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Production of ‘‘Tomaloo’’ Plant Through Grafting Tomato on Potato at IUBAT: A Promising Technology for Bangladesh Agriculture

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Compatibility; Grafting; Propagation; Production; Rootstock; Scion; Tomaloo; Technology.

Abstract

An experiment was conducted at the Agricultural Research Field of International University of Business Agriculture and Technology (IUBAT), Dhaka, Bangladesh from November 2017 to March 2018 to investigate the potentiality of producing tomato and potato from a single plant using grafting technology. In this study, tomato was used as scion and potato as rootstock. Two tomato varieties such as Red Cherry tomato, BARI Tomato-15, and a potato variety Diamant were used in this experiment. Regarding their respective success of grafting on potato, both tomato varieties showed a higher degree of compatibility. The Cherry tomato variety showed 96% success in the union process, while the BARI Tomato-15 showed 94% success. The maximum plant growth was found in Cherry tomato from both non-grafted and grafted plants being 130.56 cm and 115.06 cm respectively. Whereas, 108.36 cm and 95.44 cm were recorded from BARI Tomato-15 non-grafted and grafted plants respectively. The grafted plant (Cherry tomato + Potato) produced 2.73kg tomato + 0.48kg potato per plant and BARI Tomato-15 + Potato produced 2.3kg tomato + 0.49kg potato per plant respectively. Whereas a single Cherry tomato plant produced 3kg of tomato, BARI Tomato-15 produced 2.91kg of tomato and Diamant produced 0.56kg of potato per plant.

1. Introduction

Bangladesh is an agricultural country. Agriculture is the main source of income for both the population and the economy. Growing vegetables significantly enhances the socio-economic status of marginal and small-scale farmers, driven by the rising demand attributed to evolving dietary preferences, emphasis on balanced nutrition, higher yield per unit area, and increased profitability per unit area of vegetables. So, vegetables are more economical to grow and have a significant role in nutritional security for the human being. Tomato (*Solanum lycopersicum*) and potato (*Solanum tuberosum*) are the two most important solanaceous high-valued vegetables commercially grown in Bangladesh for their usefulness economic and nutritional value.

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Potato holds significant agricultural importance in Bangladesh as one of the essential vegetables, which produces up to 67% of its total vegetable production (BBS, 2021). Another important vegetable crop is the tomato. Because it can be produced in a wide range of agroclimatic environments, from home gardens and greenhouses to large commercial farms, it is consumed in most parts of the world (Laily *et al*., 2021). Tomatoes are widely grown vegetables that rank third in the world in terms of vegetable production (Javaria *et al*., 2012). Bangladesh produced 442 thousand metric tons of tomatoes during 2021-2022 (BBS, 2022).

In Bangladesh, nearly four million individuals, with over a million being women, are engaged in commercial or homestead vegetable cultivation. Presently, 3.73 million tons of vegetables are produced annually from 2.57 percent of Bangladesh's total land area (Haque & Hoque, 2021). The country has achieved self-sufficiency in cereal food production; however, it still faces a shortfall in vegetable production, which serves as the primary source of nutrition. The population is also increasing day by day; on the other hand, Bangladesh is losing 0.19 percent of agricultural land every year (BBS, 2019). This is putting further pressure on fulfilling the increased demand for vegetables. This clearly indicates that there is substantial scope for increasing vegetable production in Bangladesh.

Therefore, the time has come for the innovation of new technology to increase vegetable production from minimum land through the process of grafting- a method of asexual propagation. “Tomaloo” production technology might be one of them to ensure the nutrition security of the country.

Tomato and potato are members of the Solanaceae family and are also under the same genus Solanum. From this scientific information, it was thought that because of their close proximity to genetic makeup, there could be a greater chance of achieving a successful graft union. Such a compatible and successful graft union would produce a new plant named “Tomaloo” whose upper part would produce tomato and underground part would produce potato. This innovative approach would introduce a beneficial practice for growers. Cultivating two plants in one for dual crops could prove highly beneficial, especially for small-scale growers, while simultaneously holding immense potential for commercial production including rooftop gardening. With this background, the possibility of “Tomaloo” plant production by grafting was explored at IUBAT.

