) then spread to the rest of Eurasia and was well established in ancient Greece (Garner, 1988).

Grafting or graft age is a horticultural technique whereby tissues from one plant are inserted into those of another so that the two sets of vascular tissues may join together. This vascular joining is called inosculation. The technique is most commonly used in asexual propagation of commercially grown plants for the horticultural and agricultural trades. In most cases, one plant is selected for its roots and this is called the stock or rootstock. The other plant is selected for its stems, leaves, flowers, or fruits and is called the scion or cion (Hottes, 1925). The scion contains the desired genes to be duplicated in future production by the stock/scion plant.

In stem grafting, a common grafting method, a shoot of a selected, desired plant cultivar is grafted onto the stock of another type. In another common form called bud grafting, a dormant side bud is grafted onto the stem of another stock plant, and when it has inosculated successfully, it is encouraged to grow by pruning off the stem of the stock plant just above the newly grafted bud. For successful grafting to take place, the vascular cambium tissues of the stock and scion plants must be placed in contact with each other. Both tissues must be kept alive until the graft has "taken", usually a period of a few weeks. Successful grafting only requires that a vascular connection take place between the grafted tissues. Joints formed by grafting are not as strong as naturally formed joints, so a physical weak point often still occurs at the graft because only the newly formed tissues inosculate with each other. The existing structural tissue or wood of the stock plant does not fuse. Grafting is the process of combining two different plants to create a single one so requires lots of skill and practice, but has been successfully achieved by providing a clean cut on the two plants and taping the ends together until they heal. The purpose is to combine one plant's qualities of flowering or fruiting with the roots of another that offers vigour and resilience. Most plants need to be grafted within their own genus - such as potatoes and tomatoes - but it is sometimes possible to graft those of a differing makeup. The concept of grafting related potatoes and tomatoes so that both are produced on the same plant was originally developed in 1977 at the Max Planck Institute for

developmental Biology in Tubingen, Germany, and although healthy, the plant produced neither potatoes nor tomatoes (Renneberg, 2008).

According to Hottes (1925) grafting or graftage is a horticultural technique whereby tissues from one plant are inserted into those of another so that the two sets of vascular tissues may join together. This vascular joining is called inosculation. The technique is most commonly used in asexual propagation of commercially grown plants for the horticultural and agricultural trades. In most cases, one plant is selected for its roots and this is called the stock or rootstock. The other plant is selected for its stems, leaves, flowers, or fruits and is called the scion or cion (Hottes, *1925*) The scion contains the desired genes to be duplicated in future production by the stock/scion plant.

Cooper and Chapot (1977), suggested that grafting with detached scions has been practiced for thousands of years. It was in use by the Chinese before 2000 BC, then spread to the rest of Eurasia and was well established in ancient Greece (Garner, 1988). According to Oda (1995) tube grafting has been adopted as the primary method for vegetable grafting on the farm as it can be easily carried out with small healing chambers with typical success rates ranging from 85 to 90 percent. The use of this cultural technique is mainly carried out for intensive cropping systems like greenhouse and tunnel production. This method is especially popular for vegetable production in the orient, and the number of vegetables in 1998 was estimated to be 540 million transplants in Korea and 750 million in Japan (Lee and Bang, 1998).

The first grafts in the early 20th century were made in order to diminish attacks by infectious organisms, such as *Fusarium oxysporum* on watermelons. Furthermore, many researchers are looking to utilize specific rootstocks as an alternative to methyl bromide-a soil fumigant that has been widely used until recently. Grafting has been highly effective at overcoming (Rivero and Ruiz, 2003) abiotic sources of stress, such as soil salinity, temperature extremes, and excessive soil moisture. Grafting has also been utilized to reduce the effects of flooding in areas where a wet season may occur (Black *et al*., 2003).

Many of the most economically important vegetable crops like tomato, squash, cucumber, and watermelon are highly sensitive to thermal stress in the roots throughout vegetative development and reproduction. Whether using rootstock tolerant of hot or cold temperatures, the use of temperature tolerant rootstocks often leads to the extension of the growing season in either direction, resulting in better yield and economic stability through the year (Rivero and Ruiz, 2003). Although the vegetable grafting is typically associated with reduction of disease or abiotic stress, yield is often increased without the presence of these identified sources of stress.

Grafting can take place on a number of crops. However, because of the added expense, it is typically associated with melons, cucurbits, and members of the Solanaceae family such as eggplant and tomato. Tomato grafting became popular in the 1960s as a way to reduce certain diseases caused by soil borne plant pathogens such as *Ralstonia solanacearum.* Currently, however, grafting is used to offer not only protection from certain diseases, but also tolerance to abiotic stress like flooding, drought, and salinity (Rivero and Ruiz, 2003).

Core (2005), suggested that grafting is often done for non -woody and vegetable plants tomato, cucumber, eggplant and watermelon. Tomato grafting is very popular in Asia and Europe, and is gaining popularity in the United States. The main advantage of grafting is for disease-resistant rootstocks. Plastic tubing can be used to prevent desiccation and support the healing at the graft/scion interface.

Grafting of chile peppers (*Capsicum annuum* L.) is a recent practice where *C. annuum* scions are grafted onto *C. annuum* rootstocks that have soil borne disease and nematode resistance (Morra and Biloto, 2006). However, research has shown that this technique can be effective against a variety of fungal, bacterial, viral, and nematode diseases (King *et al.*, 2008). Checking the genetic lines of Solonaceous plants, though, it does seem that as eggplants (*Solanum melongena*), are more closely related to potatoes than sweet peppers or chillies (*Capsicum annuum*), they are probably the most likely grafts to work. A graft of

peppers on potatoes would require a match between different genera, whereas those with tomatoes, eggplants and potatoes are between the same genuses. During the past years, the primary objective of horticulture has been to increase yield and productivity. Grafting of woody plants has been common for centuries, but herbaceous grafting has only become popular recently in agricultural systems. The cultivation of grafted vegetable plants began in Korea and Japan at the end of the 1920s when watermelon plants were grafted onto squash rootstock (Kubota *et al*., 2008). Grafting of vegetables is a common practice to control soil borne diseases and nematodes, for both field and greenhouse grown crops (King *et al*., 2008).

Youssef *et al*., (2010) found that high quality is even more important than total yield for attaining competitiveness in modern horticulture due to the beneficial role of vegetables in human diet. This report gives an overview of the recent literature on the effects of grafting on fruit vegetable (Solanaceae and Cucurbitaceae) quality including physical properties, flavor and health-related compounds of the product. The review will conclude by identifying several prospects for future researches aiming to improve the product quality of grafted vegetables. An experiment was conducted by Xiao *et al.* (2011) on effects of grafting on bitter gourd and they found good controlling effect on *phytophthora* blight. Marios and Georgios (2015), suggested that grafting on disease-resistant rootstocks is a growing practice in watermelon cultivation worldwide. Reports on effects of grafting on watermelon fruit postharvest performance are scarce. The current work examined postharvest performance at $25^0$C of four diploid cultivars grown non-grafted or grafted onto three *Cucurbita maxima* × *C. moschata* rootstocks).

There are a variety of methods for grafting vegetable crops. Cleft grafting occurs when a V-shape is cut into the rootstock and a complementing wedge-shaped scion is inserted. The graft is then held with a small clip until healing occurs (Oda, 1999). Nutrient uptake for the macronutrients, such as phosphorus and nitrogen, were enhanced by grafting (Ruiz and Romero, 1999). Research has

shown that possible mechanisms for increased yield are likely due to increased water and nutrient uptake among vigorous rootstock genotypes. Conductance through the stoma was improved in tomato plants when grafted onto vigorous rootstock (Fernandez-Garcia, 2002).

Approach grafting involves notching opposing sides of the stems of the rootstock and scion, and then using a clip to hold the stems together while they fuse. Once the graft has healed, the original scion is then cut off of the desired rootstock and the unused rootstock is detached from the scion (Lee, 2003). Since this time, this technique has spread throughout Asia and Europe. Currently, 81% of Korean and 54% of Japanese vegetable cultivation uses grafting (Rivero and Ruiz, 2003). In addition, grafted vegetables can produce higher yields and have improved tolerance to environmental stresses, soil salinity, and low soil temperatures (Edelstein, 2004). This technique has moved to the Mediterranean region as well, where the use of grafting has been proposed as a major component of an integrated management strategy for managing soil borne disease and increasing crop productivity.

Micrografting is a new technique that has been recently integrated into micropropagation production for hybrid tomato. This method uses micropropagated scion shoots that grafted onto 3-week-old rootstock seedlings (Grigoriadis *et al*., 2005). Grafted tomato transplant production has increased in Spain from less than one million plants in 1999-2000 to over 45 million plants in 2003-2004. Grafted tomato is also cultivated in France and Italy, and over 20 million tomato plants were grafted in Morocco in 2004 as a way to reduce soil born disease and increase crop production (Besri, 2005). In tomatoes, increases in fruit yield are typically the results of increased fruit size (Pogonyi *et al*., 2005). The most common commercial technique for grafting tomato is tube grafting. Tube grafting takes place when the scion and rootstock are severed as seedlings and reattached with a small, silicone tube or clip (Rivard and Louws, 2006). This technique has been highly effective as it can be carried out when plants are very small, thereby eliminating the need for large healing chambers while increasing

the output. Grafting tomatoes with tolerant rootstocks has been highly effective at producing saline tolerant plants. Research indicates that several rootstocks prevent the translocation of sodium and chloride into the shoot (Leonardi and Giuffrida, 2006).

According to Kubota (2007), more than 40 million grafted tomato seedlings are estimated to be used annually in North American greenhouses. Tomato Grafting has been utilized worldwide in Asia and Europe for greenhouse and high tunnel production and is gaining popularity in the United States (Kubota *et al.*, 2008). Typically, stock or rootstock are selected for their ability to resist infection by certain soil borne pathogens or their ability to increase vigor and fruit yield. The scion of the grafted tomato represents the upper portion of the plant and is selected for its fruit quality characteristics. There are several methods for grafting tomatoes and they have certain advantages and disadvantages. Once the grafts are made, the plants are moved into a chamber or environment with high relative humidity (>90%) and low light levels to reduce water stress in the scion while the graft union forms.

Based on a report published in, www.businessdailyafrica.com, grafted vegetables are created when the top part of one plant (the scion) is attached to the root system of a separate plant (the rootstock). The rootstock contributes vigor and disease resistance while the scion is chosen for fruit flavor and quality. Grafting requires same thickness of the tomato and the potato stems. Fertilization with a water soluble fertilizer in every two weeks is required. New shoots should be trimming away that come from the potato plant on a regular basis. These will grow quickly and rob the tomato plant from valuable nutrients. Successful grafting requires placing the vascular cambia of both the rootstock and scion in close contact and then bind the scion and rootstock with a rubber band, tape, staples, string or wax. Over the next few weeks, the scion and rootstock fuse their internal tissues and grow thickened scar tissue around the graft. First, both plants kill and wall off damaged cells. Meanwhile, callus cells in the vascular cambia proliferate and cement themselves together with sticky proteins, forming a living

link between scion and rootstock known as the “callus bridge.” Callus cells also provide temporary links between the primary vascular tissues in the scion and rootstock the xylem, which transports water, and the phloem, which carries sugars. Eventually, the vascular cambia builds brand new xylem and phloem that unite scion and rootstock into a single functional organism (Anonymous, 2013b).

### 2.5. Compatibility of cells

Compatibility is one of the four essential criteria for successful grafting. Compatibility is defined as a sufficiently close genetic (taxonomic) relationship between stock and scion for a successful graft union to form, assuming that all other factors (technique, temperature, etc.) are satisfactory. A comprehensive survey of the taxonomic limits of graft compatibility has been published by Nelson (1968). According to Heslop-Harrison (1975) Tissue compatibility or incompatibility in plants can be regarded as a physiological tolerance or intolerance, respectively, between the protoplasts of different cells. Although substantial work has been done on reproductive tissue compatibility, such as pollen-stigma interactions little attention has been focused on the mechanisms of vegetative compatibility/incompatibility in plants. Prominent examples involving such vegetative compatibility responses include stem and root grafts, protoplast fusions, mycorrhizal associations, and the interactions of a parasitic vascular plant or of certain epiphytes with a host plant.

A more recent compilation is cited by Andrews and Marquez (1993). Quince (*Cydonia oblonga*) is sometimes used as a dwarfing rootstock for pear, but only certain pear (*Pyrus communis*) cultivars are dirctly compatible with quince. For example, the pear cultivars Old Home, Anjou, Comice, Hardy, Gorham, Flemish Beauty and others are all compatible with quince, but the cultivars Bartlett, Bosc, Seckel, Winter Nelis, and others are not (Lombard and Westwood, 1987).

Kumer *et al*. (2013); found that compatibility of stock and scion for grafted plants to unite and grow successfully, the combined plant parts (stock and scion) should be compatible with each other. Closely related plants have a good chance of

forming a union, while those remotely related have little or no chance. Plants in the grass family and other monocotyledonous plants cannot be grafted or budded, so they are outside the compatibility pyramid. Conifers and other flowering plants, as well as many herbaceous and woody plants, can be grafted. The highest success in grafting or budding is achieved by grafting plants within or between clones.

# CHAPTER III
# MATERIALS AND METHODS

This chapter explains the information concerning methodology that was used in leading out the experiment. It covers up a brief description of location of the experiment, planting materials, characteristics of climate and soil, seed bed preparation, layout and design of the experiment, land preparation, manuring and fertilizing, transplanting of seedlings, intercultural operations, harvesting, data collection procedure and statistical analysis procedure which are presented as follows:

## 3.1 Experimental site

The experiment was conducted at the horticulture farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during the period from November 2014 to April 2015. The location of the experimental site was 23°74' N latitude and 90°35' E longitude with an elevation of 8 meter from sea level in Agro-ecological zone of "Madhupur Tract" (AEZ-28) (Anonymous, 1988). The experimental site is shown in the map of AEZ of Bangladesh in Appendix I.

## 3.2 Planting materials

A total of three genotypes of potato and two genotypes of tomato were used to make three grafting combination. and three different dose of fertilizer and two different seedlings age of tomato are confined in this experiment. The three potato varieties were collected with a courtesy of Bangladesh Agricultural Development Corporation (BADC), Dhaka and the two tomato varieties were collected from Plant Genetic Resource Centre (PGRC) at Bangladesh Agricultural Research Institute (BARI), Gazipur. The name and origin of these genotypes are included in Table 1.

### 3.3 Climate and soil

The experimental area under the sub- tropical climate that is characterized by less rainfall associated with plenty of sunshine and moderately low temperature during rabi season (October-March). The farm belongs to sandy loam in texture, shallow red brown terrace soils under Tejgaon series. Soil pH ranged from 6.0-6.6 and had organic matter 0.84%. The land was above flood level and sufficient sunshine was available during the experimental period. Weather information and physicochemical properties of the soil are presented in Appendix II and Appendix III, respectively.

**Table 1. Name and place of collection of tomato and potato genotypes used in the study**

| Sl. No. | Genotypes | Name/Acc. No. (BD) | Place of collection |
|---|---|---|---|
| 1 | $T_1$ | BARI Tomato 2 | PGRC, BARI |
| 2 | $T_2$ | BARI Tomato 11 | PGRC, BARI |
| 3 | $P_1$ | Daimant | BADC |
| 4 | $P_2$ | Cardinal | BADC |
| 5 | $P_3$ | Asterix | BADC |

PGRC = Plant Genetic Resource Centre, BARI = Bangladesh Agricultural Research Institute, BADC= Bangladesh Agricultural Development Corporation

### 3.4 Land preparation

The experimental plots were ploughed, well prepared, brought into a good tilth and raised the nursery bed, applied the recommended dose of fertilizers according to the fertilizer dose of treatment mention. Weeds and other stubbles were removed carefully from the experimental plot and leveled properly. The final land preparation was done on November 20, 2014.

### 3.5 Design and layout of the experiment

The experiment was laid out and evaluated under field condition during Rabi 2014-15 in Randomized Complete Block Design (RCBD). Five genotypes were used in the study. Three fertilizer doses were applied and two seedling age of tomato were used. The experiment was laid out in three replications. Plant to

plant spacing was 40 cm and the plot size was 0.85m × 1.6 m. The date of grafting was 22nd November 2014.

### 3.6 Seed bed preparation and raising of tomato seedling

Tomato seed was sown twice for producing 25 days and 35 days' seedlings in the seedbed on October 23, 2014 and November 2, 2014, respectively. Seeds were treated with Bavistin for 5 minutes before sowing. Seedlings of all genotypes were raised in seedbeds in the Sher-e-Bangla Agricultural University, Dhaka-1207 horticulture farm. Seeds were sown in broadcast sowing in separate seedbed and thinning out as required, beds were watered regularly. Seedlings were raised using regular nursery practices. Required cultural practices were done before and after sowing the seeds. Seven days old seedlings were transferred into polybags for hardening. Raising of two tomato genotypes seedlings in the seedbed, hardening in polybags and two varieties of tomato seedling is shown in Plate 1.

### 3.7 Raising of potato seedlings

The tubers were cut in a half with at least two eyes and sown in polybags. Necessary intercultural operations were provided as and when required. Growing of potato seedling in the polybags are shown in Plate 1.

### 3.8 Grafting

Tomato seedlings aged 15 days and 25 days, raised in the polybags were grafted on potato plant in the polybags on December 23, 2014. Cleft grafting was done for producing pomato plant. After grafting potato and tomato plant, grafted plant store for 3-4 days in the shaded place for hardening. The grafted seedlings were watered regularly to make a firm relation with scion - root stock and soil to stand along (Plate 2). The grafting between potato and tomato are performed in different combination and presented in Table 2.

