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RESPONSIS OF BIO-FERTILIZER AGAINST GROWTH AND YIELD OF DIFFERENT TYPES OF *Solanum lycopersicum*

Muhammad Fezan Arshad[1*], Faheem Ahmed Khan[2], Abida Parveen[3], Sumaira Thind[3]

[1]*Department of Botany, Mirpur University of Science and Technology (MUST), Mirpur-10250 (AJK) Pakistan*
[2]*Department of Allied Health Sciences, Iqra National University, Phase 2 Hayatabad, Peshawar, Khyber Pakhtunkhwa- 25000, Pakistan*
[3]*Department of Botany, Government College (GC) University, Faisalabad*

Corresponding Author Email: fezanraja786@yahoo.com

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ABSTRACT

The present research work is based on the effect of bio-fertilizer on development and productivity of the tomato as the most commercially important crop across the map. Tomato seeds were collected from NARC (National Agriculture and Research Center) and inoculated with biofertilizer. Two groups of seeds were inoculated and controlled experiment was performed. The emergence of seedling, flowering and fruiting occurred at different time in different varieties. These varieties of seeds of tomato were used mainly grouped into two categories one group as inoculated while other as control group. Seed germination occurred after 7 days of sowing. After 120 days plants were matured. The result of this experiment showed that seeds inoculated with biofertilizer increased growth charateristics and production of tomato varieties whereas Nadar is declared a good variety of tomato with maximum increased growth and productivity when inoculated with biofertilizer. It showed maximum shoot length (66 cm). Other two varieties Roma and Piogrande also showed higher shoot length (56 cm, 55 cm) respectively. It was observed that the inoculated varieties indicated more leaves number, flowers number and fruits. Length of plants, leaves width, roots enlargement and the size of fruits were also increased as comparison to control. It was concluded that biofertilizers increased the growth and productivity of tomato varieties that have better potential and good alternative source for better growth of commercially important tomato varieties.

INTRODUCTION

Tomato is one amongst the foremost economically vital and loosely full-grown vegetable crops within the world ranking second once potato. Ripe tomato could be a smart supply of minerals and nourishment "c" and carotenoids. Production of tomato depends upon soil nutrition seedling institution and plant protection measures. The tactic of nutrient application plays a very important role in supply the nutrient to plants, as a result of the effectuality of fertilizers applied in soil being low because of varied losses and fixations (Narayan *et al*., 2008).

Since tomato may be a gentle season tender vegetable yield, thus it is troublesome for raising it and find its best crop in an exceedingly one cultivation division of Asian nation around year below ordinary climate thanks to extremeness in the temperature. In Asian nation there are typically two types of crops of one in the craggy areas and second in plains. In plains maturation of tomato occur in gentle winter season whereas craggy areas it is grown in summer thanks to convenience of calm temperature. In plain stomato were seeded and transplanted around mid-October and it may also seeded around mid- November (protected nursery growing) and tomato is transplanted around phase of time once danger of cold is over (Ho and White. 2005).

Generally, Solanaceae vegetables need profusion of major nutrients like chemical element, phosphorus and potassium, additionally to secondary nutrients like Sulphur and iron for quality crop and higher growth. The value of inorganic manures has been hugely increasing to associate extent that they're out of reach of the little and marginal farmers. It has become impractical to use such expensive inputs for a crop of marginal returns. The utilization of PGPRs in such state of affairs is, therefore, a much paying proposal. Phosphorus-solubilizers are PGPRs that solubilize phosphorus in soil and build it on the market for plants. While, Azospirillum, a heterotrophic chemical element fixing organism are reported to be useful and economical on many crops (Chaparro *et al.,* 2014).

The present farming wholly depends on use of pesticides, chemical fertilizers and growth regulators for increasing crop productivity. Bit by bit culminated in an exceedingly scenario wherever in required to rethink the choice to chemical agriculture as gradually developed within the western world. It's a well-documented indisputable fact that exaggerated dependence on agro-chemicals together with fertilizers has led to many sick effects on the

atmosphere. Organic farming may be a production scheme that avoids or for the most part eliminates the utilization of synthetically made insecticides, growth promoters, farm animal fodder flavors and manures farm animal fodder flavors (Ji *et al.*,2006).

PGPRs are carrier-based measures holding helpful microorganisms in an exceedingly executable state planned for seed or soil application to extend soil fertility and plant development by enhancing the biological activity and quantity of useful microorganisms within the rhizosphere. They improve soil fertility level by exploitation atmospheric gas, solubilizing insoluble soil phosphates and liberating plant growth elements within the loam. PGPRs are worth effective, ecological, and reusable sources of plant nutrition (Khan et al, 2007).

PGPR are assortment bacterium that colonize the root of plant and will increases the plant yield and growth. Important increase in yield and growth of crop by the action of immunization with biofertilizer has been delineating. One more major importance of biofertilizer is to create bactericide compounds which are effective against bound plant infectious agent and pests. Furthermore, PGPR facilitate organic management indirectly by manufacturing induced systematic resistance against variety of plant diseases. Beneath salt stress, PGPR have useful impact in plants on such parameters as drought tolerance germination rate, plant growth, and yield (Naili *et al.,* 2018).

MATERIALS AND METHOD

A soil plot culture evaluation was conducted during February 2019 to evaluate efficiency of biofertilizer on growth and productivity of tomato (*Lycopersicon esculentum*) variety Nadar, Roma and piogranda were collected from the NARC (National Agriculture and Research Center).

COLLECTION OF BIOFERTILIZER

Biofertilizer was collected from AARI (Ayub Agriculture Research Institute). PGPR were used for inoculation of seeds.