2. Materials and Methods

The present research work was conducted at the Agricultural Research Field of IUBAT-International University of Business Agriculture and Technology, Dhaka Bangladesh, during the period from 22 November 2017 to 28 March 2018. The site is under the Agro-Ecological Zone–Modhupur Tract (AEZ 28). Geographically the experimental field is located at 23.8883° N latitude and 90.3907° E longitude. The geographic position of the experimental site is in the sub-tropical zone, characterized by the dry season from November to March.

2.1 Experimental Materials of “Tomaloo” Plant Production

The “Tomaloo” plant was created by grafting tomato with potato, where the tomato plant was used as scion and the potato plant was used as rootstock. The experimental materials were two tomato varieties Red Cherry tomato, BARI Tomato-15, and a potato variety Diamant.

2.2 Treatment and Design of the Experiment

The experiment was laid out in a Completely Randomized Design (CRD) with two tomato varieties and one potato variety. Fifty (50) number of each of tomato scions of cherry and BARI 15 varieties were grafted with potato rootstock. While the other fifty plants of each of the tomato variety and potato were treated as control. This study was conducted to find out grafting success to create a new plant using tomato scion and potato rootstock. It was also tested to find out the production comparison between grafted and non-grafted tomato and potato plants.

2.3 Land Preparation

The land was repeatedly plowed and cross-plowed, and then the surface was leveled using laddering. Both stubble and weeds were pulled out. The clods were broken and the earth was turned over at the same time.

2.4 Application of Manures and Fertilizers

Manure and fertilizers were applied following Fertilizer Recommendation Guide-2018 (Ahmmed *et al.,* 2018) for tomato and potato. The amount of manure and fertilizers applied was an average of the two crops. As such rate of fertilizers used was well rotten cow dung @5 t/ha, urea @400 kg/ha, TSP @250 kg/ha, and MoP @300 kg/ha. of these, the total amount of cow dung, TSP, and MoP was applied during land preparation and urea was applied in two installments as top dressing on standing crops.

2.5 Raising of Tomato and Potato Seedlings

At first tomato seeds were sown in a seedbed to raise seedlings to be used for scion preparation. At the same time, potato tubers were planted in the field for rootstock production. When tomato (20-22 days aged) and potato (15-18 days aged) seedlings were 10-15 cm in height, they were ready for grafting (Plate 1 A & B).

2.6 Method of Grafting

The cleft grafting method was followed in this study. Here, the potato plant was used as rootstock. The top of the rootstock was severed just below a node about 10-15cm from the base with the help of a secateurs. Some leaves were kept at the basal nodes. A sharp grafting knife was then placed at the center on the top of the cut surface and was carefully pressed down to 3-4cm deep to make the cleft (Plate 1C). Similarly, scion was collected from raised tomato seedlings. A ‘V’ shaped cut of 3-5cm was given at the base and on both sides of the scion (Plate 1D). The prepared scion was then inserted into the open cut of the prepared rootstock in such a way that the cambium layer of stock and scion on both sides came in close contact (Plate

1E). Then the cut parts were tied tightly with a polythene strip. The union area together with the scion and rootstock was covered with an appropriate size of polythene bag. After 7-10 days of grafting new shoots came out from the scion part indicating success of grafting. Then polythene bag was removed and the grafts were allowed to grow. The plants for grafting were selected based on the rootstock's similar diameter to the scion, which was naturally strong and free from disease and pest attack. Scion and rootstock were appropriate and the diameter was pencil-like. In this experiment, only the cleft grafting method was tried, performance of other methods of grafting should also be tested.