### 3.9 Application of manure and fertilizers

Total cow dung and triple super phosphate (TSP) were applied in the field during final land preparation according to the fertilizer treatment mention in

**Plate 1. Different steps of raising tomato and potato seedlings A. BARI tomato 2 (25 days); B. BARI tomato 11 (25 days); C. BARI tomato 2 (35 days); D. BARI tomato 11 (35 days); E. Diamant; F. Cardinal; G. Asterix**

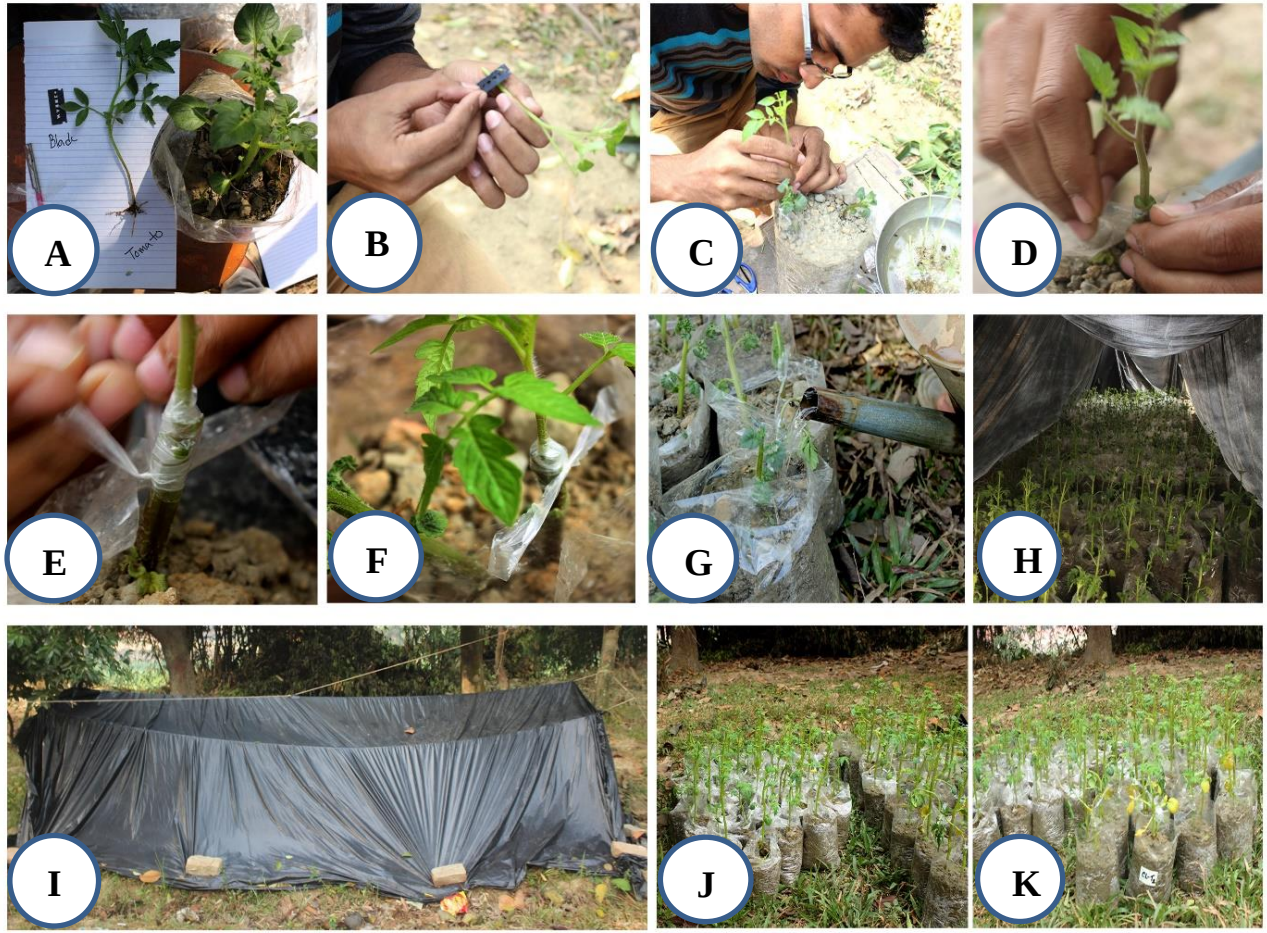


**Plate 2. Different steps of grafting between tomato and potato seedlings and hardening. A. Grafting accessories; B. V-shaped cut of scion; C. Attach the scion with root stock; D. tying of grafted joint; E. Fixed joint; F. Complete grafted pomato seedlings; G. Watering after grafting; H. Hardening of seedling in shed; I. Hardening shed tent; J. Established seedling (Daimant, Cardinal) K. Astarix**

**Table 2. Grafting Combination**

| Potato genotype | Tomato genotype | Grafting Combination | Grafted genotype |
|---|---|---|---|
| P1 | T1 | P1T1 | G1 |
| | | P2T1 | G2 |
| | | P3T1 | G3 |
| P2 | T2 | P1T2 | G4 |
| P3 | | P2T2 | G5 |
| | | P3T2 | G6 |

experiment. After three weeks of transplanting, half urea and half muriate of potash (MOP) were applied in the field. Remaining urea and muriate of potash (MOP) were applied after five weeks of transplanting. Doses of manure and fertilizers used in the study are presented in Table 3.

**Table 3. Doses of fertilizer according to treatment used in the study**

| Fertilizer Name | Recommended Dose (kg/ha) | | |
|---|---|---|---|
| | Treatment (FR1) | Treatment (FR2) | Treatment (FR3) |
| **Urea** | 300 | 360 | 390 |
| **TSP** | 200 | 240 | 280 |
| **MoP** | 220 | 262 | 312 |
| **Gypsum** | 100 | 120 | 140 |
| **Cowdung** | 10000 | 12000 | 13000 |

### 3.10 Intercultural operations

After 10 days of transplanting when the grafter seedlings were well established they were earthen up uniformly. After 35 days of grafting second earthen up was done. First weeding was done uniformly in all the plots. Second weeding was done after 20 days of the first one. Mechanical support was provided to the growing plants by bamboo sticks to keep them erect. During early stages of growth, pruning was done by removing some of the lateral branches to allow the plants to get more sunlight and to reduce the self-shading and incidence of increased insect infestation. Staking, pesticide application, irrigation and after-care were also done as per requirement (Plate 3).


**Plate 3. Different steps of intercultural operation and field visit A. Experimental plot; B. Field visit by supervisor; C. Side shot and branch cutting; D. tying of plant with stock; E. Complete stocking F. flowering and fruit setting**

### 3.11 Harvesting and processing

All of the tomato varieties used in this experiment was indeterminate types. So, harvesting continued for about one and half month because fruits of different lines matured progressively at different dates and over long time. The potatoes were harvested after several successful harvestings of tomato. Harvesting was started from March 7, 2015 and completed by April 15, 2015. Harvesting and processing are shown in Plate 4.

### 3.12 Data collection

Three plants were selected from each unit plot for assumption of yields of plots, which was recorded plot wise. Data were recorded in respect of the following parameters to assess plant growth yield attributes and yields (Plate 5).

#### 3.12.1 Days to first flowering

First flowering was observed and it was continued when all plots bloomed completely.

#### 3.12.2 Days to 50% flowering

The number of days was counted from the date of sowing to 50 per cent of plants flowered.

#### 3.12.3 Plant height (cm)

Plant height at last harvest was measured from sample plants in centimeter from the ground level to the tip of the longest stem of five plants and mean value was calculated.

#### 3.12.4 Number of leaves per plant

The number of leaves counting from the main stem above the ground was recorded at 15 days' interval and completed counting at 70 days after transplanting.

#### 3.12.5 Branches per plant

The number of branches arising from the main stem above the ground was recorded at 70 days after transplanting.

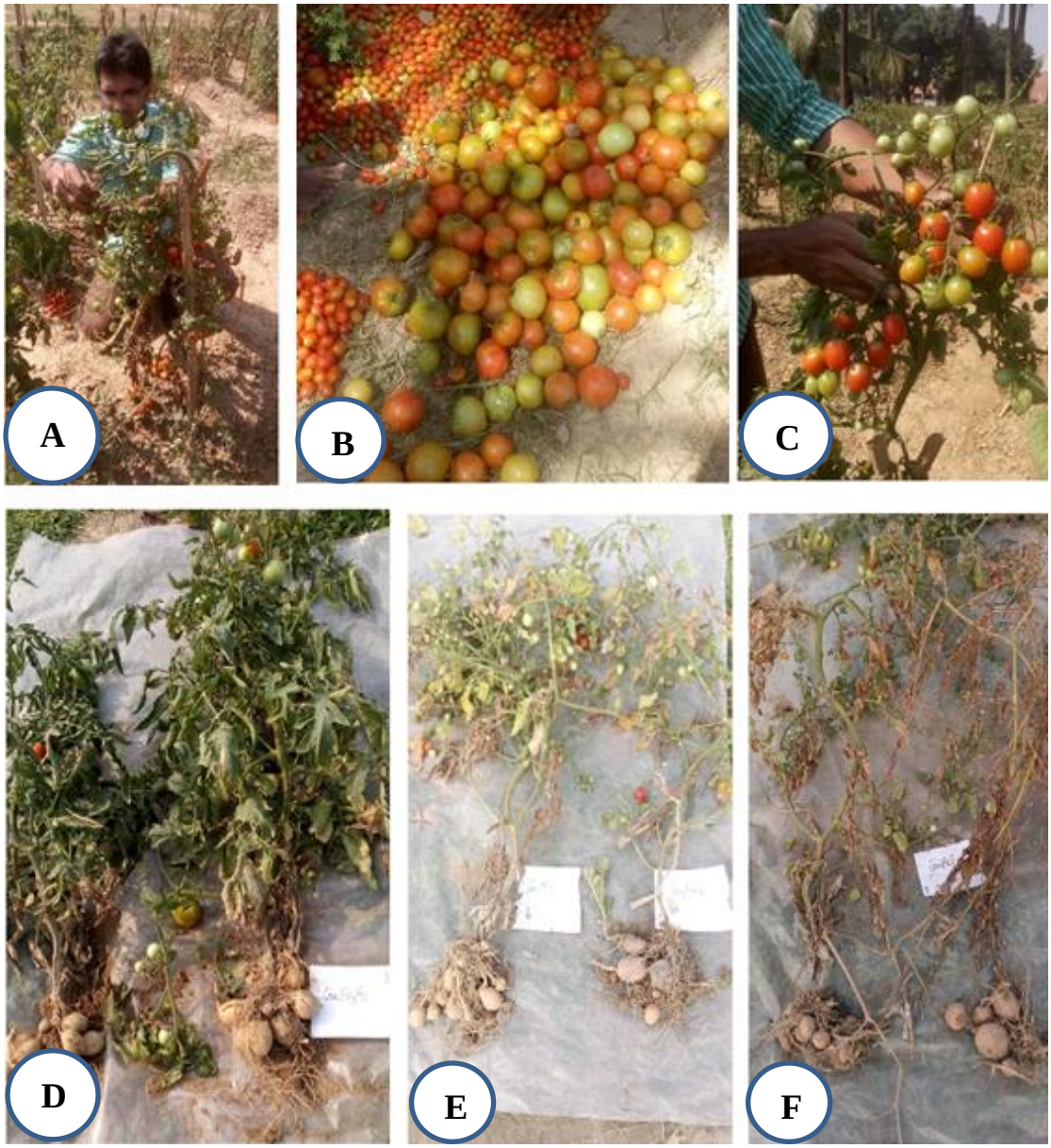


**Plate 4. Different steps of fruit and tuber harvesting. A. BARI tomato 11 harvesting; B. BARI tomato 2 harvesting; C. Fruit counting and harvesting; D. Diamant harvest; E. Cardinal harvest; F. Asterix harvest**


**Plate 5. Different steps of data collection. A. Branch counting; B. Flower counting; C. Data entry in register; D. Weighing tuber yield.**

### 3.12.6 Number of clusters per plant

Number of clusters per plant was recorded at the time of harvesting.

### 3.12.7 Number of fruits per cluster

Three clusters in each plant were taken at random and the number of fruits in each cluster was counted and then averaged the number of fruits per cluster.

### 3.12.8 Number of fruits per plant

The number of fruits/plant was counted from the sample plants throughout the growing period and the average number of fruits produced/plant was recorded.

### 3.12.9 Fruit length (cm)

The length of fruit was measured with a meter scale from stalk end to blossom end of 10 selected marketable fruits from each plot and there average was taken and expressed in centimeter (cm).

### 3.12.10 Fruit diameter (cm)

Diameter of fruit was measured at the middle portion of 10 selected marketable fruit from each plot with a digital calipers-515 (DC-515) and average was taken and expressed in centimeter (cm).

### 3.12.11 Single fruit weight (g)

The three fruit are collect for taking weight from the individual plant then took average data for the single fruit weight expressed in gram (g).

### 3.12.12 Fruit yield per plant (kg)

The weight of individual fruit was measured with a digital weighing machine from 10 selected marketable fruits from each selected plot and their average was taken and expressed in kilogram (kg) per plant.

### 3.12.13 Total yield of tomato (ton/ha)

The total yield of tomato was measured by multiplying the average yield of individual plant and the total area of the land given in hectare. The yield was then converted in ton/ha.

### 3.12.14 Number of tuber per plant

The total number of tuber was counted from the selected pomato plants and their average was taken as the number of tubers per plant.

### 3.12.15 Single tuber weight (g)

The three tubers were collect for taking weight from the individual plant then took average data for the single fruit weight expressed in gram (g).

### 3.12.16 Tuber yield per plant (kg)

The weight of tuber from pomato plant was recorded from the three labeled plants of each experimental plot. Total tuber yield per plant was expressed in kilogram (kg) per plant.

### 3.12.17 Total yield of tuber (ton/ha)

The total yield of tuber was measured by multiplying the average yield of individual plant and the total unit area of the land given in hectare and expressed in ton/ha.

## 3.13 Statistical analysis

The collected data were statistically analyzed. Univariate analysis of the individual character was done for all characters under study using the mean values (Singh and Chaudhury, 1985) and was estimated using MSTAT-C computer programme. Duncan's Multiple Range Test (DMRT) was performed for all the characters to test the differences between the means of the genotypes. Mean, range and co-efficient of variation (CV %) were also estimated using MSTAT-C.

# CHAPTER IV
# RESULTS AND DISCUSSION

The experimental work was accomplished for the evaluation of six pomato grafted genotypes to different fertilizer and seedlings age of tomato treatments based on agromorphogenic traits. In this experiment three potato genotypes Diamant (P1), Cardinal (P2) and Asterix (P3) and two tomato genotypes BARI tomato-2 (T1) and BARI tomato-11 (T2) were used for grafting in all possible combinations. The grafted combinations are mentioned here as genotypes such as genotype G1, G2, G3, G4, G5 and G6 are the grafted combination such as P1T1, P2T1, P3T1, P1T2, P2T2 and P3T2 respectively. These grafted genotypes were obtained using two seedling age of tomato for grafting *viz*. 25 days (S1) and 35 days (S2). These grafted genotypes were grown under three fertilizer treatments FR1, FR2 and FR3 mentioned in chapter III. Analysis of cell compatibility was performed based on yield and yield components. In this chapter the findings of executed experimental work have been put forwarded and discussed. Data have been presented in table(s) for easy discussion, comprehension and understanding.

## 4.1 Analysis of variance

Analyses of variance showed the presence of significant variation among the tested genotypes for all the characters studied viz. days to first flowering, days to 50% flowering, plant height, branches per plant, clusters per plant, fruits per cluster, fruits per plant, tuber per plant, fruit length, fruit diameter fruit yield per plant (kg), tuber yield per plant and total yield per plant (Appendix IV). Similar finding were observed by Naz *et al*. (2013) and Reddy *et al*. (2013) in tomato. The variation due to replication was non-significant for all the traits.

## 4.2 Mean Performance

The mean value of all genotypes, fertilizer and seedling age interaction for each character is shown in different yield contributing characters. Performance of the genotypes is described below for each character.

### 4.2.1 Days to first flowering

From the result of the experiment it was observed that statistically significant variation was found among the pomato genotypes in respect of days to first flowering of pomato seedlings (Appendix IV). The maximum days to first flowering was found 37.94 days in both G1 and G2 which were statistically similar to G3 (37.83), G4 (37.78), G5 (37.72) and G6 (37.83) (Table 4). The mean of days to first flowering was 37.84 (Table 5). It had a range of 37.72 to 37.94 days. The result showed that G1, G2 was the late flowering genotype and G5 (37.72) was the early flowering genotype. For fertilizer treatment, it was observed that all the genotypes were statistically similar where the highest value for days to first flowering was observed in FR2 (37.97) and the lowest value was observed in FR1 (37.78) which was exactly similar to FR3 (37.78). In this experiment the mean value in three different fertilizer treatments was (37.84) (Table 5). From the seedlings age treatment, days of first flowering was shown the highest value in S2 (38.13) (Table 6) and the lowest value in S1 (37.55), which were significantly different from each other.

### 4.2.2 Days of 50% flowering

Days of 50% flowering was found the maximum in G4 (58.44) which was statistically similar to G1 (58.06), G3 (57.50) and G6 (57.56), (Table 4). Shashikanth *et al.* (2011) found the range of mean values was the maximum for this character which supported this finding. Minimum days to 50% flowering was observed in G2 (56.89) (Table 5). The mean of days to 50% flowering was 56.58 days. The genotype G2 was the earliest to flower at 56.89 days while G4 were late to flower (58.44 days) (Appendix IV). In terms of fertilizer application for days of 50% flowering, all treatments showed the statistically similar result where the highest value was FR3 (57.64) and the lowest value was FR2 (57.50). The mean of these three treatments was (57.58) (Table 5). The maximum days to 50% flowering was found in seedling age S1 (57.79) and the minimum was in S2 (57.37) (Table 6) which were statistically similar.

**Table 4. Performance of pomato genotypes on days to first flowering, days to 50% flowering, plant height and number of leaf per plant[Y].**

| Genotype[X] | Days to first flowering | Days to 50% flowering | Plant Height (cm) | No. of leaf per plant |
|---|---|---|---|---|
| G1 | 37.94 a | 58.06 ab | 97.50 b | 25.39 bc |
| G2 | 37.94 a | 56.89 c | 97.33 b | 24.22 c |
| G3 | 37.83 a | 57.50 abc | 95.00 c | 24.78 c |
| G4 | 37.78 a | 58.44 a | 111.50 a | 28.17 a |
| G5 | 37.72 a | 57.06 bc | 112.00 a | 26.67 abc |
| G6 | 37.83 a | 57.56 abc | 111.80 a | 27.72 ab |
| CV (%) | 1.29 | 1.02 | 0.49 | 5.78 |
| $LSD_{0.05}$ | 0.80 | 0.96 | 0.83 | 2.46 |

[X]Six pomato genotypes coded from G1 to G6

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 5. Performance of fertilizers on days to first flowering, days to 50% flowering, plant height and number of leaf per plant[Y].**

| Fertilizer[X] | Days to first flowering | Days to 50% flowering | Plant Height (cm) | No. of leaf per plant |
|---|---|---|---|---|
| FR1 | 37.78 a | 57.61 a | 104.60 a | 24.81 b |
| FR2 | 37.97 a | 57.50 a | 102.80 b | 26.00 ab |
| FR3 | 37.78 a | 57.64 a | 105.20 a | 27.67 a |
| CV (%) | 1.29 | 1.02 | 0.49 | 5.78 |
| $LSD_{0.05}$ | 0.80 | 0.96 | 0.83 | 2.46 |

[X]Three fertilizers doses coded from FR1 to FR3

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 6. Performance of seedling age on days to first flowering, days to 50% flowering, plant height and number of leaf per plant[Y].**

| Seedling age[X] | Days to first flowering | Days to 50% flowering | Plant Height (cm) | No. of leaf per plant |
|---|---|---|---|---|
| S1 | 37.55 b | 57.79 a | 104.44 a | 26.46 a |
| S2 | 38.13 a | 57.37 a | 103.94 a | 25.85 a |
| CV (%) | 1.29 | 1.02 | 0.49 | 5.78 |
| $LSD_{0.05}$ | 0.80 | 0.96 | 0.83 | 2.46 |

[X]Two different seedling age of tomato coded from S1 to S2

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

### 4.2.3 Plant height (cm)

It was observed from the result of the experiment that plant height showed statistically significant variation among six pomato genotypes (Appendix IV). The tallest plant was obtained from G5 (112.00 cm) which was statistically similar to G4 (111.50 cm) and G6 (111.80 cm). The minimum plant height was found in genotype G3 (95.00 cm) (Table 4). The grand mean plant height recorded was 104.18 cm. Maximum ranges of mean values were also observed in tomato by Shashikanth *et al.* (2011). In respect of the fertilizer treatment of plant height, FR1 and FR3 showed statistically significant variation (104.6 cm and 105.2 cm respectively) followed by FR2 (102.8 cm) (Table 5). For seedling age, both showed the statistically similar result (Table 6).

### 4.2.4 Number of leaf per plant

The highest number of leaves per plant were observed in G4 (28.16) which were statistically similar to G5 (26.67) and G6 (27.72). The lowest value was observed in G2 (24.22) which was statistically similar to G1 (25.39) and G3 (24.78). The mean value of the number of leaves per plant was 27.72. The maximum mean no. of leaf per plant was 28.17, whereas the minimum no. of leaf per plant was 24.11(Table 4). In case of fertilizer treatment, no. of leaves per plant was the highest in FR3 (27.3) treatment (Table 5). The lowest no. of leaf per plant was found in FR1 (24.8) treatment. In terms of the seedling age of the tomato for grafting time, the highest number of leaves per plant (26.46) was observed when grafted with S1seedling age and the lowest no. of leaves per plant (25.85) was observed when grafted with S2 seedling age (Table 6).