FIELD PREPARATION

Soil typescript of Investigational Site

From depth of 0 to 30 cm in loam, the samples of loam are collected randomly at site of experiment before sowing. Analysis was done for different chemical & physical characters. The soil which is used for the experiment has sandy nature. This soil is rich in minerals and nutrients.

Design and Layout

The experimentation was done in random blocks having six treatment combinations & two replications.

Salient Features of Cultivar

The 3 varieties of tomatoes were used in the study, which was collected from the National Agriculture and Research Center. These tomato plants become mature in 115 to 120 days & plant reaches the height of 168 to 192 cm. The plant takes 57 and 65 days in kharif and Rabi Respectively. These plant verities have resistance against leaf blight & Downy mildew. Further it is resistant to stalk borer, corn and ear worm and flea beetles.

Land Preparation

The investigational soil was mechanically tilled for two times with the help of plough and harrow. Then the soil was leveled with the help of different instruments. By bunds of15 cm height and 20 cm width each plot was bounded. The channel of 30 cm width was opened for irrigation.

Seeds and sowing

Furrows were opened at 60 cm intervals using a hand hoe prior to seeding. In each hill, two to three seeds were strewn at 30 cm intervals. Sowing began on March 23, 2019. For seeding, certified tomato seedlings were utilized.

Thinning

Thinning was performed ten days following seedling emergence by plucking out surplus seedlings in each hill and eventually retaining just one seedling per hill.

Weed management

Hand weeding was done thrice at 25, 45 and 70 days after sowing and 2 times inter cultivation by passing hoe was carried out at 30 and 45 days after sowing, to keep all the plots weed free throughout the crop growth period.

Harvesting

From the 3rd to the 4th of December, 2018, the crop was harvested after reaching physiological maturity in several plots. As border rows, two rows on each side of each plot were collected, and the remaining space was the net plot. Each net plot's produce was collected and threshed separately. Grain and Stover were sun dried separately and weighed. The figures were then translated to per hectare.

Biometric observations

For recording growth parameters Five plants from every plot were arbitrarily elect and labeled at totally different growth stages viz, 30, 60 and 90 days after sowing and at the harvest of the crop.

Growth parameters

Plant Height

Took 5 labeled plants and measure the height of each plant from the tip to the base of plant. Average height of plant was figured out and expressed in centimeter.

Variety of Leaves per Plant

Counted the number of leaves of 5 labeled plant of all varieties. And also, the average number of leaves per plant was counted at totally different growth stages of crop.

Variety of Branches per Plant

Numbers of twigs rising on the central shoot were counted on of 30, 60 and 90 Days. For every replication, quantity of branches per plant was recorded and apply analysis.

Variety of Flowers per Plant

Number of flowers was calculated from every duplication of all plant groups at sixty days. The typical number of flowers per plant of every replication was recorded and subjected for statical analysis.

Variety of Fruits per Plant

The quantity of fruits was counted for every plant when ninety days. The typical recorded knowledge was subjected to statical analysis.

Contemporary Weight of Fruit

The contemporary weights of fruits were taken at fruiting stage The gathered data of weight was subjected to statical analysis.

Total Yield for each Plant

The whole yield of tomato for each plant was taken. The specific data is subjected to statical analysis.

Dry matter accumulation and distribution

The dry matter production of five randomly selected plants was measured at various phases of development. The plants were divided into three categories: leaves, stems (including sheaths), and cobs with husk. These samples were dried in a hot air oven at 65 to 70 0C until they reached a consistent weight and dry weight. To quantify dry matter accumulation in different sections, dry weight was recorded independently at each stage, and total dry matter output was represented in grammes per plant.

Analysis of soil

Range of Soil Samples

During the field experiment, a composite soil sample was obtained from each plot before seeding as well as after the maize crop was harvested. The soil samples were collected, dried in the shade, pulverised using a wooden pestle and mortar, passed through a 2 mm screen, and stored for analysis. The 2 mm sieved soil samples were ground further and put through a 0.2 mm sieve for organic carbon measurement.

Knowledge Analysis

Fisher's method of analysis of variances was adopted for statistical analysis and interpretation of the data. The level of significance used in T-test was P = 0.05. Critical distinction (CD) worth was calculated solely where the 'F' tests was found vital. ANOVA and DMR accustomed analyzed the information.

RESULTS

The current study was conducted during 2018-19. This work comprises of biofertilizer effect on productivity and growth of three varieties tomato (*Lycopersicom esculentum).* Three verities of tomato were selected with two different preparations where each variety was inoculated with biofertilizer and un-inoculated control.

Effect of Biofertilizer on Plant Shoot Length

Plant inoculated with biofertilizer show growth in tallness as compare to the un-inoculated control plants. Each inoculated variety show slight difference in shoot length. Nadar shows maximum shoot length of 60-64cm in 115-120 days after seed germination. Roma shows maximum shoot length of 57-60cm and Piogrande shows maximum shoot length of 55-57cm.

In un-inoculated control varieties of Nadar shows shoot length of 50-53cm, while Roma shows shoot length of 47-49cm and Piogrande show shoot length of 4447cm.

Effect of Biofertilizer on Number of Leaflets

Leaves of tomato are compound. Number of leaflets varies from plant to plant and also from variety to variety. Inoculated varieties, Nadar contains maximum number of leaflets 84 per plant. Roma contains 78 leaflets per plant. Piogrande contains 68 leaflets per plant

In un-inoculated varieties, Nadar contains maximum 60 number of leaflets per plant. Roma contains 54 leaflets per plant. Piogrande contain 46 leaflets per plant.

