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Kartik Pramanik
Department of Horticulture, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Jyostnarani Padhan
Department of Botany, Plant Physiology and Biochemistry, College of Basic Science & Humanities, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar, India

Dwity Sundar Rout
Department of Horticulture, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Aman Jaiswal
Department of Microbiology, College of Basic Science & Humanities, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar, India

Hemlata Singh
Department of Botany, Plant Physiology and Biochemistry, College of Basic Science & Humanities, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar, India

Geeta Kumari
Department of Microbiology, College of Basic Science & Humanities, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar, India

Corresponding Author:
Jyostnarani Padhan
Department of Botany, Plant Physiology and Biochemistry, College of Basic Science & Humanities, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar, India

Assessing grafting compatibility of tomato scions on brinjal and chilli rootstocks

Kartik Pramanik, Jyostnarani Padhan, Dwity Sundar Rout, Aman Jaiswal, Hemlata Singh and Geeta Kumari

Abstract
What the plant breeders are up to now? Farmers of Odisha face uphill task in controlling the devastating wilt complex incidence caused by bacterium (*Ralstonia solanacearum*), fungus (*Verticillium dahliae* and *Fusarium oxysporum* f.sp. melongenae) and root knot nematode (*Meloidogyne incognita*) in solanaceous vegetable crops. Tomato is most susceptible to the disease amomg all solanaceoous vegetable crops. Furthermore, climate change has created serious issue of extreme high temperature, drought, uncertain lash out rainfall accompanied with havocking of minor pest such as leaf miner, white fly which have become major hurdle for expanding area and production in tomato cultivation. In this context, it is pertinent to say; developing a superior cultivar/ hybrid/ variety may not be possible to cater all such constraints. In pursuance, the local types of tomato, brinjal and chilli have high degree of tolerance/ resistance to most of the biotic and abiotic stresses though the fruits are not up to the mark in fruit yield and quality. These give an opportunity to employ and develop grafted plants instead of breed a variety to manage the multi-complication in cultivation as suggested by many workers. Our investigation demonstrated compatibility of tomato scion with brinjal rootstocks but did not witness promising results with chilli rootstocks. The results recommended the use of brinjal as rootstocks having resistant to abiotic and biotic stresses would be beneficial for the farming community.

Keywords: Tomato scions, brinjal, chilli rootstocks

1. Introduction
In a world where new pests and diseases are constantly emerging and the environment is being altered by climate change, ensuring food production is both sustainable and resilient is a significant challenge. Vegetable crops being succulents and needs intensive growing condition are most susceptible to many biotic and abiotic stresses. Plant grafting is indeed a valuable tool in addressing these challenges, especially in vegetable production. Increased yields in harsh environments, an extension of the growing period, less use of fertilizers and agrochemicals, a wide range of rootstocks derived from phytogenetic resources, and the elimination of crop rotation are a few of the benefits of using grafted plants (Lee *et al*., 2010) [19]. Grafting confers disease resistance, increasing productivity, or growing multiple varieties on a single plant.
Today, a large portion of crop production adopts vegetable grafting to improve the phenotypic traits of the scion and control soil-borne diseases, abiotic, and biotic challenges. Grafting is like a surgical procedure allows two sets of vascular tissue from two separate plants to fuse together. It involves the skillful technique of uniting two distinct living plant components, the rootstock (the lower part of the plant that interacts with the soil to nourish the new plant) and the scion (the detached upper portion of a plant shoot joined to the rootstock).Currently, commercial vegetable grafting is done on pepper, tomato, watermelon, eggplant, and melon. It is also seen as a quick substitute for the often laborious process of developing fruit and vegetable cultivars with higher environmental stress tolerance.
Grafting has emerged as a promising and efficient alternative to traditional breeding methods, which can be slow, to bolster resistance to abiotic stresses. It has also demonstrated the ability to improve crop resistance to biotic stress and enhance fruit quality. Fruits obtained from grafted plants often exhibit superior quality compared to those from non-grafted plants due to the influence of the rootstock. In the late 1920s, the practice of grafting vegetables began in Japan and Korea, primarily with the goal of combatting *Fusarium* wilt in cucurbits, such as watermelon (*Citrullus lanatus* L.) grafted onto pumpkin (*Cucurbita moschata*). Following the introduction of vegetable grafting in India by R.M. Bhatt and colleagues at IIHR, Bangalore, NBPGR regional station in Thrissur, Kerala, explored Cucurbitgrafting in *Momordica*