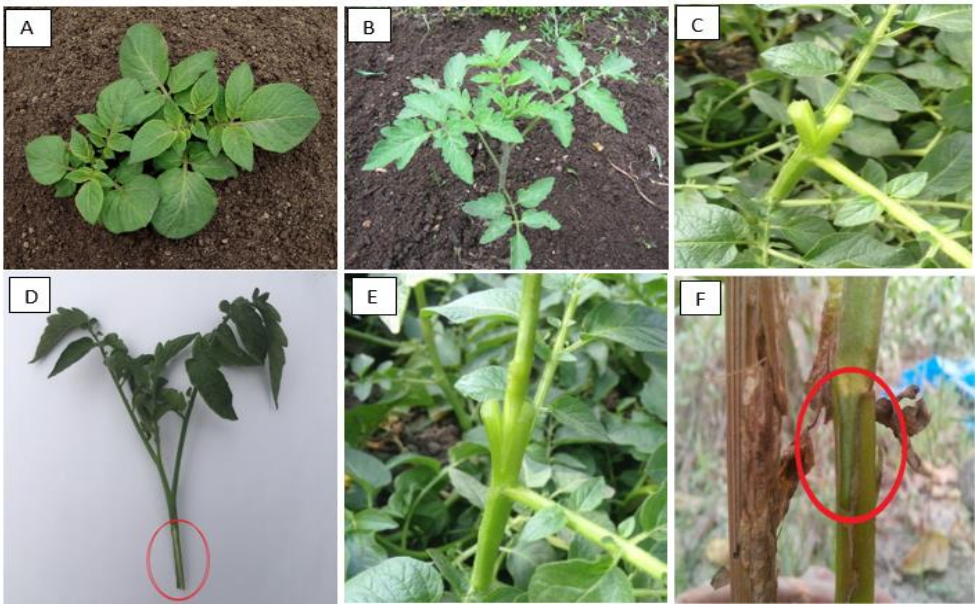

Plate 1. Photograph showing the different stages of "Tomaloo" plant production. (A) Raising of potato seedling from potato tuber, (B) Raising of tomato seedling, (C) Preparation of rootstock, (D) Preparation of scion, (E) Inserted tomato scion on potato rootstock, and (F) Showing how union takes place in "Tomaloo" graft.

2.7 Intercultural Operation

After successful graft union, various intercultural operations, such as irrigation, weeding, thinning, etc., were carried out as necessary to promote optimal growth and development of the plants. Irrigation was given as and when required. Weeds were removed from the field when needed.

2.8 Harvesting

Harvesting was done with the ripeness of tomatoes. The first harvest was done on 26th February 2018 and afterward, it was done at an interval of 5 days from the "Tomaloo" plant. Final harvesting was done on 28th March 2018 along with potatoes.

3. Results and Discussion

Results on the performance of “Tomaloo” plants concerning the percentage of successful grafting, final plant height, and yield per plant have been presented (Fig 1-3).

3.1 Success in “Tomaloo” Graft Production

It appears from Fig. 1 that grafting between tomato and potato was successful. Both the varieties of tomato showed a higher degree of compatibility regarding the success in grafting on potato. The Cherry tomato variety showed 96 percent success in the union process, while BARI-15 showed 94 percent success. Both the varieties of tomato showed a higher degree of success in grafting with the Diamant variety of potato. Such a result indicated a positive response of acceptability of both the species leading to a grafting success and production of this new plant named “Tomaloo”. The acceptability of grafting might have been due to genetic closeness or compatibility among the species.

The botanical compatibility between the rootstock and the scion serves as the fundamental factor determining success in grafting (Bletsos & Olympios, 2008). The performance of grafting relies on the compatibility between the scion and rootstock. The vascular tissues of both need to make contact for cambial division, with the formation of secondary vascular tissues, to occur at the union site (Moore 1984). To create extremely compatible grafts, plants in the same family are typically grafted together. To increase fruit quality and productivity, grafting techniques are commonly utilized in the Solanaceae family, which includes tomatoes and eggplant (Flores *et al.*, 2010; Gisbert *et al.*, 2011; Moncada *et al.*, 2013). A previous investigation by Yasinok *et al.*, (2009) reported that an innovative method for producing tomatoes is tobacco-tomato grafting. Approximately 90% of the tobacco-tomato graft unions formed under low relative humidity levels (45–55%) survived.