Effect of Biofertilizer on Length and Width of Leaflets

Length of leaflets varies from plant to plant and also from variety to variety. In inoculated treatment varieties shows increase, Nadar contain maximum length and width of leaflets. It shows length of 13cm and 4cm width. Roma show 12cm and 3.4cm width and Piogrande show 11cm length and 3.2 cm width of leaflets.

In un-inoculated or controlled treatment varieties contain different length and width of leaflets, Nadar contains maximum length of 10cm and 3.8cm width. Roma shows 7.4cm length and 3.3cm width and Piogrande shows 5,8cm length and 3.1cm width of leaflets.

Effect of Biofertilizer on Number of Lateral Branches per Plant

Number of lateral twigs in tomato varies from plant to plant and also from variety to variety. In inoculated varieties, Nadar contain 16 branches per plant. Roma contains 14 branches per plant and Piogrande contain 13 branches per plant. In un-inoculated or controlled treatment varieties contain different number of branches, Nadar contain 10 branches per plant. Roma contains 8 branches per plant and Piogrande contain 7 branches per plant.

Effect of Biofertilizer on Number of Flowers

Flowers are the reproductive stage of plant. When plant is at mature stage flowers are formed on its leaflets. Flowers formed on plant 12-14 weeks after germinating. Tomato is self-pollinating plant. Number of flowers varies from plant to plant and also from variety to variety. In inoculated varieties, Nadar contain 12 flowers. Roma contains 9 flowers and Piogrande contain 9 flowers. In un-inoculated or control treatment varieties contain different number of flowers per plant, Nadar contain 7 flowers at a given time. Roma contains 5 flowers at a time and Piogrande contain 5-4 flowers.

Effect of Biofertilizer on Number of Fruits

When fertilization occurred in flower fruit is formed. Fruit formed after 15-16 weeks. Number of expected fruits on plant varies. In inoculated varieties, Nadar contain 7 fruits. Roma contains 6 fruits. Piogrande contain 5-6 fruit at a given time

In un-inoculated or control treatment varieties contain different number of fruits. Nadar contain 6 fruits. Roma contains 5 fruits and Piogrande contain 6 fruits at a time.

Effect of Biofertilizer on Size of Fruit

Varieties show a minor difference in size of fruit. In inoculated treatment Nadar shows the 9 cm size of fruit. Roma shows 7cm and Piogrande shows 6cm. In controlled or in-inoculated treatment verities show minor difference. Nadar shows 7cm fruit size. Roma shows 6cm and Piogrande shows 5cm fruit size.

Effect of Biofertilizer on Size of Root

Number of roots in inoculated treatment varies in size. Tomato root system is fibrous. Length of roots varies from plant to plant and also from varieties to varieties. Nadar shows maximum length of 10cm. Roma shows root length of 9cm and Piograndeshow length of 8cm. In un-inoculated treatment or control conditions varieties show different length. Nadar show length of 9cm. Roma shows length of 7cm. Piogrande shows length of 5cm of root.

Table 1: Biofertilizers effect on the development of inoculated verities of tomato.

S. No	Parameters	Varieties (cm)		
		Nadar	Roma	Piogrande
1	Shoot length	66	56	55
2	No. of leaflets	81	77	71
3	Length of leaflets	13	12	11
4	Width of leaflet	4	3.4	3.2
5	No. of branches	16	14	13
6	No. of flowers	18	15	13
7	No. of fruit	7	6	5
8	Size of fruit	9	6	7
9	Size of root	10	9	8

Table 2: Controlled Treatment (Un-Inoculated)

S. No	Parameters	Varieties (cm)		
		Nadar	Roma	Piogrande
1	Shoot length	53	49	47
2	No. of leaflets	60	54	46
3	Length of leaflet	10	7.4	5.8
4	Width of leaflet	3.8	3.3	3.1
5	No. of branches	10	8	7
6	No. of flowers	12	9	7
7	No. of fruit	6	5	5
8	Size of fruit	7	6	5
9	Size of root	8	7	5

Table-3: Range and Average Values of Physio-Chemical Properties of Soil Samples of District Bhimber

S. No		Range	Average
1	Soil Ph	6.88-8.06	7.56
2	Organic material	0.65-2.07	1.18
3	Lime%	1.00-9.37	4.18
4	Sand%	3.12-81.12	64.39
5	Silt%	8.56-46.00	22.99
6	Clay%	8.88-26-88	12.95

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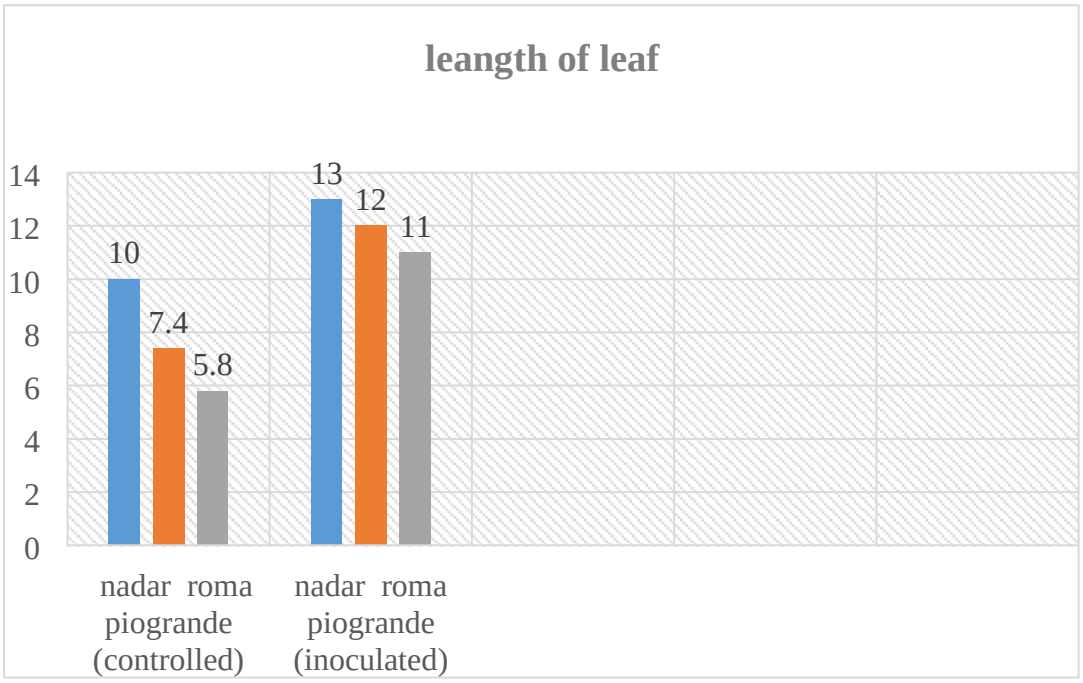