cochinchinensis. The aim was to enhance production by grafting female plants onto male plants. Additionally, private sector companies like VNR Seed Pvt. Ltd. in Chhattisgarh and Takki Seed India Pvt. Ltd. worked on supplying bacterial wilt-resistant planting materials to farmers for commercial vegetable cultivation.

In the case of solanaceous vegetables, the first grafting method was attempted with aubergine (*Solanum melongena* L.), which was grafted onto scarlet aubergine (*Solanum integrifolium* L.) in the 1950s. Grafting was also applied to tomatoes in the 1960s. Lee (1994) [26] noted that grafted seedlings of Solanaceae and Cucurbitaceae constituted up to 59 percent and 81 percent, respectively, in 1990. According to Lee *et al*. (2010) [19], both Japan and Korea extensively used grafted seedlings for watermelon cultivation, with adoption rates of around 92 percent and 95 percent, respectively. CSKHPKV in Palampur identified more than 22 rootstocks for tomato, brinjal, chili, and cucurbits that were effective against bacterial and nematode issues. Meanwhile, TNAU in Coimbatore conducted research on brinjal grafting, utilizing *Solanum nigrum* as a stock plant.

According to Genova *et al*. (2013) [12], grafting is a potential approach that can be used to increase the stress tolerance of solanaceous vegetables (Colla *et al*., 2010; Flores *et al*., 2010) [25, 11]. Studies have shown that tomato grafting offers a different strategy for increasing productivity in saline environments (Estan*et al*., 2005; Santa-Cruz *et al*., 2002) [9, 23]. The use of grafted tomatoes has become more common due to the excellent production, quality, and resistance to biotic (Barrett *et al*., 2012) [1] and abiotic (King *et al*., 2010; Savvas*et al*., 2010) [15, 22] stresses. Many researchers have explored tomato grafting, and reported that grafted tomato plants showed resistant to various infection i.e., *R. solanacearum* (Santos & Coltri, 1986; Loos *et al*., 2009; Medeiros *et al*., 2011; Fernandes &Bentes, 2018) [21, 18, 19, 7]; *Meloidogyne* spp. (Cantu *et al*., 2009) [3].

Solanaceous crops such as eggplant and potato have been grafted for the cultivation of tomato to cope with various stresses. Grafting eggplant (*Solanum melongena*) on tomato (*Solanum* lycopersicum) rootstock enhanced verticillium wilt tolerance (Liu *et al*., 2009) [17], and eggplant rootstock grafted to tomatoes displayed tolerance to flooding and waterlogging, as well as resistance to soil bornediseases (King *et al*., 2010) [15]. Wild Solanaceae rootstocks, such as common purple eggplant (*Solanum melongena*), *Solanum habrochaites* and other species, provide broadened tolerance, as well as a large range of fruit colors and shapes (Keatinge *et al*., 2014) [14]. Keeping this in view, an experiment was proposed on vegetable grafting to investigate the compatibility of tomato scion with brinjal and chilli rootstocks its survival rate which would refer the scientist and farming community.

2. Materials and Methods

2.1 Site and growing conditions

A grafting experiment was conducted under naturally ventilated polyhouse at Horticulture nursery of MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Gajapati (18.8034° N, 84.1369° E) under naturally ventilated polyhouse during rainy season of 2023. The min/max temperature was recorded as 25^{0}C/ 31^{0}C, 90% relative humidity, and suitable light intensity at different stages of seedling growth with the provision of 50% shadenet, fogger and diffused light healing chamber systems.