### 4.2.5 Number of branch per plant

Number of branches per plant was found the highest in G4 (5.11) which was statistically similar to G1 (4.27) and G5 (4.72) (Table 7).The lowest value for branches per plant was observed in G2 (3.72) which was statistically similar to G3 (3.77). From Jahanara, (2015) findings of pomato, the highest branches per plant was observed in BARI Tomato-11 (12.7) and the lowest in BARI Tomato-2 (5.59) and control potato highest and lowest branches per plant were

observed in Asterix (8.22) and Pakri Alu (Tel) (3) respectively. For the fertilizer treatment on no. of branch per plant, the three fertilizer treatments showed significant variation. The maximum value was found when treated with FR1 (4.58) which showed similarity with FR3 (4.52) and the minimum was found with FR2 (4.139). (Table 8). Seedlings age treatment was showed the average performance for the no. of branches per plant. The maximum number was found when grafted with S1 (4.51) (Table 9) and the minimum was found with S2 (4.31) but they were statistically similar.

### 4.2.6 Number of cluster per plant

Clusters per plant were found highest in grafted genotype G4 (16.22), which were statistically similar to grafted genotype G5 (16.00) and G6 (15.78) (Table 7). The lowest clusters per plant was found in G3 (5.00) which was statistically similar to G1 (5.05) and G2 (5.16). The average value of clusters per plant was estimated (10.53). According to Jahanara, (2015), the highest clusters per plant were observed in BARI Tomato-11 (12) and the lowest in BARI Tomato-2 (7.67). The no. of cluster per plant showed significant variation among the three different fertilizer treatments (Appendix IV). The highest was observed when treated with FR3 (10.64) and the lowest was with FR2 (10.44) (Table 8). Seedlings age of tomato during grafting showed statistically similar result for this character and found the maximum value with S1 (10.68) and the minimum value with S2 (10.38) (Table 9).

### 4.2.7 Number of fruit per cluster

Number of fruit per cluster was found the highest in grafted genotype G5 (15.22) and the lowest in G1 (3.50) (Table 7). The fertilizer treatment on no. of fruit per cluster was observed and found that the values were statistically similar between the highest FR2 (9.41) and the lowest FR1 (9.27) (Table 8). The two seedling age of tomato of grafted genotypes also showed statistically similar result which was the maximum value with S1 (9.79) and the minimum with S2 (8.87) (Table 9).

**Table 7. Performance of pomato genotypes on number of branch per plant, number of cluster per plant, number of fruit per cluster and number of fruit per plant[Y].**

| Genotype[X] | Number of branch per plant | Number of cluster per plant | Number of fruit per cluster | Number of fruit per plant |
|---|---|---|---|---|
| G1 | 4.27 ab | 5.05 b | 3.50 e | 15.67 b |
| G2 | 3.72 b | 5.16 b | 4.00 d | 16.78 b |
| G3 | 3.77 b | 5.00 b | 4.50 c | 18.11 b |
| G4 | 5.11 a | 16.22 a | 14.33 b | 232.80 a |
| G5 | 4.88 ab | 16.00 a | 15.22 a | 244.70 a |
| G6 | 2.72 b | 15.78 a | 14.44 b | 228.00 a |
| CV | 15.53 | 8.17 | 3.25 | 9.48 |
| $LSD_{0.05}$ | 1.12 | 1.40 | 0.49 | 19.45 |

[X] Six pomato genotypes coded from G1 to G6

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 8. Performance of fertilizers on number of branch per plant and number of cluster per plant, number of fruit per cluster and number of fruit per plant[Y].**

| Fertilizer[X] | Number of branch per plant | Number of cluster per plant | Number of fruit per cluster | Number of fruit per plant |
|---|---|---|---|---|
| FR1 | 4.58 a | 10.53 a | 9.27 a | 129.50 a |
| FR2 | 4.13 a | 10.44 a | 9.41 a | 123.80 a |
| FR3 | 4.52 a | 10.64 a | 9.30 a | 124.60 a |
| CV | 15.53 | 8.17 | 3.25 | 9.48 |
| $LSD_{0.05}$ | 1.12 | 1.40 | 0.49 | 19.45 |

[X]Three fertilizers doses coded from FR1 to FR3

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 9. Performance of seedling age on number of branch per plant and number of cluster per plant, number of fruit per cluster and number of fruit per plant[Y].**

| Seedling age[X] | Number of branch per plant | Number of cluster per plant | Number of fruit per cluster | Number of fruit per plant |
|---|---|---|---|---|
| S1 | 4.51 a | 10.68 a | 9.79 a | 133.14 a |
| S2 | 4.31 a | 10.38 a | 8.87 a | 118.85 a |
| CV | 15.53 | 8.17 | 3.25 | 9.48 |
| $LSD_{0.05}$ | 1.12 | 1.40 | 0.49 | 19.45 |

[X]Two different seedling age of tomato coded from S1 to S2

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

### 4.2.8 Number of fruit per plant

G5 (244.7) performed the highest fruits per plant which was statistically similar to G4 (232.80) and to G6 (228.00) (Table 7). The lowest number of fruits per plant was found in G1 (15.67) which was statistically similar to G2 (16.78) and to G2 (16.78) (Table 7). Fertilizer treatments influenced the number of fruit per plant. The maximum fruits were obtained with fertilizer treatment FR1 (129.50) and the minimum with FR2 (123.80) (Table 8). On the other hand, the seedling age treatment also showed the statistically significant result where the highest no. of the fruit per plant was obtained with seedling age S1 (133.148) and the lowest with S2 (118.85) (Table 9).

### 4.2.9 Fruit length (cm)

The highest fruit length was found in G2 (7.03) and it was statistically similar to G3 (7.02) (Table 10). The lowest fruit length was found in G6 (2.26) which was statistically similar to G4 (2.33) and to G5 (3.39) (Table 11). The fertilizer treatments showed the statistically similar results where the maximum was with FR1 (4.67) (Table 13) which was similar to FR2 (4.63) and the minimum result was wit FR3 (4.48). The seedlings age treatment affected the fruit length. The longest fruit was obtained with S2 (4.61) and the shortest with S1 (4.58) (Table 12).

### 4.2.10 Fruit diameter (cm)

The genotypic effects on the fruit diameter showed the statistically significant results where the maximum diameter of tomato was found in G2 (6.00) which was similar to G1 (5.57) and to G3 (5.75). The minimum diameter was found in G4 (1.99) which was similar to G5 (2.04) and to G6 (2.58) (Table 10). The fertilizer effected the fruit diameter and the maximum was found with FR1 (3.99) and the minimum with FR2 (3.83) (Table 11). The seedlings age also effected the fruit diameter and found maximum diameter with S2 (3.91) and minimum withS1 (3.8) (Table 12).

**Table 10. Performance of pomato genotypes on single fruit length (cm), single fruit diameter (cm), single tomato fruit weight (g), yield of tomato per plant (kg) and total yield of tomato (ton/ha)[Y].**

| Genotype[X] | Fruit length (cm) | Fruit diameter (cm) | Singe fruit weight (g) | Tomato yield per plant (kg) | Total yield of tomato (ton/ha) |
|---|---|---|---|---|---|
| G1 | 6.53 b | 5.57 a | 86.72 a | 1.35 b | 29.94 b |
| G2 | 7.03 a | 6.00 a | 92.39 a | 1.54 a | 34.19 a |
| G3 | 7.02 a | 5.75 a | 91.44 a | 1.65 a | 36.41 a |
| G4 | 2.33 c | 1.99 b | 5.44 b | 1.26 b | 27.78 b |
| G5 | 2.39 c | 2.04 b | 5.38 b | 1.28 b | 28.30 b |
| G6 | 2.26 c | 2.05 b | 5.38 b | 1.21 b | 26.80 b |
| CV (%) | 4.85 | 11.99 | 7.4 | 7.47 | 7.47 |
| $LSD_{0.05}$ | 0.36 | 0.76 | 5.76 | 0.17 | 3.72 |

[X]Six pomato genotypes coded from G1 to G6

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 11. Performance of fertilizers on single fruit length (cm), single fruit diameter (cm), single tomato fruit weight (g), yield of tomato per plant (kg) and total yield of tomato (ton/ha)[Y].**

| FertilizerX | Fruit length (cm) | Fruit diameter (cm) | Singe fruit weight (g) | Tomato yield per plant (kg) | Total yield of tomato (ton/ha) |
|---|---|---|---|---|---|
| FR1 | 4.67 a | 3.99 a | 47.53 a | 1.37 a | 30.30 a |
| FR2 | 4.63 a | 3.83 a | 47.19 a | 1.32 a | 29.16 a |
| FR3 | 4.48 a | 3.88 a | 48.67 a | 1.46 a | 32.24 a |
| CV (%) | 4.85 | 11.99 | 7.4 | 7.47 | 7.47 |
| $LSD_{0.05}$ | 0.36 | 0.76 | 5.76 | 0.17 | 3.72 |

[X]Three fertilizers doses coded from FR1 to FR3

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 12. Performance of seedling age on single fruit length (cm), single fruit diameter (cm), single tomato fruit weight (g), yield of tomato per plant (kg) and total yield of tomato (ton/ha)[Y].**

| Seedlings age[X] | Fruit length (cm) | Fruit diameter (cm) | Singe fruit weight (g) | Fruit yield per plant (kg) | Total yield of tomato (ton/ha) |
|---|---|---|---|---|---|
| S1 | 4.58 a | 3.89 a | 47.29 b | 1.39 a | 30.78 a |
| S2 | 4.61 a | 3.91 a | 48.29 a | 1.37 a | 30.35 a |
| CV (%) | 4.85 | 11.99 | 7.4 | 7.47 | 7.47 |
| LSD0.05 | 0.36 | 0.76 | 5.76 | 0.17 | 3.72 |

[X]Two different seedling age of tomato coded from S1 to S2

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

### 4.2.11 Single fruit weight (g)

Genotypes showed the statistically significant results whereas the maximum was in G2 (92.39) and similar with G3 (91.44) whereas the minimum was G6 (5.3) which was statistically similar with G5 (5.38) (Table 10). The fertilizer effect which showed the statistically similar whereas the maximum result shown on FR3 (48.67) (Table 11) and the minimum result was in FR2 (47.19). The seedlings age also effect the single fruit weight which was no significant but the statistically similar (48.29) (47.29) in S2 and S1respectively (Table 12).

### 4.2.12 Fruit yield per plant (kg)

In this experiment the genotypic treatments effects on fruit yield per plant showed statistically significant results whereas the highest was in G3 (1.65) and statistically similar with G2 (1.54). The lowest was G6 (1.21) and similar with G4 (1.26) and G5 (1.28) (Table 10). The fertilizer treatments effects on the single fruit weight showed statistically similar result where the highest FR3 (1.46) and the lowest was in FR2 (1.32) (Table 11). The seedlings age of the tomato plant during grafting time was nonsignificant (Table 12).

### 4.2.13 Total yield of tomato (ton/ha)

The genotypic effects on the total yield of tomato showed the significant results where the maximum was in G3 (36.41) and statistically similar with G2 (34.19). The minimum results showed in G6 (26.80) and similar with G4 (27.78), G5 (28.30) and G1 (29.94) (Table 10). The fertilizer treatments influence on the yield of the tomato showed statistically significant and the highest value was in FR3 (32.24) and the lowest was in FR2 (29.16) (Table 11). On the other seedlings age treatments were statistically similar (S1, 30.78 and S2, 30.35) (Table 12).

### 4.2.14 Number of tuber per plant

It was observed that the genotype had statistically similar effect on number of potato tubers per plant where the maximum tubers were found in G6 (4.61) the minimum in G1 (3.66) (Table 13). Fertilizer treatment and seedling age also showed statistically effects (Table 14 and Table 15).

### 4.2.15 Single tuber weight (g)

Genotypic effects on single tuber weight influence the statistically significant result (Appendix IV) where the highest was found in G1 (73.33) which was similar to G2 (70.89) and the lowest was found in G3 (63.79) which was similar to G5 (69.22) and to G6 (65.67) (Table 13). Fertilizer treatment influence on single tuber weight which showed the statistically significant results where the highest value was with fertilizer treatment FR3 (78.42) and the lowest was with FR2 (63.65) (Table 14). The seedling age treatment also influence the single tuber weight and the most heavy tuber was found with the seedling age S1 (69.81) and the lightest was with S2 (68.80) (Table 15).

### 4.2.16 Tuber yield per plant (kg)

The maximum potato yield per plant for the influence of the genotype was found in G6 (0.31) similar to G5 (0.31) and G2 (0.30) (Table 13) and the minimum was found in G3 (0.26) similar to G1 (0.27). The fertilizer treatment effect on potato yield per plant which showed the statistically significant result where the maximum yield was obtained with fertilizer treatment FR3 (0.36) and the minimum was with FR1 (0.25) (Table 14). The seedlings treatments show the statistically similar result where the maximum was with S2 (0.30) and the minimum was with S1 (0.28) (Table 15).

**Table 13. Performance of pomato genotypes on number of tuber per plant, single tuber weight (g), yield of tuber per plant (kg) and total yield of tuber (ton/ha)[Y].**

| Genotype[X] | Number of tuber per plant | Single tuber weight (g) | Tuber yield per plant (kg) | Total yield of tuber (ton/ha) |
|---|---|---|---|---|
| G1 | 3.66 a | 73.33 a | 0.27 a | 5.99 a |
| G2 | 4.22 a | 70.89 ab | 0.30 a | 6.62 a |
| G3 | 4.11 a | 63.97 b | 0.26 a | 5.90 a |
| G4 | 4.05 a | 72.78 a | 0.29 a | 6.61 a |
| G5 | 4.50 a | 69.22 ab | 0.31 a | 6.83 a |
| G6 | 4.61 a | 65.67 ab | 0.31 a | 6.97 a |
| CV (%) | 15.06 | 6.24 | 14.92 | 14.79 |
| $LSD_{0.05}$ | 1.03 | 7.04 | 0.07 | 1.56 |

[X]Six pomato genotypes coded from G1 to G6

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 14. Performance of fertilizers on number of tuber per plant, single tuber weight (g), yield of tuber per plant (kg) and total yield of tuber (ton/ha)[Y].**

| Fertilizer[X] | Number of tuber per plant | Single tuber weight (g) | Tuber yield per plant (kg) | Total yield of tuber (ton/ha) |
|---|---|---|---|---|
| FR1 | 3.86 a | 65.86 b | 0.25 b | 5.59 b |
| FR2 | 4.08 a | 63.65 b | 0.26 b | 5.77 b |
| FR3 | 4.63 a | 78.42 a | 0.36 a | 8.11 a |
| CV (%) | 15.06 | 6.24 | 14.92 | 14.79 |
| $LSD_{0.05}$ | 1.03 | 7.04 | 0.07 | 1.56 |

[X]Three fertilizers doses coded from FR1 to FR3

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

**Table 15. Performance of seedling age on number of tuber per plant, single tuber weight (g), yield of tuber per plant (kg) and total yield of tuber (ton/ha)[Y].**

| Seedlings age[X] | Number of tuber per plant | Single tuber weight (g) | tuber yield per plant (kg) | Total yield of tuber (ton/ha) |
|---|---|---|---|---|
| S1 | 4.01 a | 69.81 a | 0.28 a | 6.32 a |
| S2 | 4.37 a | 68.80 a | 0.30 a | 6.66 a |
| CV (%) | 15.06 | 6.24 | 14.92 | 14.79 |
| LSD0.05 | 1.03 | 7.04 | 0.07 | 1.56 |

[X]Two different seedling age of tomato coded from S1 to S2

[Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

### 4.2.17 Total yield of tuber (ton/ha)

Genotypic treatment effects on the total yield of tuber which showed the highest yield in G6 (6.97) similar to G5 (6.83), G4 (6.61) and G2 (6.62). The lowest was in G3 (5.90) which were similar to G1 (5.99) (Table 13). Effect of the fertilizer treatment on total yield of potato showed highest yield with FR3 (8.11) and the lowest yield with FR1 (5.59) (Table 14). The seedling age effected on the total yield of tuber and the highest yield was found with S2 (6.66) and the lowest was with S1 (6.32) (Table 15).

## 4.3. Interaction effects

### 4.3.1 Days to first flowering

Interaction of pomato genotypes and fertilizer treatments affected significantly on days taken to first flowering from transplantation of pomato seedlings (Appendix IV). G3FR3 treatment required the maximum period (39.00 days) which was statistically similar to G1FR1 (38.17 days), G2FR1 (38.17 days), G2FR2 (38.67 days), G5FR1 (38.50 days), and G6FR2 (38.17 days) for first flowering where the minimum from G2FR3 (37.00) which was statistically identical with G3FR1 (37.17), G4FR1 (37.17) and G5FR3 (37.17) (Figure 1, Appendix V). In case of the interaction of pomato genotypes and seedlings age of tomato seedlings treatments showed the significant result on days to first flowering from transplantation of pomato seedlings where G5S2 (38.44 days) showed the highest value and the minimum value showed by G5S1 (37.00 days) (Figure 2, Appendix VIII). In terms of the fertilizers and seedlings age treatments interaction results showed the maximum value by FR3S2 (38.33 days) which was statistically similar to FR2S2 (38.28 days), FR1S1 (37.78 days), and FR1S2 (37.78) where the minimum was FR3S1 (37.22 days) (Figure 3, Appendix XI). The six genotype, three fertilizer and two seedlings age treatment affected significantly the interaction result for days to first flowering. the maximum days required for flowering was G3FR3S2 (39.00 days) and the minimum days required was G5FR3S1 (36.00 days) which was similar to G2FR3S1 (36.00 days) (Table 16).