Fig. 1: Length of leaf in inoculated and un-inoculated verities of tomato.

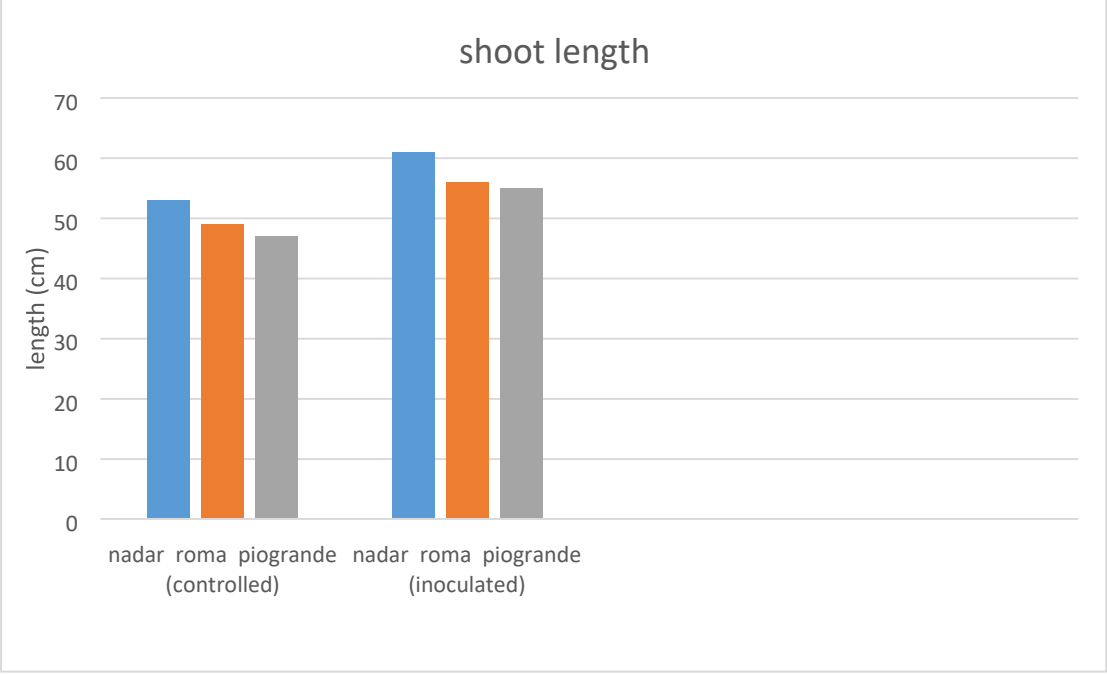

Fig. 2: Shoot length in inoculated and un-inoculated verities of tomato.

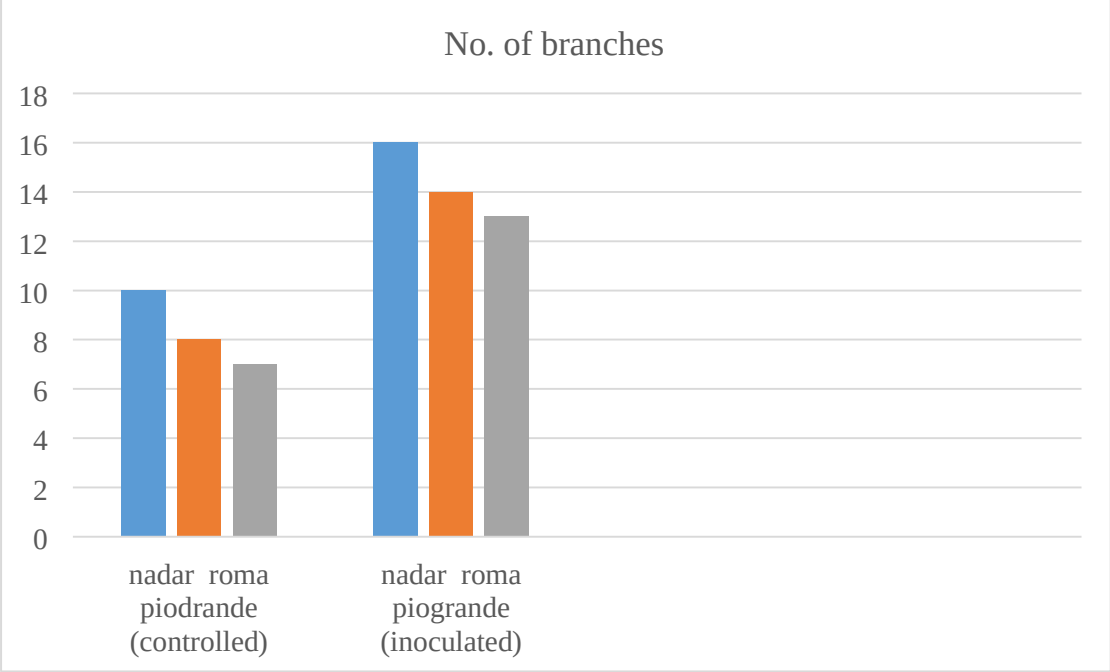

Fig. 3: Number of branches in inoculated and un-inoculated verities of tomato.