2.2 Planting materials

The seeds of brinjal variety Utkal Anushree and chilli variety Utkal Rasmi were selected as rootstocks for their strong root system, tolerant to wilts and adaptability to local soil conditions and collected from All India Network Research Project on Vegetables, Odisha University of Agriculture and Technology, Bhubaneswar. The tomato hybrid Saaho was selected as scion based on high vigour, high yield and fruit quality attributes. The rootstock and scion seeds were sown on 1st August and 10th August respectively in portray (98 holes) to match the compatible seedlings growth and stem diameter. The seeded trays were kept under natural ventilated polyhouse.

2.3 Grafting process

Two methods of grafting *i.e*., splice and cleft grafting was taken into consideration. A healthy rootstock plant and a scion (the desired plant to be grafted) were chosen. The necessary tools, including a sharp grafting knife or a razor blade, sterilized pruning shears, and silicone grafting clips was gathered. These tools were sterilized to prevent the spread of diseases. The tomato scion was prepared by giving a clean, slanting cut (45 ^{0}C) at one and both sides for splice and cleft grafting with a sharp razor blade for perfect incision. Similar matching incision at 45 ^{0}C was made on brinjal and chilli rootstocks for perfect joining with scions. This is important for a proper graft union. The cut surface of the scion was carefully fit onto the matching cut surface of the rootstock, ensuring that the cambium layers (the thin, greenish layers just under the bark) align as closely as possible. Proper alignment is crucial for a successful graft. Grafts joining were fixed by placing grafting silicon clip over grafting area to hold the scion and rootstock securely together. A gentle press is given on grafting clips. The grafting processes were illustrated by supplemented figure 1(a-i). The grafted seedlings were shifted immediately to healing chamber comprised of diffuse light, high humidity (90%) and optimum temperature (25-28 ^{0}C) for healing for a week. The grafted seedlings were acclimatized and then fed with NPK 19-19-19, micronutrient mixtures and disinfected with fungicides spray.

3. Results and Discussion

The present investigation observed the success joining of tomato scions with brinjal and chilli rootstcoks through two methods (Figure 3). The results indicated that there is high percent of survivability (>88%) observed in case grafting of tomato scions with brinjal rootstocks. The joining of tomato scion with chilli rootstocks reported mimimum (<8%) successful grafts joining. As far as different methods concerned, the cleft grafting witnessed highest percent of compatible graft (92.22%) in joining tomato scion with brinjal rootstock variety Utkal Anushree whereas, for splice grafting method the successful graft union stand at 88.75% indicating more alignment of cambium layer in cleft grafting due to both side incision on both rootstock and scion. In case of splice grafting, diagonal cut was given leads to less contact of cambium surface area though it was quicker process of making insicion and joining as compared to cleft grafting. While employing a different methodology, Stripari *et al*. (1997) [23]; Guimaraes *et al*. (2019) [11] reported that plants grafted with the cleft grafting technique had great survival rates (96.5 and 100%). In case of joining tomato scion with chilli rootstocks revealed minimum percent of survivability (7.14%, 4.85%) irrespective to methods of joining may be due to influence and incompatibility between the rootstock and scion.Caizares & Goto (2002) [2] claimed that the use of rootstock has a significant impact on the vigor of grafted plants.

Graft incompatibility can be broadly divided into two categories, namely translocated and localized (Zarrouk *et al*., 2006) [24]. In cases of "translocated" incompatibility, symptoms manifest at the early stages of plant development. Scion and root growth cease prematurely, carbohydrate translocation at the graft union diminishes, leaves wither and turn yellow, eventually reddening, and early leaf drop become common observable symptoms. On the other hand, "localized incompatibility" results in deformities at the graft union due to physiological and morphological changes. These changes ultimately impede the formation of a successful graft union. This incompatibility is characterized by the release of Phenol and Hydrocyanic acid, which obstruct actively dividing cambial cells at the graft union and disrupt phloem tissues at and above the graft union (Rasool *et al*., 2020) [24]. These may be the reasons behind the in compatibility.