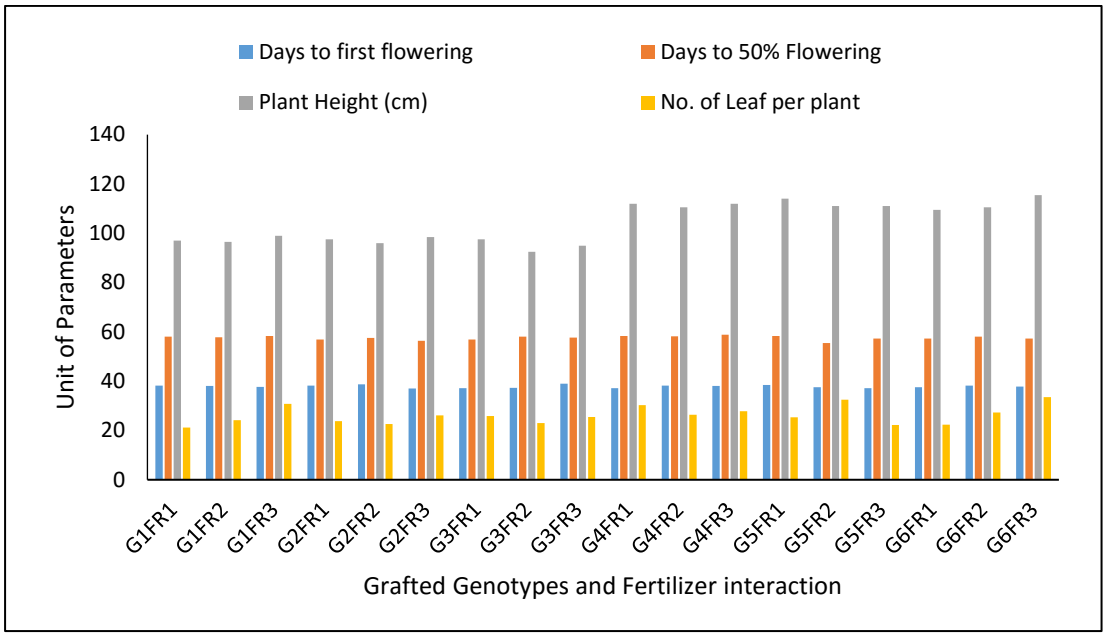


**Figure 1. Interaction effect of pomato genotypes and fertilizer treatments on days to first flowering, days to 50% flowering, plant height and number of leaf per plant.**

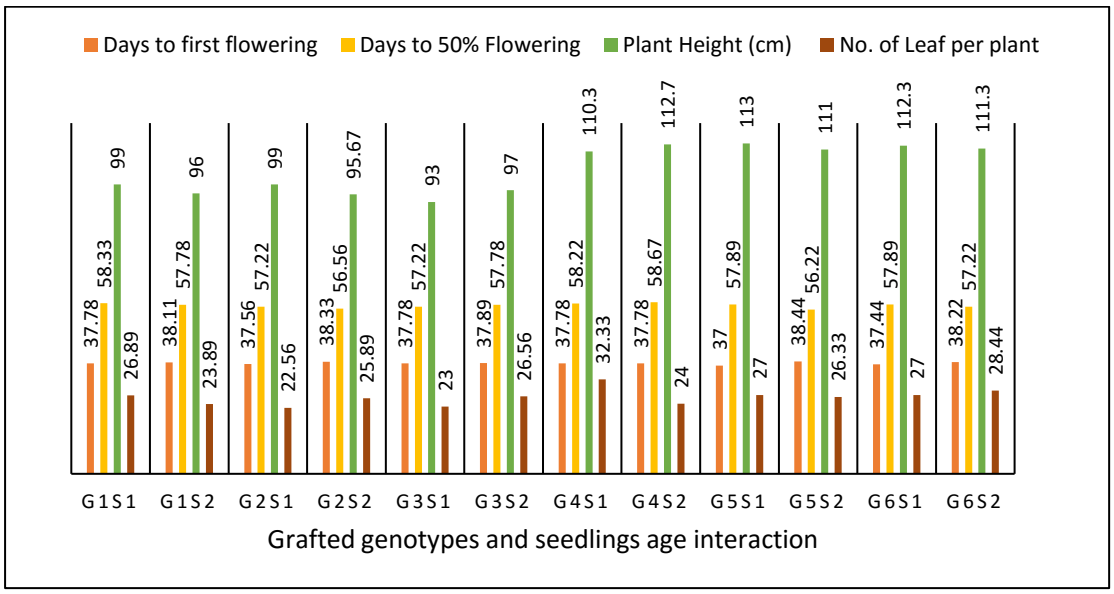


**Figure 2. Interaction effect of pomato genotypes and seedling age treatments on days to first flowering, days to 50% flowering, plant height and number of leaf per plant.**

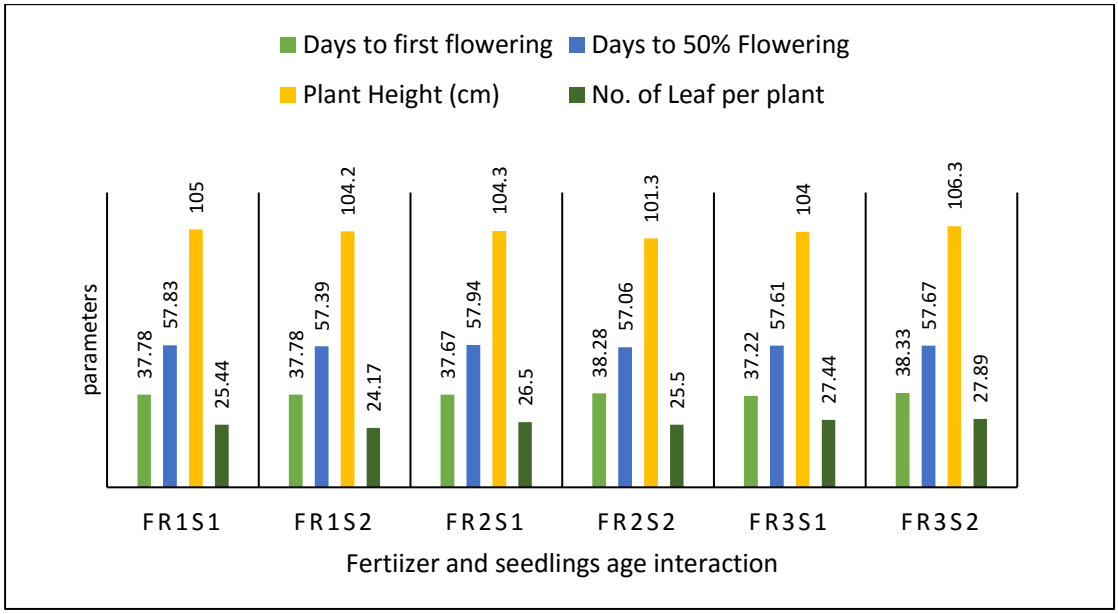


**Figure 3. Interaction effect of fertilizer and seedling age treatments on days to first flowering, days to 50% flowering, plant height and number of leaf per plant.**

### 4.3.2 Days to 50% flowering

It was observed that the interaction of pomato genotypes and fertilizer treatments affected significantly on days taken to 50% flowering from transplantation of pomato seedlings (Appendix IV). The treatment required the maximum period G4FR3 (58.83 days) which was statistically similar to G1FR1 (58.00 days), G1FR2 (57.83 days), G3FR2 (58.00 days), G4FR1 (58.33 days), and G5FR1 (58.33 days) for 50% flowering whereas the minimum from G2FR2 (55.50) which was statistically identical with G2FR1 (56.83), G3FR1 (56.83) (Figure 1, Appendix V). Interaction of pomato genotypes and seedlings age of tomato seedlings treatments showed the significant result on days to 50% flowering from transplantation of pomato seedlings. The treatment G4S2 (58.67 days) showed the maximum value which was statistically similar to G1S1 (58.33 days), G1S2 (57.78 days) and the minimum value was G5S2 (56.22 days) (Figure 2, Appendix VIII). In case of fertilizers and seedlings age treatments interaction, the highest value was obtained from the interaction of FR2S1 (57.94 days) which was statistically similar to FR1S1 (57.83 days), and FR1S2 (57.39) where the minimum was from FR2S2 (57.06 days) interaction (Figure 3, Appendix XI). The six genotype, three fertilizer and two seedlings age treatment interaction affected the result for days to 50% flowering which was statistically significant. The maximum days required for 50% flowering was in G1FR3S1 (59.00 days) identical to G3F2S1 (59.00 days) and G4F3S1 (59.00 days) and the minimum days required in G5FR2S2 (53.00 days) interaction (Table 16).

### 4.3.3 Plant Height (cm)

It was observed from the result of the experiment that plant height showed statistically significant variation among six pomato genotypes interaction with three fertilizers treatments (Appendix IV). The tallest plant was obtained from G6F3 (115.50 cm) whereas the shortest from G3FR2 (92.50 cm) (Figure 1, Appendix V). From the genotypes and seedlings age treatment interaction, the tallest plant was found from G5S1 (113.0 cm), which was statistically

**Table 16. Interaction effect of genotypes, fertilizer and seedling age treatments on days to first flowering, days to 50% flowering, plant height and number of leaf per plant.**

| Treatment | Days to first flowering | Days to 50% flowering | Plant Height (cm) | Number of leaf per plant |
|---|---|---|---|---|
| G1F1S1 | 38.33 ab | 58.00 abc | 98.00 m | 21.67 klm |
| G1F1S2 | 38.00 bc | 58.00 abc | 96.00 o | 20.67 lm |
| G1F2S1 | 37.67 bcd | 58.00 abc | 100.0 k | 26.00 fghi |
| G1F2S2 | 38.33 ab | 57.67 bcd | 93.00 q | 22.33 jklm |
| G1F3S1 | 37.33 cd | 59.00 a | 99.00 l | 33.00 ab |
| G1F3S2 | 38.00 bc | 57.67 bcd | 99.00 l | 28.67 def |
| G2F1S1 | 38.33 ab | 58.00 abc | 100.0 k | 22.67 jkl |
| G2F1S2 | 38.00 bc | 55.67 f | 95.00 p | 25.00 hij |
| G2F2S1 | 38.33 ab | 57.00 cde | 100.0 k | 22.67 jkl |
| G2F2S2 | 39.00 a | 58.00 abc | 92.00 r | 22.67 jkl |
| G2F3S1 | 36.00 f | 56.67 def | 97.00 n | 22.33 jklm |
| G2F3S2 | 38.00 bc | 56.00 ef | 100.0 k | 30.00 cde |
| G3F1S1 | 37.00 de | 56.00 ef | 95.00 p | 26.00 fghi |
| G3F1S2 | 37.33 cd | 57.67 bcd | 100.0 k | 25.67 ghi |
| G3F2S1 | 37.33 cd | 59.00 a | 92.00 r | 22.00 klm |
| G3F2S2 | 37.33 cd | 57.00 cde | 93.00 q | 24.00 ijk |
| G3F3S1 | 39.00 a | 56.67 def | 92.00 r | 21.00 lm |
| G3F3S2 | 39.00 a | 58.67 ab | 98.00 m | 30.00 cde |
| G4F1S1 | 38.00 bc | 58.00 abc | 110.0 g | 32.33 abc |
| G4F1S2 | 36.33 ef | 58.67 ab | 114.0 c | 28.33 efg |
| G4F2S1 | 38.33 ab | 57.67 bcd | 111.0 f | 33.00 ab |
| G4F2S2 | 38.00 bc | 58.67 ab | 110.0 g | 19.67 m |
| G4F3S1 | 37.00 de | 59.00 a | 110.0 g | 31.67 bc |
| G4F3S2 | 39.00 a | 58.67 ab | 114.0 c | 24.00 ijk |
| G5F1S1 | 38.00 bc | 59.00 a | 114.0 c | 27.33 efgh |
| G5F1S2 | 39.00 a | 57.67 bcd | 114.0 c | 23.33 ijkl |
| G5F2S1 | 37.00 de | 58.00 abc | 114.0 c | 32.00 bc |
| G5F2S2 | 38.00 bc | 53.00 g | 108.0 i | 33.00 ab |
| G5F3S1 | 36.00 f | 56.67 def | 111.0 f | 21.67 klm |
| G5F3S2 | 38.33 ab | 58.00 abc | 111.0 f | 22.67 jkl |
| G6F1S1 | 37.00 de | 58.00 abc | 113.0 d | 22.67 jkl |
| G6F1S2 | 38.00 bc | 56.67 def | 106.0 j | 22.00 klm |
| G6F2S1 | 37.33 cd | 58.00 abc | 109.0 h | 23.33 ijkl |
| G6F2S2 | 39.00 a | 58.00 abc | 112.0 e | 31.33 bcd |
| G6F3S1 | 38.00 bc | 57.67 bcd | 115.0 b | 35.00 a |
| G6F3S2 | 37.67 bcd | 57.00 cde | 116.0 a | 32.00 bc |
| CV | 1.29 | 1.02 | 0.49 | 5.78 |
| $LSD_{0.05}$ | 0.80 | 0.96 | 0.83 | 2.46 |

similar to G4S2 (112.7 cm) and G6S1 (112.3 cm) and the shortest plant was obtained from G3S1 (93.00 cm) (Figure 2, Appendix VIII). Interaction with fertilizer and seedlings age treatment affected the plant height significantly where the maximum was from FR3S2 (106.30 cm) interaction and the minimum was from FR2S2 (101.30 cm) interaction (Figure 3, Appendix XI). The interaction result for six genotype, three fertilizer and two seedlings age treatment affected the plant height which was statistically significant. The tallest plant was from G6FR3S2 (116.00 cm) interaction and statistically identical with G6F3S1 (115.00 cm) and G4F3S2 (114.00 cm) and the minimum plant height was found from G3FR2S1interaction (92.00 cm) (Table 16).

### 4.3.4 Number of leaf per plant

The interaction results for number of leaf per plant between six genotypes and three fertilizer doses showed statistically significant variation (Appendix IV). The highest no. of leaf was obtained from G6F3 (33.50) whereas the lowest from G1FR1 (21.17) (Figure 1, Appendix V). Genotypes and seedlings age treatment interaction showed the significant results where the maximum no. of leaf was found from G4S1 (32.33) and the lowest no. of leaf per plant was found from G3S1 (23.00) (Figure 2, Appendix VIII). Interaction with fertilizer and seedlings age treatment affected the no. of leaf per plant significantly where the maximum was from FR3S2 (27.89) and the minimum was from FR1S2 (24.17) (Figure 3, Appendix XI). The interaction result for six genotype, three fertilizer and two seedlings age treatment affected the no. of leaf per plant which was statistically significant and the maximum no. of leaf was found from G6FR3S1 (35.00) which was identical to G5F2S2 (33.00) and G1F3S1 (33.00) and the minimum no. leaf was found from G4FR2S2 (19.69) (Table 16).

### 4.3.5 Number of branch per plant

Interaction effects between six pomato genotypes and three fertilizer treatment for the no. of the branch per plant showed the statistically significant results where the maximum was from G4FR3 (6.00) interaction and statistically

similar to G5FR1 (5.50) and G6FR2 (5.16) (Figure 4, Appendix VI). The minimum no. of the branch per plant was found from G2FR2 (3.33) which was statistically similar to G3FR2 (3.83) and G3FR3 (3.50) (Figure 4, Appendix V). The six genotype and two seedlings age treatments interaction affected the no. of branches per plant significantly where the maximum was found from G4S1 (6.00) which was similar to G5S2 (5.11) and G6S1 (5.22). The minimum was from G2S1 (3.44) which were similar to G3S1 (3.55) (Figure 5, Appendix VIII). The fertilizer and seedling age treatment effected the no. of the branch per plant significantly and the maximum branches were found from FR3S1 (4.72) interaction and the minimum was from FR2S2 (4.11) interaction (Figure 6, Appendix XI). Interaction effects of genotypes, fertilizer and seedlings age treatments on no. of branch per plant showed significant results where the maximum was found from G4FR3S1 (7.33) and statistically similar to G5FR1S2 (6.67), the minimum was found from G2FR2S1 (3.00) interaction and statistically similar to G1FR2S1 (3.33), G3FR2S1 (3.33), G3FR3S1 (3.33) and G3FR3S2 (3.67) (Table 17).

### 4.3.6 Number of cluster per plant

The interaction effects between genotypes and fertilizer treatments showed the statistically significant and similar result where the maximum was number of cluster per plant was found from G5FR3 (16.33) which was similar to G4FR1 (16.33), G5FR1 (16.33) and G6FR1 (16.17). The minimum was found from G2FR1 (4.50) interaction which was statistically similar to G1FR3 (4.83), G3FR2 (4.83) and G3FR1 (4.50) (Figure 4, Appendix V). No. of cluster per plant influenced by the effects of the genotypes and seedlings age of tomato treatment where the maximum was found from G5S1 (17.00) and statistically similar to G4S1 (16.56), G4S2 (15.89) and G6S2 (16.22) and the minimum was found from G3S1 (4.88) interaction which was statistically similar to G1S2 (4.88), G2S1 (5.11) and G3S2 (5.11) (Figure 5, Appendix VIII). On the other, the fertilizers and seedlings age treatment showed the statistically similar result where the maximum was found from FR3S1 (10.94) and the minimum was

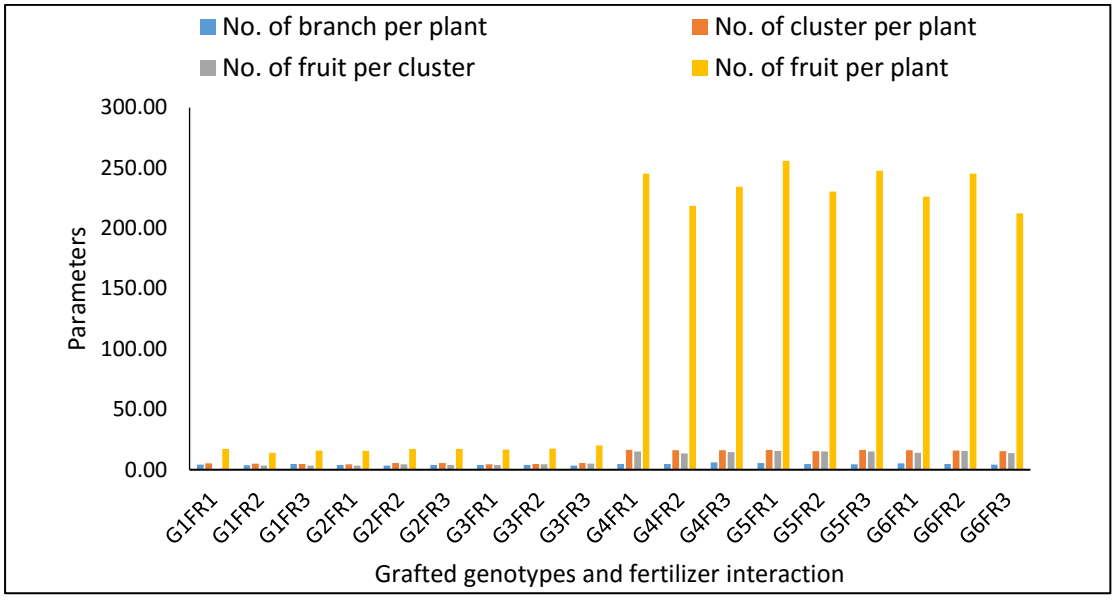


**Figure 4. Interaction effect of pomato genotypes and fertilizer treatments on number of branch per plant, number of cluster per plant, number of fruit per cluster and number of fruit per plant.**

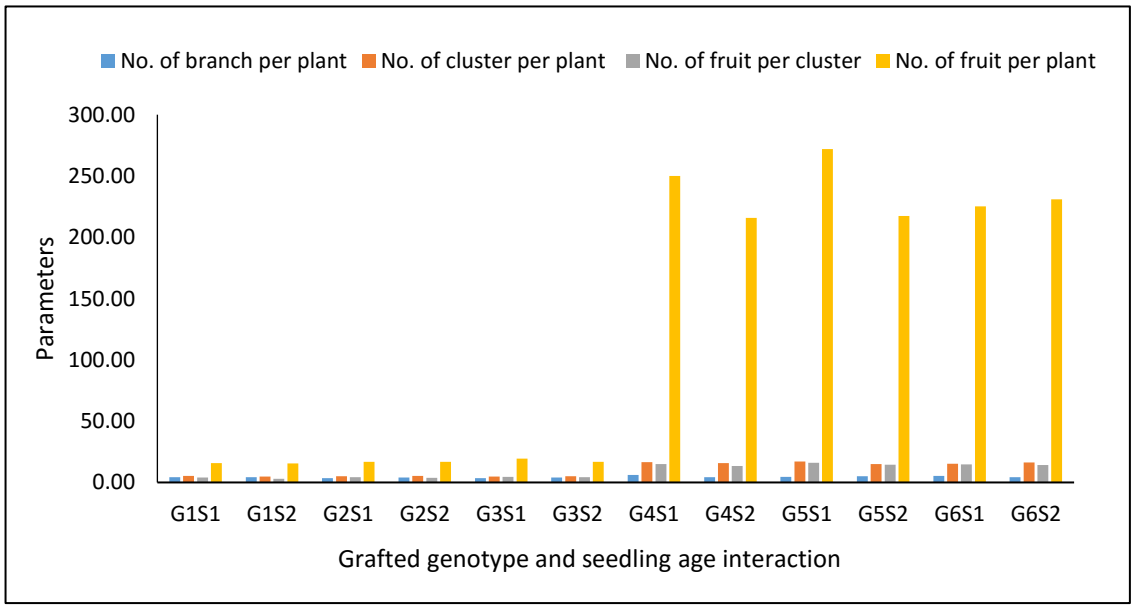


**Figure 5. Interaction effect of pomato genotypes and seedling age treatments on number of branch per plant, number of cluster per plant, number of fruit per cluster and number of fruit per plant.**