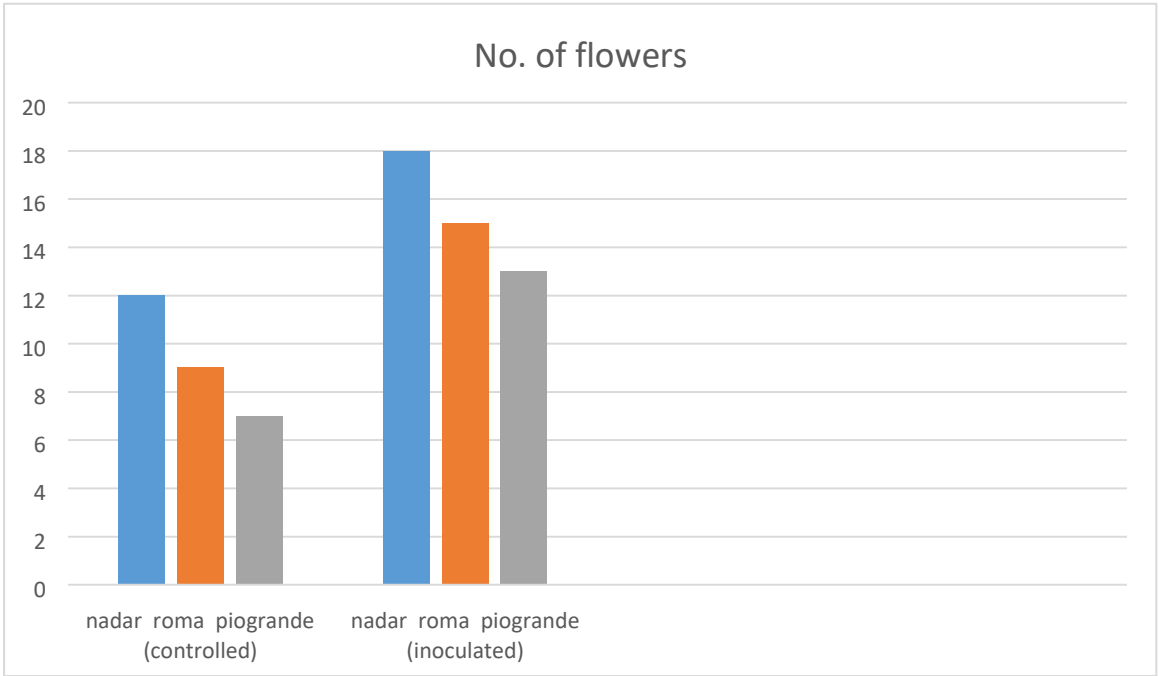

Fig. 4: Number of flowers in inoculated and un-inoculated verities of tomato.

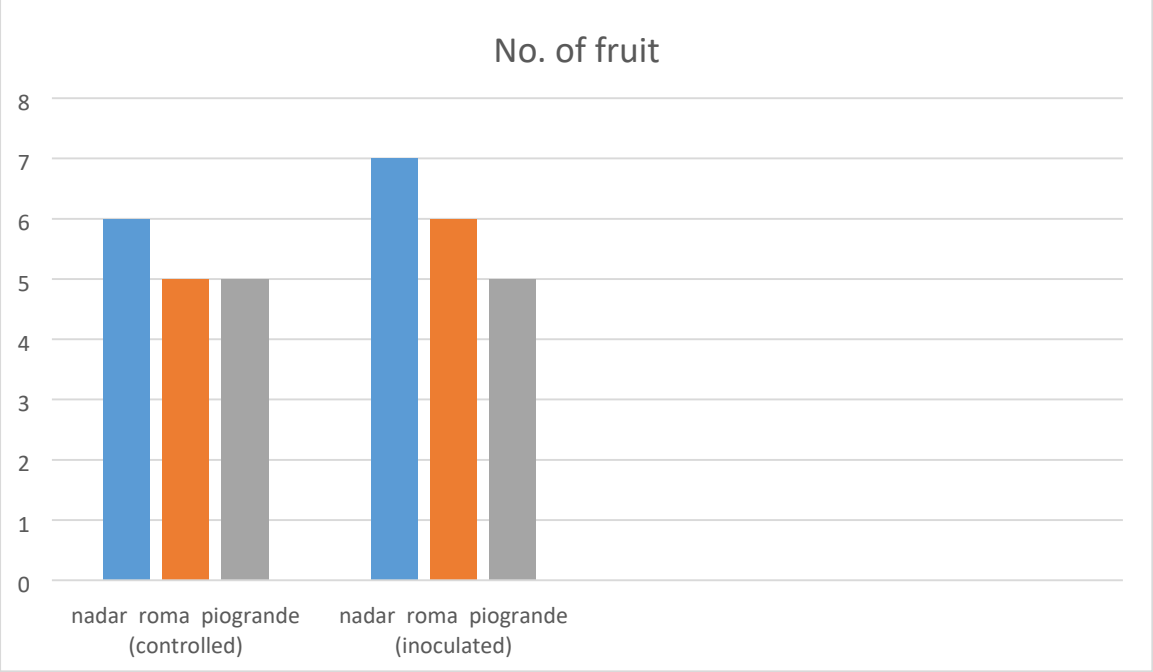

Fig. 5: Number of fruit in inoculated and un-inoculated verities of tomato.