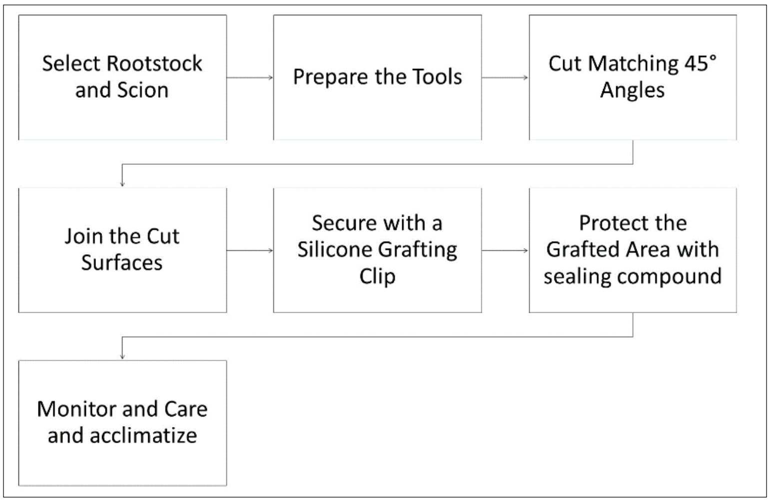
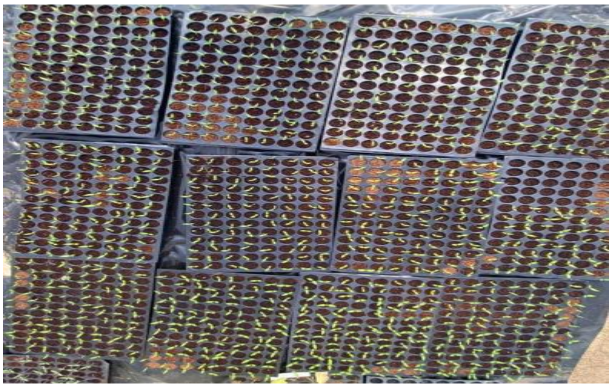


Fig 1: Schematic diagram of grafting process



a. Scion and rootstocks seeds are sown in pro-tray

b. Nursery raising of scions and rootstocks

c. Grafting of tomato scion on brinjal rootstocks

d. Grafting of tomato scion on chilli rootstocks

e. Cleft grafting (left) f. Splice grafting (right)

g. healing chamber

h. Grafting seedlings after healing process

i. Success grafted sedlings on brinjal rootstock (left) j. incompatibility of tomato scion on chilli rootstock (right)

Fig 2(a-i): Demostratingthe processes of grafting using tomato scion with brinjal and chilli rootstocks, successful and unsucceful grafted plants.