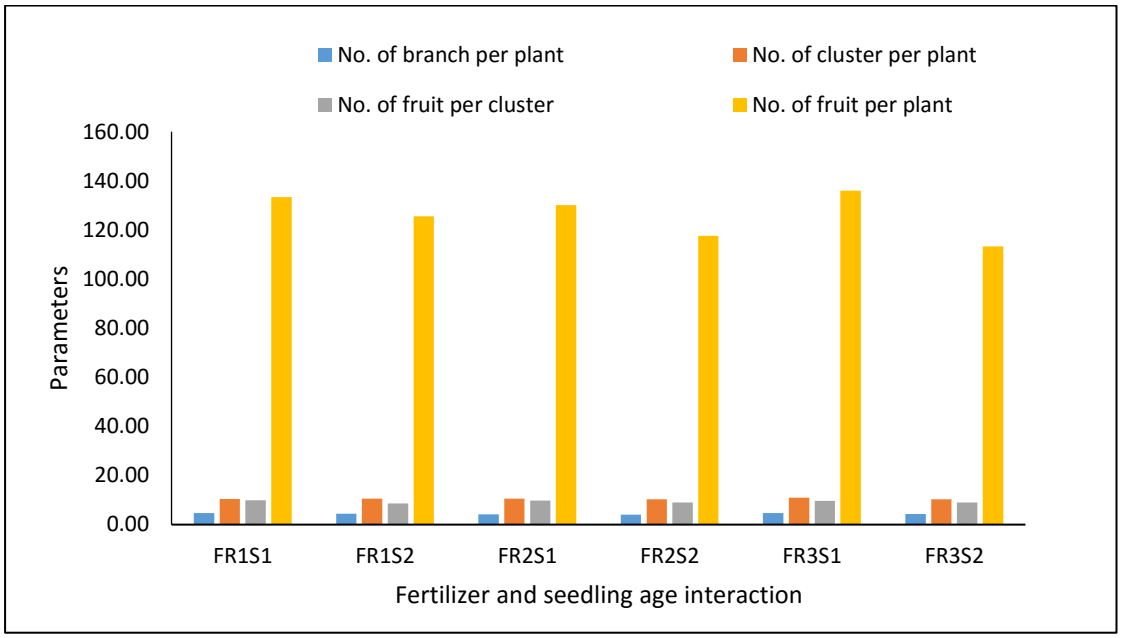


**Figure 6. Interaction effect of fertilizer and seedling age treatments on number of branch per plant, number of cluster per plant, number of fruit per cluster and number of fruit per plant.**

**Table 17. Interaction effect of genotypes, fertilizer and seedling age treatments on number of branch per plant, number of cluster per plant, number of fruit per cluster and number of fruit per plant.**

| Treatment | Number of branch per plant | Number of cluster per plant | Number of fruit per cluster | Number of fruit per plant |
|---|---|---|---|---|
| G1F1S1 | 4.667 cdef | 5.333 ef | 4.000 f | 17.33 j |
| G1F1S2 | 4.000 defg | 5.333 ef | 3.000 g | 17.00 j |
| G1F2S1 | 3.333 fg | 5.333 ef | 4.000 f | 11.33 j |
| G1F2S2 | 4.000 defg | 4.667 ef | 3.000 g | 16.67 j |
| G1F3S1 | 4.667 cdef | 5.000 ef | 4.000 f | 18.67 j |
| G1F3S2 | 5.000 cde | 4.667 ef | 3.000 g | 13.00 j |
| G2F1S1 | 3.667 efg | 4.333 ef | 4.000 f | 17.00 j |
| G2F1S2 | 4.000 defg | 4.667 ef | 3.000 g | 14.33 j |
| G2F2S1 | 3.000 g | 6.000 e | 5.000 e | 16.33 j |
| G2F2S2 | 3.667 efg | 5.000 ef | 4.000 f | 18.33 j |
| G2F3S1 | 3.667 efg | 5.000 ef | 4.000 f | 17.00 j |
| G2F3S2 | 4.333 cdefg | 6.000 e | 4.000 f | 17.67 j |
| G3F1S1 | 4.000 defg | 5.000 ef | 5.000 e | 19.00 j |
| G3F1S2 | 4.000 defg | 4.000 f | 3.000 g | 14.33 j |
| G3F2S1 | 3.333 fg | 4.333 ef | 4.000 f | 18.00 j |
| G3F2S2 | 4.333 cdefg | 5.333 ef | 5.000 e | 17.00 j |
| G3F3S1 | 3.333 fg | 5.333 ef | 5.000 e | 21.00 j |
| G3F3S2 | 3.667 efg | 6.000 e | 5.000 e | 19.33 j |
| G4F1S1 | 5.667 bc | 16.67 bc | 16.33 a | 271.3 b |
| G4F1S2 | 3.667 efg | 16.00 bc | 13.67 c | 219.3 fgh |
| G4F2S1 | 5.000 cde | 16.67 bc | 14.00 c | 233.3 defg |
| G4F2S2 | 4.333 cdefg | 15.67 bc | 13.00 d | 203.7 hi |
| G4F3S1 | 7.333 a | 16.33 bc | 15.00 b | 245.0 cde |
| G4F3S2 | 4.667 cdef | 16.00 bc | 14.00 c | 224.0 efgh |
| G5F1S1 | 4.333 cdefg | 16.33 bc | 16.00 a | 261.3 bc |
| G5F1S2 | 6.667 ab | 16.33 bc | 15.33 b | 250.7 cd |
| G5F2S1 | 5.000 cde | 15.67 bc | 16.00 a | 250.7 bcd |
| G5F2S2 | 4.333 cdefg | 15.00 cd | 14.00 c | 210.0 hi |
| G5F3s1 | 4.667 cdef | 19.00 a | 16.00 a | 304.0 a |
| G5F3S2 | 4.333 cdefg | 13.67 d | 14.00 c | 191.3 i |
| G6F1S1 | 5.667 bc | 15.33 bc | 14.00 c | 214.7 gh |
| G6F1S2 | 4.667 cdef | 17.00 b | 14.00 c | 238.0 def |
| G6F2S1 | 5.333 cd | 15.67 bc | 16.00 a | 250.7 bcd |
| G6F2S2 | 4.000 defg | 16.00 bc | 15.00 b | 240.0 cdef |
| G6F3S1 | 4.667 cdef | 15.00 cd | 14.00 c | 210.0 hi |
| G6F3S2 | 4.000 defg | bc | 13.67 c | 214.7 gh |
| CV | 15.53 | 8.17 | 3.25 | 9.48 |
| $LSD_{0.05}$ | 1.12 | 1.40 | 0.49 | 19.45 |

found from FR2S2 (10.28) interaction (Figure 6, Appendix XI). The interaction between three treatments like genotypes, fertilizer and seedlings age of tomato influenced the no. of cluster per plant where the maximum number of cluster per plant was found from G5FR3S1 (19.00) and the minimum from G3FR1S2 (4.00) interaction. (Table 17).

### 4.3.7 Number of fruit per cluster

The interaction between genotypes and fertilizer treatments showed the statistically significant results for the no. of fruit per cluster where the maximum no. of fruits per cluster was found from G5FR1 (15.67) which was statistically similar to G5FR2 (15.50). The minimum was found from G1FR1 (3.50) and statistically similar to G1FR2 (3.50), G1FR3 (3.50) and G2FR1 (3.50) (Figure 4, Appendix VI). Combined effects of genotypes and seedlings age on no. of fruit per cluster influenced significantly where the highest no. of fruits per cluster was found from G5S1 (16.00) which was statistically similar to G4S1 (15.11) and the lowest was found from G1S2 (3.00) which was statistically similar to G2S2 (3.66) (Figure 5, Appendix IX). In terms of the interaction effects between fertilizer and seedlings age in respect of the no. of fruit per cluster showed the statistically significant and similar result where the maximum was found from FR1S1 (9.88) and similar with FR1S1 (9.83) and FR3S1 (9.66). The minimum no. of fruit per cluster was found from FR1S2 (8.66) and similar to FR3S2 (8.94). (Figure 6, Appendix XII). The genotypes, fertilizer and seedlings age had combined effects on the no. of the fruit per cluster which showed the significant result where the highest was found from G4FR1S1 (16.33) which was statistically similar to G5FR1S1 (16.00), G5FR2S1 (16.00), G5FR3S1 (16.00) and G6FR2S1 (16.00) interaction. The lowest was found from G1FR1S2 (3.00) similar to G1FR3S2 (3.00), G2FR1S2 (3.00) and G3FR1S2 (3.00) interaction. (Table 17).

### 4.3.8 Number of fruit per plant

The interaction between genotypes and fertilizers treatments showed the statistically significant results where the maximum was obtained from G5FR1

(256.0) interaction and statistically similar to G4FR3 (234.5), G5FR3 (247.7) and G6FR2 (245.3) interaction (Figure 4, Appendix VI). The minimum was found from G1FR2 (14.0) which was similar to G1FR3 (15.83) and G2FR1 (15.67) (Figure 4, Appendix VI). The combined effect of the genotypes and seedlings age treatments showed the significant results on no of the fruit per plant where the maximum was found from G5S1 (272.0) and the minimum was found from G1S2 (15.56) and statistically similar to G1S1 (15.78), G2S1 (16.78) and G2S2 (16.78) (Figure 5, Appendix IX). Interaction effects of fertilizer and seedlings age treatments on no. of fruit per plant showed the significant results where the highest was found from FR3S1 (135.9) and statistically similar to FR1S1 (133.4) and FR2S1 (130.1). The minimum values were found from FR3S2 (113.3) and similar to FR2S2 (117.6) (Figure 6, Appendix XII). The combined effects of the genotypes and fertilizers and seedlings age on the pomato in respect to the no. of the fruit per plant showed statistically significant results where the maximum was found from G5FR3S1 (304.0) and similar to G4FR1S1 (271.3) and G5FR1S1 (161.3). The minimum values was found from G1FR2S1 (11.33) interaction and statistically similar to G1FR3S2 (13.00) and G2FR1S2 (14.33) (Table 17).

### 4.3.9 Fruit length (cm)

The interaction effects of the genotypes and fertilizer treatments showed the statistically significant results where the maximum fruit length was found from G3FR2 (7.11) which was statistically similar to G2FR1 (7.05), G2FR2 (7.11), G2FR3 (6.95) and G3FR1 (7.01). The minimum results was obtained from G5FR3 (2.13) and it was statistically similar to G4FR2 (2.25), G4FR3 (2.20), G6FR1 (2.25) and G6FR2 (2.18) (Figure 7, Appendix VI). Interaction effects of the genotypes and seedlings age treatments showed the statistically significant results where the maximum was from G3S1 (7.18) which was statistically similar to G2S1 (7.06) and G2S2 (7.01) (Figure 8, Appendix IX). The minimum result was obtained from G6S1 (2.14) which was statistically similar to G1S1 (2.35), G4S2 (2.31), G5S1 (2.18) and G6S2 (2.37). The

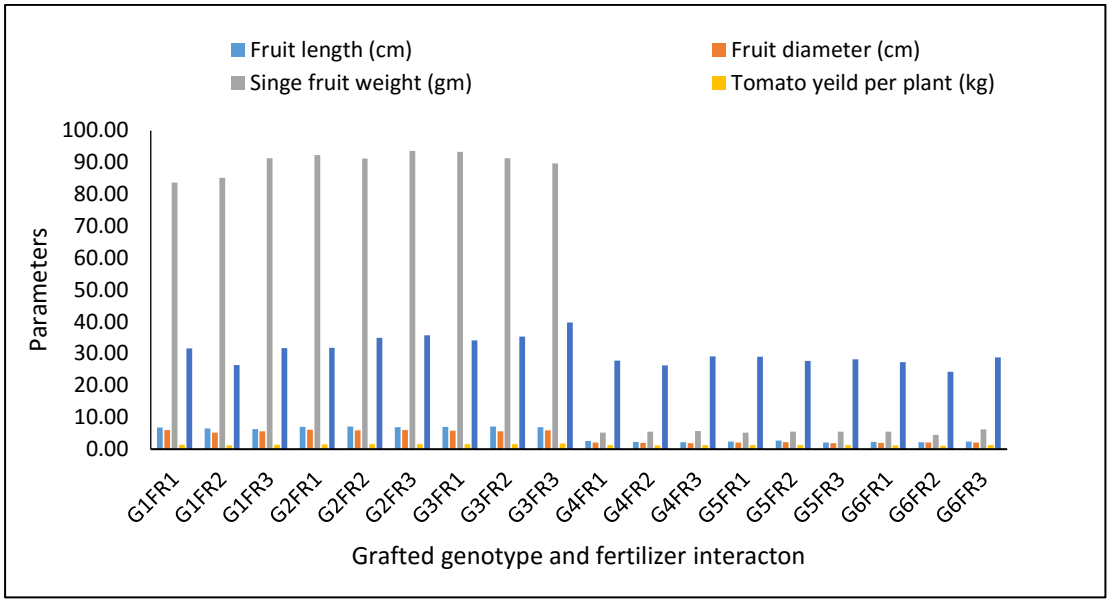


**Figure 7. Interaction effect of pomato genotypes and fertilizer treatments on single fruit length (cm), single fruit diameter (cm), single tomato fruit weight (g), yield of tomato per plant (kg) and total yield of tomato (ton/ha).**

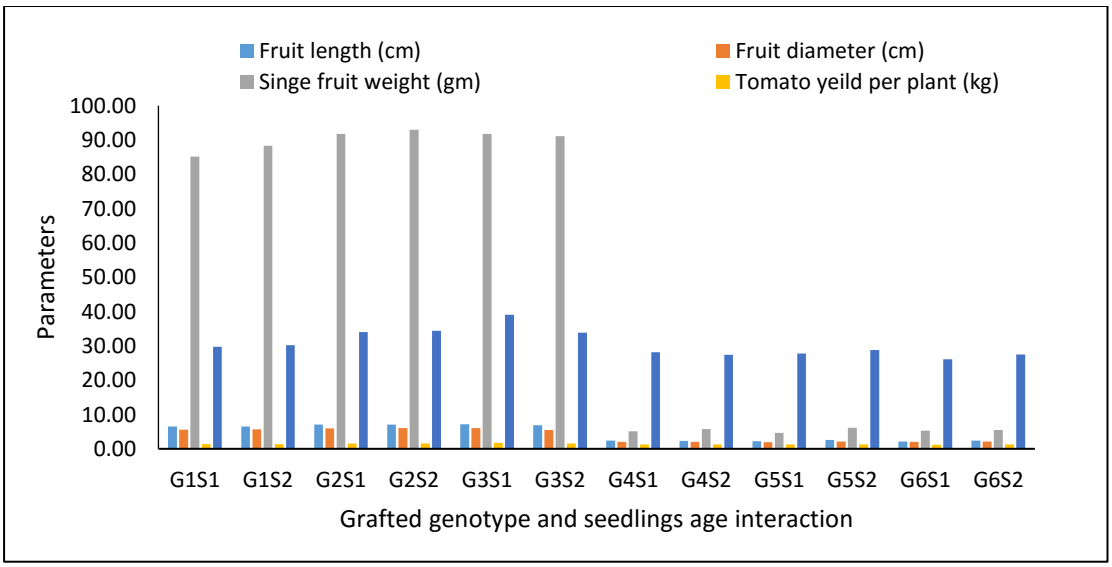


**Figure 8. Interaction effect of pomato genotypes and seedling age treatments on single fruit length (cm), single fruit diameter (cm), single tomato fruit weight (g), yield of tomato per plant (kg) and total yield of tomato (ton/ha).**

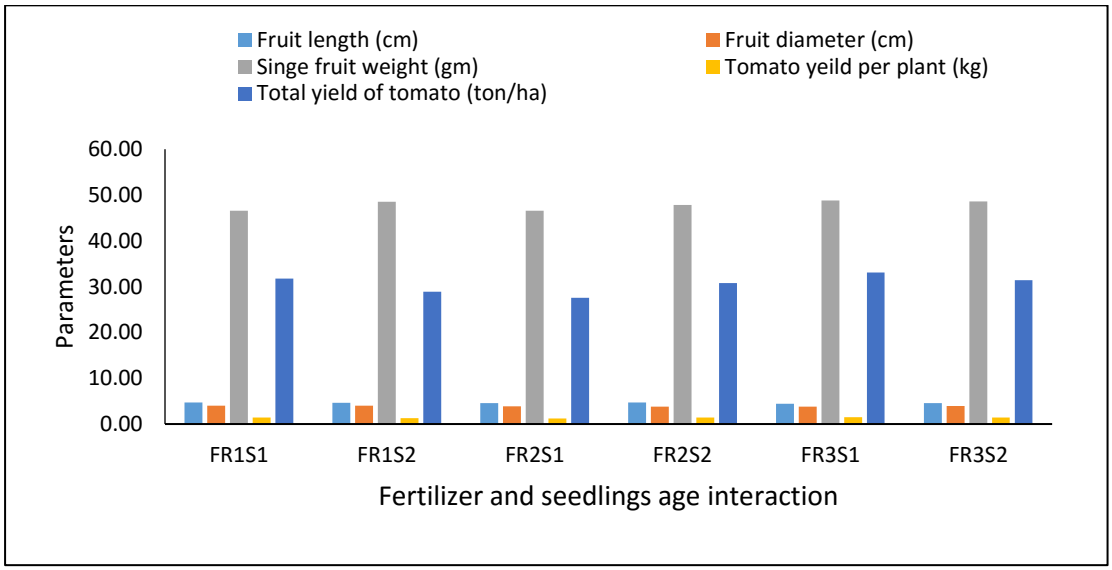


**Figure 9. Interaction effect of fertilizer and seedling age treatments on single fruit length (cm), single fruit diameter (cm), single tomato fruit weight (g), yield of tomato per plant (kg) and total yield of tomato (ton/ha).**