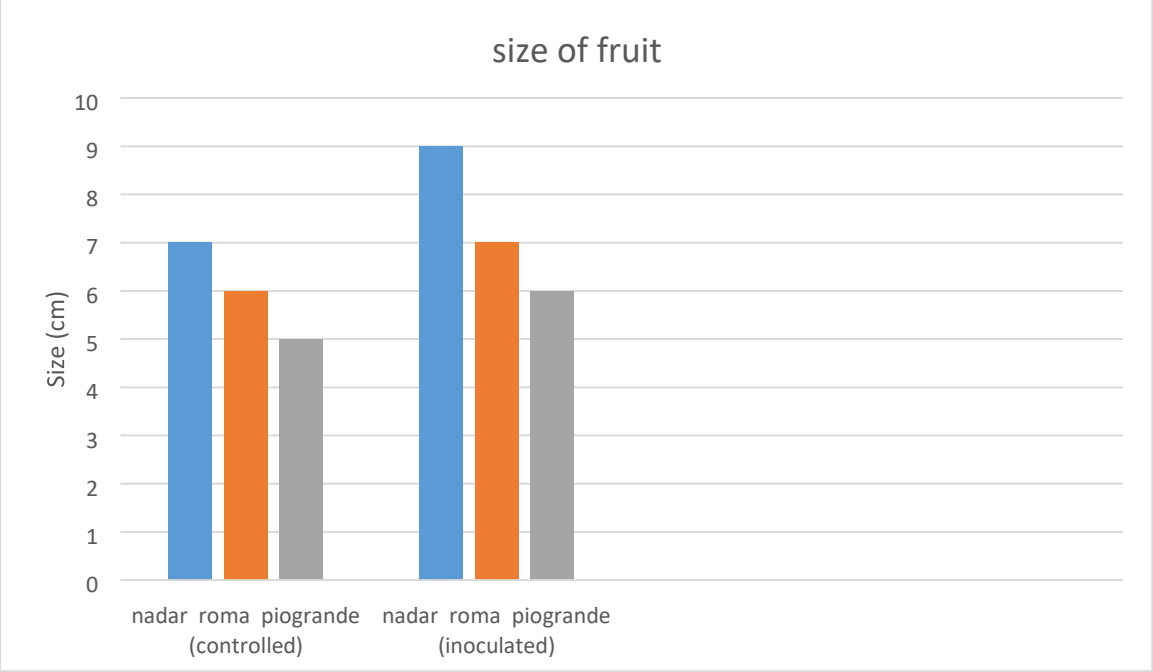

Fig. 6: Size of fruit in inoculated and un-inoculated verities of tomato.

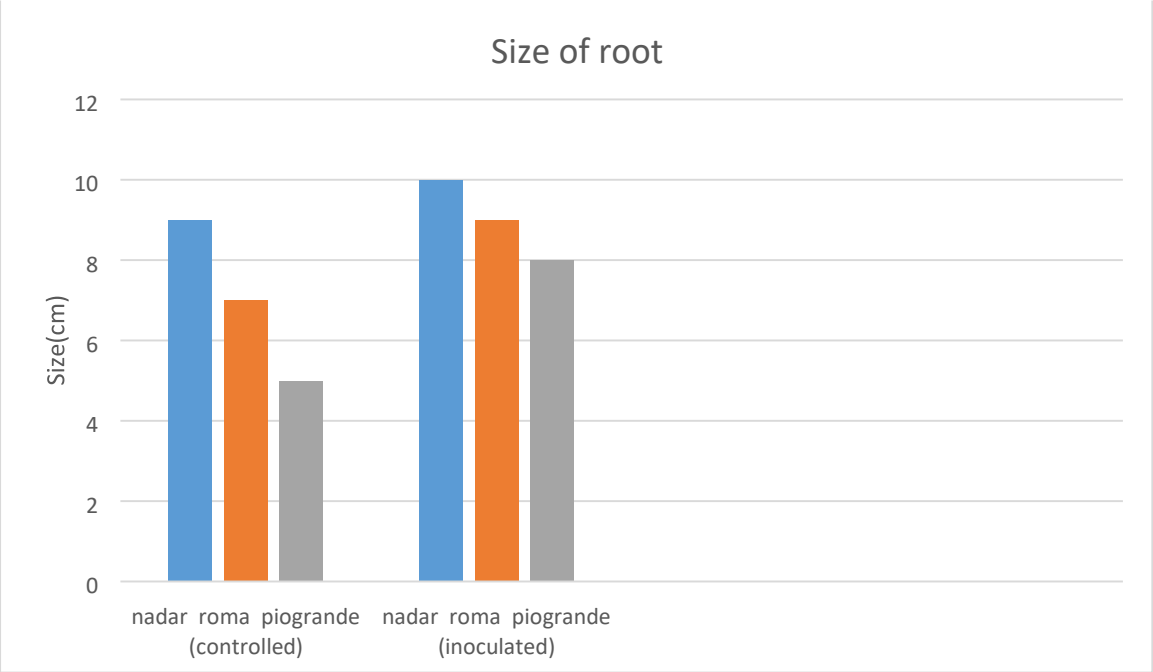

Fig. 7: Size of root in inoculated and un-inoculated verities of tomato.