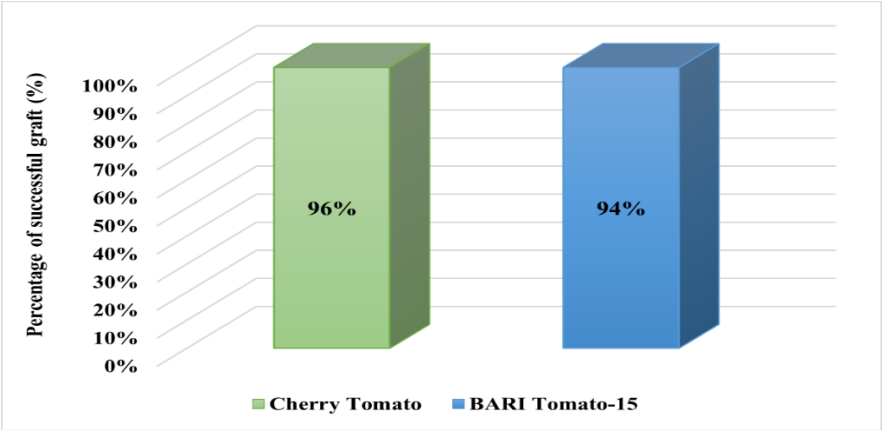

Figure 1: Successful “Tomaloo” plant production as affected by grafting two varieties of tomato scion on the potato rootstock

3.2 Effect of Grafting on the Growth of "Tomaloo" Plant

After the successful grafting of "Tomaloo" plants their performance in terms of growth was studied. The result may be noted from Fig. 2. Initially the growth was measured by the height attained at the time of harvesting of the crops. The plant height of "Tomaloo" plant was 115.06 cm and 95.44 cm in tomato verities Cherry and BARI-15 respectively with Diamant variety of potato, whereas only tomato varieties Cherry and BARI-15 produced 130.56 cm and 108.36 cm respectively. However, the potato plant reached a height of 42.89 cm. It appears to be clear from the present result that individual tomato plants as well as the "Tomaloo" plant attained more or less a similar height. The existing small difference in height may be accounted for disturbance cause by grafting. This clearly indicates a higher degree of compatibility irrespective of tomato varieties regarding success in grafting followed by growth of "Tomaloo" plant.

Plate 2. "Tomaloo" graft has started flowering at IUBAT Agricultural Research Field

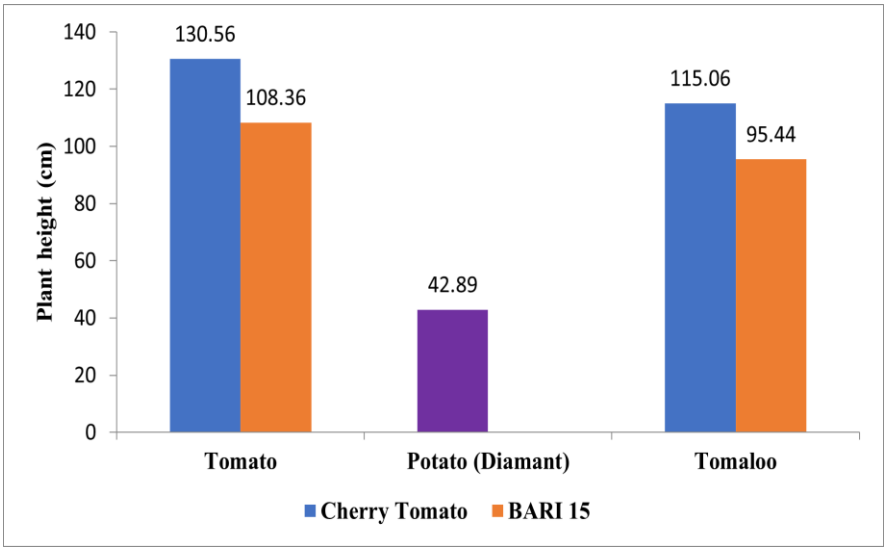

Figure 2. Performance of “Tomaloo” plant in respect of plant height.

3.3 Performance of the “Tomaloo” Plant in the Production of Tomato and Potato

The performance of “Tomaloo” plant on the production of tomato and potato per plant has been presented in Fig.3. It may be noted from the figure that “Tomaloo” plant of Cherry + Potato produced 2.73kg +0.48kg of tomato and potato respectively. Compared with this “Tomaloo” plant by BARI-15 Tomato + Potato produced 2.3kg+ 0.49kg of tomato and potato respectively. Whereas, a single Cherry tomato plant produced 3kg and a BARI-15 tomato plant produced 2.91kg tomato respectively. On the other hand, 0.56kg potato was produced by the variety Diamant. It is clear from the result that when tomatoes were grown singly, produced slightly higher yield per plant than the grafted "Tomaloo" plant.