**Table 18. Interaction effect of genotypes, fertilizer and seedling age treatments on single fruit length (cm), single fruit diameter (cm), single tomato fruit weight (g), yield of fruit per plant (kg) and total yield of tomato (ton/ha).**

| Treatment | Fruit length (cm) | Fruit Diameter (cm) | Singe fruit weight (gm) | Fruit yield per plant (kg) | Total Yield of Tomato (ton/ha) |
|---|---|---|---|---|---|
| G1F1S1 | 6.66 efgh | 5.66 abc | 83.00 h | 1.43 efgh | 31.74 efgh |
| G1F1S2 | 6.93 bcde | 6.26 a | 84.33 fgh | 1.433 efgh | 31.63 efgh |
| G1F2S1 | 6.56 efgh | 5.56 abc | 83.33 gh | 0.94 m | 20.71 m |
| G1F2S2 | 6.36 gh | 4.80 c | 87.00 efgh | 1.45 efgh | 32.04 efgh |
| G1F3S1 | 6.40 gh | 5.33 bc | 89.00 cdefgh | 1.66 bcd | 36.65 bcd |
| G1F3S2 | 6.30 h | 5.80 ab | 93.67 abcde | 1.21 ijk | 26.85 ijk |
| G2F1S1 | 7.63 a | 6.40 a | 90.33 bcdef | 1.53 cdef | 33.88 cdef |
| G2F1S2 | 6.46 fgh | 5.83 ab | 94.33 abcd | 1.35 fghijk | 29.85fghijk |
| G2F2S1 | 6.50 fgh | 5.56 abc | 87.00 efgh | 1.41 efghi | 31.32 efghi |
| G2F2S2 | 7.73 a | 6.26 a | 95.33 abc | 1.74 ab | 38.51 ab |
| G2F3S1 | 7.06 bcd | 5.80 ab | 98.00 a | 1.66 bcd | 36.78 bcd |
| G2F3S2 | 6.83 bcdef | 6.13 ab | 89.33 cdefgh | 1.58 bcde | 34.79 bcde |
| G3F1S1 | 7.20 b | 5.93 ab | 90.00 bcdefg | 1.71 abc | 37.72 abc |
| G3F1S2 | 6.83 bcdef | 5.60 abc | 96.67 ab | 1.38 efghij | 30.53efghij |
| G3F2S1 | 7.60 a | 5.96 ab | 95.00 abc | 1.71 abc | 37.72 abc |
| G3F2S2 | 6.63 efgh | 5.30 bc | 87.67 defgh | 1.49 defg | 32.88 defg |
| G3F3S1 | 6.76 cdefg | 6.10 ab | 90.33 bcdef | 1.88 a | 41.65 a |
| G3F3S2 | 7.13 bc | 5.63 abc | 89.00 cdefgh | 1.72 abc | 37.95 abc |
| G4F1S1 | 2.60 j | 2.03 d | 5.000 i | 1.35 fghijk | 29.93fghijk |
| G4F1S2 | 2.50 jkl | 2.10 d | 5.333 i | 1.17 kl | 25.72 kl |
| G4F2S1 | 2.33 jkl | 2.03 d | 5.000 i | 1.16 kl | 25.74 kl |
| G4F2S2 | 2.16 kl | 1.96 d | 6.000 i | 1.22 ijk | 26.96 ijk |
| G4F3S1 | 2.13 kl | 1.90 d | 5.333 i | 1.30 ghijk | 28.68 ghijk |
| G4F3S2 | 2.26 jkl | 1.93 d | 6.000 i | 1.34 fghijk | 29.65fghijk |
| G5F1S1 | 2.20 jkl | 2.03 d | 5.000 i | 1.30 ghijk | 28.82 ghijk |
| G5F1S2 | 2.56 jk | 2.06 d | 5.333 i | 1.32 ghijk | 29.17 ghijk |
| G5F2S1 | 2.26 jkl | 1.93 d | 5.000 i | 1.25 hijk | 27.65 hijk |
| G5F2S2 | 3.06 i | 2.36 d | 6.000 i | 1.26 hijk | 27.79 hijk |
| G5F3s1 | 2.10 l | 1.86 d | 4.000 i | 1.21 ijk | 26.82 ijk |
| G5F3S2 | 2.16 jkl | 2.00 d | 7.000 i | 1.33 fghijk | 29.54 ghijk |
| G6F1S1 | 2.13kl | 1.80 d | 6.000 i | 1.28 ghijk | 28.41 ghijk |
| G6F1S2 | 2.36 jkl | 2.16 d | 5.000 i | 1.19 jk | 26.25 jk |
| G6F2S1 | 2.20 jkl | 2.21 d | 4.000 i | 1.00 lm | 22.12 lm |
| G6F2S2 | 2.16 jkl | 2.03 d | 5.000 i | 1.20 jk | 26.47 jk |
| G6F3S1 | 2.10 l | 1.96 d | 6.000 i | 1.26 hijk | 27.79 hijk |
| G6F3S2 | 2.60 j | 2.16 d | 6.333 i | 1.34 fghijk | 29.75fghijk |
| CV (%) | 4.85 | 11.99 | 7.4 | 7.47 | 7.47 |
| LSD0.05 | 0.36 | 0.76 | 5.76 | 0.17 | 3.72 |

combined effects of the fertilizer and seedling age in respect on the fruit length showed the statistically similar result where the maximum was obtained from FR1S1 (4.73) and the minimum was obtained from FR3S1 (4.42) (Figure 9, Appendix XII). The interaction of genotypes, fertilizer and seedlings age affected the fruit length which showed the statistically significant results where the maximum fruit length was found from G2FR2S2 (7.73) which was statistically similar to G2FR1S1 (7.63) and G3FR2S1 (7.60). The minimum length was obtained from G3FR3S1 (2.10) which was statistically similar to G5FR3S2 (2.16), G6FR1S1 (3.13), G6FR2S2 (2.16) and G4FR2S2 (2.16) (Table 18).

### 4.3.10 Fruit diameter (cm)

It was observed that the genotypes and fertilizer treatments interaction effects on the fruit diameter showed the statistically significant result in which the highest fruit diameter was obtained from G2FR1 (6.11) which was statistically similar to G2FR2 (5.91), G2FR3 (5.96) and G3FR1 (5.76) the lowest diameter was found from the interaction G4FR3 (1.91) which was statistically similar to G5FR3 (1.93), G6FR1 (1.98), G6FR2 (2.12) and G6FR3 (2.06) (Figure 7, Appendix VI). It was observed that the genotype and seedlings age treatment showed the statistically significant results where the maximum was from G2S2 (6.07) and statistically similar to G3S1 (6.00), G2S1 (5.92) (Figure 8). The minimum results were found from G6S1 (1.94) and was similar to G5S1 (1.94), G4S1 (1.98) and G5S2 (2.14) (Figure 8, Appendix IX). The maximum fruit diameter had been shown from the interaction effects of fertilizer and seedlings age on fruit diameter and it was FR1S2 (4.00) which was statistically similar to FR1S1 (3.97) and FR3S2 (3.94). The lowest diameter was found in the interaction FR2S2 (3.78) (Figure 9, Appendix XII). The combined interaction of genotypes, fertilizers and seedlings age treatments effects on the fruit diameter showed statistically similar result where the maximum was in G2FR1S1 (6.40) interaction which was similar to G1FR1S2 (6.26), G2FR2S2 (6.26), G2FR3S2 (6.13) and G3FR3S1 (6.10). The minimum was obtained

from G6FR1S1 (1.80) interaction which was statistically similar to G4FR2S2 (1.96), G4FR3S1 (1.90), G4FR3S2 (1.93), G5FR2S1 (1.93) and G6FR3S1 (1.96) (Table 18).

### 4.3.11 Single fruit weight (g)

It was observed that the genotype and fertilizer treatment interaction affected the single fruit weight and statistically significant variation was found among the interaction. The maximum fruit weight was obtained from G2FR3 (93.67) interaction which was similar to G1FR3 (91.33), G2FR1 (92.33), G3FR1 (93.33) and G3FR2 (91.33) and the minimum result was obtained from G6FR2 (4.50) interaction which was similar to G4FR1 (5.16), G5FR1 (5.16), G5FR2 (5.50) and G6FR1 (5.50) (Figure 7, Appendix VI). Influence of the interaction effect of genotypes and seedlings age on single fruit weight of tomato in pomato plant showed statistically significant result where the highest was in G2S2 (93.00) which was statistically similar to G2S1 (91.78), G3S1 (91.78), G3S2 (91.11) and G1S2 (88.33). The lowest was obtained from G5S1 (4.66) which was statistically similar G4S1 (5.11), G4S2 (5.77), G6S1 (5.33) and G6S2 (5.44) (Figure 8, Appendix IX). Interaction effect of the fertilizer and seedlings age on the single fruit weight showed statistically similar results where the maximum was in FR3S1 (48.78) and similar to FR3S2 (48.56), FR1S2 (48.50) and the minimum was in FR1S1 (46.56) similar to FR2S1 (46.56) (Figure 9, Appendix XII). The combined effects of the genotypes, fertilizer and seedlings age on the single fruit weight showed statistically significant result where the maximum was G2FR3S1 (98.00) which was statistically similar to the G2FR1S2 (94.33), G2FR2S2 (95.33) and G3FR1S2 (96.67) where the minimum was G6FR2S1 (4.00) and similar to G5FR3S1 (4.00) (Table 18).

### 4.3.12 Fruit yield per plant (kg)

The interaction effects of the genotypes and fertilizer on the tomato yield per plant showed the statistically significant result in which the highest fruit yield was obtained from G3FR3 (1.80) interaction and statistically similar to G2FR3

(1.62) and G3FR2 (1.60). The lowest was obtained from G6FR2 (1.10) similar to G4FR2 (1.19) (Figure 7, Appendix VI). It was observed that the interaction of genotypes and fertilizer treatment influenced the tomato yield per plant. The interaction showed the statistically significant result in which the highest was obtained in G3S1 (1.76) and the lowest was in G6S1 (1.18) which was statistically similar to G4S1 (1.27), G4S2 (1.24), G5S1 (1.25), G5S2 (1.30) and G6S2 (1.24) (Figure 8, Appendix IX). The fertilizer and seedlings age treatment interaction effected on the tomato yield which showed the statistically significant result where the maximum was in FR3S1 (1.49) and similar to FR1S1 (1.43), FR3S2 (1.42) whereas the minimum was in FR2S1 (1.24) and statistically similar to FR1S2 (1.30) (Figure 9, Appendix XII). The interaction of the genotypes, fertilizer and seedlings age influenced the yield and statistically significant variation was obtained among the interaction. The highest yield was obtained from G3FR3S1 (1.88) interaction which was statistically similar to G2FR2S2 (1.74), G3FR2S1 (1.71), G3FR1S1 (1.71), G3FR2S1 (1.71) and G3FR3S2 (1.72). The lowest was obtained from G2FR2S1 (0.94) and G6FR2S1 (1.00) (Table 18).

### 4.3.13 Total yield of tomato (ton/ha)

The interaction between genotypes and fertilizer affected the total yield of tomato and showed the statistically significant results where the maximum was in G3FR3 (39.80) interaction and the minimum was in G6FR2 (24.30) interaction which was similar to G5FR2 (27.72) and G6FR1 (27.33) (Figure 7, Appendix VII). The maximum yield was obtained in G3S1 (39.03) interaction. The interaction effect between genotypes and seedling age for the total yield of tomato showed significant variation. The lowest yield of tomato was obtained in G6S1 (26.11) interaction which was statistically similar to G4S1 (27.44) and G5S1 (27.76) (Figure 8, Appendix X). The fertilizer and seedling age treatment interaction showed the statistically significant results where the maximum was in FR3S1 (33.06) which was statistically similar to FR1S1 (31.75) and FR2S2 (30.78). The lowest yield was obtained in FR2S1 (27.54) (Figure 9, Appendix

XIII). The highest tomato yield was obtained in G3FR3S1 (41.65) interaction. For the interaction effect on genotypes, fertilizer and seedling age treatment showed the significant result which was similar to G2FR2S2 (38.51) and G3FR1S1 (37.72) whereas the lowest result was in G1FR2S1 (20.71) which was statistically similar to G6FR2S1 (22.12) (Table 18).

### 4.3.14 Number of tuber per plant

Interaction between genotypes and fertilizers treatments showed statistically significant results where the highest number of tuber per plant was found in G6FR3 (5.66) and statistically similar to G5FR2 (5.50), G2FR3 (4.50) and G2FR2 (4.66) (Figure 10, (Appendix VII). The lowest yield was obtained in G1FR2 (3.16) and similar to G1FR1 (3.33) and G4FR2 (3.33). It was observed that the combined effect of the genotypes and seedlings age treatments showed the significant results on number of the tuber per plant where the highest was in G6S1 (5.00) and similar to G5S2 (4.77), G4S2 (4.44). The minimum was G1S1 (3.11) and statistically similar to G4S1 (3.66), G2S1 (4.00) (Figure 11, Appendix X). Interaction effects of fertilizer and seedlings age treatments on number of tuber per plant showed the statistically similar results where the highest was in FR3S1 (4.66) and similar to FR2S2 (4.61) and FR3S2 (4.61). The minimum result was in FR2S1 (3.55) (Figure 12, Appendix XIII). It was observed that effects of the genotypes and fertilizers and seedlings age on the pomato in respect of the number of the tuber per plant showed statistically significant results. The highest was in G6FR3S1 (6.67) and the similar to G5FR2S1 (5.66), the minimum result was in G1FR2S1 (1.66) (Table 19).

### 4.3.15 Single tuber weight (g)

It was observed that the genotype and fertilizer treatment interaction effects on the single tuber weight showed the statistically significant results in which the highest was in G6FR3 (88.00) which was similar to G4FR3 (80.83). The minimum result was in G3FR1 (55.00) which was similar to G6FR1 (53.25) and G6FR2 (55.75) (Figure 10, Appendix VII). Influence of the interaction effect of genotypes and seedlings age on single tuber weight of pomato showed

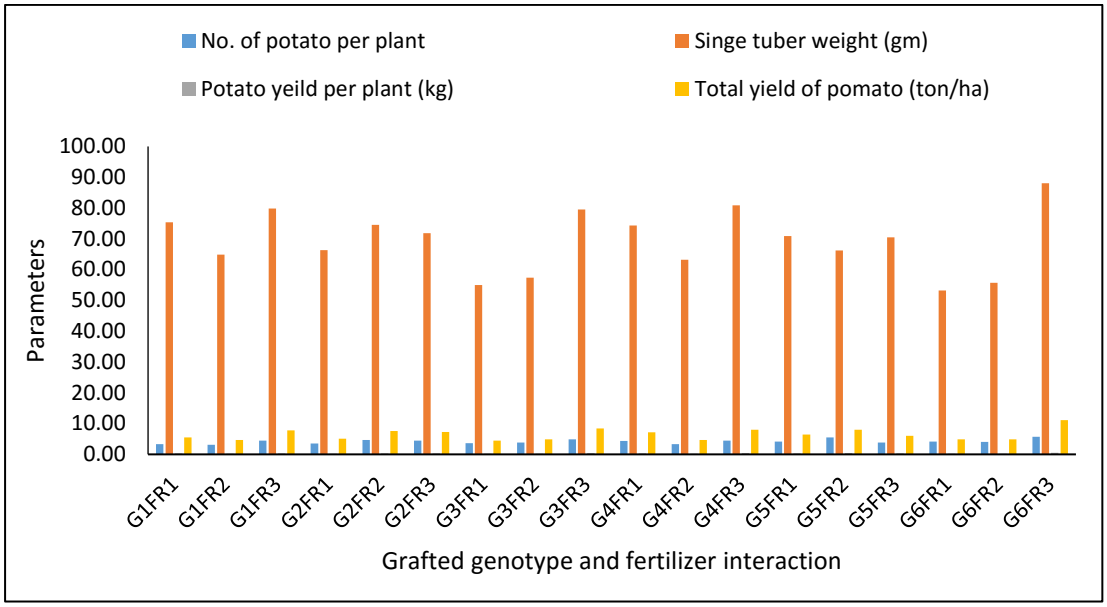


**Figure 10. Interaction effect of pomato genotypes and fertilizer treatments on number of tuber per plant, single tuber weight (g), yield of tuber per plant (kg) and total yield of tuber (ton/ha).**

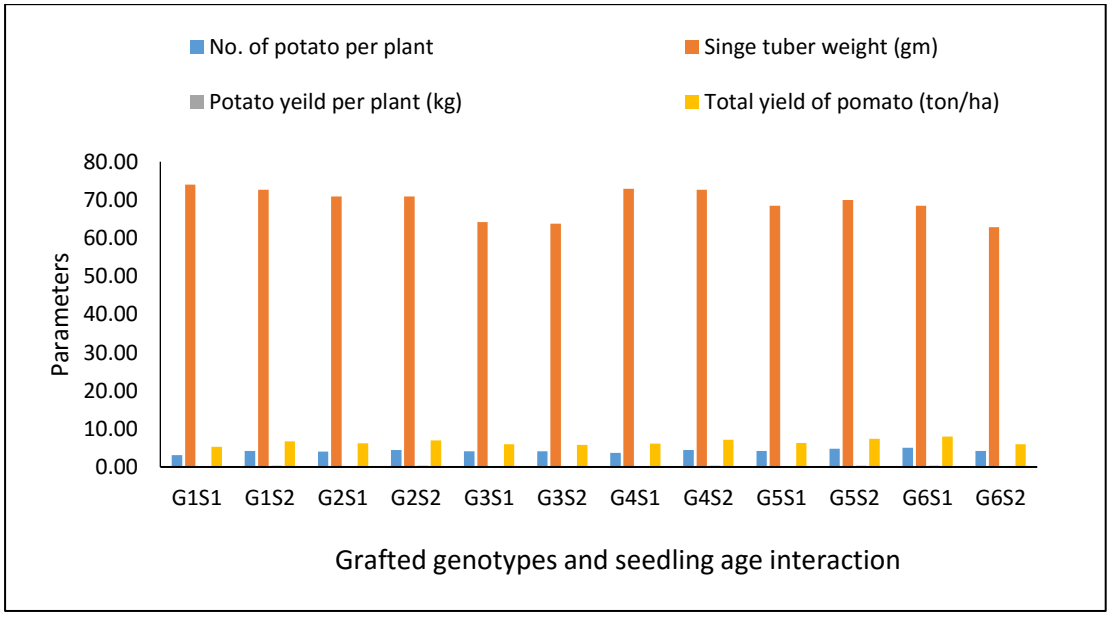


**Figure 11. Interaction effect of pomato genotypes and seedling age treatments on number of tuber per plant, single tuber weight (g), yield of tuber per plant (kg) and total yield of tuber (ton/ha).**

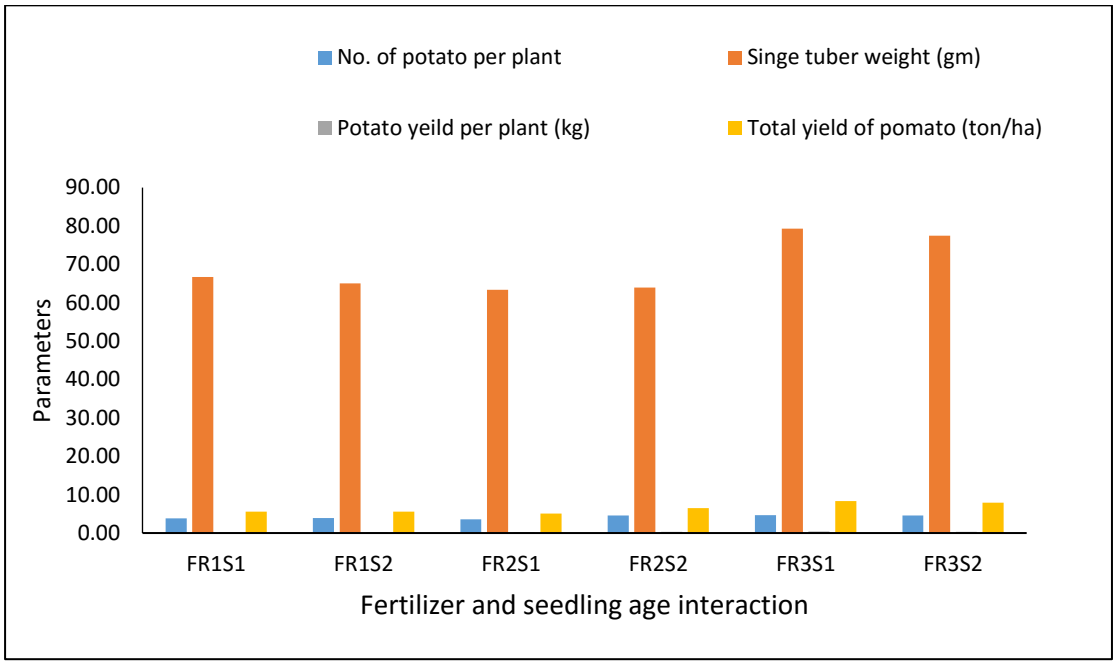


**Figure 12. Interaction effect of fertilizer and seedling age treatments on number of tuber per plant, single tuber weight (g), yield of tuber per plant (kg) and total yield of tuber (ton/ha).**