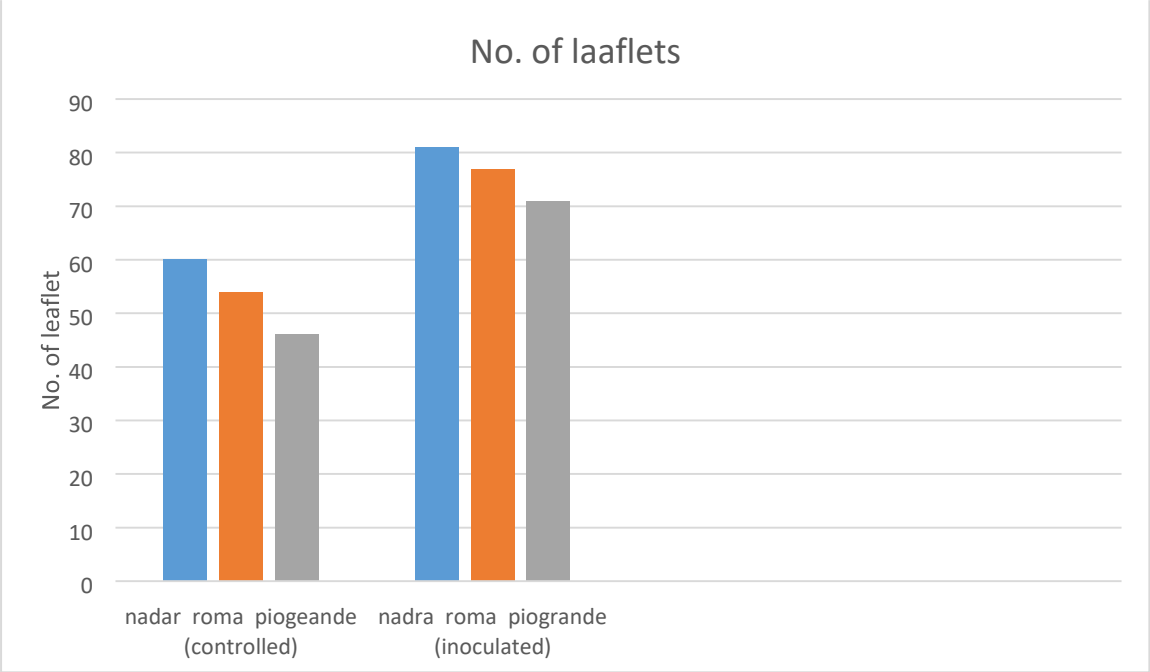

Fig. 8: Number of leaflet in inoculated and un-inoculated verities of tomato.

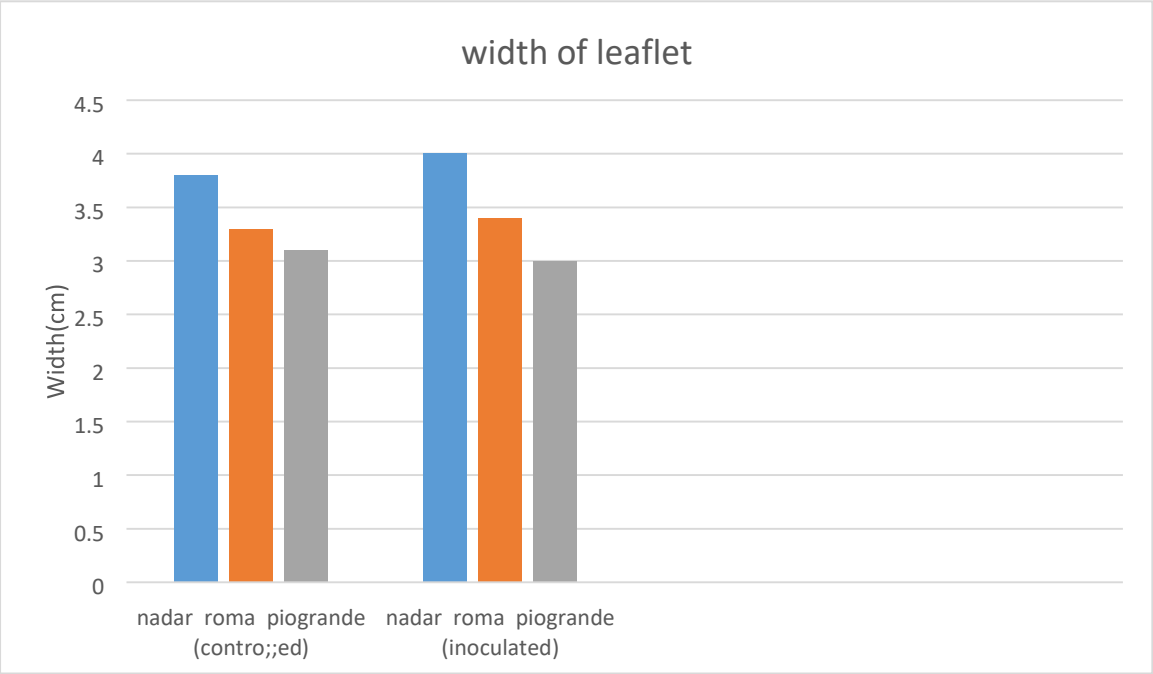

Fig. 9: Width of leaflet in inoculated and un-inoculated verities of tomato.