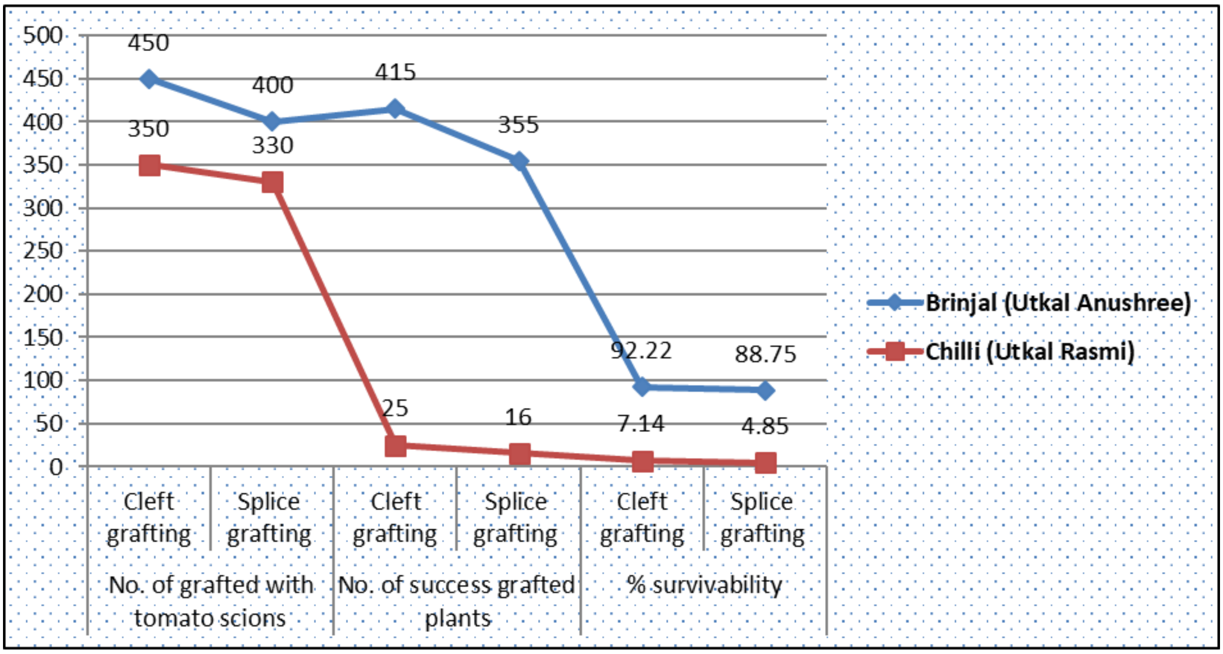


Fig 3: Data demonstrating the success of grafting, % survivability of the scions with different rootstocks and methods

4. Conclusions

Grafting has become a promising techniques for solving persistent problem in tomato and the techniques regarded as rapid and economical approach. The tomato crop is most delicate crop among all solanaceous vegetables affected by many biotic (wilt complex) and abiotic stresses (extreme temperature, drought, heavy rains, salt and alkali injury, nutrient deficiencies etc.). Considering breeding approach to tackle all the constraints in tomato might take quite long period or impossible to solve. In this context, the grafting techniques look promising gaining importance among growers because of multi-benefits. Our experiments, reported clear cut results of higher percentage of grafting success on joining tomato scions with brinjal rootstocks cv. Utkal Anushree by cleft and splice grafting though cleft grafting proved better. The chilli rootstocks were found less compatible witnessed less survivability percent irrespective of grafting methods. The findings were well supported by prior workers and could be recommended for farming community and useful for future investigation.