The potato yield per plant obtained from the current study agreed with the previous investigation of Howlader & Hoque, (2018) who reported the potato yield per plant ranging from 0.3726 kg to 0.4720kg of different potato varieties and 0.45 kg yield from the Diamant variety. Likewise, Karim *et al.*, (2011) reported that the highest potato yield was 0.3446kg per plant (from Diamant) when comparing 10 exotic potato varieties. The potato yield was 0.4248 kg per plant from the Diamant variety reported by Eaton *et al.*, (2017). Tomato yield from non-grafted tomato plants Cherry and BARI Tomato-15 noted 3kg and 2.91kg per plant respectively (Fig.3). Conversely, tomato yield from grafted plants recorded 2.73kg and 2.3kg per plant respectively. The tomato yield per plant observed in this study aligns with the findings of Islam *et al.*, (2021), who reported a yield of 2.53 kg (BARI Tomato-15) per plant. Similarly, Hossain *et al.*, (2017) reported that tomato yield per plant ranging from 1.32kg to 2.09kg comparing 5 BARI varieties and 1.56kg yield from

BARI Tomato-15. Cherry tomato yield was 0.8kg to 1.7kg per plant compared to seven exotic cherry tomatoes reported by Uddin *et al.*, (2015).

Therefore, such results by "Tomaloo" plant may be accounted for compatibility in grafting between tomato and potato. Hence, the "Tomaloo" plant production may be a new promising technology that will remarkably contribute to Bangladesh's agriculture.

Plate 3. Potatoes produced by the "Tomaloo" plant

Plate 4. Tomatoes are bearing and ripening on the "Tomaloo" plant

Plate 5. "Tomaloo" plant producing tomato and potato

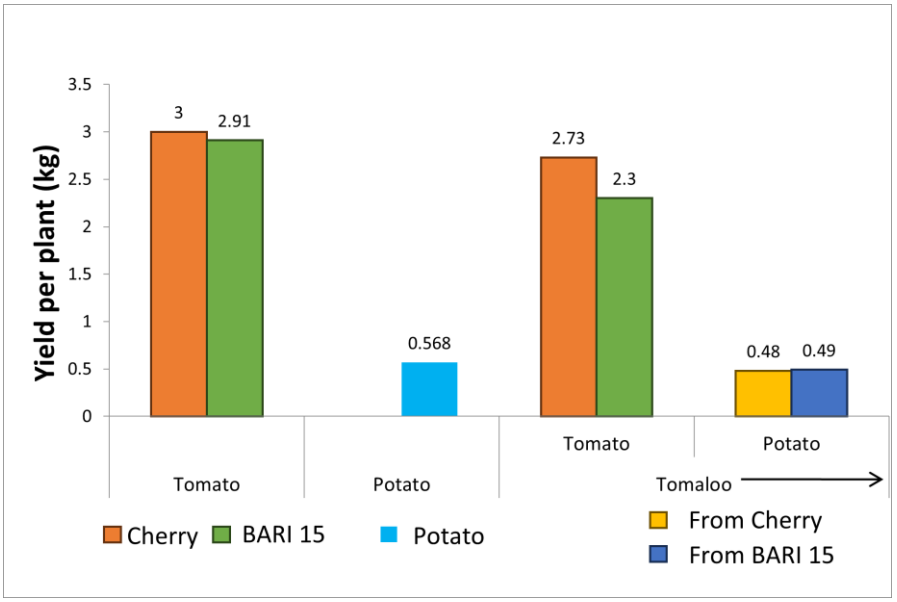

Figure 3. Performance of “Tomaloo” plant in respect of yield.

Plate 6. Harvested Tomato and Potato from “Tomaloo” plants

4. Conclusion

Production of the ‘‘Tomaloo’’ plant through grafting Tomato on Potato is a promising technology for Bangladesh Agriculture. Efficacy of different methods of

grafting and different varieties of tomato and potato related to the success of grafting and production of tomato & potato from "Tomaloo" plant to be investigated further.

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Conflict of interest

The authors affirm no potential conflict of interest concerning the publication of this work. Furthermore, the authors attest to addressing ethical considerations, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, with full diligence.

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