DISCUSSION

Seeds of all the 3 varieties are inoculated with biofertilizer by combining seed with biofertilizer response ready by adding sugar solution and let it dry at temperature in an exceedingly shady place. Inoculated seed and controlled seeds planted in soil beds. Germination of seeds and formation of spermatophyte started when every week, proceeded by accrued plant growth when few weeks. Inoculated verities showed dark inexperienced color as compare to the controlled ones. when 12-15 weeks flowering occurred in controlled and inoculated plants. Inoculated varieties show increase in growth and production of tomato. Controlled varieties contain short stem and root as compare to inoculate plants.

Seeds inoculated with biofertilizer showed increase in growth and development. 3 varieties showed increase in growth and development. Inoculated Nadar showed most increase in root length of (10cm) and in controlled Nadar root length was (8cm), inoculated Roma showed root length of (9cm) and in controlled Roma root length was (7cm), inoculated Piogrande showed root length of (8cm) and in controlled Piogrande root length was (5cm). Inoculated Nadar showed shoot length of (66cm) and just in case of controlled shoot length is (53cm), inoculated Roma showed shoot length of (56cm) and just in case of controlled shoot

length was (49cm), inoculated Piogrande showed shoot length of (55cm) and just in case of controlled shoot length was (46cm).

Inoculated Nadar have 81 number of leaves and controlled have 60 number of leaves, inoculated Roma have 77 number of leaves and controlled have 54, inoculated Piogrande have 71 number of leaves and controlled have 46. Inoculated Nadar showed 13cm length of leaf and just controlled show 10cm length of leaf, inoculated Roma shows 12cm length of leaf and controlled show 7.4cm length of leaf, inoculated Piogrande showed 11cm length of leaf and controlled leaf was 5.8cm of length.

Inoculated Nadar showed 16 branches per plant and controlled have 10 branches per plant, inoculated Roma contain 14 branches per plant and controlled have 8 branches per plant, inoculated Piogrande showed 13 branches per plant and controlled have 7 branches per plant.

Inoculated Nadar showed 18 number of flowers and controlled have12 number of flowers, inoculated Roma have 15 flowers and controlled have 9 flowers, inoculated Piogrande showed 13 flowers and controlled show 7 flowers. Inoculated Nadar gave 7 fruits at a given time and controlled gave 6 fruits, inoculated Roma contain 6 fruits at a given time and controlled gave 5 fruits, inoculated Piogrande have 5 fruits at a given time and controlled also have 5 fruits.

Ordookhani *et al.,* (2010) showed that PGPR will increase tomato fruit quality. It should be associated with increasing of minerals by plant inoculated. Accrued uptake of nutrient by inoculated plants with microorganism that promote growth of plant has been attributed to the assembly of plant growth controllers at the foundation interface that stirred up development of root and caused in higher absorption of water and nutrients from the soil.

CONCLUSION

Application of biofertilizer improves the growth and productivity of tomato (*lycopersicon esculentom)*. The increase in crop might be because of the positive effect of applied biofertilizer that enhanced growth of root and improved uptake of nutrient. In the performance of biofertilizer, there were variances on development and productivity of different varieties of tomato. Tomato seeds inoculation with biofertilizer has the potential to enhance the growth and productivity of tomato.

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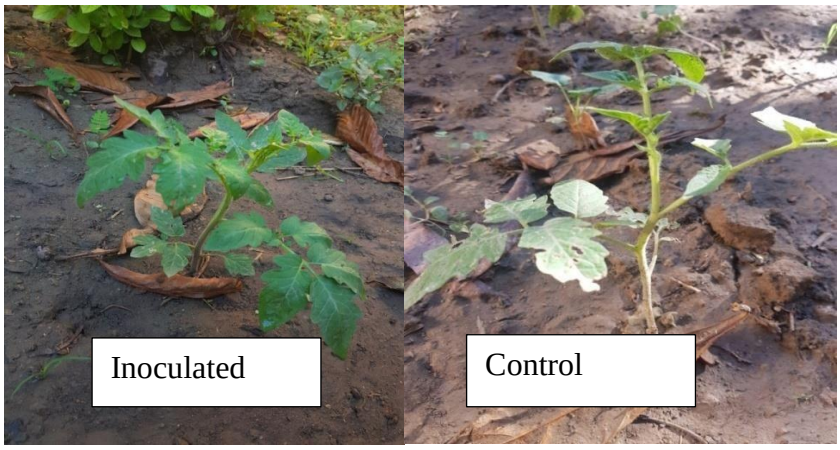
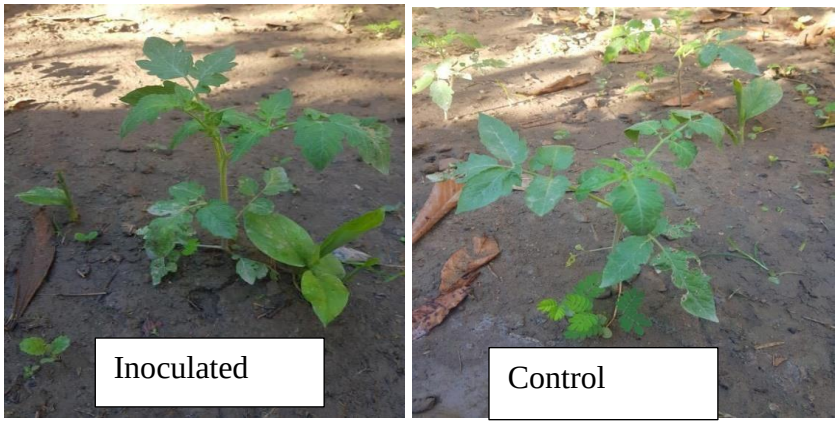
APPENDIX



Appendix 1: Nadar Variety (inoculated and Un-inoculated)



Appendix 2: Roma Variety (inoculated and and Un-inoculated)