**Table 19. Interaction effect of genotypes, fertilizer and seedling age treatments on number of tuber per plant, single tuber weight (g), yield of tuber per plant (kg) and total yield of tuber (ton/ha).**

| Treatment | Number of tuber plant | Singe tuber weight (g) | Tuber yield per plant (kg) | Total yield of tuber (ton/ha) |
|---|---|---|---|---|
| G1F1S1 | 3.66 efg | 72.00 efghi | 0.26 fghijk | 5.83 fghijkl |
| G1F1S2 | 3.00 gh | 78.67 defg | 0.23 hijk | 5.20 ijkl |
| G1F2S1 | 1.66 i | 61.67 jklm | 0.10 m | 2.22 n |
| G1F2S2 | 4.66 bcde | 68.00 hij | 0.32 cdefgh | 7.03 cdefghi |
| G1F3S1 | 4.00 defg | 88.33 ab | 0.35 bcde | 7.78 bcde |
| G1F3S2 | 5.00 bcd | 71.33 fghi | 0.36 bcde | 7.86 bcde |
| G2F1S1 | 3.33 fgh | 71.00 ghi | 0.23 ijk | 5.12 jkl |
| G2F1S2 | 3.66 efg | 61.67 jklm | 0.22 ijk | 5.01 jkl |
| G2F2S1 | 4.66 bcde | 78.00 defg | 0.36 bcde | 8.02 bcde |
| G2F2S2 | 4.66 bcde | 71.00 ghi | 0.32 cdefg | 7.17 cdefgh |
| G2F3S1 | 4.00 defg | 63.67 ijkl | 0.25 ghijk | 5.62 ghijkl |
| G2F3S2 | 5.00 bcd | 80.00 cde | 0.40 bc | 8.82 bc |
| G3F1S1 | 3.66 efg | 55.67 lmn | 0.20 jkl | 4.47 klm |
| G3F1S2 | 3.66 efg | 54.33 mn | 0.20 jkl | 4.40 klm |
| G3F2S1 | 3.33 fgh | 57.50 klmn | 0.19 kl | 4.23 lm |
| G3F2S2 | 4.33 cdef | 57.33 klmn | 0.25 ghijk | 5.45 hijkl |
| G3F3S1 | 5.33 bc | 79.33 cdefg | 0.42 b | 9.27 b |
| G3F3S2 | 4.33 cdef | 79.67 cdef | 0.34 bcdef | 7.60 bcdef |
| G4F1S1 | 4.00 defg | 71.33 ghi | 0.28 efghij | 6.29 efghijk |
| G4F1S2 | 4.66 bcde | 77.33 defg | 0.36 bcde | 7.97 bcde |
| G4F2S1 | 2.33 hi | 60.67 jklmn | 0.13 lm | 3.10 mn |
| G4F2S2 | 4.33 cdef | 65.67 ijk | 0.28 efghij | 6.26 efghijk |
| G4F3S1 | 4.66 bcde | 86.67 abc | 0.40 bc | 8.91 bc |
| G4F3S2 | 4.33 cdef | 75.00 defgh | 0.32 cdefg | 7.13 cdefgh |
| G5F1S1 | 3.66 efg | 76.33 defg | 0.27 efghijk | 6.17 efghijk |
| G5F1S2 | 4.66 bcde | 65.50 ijk | 0.31 defghi | 6.79 defghij |
| G5F2S1 | 5.66 ab | 65.00 ijk | 0.36 bcde | 8.03 bcde |
| G5F2S2 | 5.33 bc | 67.50 hij | 0.36 bcde | 7.93 bcde |
| G5F3S1 | 3.33 fgh | 64.00 ijk | 0.21 jkl | 4.71 klm |
| G5F3S2 | 4.33 cdef | 77.00 defg | 0.33 bcdefg | 7.35 cdefg |
| G6F1S1 | 4.66 bcde | 54.00 mn | 0.25 ghijk | 5.56 ghijkl |
| G6F1S2 | 3.66 efg | 52.50 n | 0.19 kl | 4.24 lm |
| G6F2S1 | 3.66 efg | 57.50 klmn | 0.21 jkl | 4.65 klm |
| G6F2S2 | 4.33 cdef | 54.00 mn | 0.23 hijk | 5.16 jkl |
| G6F3S1 | 6.66 a | 94.00 a | 0.62 a | 13.8 a |
| G6F3S2 | 4.66 bcde | 82.00 bcd | 0.38 bcd | 8.44 bcd |
| CV (%) | 15.06 | 6.24 | 14.92 | 14.79 |
| LSD0.05 | 1.03 | 7.04 | 0.07 | 1.56 |

statistically significant result where the maximum was in G1S1 (74.00) which was statistically similar to G1S2 (72.67), G4S1 (72.89), G4S2 (72.67) and G2S1 (70.89). The lowest was in G6S2 (62.83) which was statistically similar to G3S1 (64.17) and G3S2 (63.78) (Figure 11, Appendix X). Interaction effect of the fertilizer and seedlings age on the single tuber weight had showed the statistically significant results where the maximum was in FR3S1 (79.33) and similar to FR3S2 (77.50) and the minimum was in FR2S1 (63.39) similar to FR2S2 (63.92) and FR1S2 (65.00) (Figure 12, Appendix XIII). The combined effects of the genotypes, fertilizer and seedlings age on the single tuber weight had showed the statistically significant result where the maximum was in G6FR3S1 (94.00) which was statistically similar to the G4FR3S1 (86.67) and G1FR3S1 (88.33) whereas the minimum was in G6FR1S2 (52.50) and similar to G6FR1S1 (54.00) (Table 19).

### 4.3.16 Tuber yield per plant (kg)

The interaction effects of the genotypes and fertilizer on the tuber yield per plant showed the statistically significant result where the highest was in G6FR3 (0.50) and the lowest was in G3FR1 (0.20) and statistically similar to G1FR2 (0.21), G3FR2 (0.22) and G1FR1 (0.25) (Figure 10, Appendix VII). It was observed that the interaction of genotypes and fertilizer treatment influenced on the tuber yield per plant which showed the statistically significant result. The highest tuber yield per plant was found in G6S1 (0.36) interaction and the lowest was in G1S1 (0.23) which was statistically similar to G3S1 (0.27), G3S2 (0.26) and G4S1 (0.27) (Figure 11, Appendix X). The fertilizer and seedlings age treatment interaction effects on the tuber yield showed the statistically significant result where the maximum was in FR3S1 (0.37) and similar to FR6S2 (0.35) where the minimum was in FR2S1 (0.22) and statistically similar to FR1S1 (0.25) and FR1S2 (0.25) (Figure 12, Appendix XIII). The interaction of the genotypes, fertilizer and seedlings age influenced tuber yield per plant and showed the highest yield in G6FR3S1 (0.62) and the lowest in G1FR2S1 (0.10) similar to G4FR2S1 (0.13) (Table 19).

### 4.3.17 Total yield of tuber (ton/ha)

The interaction between genotypes and fertilizer effects on the total yield of tuber showed the statistically significant results where the highest was in G6FR3 (11.13) and the minimum was in G3FR1 (4.40) which was similar to G1FR2 (4.62) and G3FR2 (4.84) (Figure 10, Appendix VII). The highest result showed in G6S1 (8.00) interaction where the minimum result was in G1S1 (5.28) which was statistically similar to G3S1 (5.99) and G3S2 (5.82) (Figure 11, Appendix X). The fertilizer and seedlings treatment interaction effects showed the statistically significant results where the highest was in FR3S1 (8.35) which was statistically similar to FR3S2 (7.87). The minimum result was in FR2S1 (5.04) (Figure 12, Appendix XIII). The highest potato yield was obtained in G6FR3S1 (13.41) for the interaction effect on genotypes, fertilizer and seedling age treatment showed the significant results where the lowest yield was found in G1FR2S1 (2.22) which was statistically similar to G4FR2S1 (3.10) (Table 19).

# CHAPTER V
# SUMMARY AND CONCLUSION

This experiment was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka-1207, Bangladesh with two genotypes of tomato *(Solanum lycopersicum* L.) and three genotypes of potato (*Solanum tuberosum* L.) during the period of November 2014 to April 2015. The experiment was laid out in RCBD design with three replications to study the mean performance for the treatment of fertilizer and seedlings age of the tomato of developed pomato genotypes based on yield contributing seventeen characters. The salient findings of the present study have been summarized on the basis of the characters studied.

The genotype, fertilizer and seedlings age interaction had the effect on days to first flowering and days to 50% flowering. The late flowering pomato plants which took the longest period of days (39.00 days) to first flowering was found in G3FR2S2 interaction whereas the early flowering pomato plants which took the shortest period of days (36.00 days) to first flowering was found in G5FR3S1 interaction. The combined effect of three treatments showed the shortest period of days (53.00 days) to 50% flowering and was found in G5FR2S2 interaction and the longest period of days to (59.00 days) 50% flowering was found in G1FR3S1 interaction.

The plant height and number of leaves were also affected by genotype, fertilizer and seedling age treatment. The tallest plant was obtained in G6FR3S2 (116.00 cm) and the shortest plant was obtained in G3FR2S1 (92.00 cm). The maximum number of leaf per plant (35) was obtained from G6FR3S1 interaction and the minimum number of leaves per plant were obtained from G4FR2S2 (19.67) interaction.

For other yield contributing characters, the combined interaction effects of six pomato genotypes, three fertilizer treatments and two seedlings ages also showed significant variation. The maximum branches were obtained in

G4FR3S1 (7.33) and the minimum was in G2FR2S1 (3.00). Clusters per plant were found the highest in G5FR3S1 (19.00) and the minimum was in G3FR1S2 (4.00). Fruits per cluster were found the highest in G5FR3S1 (19.00) and the lowest in G3FR1S2 (4.00). The number of the fruits per plant showed the maximum in G5FR3S1 (304.0) and the minimum in G1Fr2S1 (11.33). The fruit length showed highest in G2FR2S2 (7.73) and the lowest was in G3FR3S1 (2.10). Fruit diameter showed maximum in G2FR1S1 (6.40) and the minimum in G6FR1S1 (1.80).

The combined effects of genotype, fertilizer and seedling age treatment showed the maximum single fruit weight in G2FR3S1 (98.00) and minimum in G6FR2S1 (4.00). For tomato yield per plant the highest was found in G3FR3S1 (1.88) and the lowest was found in G2FR2S1 (0.94). The highest tomato yield was showed in G3FR3S1 (41.65) and the lowest result was in G1FR2S1 (20.71).

The Interaction between genotypes, fertilizers and seedlings age treatments also showed effects on the number of potato per plant. The maximum number of potato per plant was found in G6FR3S1 (6.67) and the minimum was found in G1FR2S1 (1.66). The single tuber weight was the highest in G6FR3S1 (94.00) and the lowest in G6FR1S2 (52.50). The highest potato yield per plant was found in G6FR3S1 (0.62) where the lowest was in G1FR2S1 (0.10). The highest total yield of potato was obtained in G6FR3S1 (13.41) and the lowest was in G1FR2S1 (2.22).

It could be concluded from the findings of the study, firstly, the improvement of yield in grafted pomato plant would be achieved through selection of the characters like, plant height, number of leaf, branches per plant, clusters per plant, fruits per cluster, fruits per plant, tubers per plant, fruit length, fruit diameter, fruit yield per plant, number of tuber per plant, single weight of tomato and potato and total yield per plant as they have efficient influence on fertilizer treatment. Secondly, the yield contributing characters also have

influenced by seedlings age of tomato. Lastly, the pomato G3 also showed the best performance for total tomato yield (41.65 ton/ha) when grafted with same aged of seedling of tomato and with the same fertilizer doses as mentioned for total tuber yield. Hence, pomato G3 (BARI tomato-2 grafted on Asterix) could be recommended to the farmers for grafting and cultivation for total yield including both potato and tomato when grafted with young tomato seedling of 25 days old and with the fertilizer dose of 390 Kg/ha of urea, 280 Kg/ha of TSP, 312 Kg/ha of MoP, 140 Kg/ha of gypsum and 13000 Kg/ha of cowdung. The pomato G6 (BARI tomato-11 grafted on Asterix) showed the best performance for total tuber yield (13.8 ton/ha) followed by pomato G3 (BARI tomato-2 grafted on Asterix) which showed the total tuber yield 9.27 ton/ha. Both the pomato genotypes for giving high tuber yield were grafted with 25 days old seedling of tomato and the applied fertilizer dose was 390 Kg/ha of urea, 280 Kg/ha of TSP, 312 Kg/ha of MoP, 140 Kg/ha of gypsum and 13000 Kg/ha of cowdung.

Some recommendation could be consigned, such as; similar cell compatibility research could be performed for local potato varieties with varying age of tomato seedling and fertilizer doses, the grafted pomato seedlings (BARI tomato-2 grafted on Asterix) could be produced and distributed to the farmers for commercial cultivation and the tomato seedling age (25 days) and fertilizer doses (390 Kg/ha of urea, 280 Kg/ha of TSP, 312 Kg/ha of MoP, 140 Kg/ha of gypsum and 13000 Kg/ha of cowdung) could be recommended to the farmers for successful pomato cultivation.

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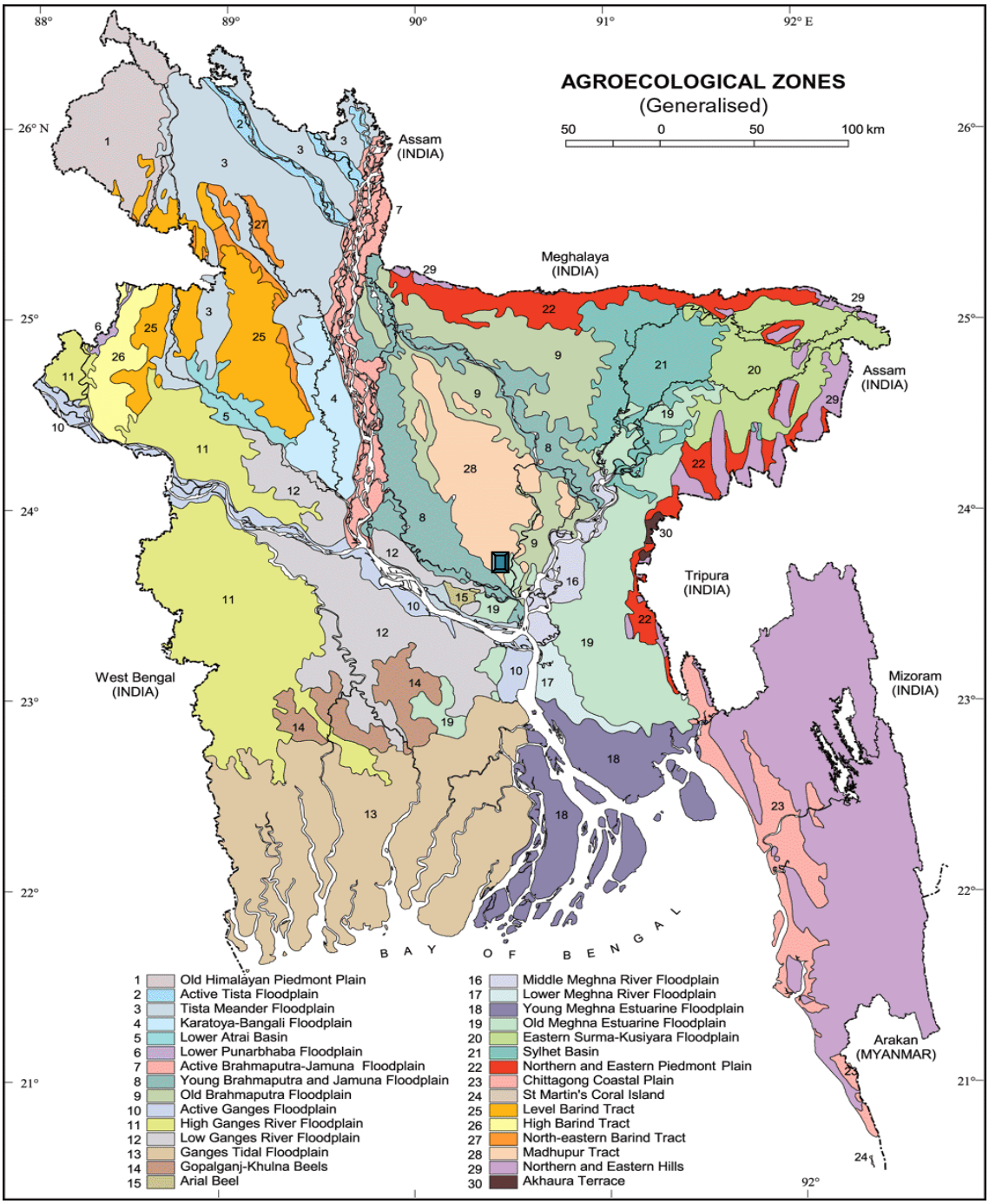
## Appendix I. Map showing the experimental site under the study




The experimental site under study

**Appendix II. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from October 2014 to March 2015**

| Month | Year | Monthly average air temperature (°C) | | | Average relative humidity (%) | Total rainfall (mm) | Total sunshine (hours) |
|---|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Mean | | | |
| Oct. | 2014 | 29.37 | 18.67 | 24.02 | 74.80 | Trace | 216.50 |
| Nov. | 2014 | 30.11 | 16.33 | 23.22 | 68.92 | Trace | 210.50 |
| Dec. | 2014 | 28.12 | 15.11 | 21.615 | 71.05 | Trace | 218.50 |
| Jan. | 2015 | 21.11 | 18.2 | 19.655 | 73.90 | 4.01 | 190.00 |
| Feb. | 2015 | 32.19 | 18.4 | 25.295 | 69.78 | 3.35 | 222.50 |
| Mar. | 2015 | 32.22 | 21.25 | 26.735 | 71.92 | 4.10 | 215.50 |

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

**Appendix III. The mechanical and chemical characteristics of soil of the experimental site as observed prior to experimentation (0 - 15 cm depth)**

**Mechanical composition:**

| Particle size | constitution |
|---|---|
| Sand | 40% |
| Silt | 40% |
| Clay | 20% |
| Texture | Loamy |

**Chemical composition:**

| **Soil characters** | **Value** |
|---|---|
| Organic matter | 1.44 % |
| Potassium | 0.15 meq/100 g soil |
| Calcium | 3.60 meq/100 g soil |
| Magnesium | 1.00 meq/100 g soil |
| Total nitrogen | 0.072 |
| Phosphorus | 22.08 µg/g soil |
| Sulphur | 25.98 µg/g soil |
| Boron | 0.48 µg/g soil |
| Copper | 3.54 µg/g soil |
| Iron | 262.6 µg/g soil |
| Manganese | 164 µg/g soil |
| Zinc | 3.32 µg/g soil |

**Source:** Soil Resources Development Institute (SRDI), Khamarbari, Dhaka

**Appendix IV. Analysis of variance for yield and related characters of pomato.**

| Source | DF | Mean Sum of square (MSS) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **DFF** | **D50%F** | **PH** | LPP | BPP | **CPP** | **FPC** | **FPP** | **FL** | **FD** |
| **Factor A (genotype/ grafting combination)** | 5.00 | 0.14** | 6.24** | 1256.68** | 46.74** | 6.15** | 645.04** | 617.89** | 257868.80** | 111.87** | 76.02** |
| **Factor B (fertilizer)** | 2.00 | $0.45^{NS}$ | 0.19** | 53.08** | 74.34** | 2.11** | 0.34** | $0.19^{NS}$ | $341.86^{NS}$ | 0.34** | 0.23** |
| **A x B** | 10.00 | 3.15** | 3.68** | 17.78** | 97.28** | 1.48** | 1.47* | 2.45** | 693.39** | 0.15** | 0.19** |
| **Factor C (Seedling age)** | 1.00 | 8.90** | 4.90** | 6.75** | 10.08* | $1.12^{NS}$ | $2.37^{NS}$ | 23.15** | 5518.37** | 0.03** | 0.01** |
| **A x C** | 5.00 | 1.30** | 3.05** | 40.55** | 92.24** | 4.17** | 4.39** | 1.30** | 2675.44** | 0.29** | $0.30^{NS}$ |
| **B x C** | 2.00 | 2.79** | 2.01** | 64.75** | 7.69* | 0.26** | $1.01^{NS}$ | 0.62** | 514.51* | $0.18^{NS}$ | 0.10** |
| **ABC** | 10.00 | 1.49** | 5.37** | 17.25** | 30.32** | 1.34** | 3.20** | 1.21** | 897.18** | 0.63** | $0.33^{NS}$ |
| **Error** | 70.00 | 0.24 | 0.35 | 0.26** | 2.29 | 0.47 | 0.74 | 0.09 | 142.70 | 0.05 | 0.22 |

** Significant at 1% level of probability; * Significant at 5% level of probability; NS = Non-significant

DFF = Days to first flowering, D50%F = Days to 50% flowering, PH = Plant height (cm), BPP = Branches per plant, CPP = Clusters per plant, FPC = Fruits per cluster, FPP = Fruits per plant, FL = Fruit length (cm), FD = Fruit diameter (cm)

## Appendix IV (Cont'd)

| Source | DF | Mean sum of square (MSS) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | SFW | FYP | TYT | TuPP | STW | TuYP | TYTu |
| **Factor A (genotype)** | 5.00 | 38877.64** | 0.55** | 269.03** | 2.06** | 260.93** | 0.01** | 3.53** |
| **Factor B (fertilizer)** | 2.00 | $21.45^{NS}$ | 0.18** | 87.44** | 5.78** | 2282.95** | 0.15** | 71.08** |
| **A x B** | 10.00 | $22.41^{NS}$ | 0.04** | 18.93** | 2.86** | 408.66** | 0.04** | 17.43** |
| **Factor C (Seedling age)** | 1.00 | $27.00^{NS}$ | 0.01** | 5.03** | 3.34** | $27.50^{NS}$ | 0.01* | $3.04^{NS}$ |
| **A x C** | 5.00 | 7.98** | 0.06** | 27.24** | 1.99** | $27.36^{NS}$ | 0.02** | 7.49** |
| **B x C** | 2.00 | 11.08** | 0.19** | 94.24** | 3.37** | 15.98** | 0.02** | 9.12** |
| **ABC** | 10.00 | 37.79** | 0.07** | 33.08** | 1.85** | 194.36** | 0.02** | 8.07** |
| **Error** | 70.00 | 12.51 | 0.01 | 5.22 | 0.40 | 18.68 | 0.00 | 0.92 |

** Significant at 1% level of probability; * Significant at 5% level of probability; NS = Non-significant

SFW = Single fruit weight (g), FYP = Fruit yield per plant (kg), TYT = Total yield of Tomato (ton/ha), TuPP = Tuber per plant (kg), STW = Single tuber weight (g), TuYP = Total yield per plant (kg), TYTu = Total yield of Tuber (ton/ha).