5. References

1. Barrett CE, Zhao X, McSorley R. Grafting for root-knot nematode control and yield improvement in organic heirloom tomato production. Hortic. Sci. 2012;47:614-620.
2. Canizares KAL, Goto R. Comparação De Métodos De Enxertia Em Pepino. Horticultura Brasileira. 2002;20:95-99.
3. Cantu RR, Wilcken SRS, Rosa JMO, Goto R. Reação De Porta-Enxertos Comerciais De Tomateiro A Meloidogyne Mayaguensis. Summa Phytopathologica. 2009;35:216-218.
4. Colla G, Rouphael Y, Leonardi C, Bie Z. Role of grafting in vegetable crops grown under saline conditions. Sci. Hortic. 2010;127:147-155.
5. Dirr MA. Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Varsity Press; c1997.
6. Estan MT, Martinez-Rodriguez MM, Perez-Alfocea F, Flowers TJ, Bolarin MC. Grafting raises the salt tolerance of tomato through limiting the transport of sodium and chloride to the shoot. J Exp. Bot. 2005;56:703-712.
7. Fernandes BS, Bentes JLS. Enxertia De Tomateiro Em Solanáceas Silvestres No Controle Da Murcha Bacteriana. Revista Agrária Acadêmica. 2018;1:26-32.
8. Flores FB, Sanchez-Bel P, Estan MT, Martinez-Rodriguez MM, Moyano E, Morales B, *et al*. The effectiveness of grafting to improve tomato fruit quality. Sci. Hortic. 2010;125:211-217.
9. Genova C, Schreinemachers P, Afari-Sefa V. An Impact Assessment of AVRDC's Tomato Grafting in Vietnam. AVRDC – The World Vegetable Center, Shanhua, Taiwan. AVRDC Publication No. 2013;52:13-773.
10. George EF, Hall MA, De Klerk GJ. The Components of Plant Tissue Culture Media I: Macro- and Micro-Nutrients. Plant Propagation by Tissue Culture; c2008. p. 65-113.
11. Guimarães MA, Garcia MFN, Tello JPJ, Neto LHS, Neto LBP, Rabelo JS. Tomato grafting on rootstock of Jilo, Cocona and Jurubeba. Horticultura Brasileira. 2019;37:138-145. DOI - http://dx.doi.org/10.1590/S0102-053620190203
12. Harris R, Clark G. Plant Grafting: Basic Techniques and Scion Wood Sources. University of Missouri Extension; c2008.
13. Hartmann HT, Kester DE. Plant propagation: principles and practices. Prentice-Hall; c1975.
14. Keatinge JDH, Lin LJ, Ebert AW, Chen WY, Hughes JA, Luther GC, *et al*. Overcoming biotic and abiotic stresses in the Solanaceae through grafting: current status and future perspectives. Biol. Agric. Hortic. 2014;30(4):272–287.
15. King SR, Davis AR, Zhang X, Crosby K. Genetics, breeding and selection of rootstocks for Solanaceae and Cucurbitaceae. Sci. Hortic. 2010;127:106–111.
16. Lee JM, Kubota C, Tsao SJ, Bie Z, Echevarria PH, Morra L, *et al*. Current status of vegetable grafting: Diffusion, grafting techniques, automation. Sci. Hortic. 2010;127:93-105. doi: 10.1016/j.scienta.2010.08.003
17. LiuN, Zhou B, Zhao X, Lu B, Li Y. Grafting eggplant onto tomato rootstock to suppress Verticillium dahliae infection: the effect of root exudates. HortSci. 2009;44:2058-2062.
18. Loos RA, Caliman FRB, Silva DDJH. Grafting, Production and Quality of Tomato Growth in Protected Environment/Grafting, Production and Quality of Tomato Plants Grown In a Protected Environment. Rural Science. 2009;39(1):232-236.
19. Vincula MAJ, Araújo MD, Veiga F. Controle Da Murcha Bacteriana Por Meio Da Enxertia De Tomate Com Jiló No Município De Rio Branco–AC. Cadernos De Agroecologia. 2011;6(2):1.
20. Santa-Cruz A, Martinez-Rodriguez MM, Perez-Alfocea F, Romero-Aranda R, Bolarin MC. The rootstock effect on the tomato salinity response depends on the shoot genotype. Plant Sci. 2002;162:825–831.
21. Santos J, Coltri M. Reação De Solanáceas À MurchaBacteriana Do Tomateiro. Embrapa. Comunicado Técnico. 1986;44:1-6.
22. Savvas D, Colla G, Rouphael Y, Schwarz D. Amelioration of heavy metal and nutrient stress in fruit vegetables by grafting. Sci. Hortic. 2010;127:156-161.
23. Stripari P, Iozi R, Cañzares K, Travassos L, Goto R. Influência Do Intervalo De Semeadura Na Sobrevivência E Na Qualidade De Mudas De Pepino Enxertado Em Abóbora. Actas De Horticultura. 1997;16:33-37.
24. Zarrouk O, Gogorcena Y, Moreno MA, Pinochet J. Graft compatibility between peach cultivars and Prunus rootstocks. HortScience.2006;41:1389-1394. doi: 10.21273/hortsci.41.6.1389.
25. Rasool A, Mansoor S, Bhat KM, Hassan GI, Baba TR, Alyemeni MN, *et al*. Mechanisms Underlying Graft Union Formation and Rootstock Scion Interaction in Horticultural Plants. Front. Plant Sci. 2020;11:590847. doi: 10.3389/fpls.2020.590847.
26. Lee JC, Laydon JT, McDonnell PC, Gallagher TF, Kumar S, Green D, *et al*. A protein kinase involved in the regulation of inflammatory cytokine biosynthesis. Nature. 1994;372(6508):739-746.