**Appendix V. Interaction effect of pomato genotypes and fertilizer treatments on days to first flowering, days to 50% flowering, plant height and number of leaf per plant, number of branch per plant, number of cluster per plant**

| Treatment | Days to first flowering | Days to 50% flowering | Plant Height (cm) | No. of leaf per plant | Number of branch per plant | Number of cluster per plant |
|---|---|---|---|---|---|---|
| G1FR1 | 38.17 abcd | 58.00 ab | 97.00 gh | 21.17 h | 4.33 bcde | 5.333 b |
| G1FR2 | 38.00 bcde | 57.83 abc | 96.50 hi | 24.17 defg | 3.66 de | 5.000 b |
| G1FR3 | 37.67 cdef | 58.33 ab | 99.00 f | 30.83 b | 4.83 abcd | 4.833 b |
| G2FR1 | 38.17 abcd | 56.83 cd | 97.50 g | 23.83 defgh | 3.83 cde | 4.500 b |
| G2FR2 | 38.67 ab | 57.50 bc | 96.00 i | 22.67 fgh | 3.33 e | 5.500 b |
| G2FR3 | 37.00 f | 56.33 de | 98.50 f | 26.17 cd | 4.00 cde | 5.500 b |
| G3FR1 | 37.17 ef | 56.83 cd | 97.50 g | 25.83 cd | 4.00 cde | 4.500 b |
| G3FR2 | 37.33 def | 58.00 ab | 92.50 k | 23.00 efgh | 3.83 cde | 4.833 b |
| G3FR3 | 39.00 a | 57.67 bc | 95.00 j | 25.50 cde | 3.50 de | 5.667 b |
| G4FR1 | 37.17 ef | 58.33 ab | 112.00 c | 30.33 b | 4.66 bcde | 16.33 a |
| G4FR2 | 38.17 abcd | 58.17 ab | 110.50 d | 26.33 cd | 4.66 bcde | 16.17 a |
| G4FR3 | 38.00 bcde | 58.83 a | 112.00 c | 27.83 c | 6.00 a | 16.17 a |
| G5FR1 | 38.50 abc | 58.33 ab | 114.00 b | 25.33 cdef | 5.50 ab | 16.33 a |
| G5FR2 | 37.50 def | 55.50 e | 111.00 d | 32.50 ab | 4.66 bcde | 15.33 a |
| G5FR3 | 37.17 ef | 57.33 bcd | 111.00 d | 22.17 gh | 4.50 bcde | 16.33 a |
| G6FR1 | 37.50 def | 57.33 bcd | 109.50 e | 22.33 gh | 5.16 abc | 16.17 a |
| G6FR2 | 38.17 abcd | 58.00 ab | 110.50 d | 27.33 c | 4.66 bcde | 15.83 a |
| G6FR3 | 37.83 bcdef | 57.33 bcd | 115.50 a | 33.50 a | 4.33 bcde | 15.33 a |

**Appendix VI. Interaction effect of pomato genotypes and fertilizer treatments on number of number of fruit per cluster and number of fruit per plant, single fruit length, single fruit diameter, single tomato fruit weight, yield of tomato per plant**

| Treatment | Number of fruit per cluster | Number of fruit per plant | Fruit length (cm) | Fruit diameter (cm) | Singe fruit weight (g) | Tomato yield per plant (kg) |
|---|---|---|---|---|---|---|
| G1FR1 | 3.50 g | 17.17 e | 6.80 ab | 5.96 ab | 83.67 c | 1.43 bcd |
| G1FR2 | 3.50 g | 14.00 e | 6.46 bc | 5.18 b | 85.17 bc | 1.19 ef |
| G1FR3 | 3.50 g | 15.83 e | 6.35 c | 5.56 ab | 91.33 ab | 1.43 bcd |
| G2FR1 | 3.50 g | 15.67 e | 7.05 a | 6.11 a | 92.33 a | 1.44 bc |
| G2FR2 | 4.50 ef | 17.33 e | 7.11 a | 5.91 ab | 91.17 ab | 1.58 b |
| G2FR3 | 4.00 fg | 17.33 e | 6.95 a | 5.96 ab | 93.67 a | 1.62 b |
| G3FR1 | 4.00 fg | 16.67 e | 7.01 a | 5.76 ab | 93.33 a | 1.54 b |
| G3FR2 | 4.50 f | 17.50 e | 7.11 a | 5.63 ab | 91.33 ab | 1.60 b |
| G3FR3 | 5.00 e | 20.17 e | 6.95 a | 5.86 ab | 89.67 abc | 1.80 a |
| G4FR1 | 15.00 c | 245.30 ab | 2.55 de | 2.06 c | 5.16 d | 1.26 cdef |
| G4FR2 | 13.50 d | 218.50 cd | 2.25 e | 2.00 c | 5.50 d | 1.19 ef |
| G4FR3 | 14.50 c | 234.50 abc | 2.20 e | 1.91 c | 5.66 d | 1.32 cde |
| G5FR1 | 15.67 a | 256.00 a | 2.38 de | 2.05 c | 5.16 d | 1.31 cde |
| G5FR2 | 15.00 bc | 230.30 bcd | 2.66 d | 2.15 c | 5.50 d | 1.25 cdef |
| G5FR3 | 15.00 bc | 247.70 ab | 2.13 e | 1.93 c | 5.50 d | 1.27 cdef |
| G6FR1 | 14.00 d | 226.30 bcd | 2.25 e | 1.98 c | 5.50 d | 1.23 def |
| G6FR2 | 15.50 ab | 245.30 ab | 2.18 e | 2.12 c | 4.50 d | 1.10 f |
| G6FR3 | 13.83 d | 212.30 d | 2.35 de | 2.06 c | 6.16 d | 1.30 cde |

**Appendix VII. Interaction effect of pomato genotypes and fertilizer treatments on and total yield of tomato, number of tuber per plant, single tuber weight, yield of tuber per plant and total yield of tuber.**

| Treatment | Total yield of tomato (ton/ha) | Number of tuber per plant | Single tuber weight (gm) | Tuber yield per plant (kg) | Total yield of tuber (ton/ha) |
|---|---|---|---|---|---|
| G1FR1 | 31.68 bc | 3.33 ef | 75.33 bcd | 0.25 efg | 5.52 efg |
| G1FR2 | 26.38 de | 3.16 f | 64.83 ef | 0.21 fg | 4.62 g |
| G1FR3 | 31.75 bc | 4.50 bcde | 79.83 b | 0.35 bcd | 7.82 bc |
| G2FR1 | 31.86 bc | 3.50 def | 66.33 ef | 0.23 fg | 5.06 fg |
| G2FR2 | 34.91 b | 4.66 abcd | 74.50 bcd | 0.34 bcd | 7.60 bcd |
| G2FR3 | 35.78 b | 4.50 abcde | 71.83 cde | 0.33 bcde | 7.22 bcde |
| G3FR1 | 34.13 b | 3.66 cdef | 55.00 h | 0.20 g | 4.44 g |
| G3FR2 | 35.30 b | 3.83 cdef | 57.42 gh | 0.22 fg | 4.84 fg |
| G3FR3 | 39.80 a | 4.83 abc | 79.50 bc | 0.38 b | 8.43 b |
| G4FR1 | 27.83 cde | 4.33 bcdef | 74.33 bcd | 0.32 bcde | 7.13 bcde |
| G4FR2 | 26.35 de | 3.33 ef | 63.17 fg | 0.21 fg | 4.68 fg |
| G4FR3 | 29.16 cd | 4.50 bcde | 80.83 b | 0.36 bc | 8.02 bc |
| G5FR1 | 29.00 cd | 4.16 cdef | 70.92 def | 0.29 cdef | 6.48 cdef |
| G5FR2 | 27.72 cde | 5.50 ab | 66.25 ef | 0.36 bc | 7.98 bc |
| G5FR3 | 28.18 cde | 3.83 cdef | 70.50 def | 0.27 defg | 6.03 defg |
| G6FR1 | 27.33 de | 4.16 cdef | 53.25 h | 0.22 fg | 4.90 fg |
| G6FR2 | 24.30 e | 4.00 cdef | 55.75 h | 0.22 fg | 4.90 fg |
| G6FR3 | 28.77 cd | 5.66 a | 88.00 a | 0.50 a | 11.13 a |

**Appendix VIII. Interaction effect of pomato genotypes and seedling age on days to first flowering, days to 50% flowering, plant height and number of leaf per plant, number of branch per plant, number of cluster per plant**

| Treatment | Days to first flowering | Days to 50% flowering | Plant Height (cm) | No. of leaf per plant | Number of branch per plant | Number of cluster per plant |
|---|---|---|---|---|---|---|
| G1S1 | 37.78 abc | 58.33 ab | 99.00 d | 26.89 b | 4.22 bc | 5.22 c |
| G1S2 | 38.11 ab | 57.78 abc | 96.00 f | 23.89 cd | 4.33 bc | 4.88 c |
| G2S1 | 37.56 abc | 57.22 cd | 99.00 d | 22.56 d | 3.44 c | 5.11 c |
| G2S2 | 38.33 ab | 56.56 d | 95.67 f | 25.89 bc | 4.00 bc | 5.22 c |
| G3S1 | 37.78 abc | 57.22 bcd | 93.00 g | 23.00 d | 3.55 c | 4.88 c |
| G3S2 | 37.89 abc | 57.78 abc | 97.00 e | 26.56 bc | 4.00 bc | 5.11 c |
| G4S1 | 37.78 abc | 58.22 abc | 110.30 c | 32.33 a | 6.00 a | 16.56 ab |
| G4S2 | 37.78 abc | 58.67 a | 112.70 a | 24.00 cd | 4.22 bc | 15.89 ab |
| G5S1 | 37.00 c | 57.89 abc | 113.00 a | 27.00 b | 4.66 bc | 17.00 a |
| G5S2 | 38.44 a | 56.22 d | 111.00 bc | 26.33 bc | 5.11 ab | 15.00 b |
| G6S1 | 37.44 bc | 57.89 abc | 112.30 a | 27.00 b | 5.22 ab | 15.33 b |
| G6S2 | 38.22 ab | 57.22 bcd | 111.30 b | 28.44 b | 4.22 bc | 16.22 ab |

**Appendix IX. Interaction effect of pomato genotypes and seedling age on number of number of fruit per cluster and number of fruit per plant, single fruit length, single fruit diameter, single tomato fruit weight, yield of tomato per plant**

| Treatment | Number of fruit per cluster | Number of fruit per plant | Fruit length (cm) | Fruit diameter (cm) | Singe fruit weight (g) | Tomato yield per plant (kg) |
|---|---|---|---|---|---|---|
| G1S1 | 4.00 fg | 15.78 d | 6.54 b | 5.52 a | 85.11 b | 1.34 d |
| G1S2 | 3.00 h | 15.56 d | 6.53 b | 5.62 a | 88.33 ab | 1.36 cd |
| G2S1 | 4.33 ef | 16.78 d | 7.06 a | 5.92 a | 91.78 a | 1.53 bc |
| G2S2 | 3.66 g | 16.78 d | 7.01 a | 6.07 a | 93.00 a | 1.55 b |
| G3S1 | 4.66 e | 19.33 d | 7.18 a | 6.00 a | 91.78 a | 1.76 a |
| G3S2 | 4.33 ef | 16.89 d | 6.86 ab | 5.51 a | 91.11 ab | 1.53 bc |
| G4S1 | 15.11b | 249.90 b | 2.35 cd | 1.98 b | 5.11 c | 1.27 d |
| G4S2 | 13.56 d | 215.70 c | 2.31 cd | 2.00 b | 5.77 c | 1.24 d |
| G5S1 | 16.00 a | 272.00 a | 2.18 d | 1.94 b | 4.66 c | 1.25 d |
| G5S2 | 14.44 c | 217.30 c | 2.60 c | 2.14 b | 6.11 c | 1.30 d |
| G6S1 | 14.67 bc | 225.10 c | 2.14 d | 1.99 b | 5.33 c | 1.18 d |
| G6S2 | 14.22 c | 230.90 bc | 2.37 cd | 2.12 b | 5.44 c | 1.24 d |

**Appendix X. Interaction effect of pomato genotypes and seedling age on and total yield of tomato, number of tuber per plant, single tuber weight, yield of tuber per plant and total yield of tuber**

| Treatment | Total yield of tomato (ton/ha) | Number of tuber per plant | Single tuber weight (g) | Tuber yield per plant (kg) | Total yield of tuber (ton/ha) |
|---|---|---|---|---|---|
| G1S1 | 29.70 d | 3.11 c | 74.00 a | 0.23 c | 5.28 c |
| G1S2 | 30.17 cd | 4.22 abc | 72.67 a | 0.30 abc | 6.69 abc |
| G2S1 | 33.99 bc | 4.00 abc | 70.89 ab | 0.28 abc | 6.25 abc |
| G2S2 | 34.38 b | 4.44 ab | 70.89 ab | 0.31 abc | 7.00 abc |
| G3S1 | 39.03 a | 4.11 abc | 64.17 b | 0.27 bc | 5.99 bc |
| G3S2 | 33.79 bc | 4.11 abc | 63.78 b | 0.26 bc | 5.82 bc |
| G4S1 | 28.11 d | 3.66 bc | 72.89 a | 0.27 bc | 6.10 bc |
| G4S2 | 27.44 d | 4.44 ab | 72.67 a | 0.32 abc | 7.12 abc |
| G5S1 | 27.76 d | 4.22 abc | 68.44 ab | 0.28 abc | 6.30 abc |
| G5S2 | 28.84 d | 4.77 ab | 70.00 ab | 0.33 ab | 7.36 ab |
| G6S1 | 26.11 d | 5.00 a | 68.50 ab | 0.36 a | 8.00 a |
| G6S2 | 27.49 d | 4.22 abc | 62.83 b | 0.27 bc | 5.94 bc |

**Appendix XI. Interaction effect of fertilizer and seedling age on days to first flowering, days to 50% flowering, plant height and number of leaf per plant, number of branch per plant, number of cluster per plant**

| Treatment | Days to first flowering | Days to 50% flowering | Plant Height (cm) | No. of leaf per plant | Number of branch per plant | Number of cluster per plant |
|---|---|---|---|---|---|---|
| FR1S1 | 37.78 ab | 57.83 a | 105.00 b | 25.44 ab | 4.66 a | 10.50 a |
| FR1S2 | 37.78 ab | 57.39 a | 104.20 bc | 24.17 b | 4.50 a | 10.56 a |
| FR2S1 | 37.67 ab | 57.94 a | 104.30 bc | 26.50 ab | 4.16 a | 10.61 a |
| FR2S2 | 38.28 a | 57.06 a | 101.30 d | 25.50 ab | 4.11 a | 10.28 a |
| FR3S1 | 37.22 b | 57.61 a | 104.00 c | 27.44 a | 4.72 a | 10.94 a |
| FR3S2 | 38.33 a | 57.67 a | 106.30 a | 27.89 a | 4.33 a | 10.33 a |

**Appendix XII. Interaction effect of fertilizer and seedling age on number of number of fruit per cluster and number of fruit per plant, single fruit length, single fruit diameter, single tomato fruit weight, yield of tomato per plant**

| Treatment | Number of fruit per cluster | Number of fruit per plant | Fruit length (cm) | Fruit diameter (cm) | Singe fruit weight (gm) | Tomato yield per plant (kg) |
|---|---|---|---|---|---|---|
| FR1S1 | 9.88 a | 133.40 ab | 4.73 a | 3.97 a | 46.56 a | 1.43 ab |
| FR1S2 | 8.66 b | 125.60 ab | 4.61 a | 4.00 a | 48.50 a | 1.30 bc |
| FR2S1 | 9.83 a | 130.10 ab | 4.57 a | 3.88 a | 46.56 a | 1.24 c |
| FR2S2 | 9.00 b | 117.60 ab | 4.68 a | 3.78 a | 47.83 a | 1.39 abc |
| FR3S1 | 9.66 a | 135.90 a | 4.42 a | 3.82 a | 48.78 a | 1.49 a |
| FR3S2 | 8.94 b | 113.30 b | 4.55 a | 3.94 a | 48.56 a | 1.42 abc |

**Appendix XIII: Interaction effect of fertilizer and seedling age on and total yield of tomato, number of tuber per plant, single tuber weight, yield of tuber per plant and total yield of tuber.**

| Treatment | Total yield of tomato (ton/ha) | Number of tuber per plant | Single tuber weight (gm) | Tuber yield per plant (kg) | Total yield of tuber (ton/ha) |
|---|---|---|---|---|---|
| FR1S1 | 31.75 ab | 3.83 a | 66.72 b | 0.25 c | 5.57 c |
| FR1S2 | 28.86 bc | 3.88 a | 65.00 b | 0.25 c | 5.60 c |
| FR2S1 | 27.54 c | 3.55 a | 63.39 b | 0.22 c | 5.04 c |
| FR2S2 | 30.78 abc | 4.61 a | 63.92 b | 0.29 bc | 6.50 bc |
| FR3S1 | 33.06 a | 4.66 a | 79.33 a | 0.37 a | 8.35 a |
| FR3S2 | 31.42 abc | 4.61 a | 77.50 a | 0.35 ab | 7.87 ab |