Volume 24(2), 39 - 44, 2020
JOURNAL of Horticulture, Forestry and Biotechnology
www.journal-hfb.usab-tm.ro

Behaviour in grafting of ”Tuleu gras” plum cultivar grafted on generative rootstocks with intermediate

Zanfir V.,[1*] Baciu A. A.[1]

[1]University of Craiova, Faculty of Horticulture, Str. A.I. Cuza, No.13, Romania

*Corresponding author. Email: zanfirvaleriu@gmail.com

Abstract The behavior of the ”Tuleu gras” plum variety was studied, on different rootstocks and with different grafting variants. As rootstock, selections of ”*Prunus cerassifera*” and ”*Armeniaca vulgaris*” (*Prunus cerasifera* and *Prunus armeniaca*) were used. And the graft variants were with the intermediary (Rival) and without the intermediary, by different grafting methods (improved copulation and budding chip). The diameter was analyzed at the grafting point, 5 cm above and below the grafting point, graft height, length and number of shoots anticipated. The results show that regardless of the rootstock used, the intermediary influences the growth force in a positive way. The grafting of the intermediate on the rootstock and of the variety on the intermediate were carried out at the same time. The length of the intermediate was 20 cm.The same rootstock and variety were used as a control, but without the Rival intermediary The same rootstock and variety were used as a control, but without the Rival intermediary The vigor of fruit trees and vegetative growth is generally given by the size of the trunk diameter. According to the data obtained, it is found that there are positive correlations between the three diameters (at the grafting point, 5 cm below the grafting point and 5 cm above the grafting point) and the graft height in all the analyzed variants. Intermediate grafting was performed in order to reduce the vigor of the graft in order to intensify plum crops, early fruiting, increase productivity and fruit quality.Comparing the two generative rootstocks used, *Prunus cerassifera* and *Armeniaca vulgaris* it is found that the *Prunus cerassifera* rootstock determined an average value of the diameter lower than that determined by the generative rootstock *Armeniaca vulgaris*, both 5 cm above the grafting point and 5 cm below the grafting point, which determines a lower force given by this generative rootstock used for grafting.

Key words

grafting, rootstock, intermediary

Horticulture research aims to find new solutions to obtain large quantities of good quality fruit seedlings within a short time, with minimal costs and at affordable prices for fruit growers.

Grafting is a common practice for propagating fruit trees. Rootstocks used for a specific crop are close relatives of the crop or wild selections (especially within genera), but grafts between different families have also been observed [34]. The use of rootstocks that control vigour is a method used to promote precocity, to reduce vigour, and to increase productivity [35]. Grafting with intermediate is also used to induce cold tolerance, disease resistance, and reduced vigour [3]. Rootstock selection is a powerful tool for sustainably intensifying fruit production, as while the graft can be used to induce fruit properties, the adaptation to water deficiency and high salinity, alkaline soil tolerance and susceptibility to agents can all be influenced by rootstock choice [13, 18, 28]. Necas and Krska (2013) evaluated the propagation potential and efficacy of fruit rootstocks using different concentrations of phyto-hormones. Koepke and Dhingra (2013) state that rootstock controls many aspects of graft growth and physiology, including production and quality attributes, as well as biotic and abiotic stress tolerance, and the study of somato-genetic interactions between rootstock and graft is an area that can bring major improvements in the next decade under the current agricultural environment, where sustainable production practices are needed, the rootstock providing a non-transgenic approach to respond quickly to the changing environment and to expand agricultural production of annual and perennial crops, where grafting is possible in order to meet the needs of global food, fiber and fuel.

Tuleul gras, a Romanian plum cultivar, native to Leordeni-Argeș area, has a vigorous growth of the tree in the nursery and in the first years in the orchard, after which the vigour begins to gradually decrease. It has an affinity grafted on Prunus cerasifera, but it is easily detached by strong winds in the nursery; grafting on the generative rootstock is preferred. The skeletal

branches have a small insertion angle, splitting easily slightly under the fruit weight. It bears fruit on May bouquets and medium branches. In good agrotechnical conditions, it produces a lot of fruits but inconstantly, the good harvests alternating with the mediocre ones. Delayed harvesting leads to alternating fruiting. Andro-sterile variety, with atrophied stamens, lemon coloured and without pollen, in need of pollination with Stanley and Anna Spath cultivars, it is sensitive to moniliasis and shows symptoms of Plum pox, on leaves only. The fruit is medium sized, ellipsoidal, reddish in colour, being considered the best cultivar in terms of taste, the pulp not adhering to the stone. It is recommended both for fresh consumption and for processing, dehydration and distillation. It matures during 20-31 of August. *Prunus cerasifera* and *Armeniaca vulgaris* were used as a generative rootstock for grafting the Tuleu gras plum cultivar, while the Rival vegetative rootstock was used as an intermediate.

Specific to culture technology, the use of grafted material brings multiple advantages [7]. Studies on the influence of the intermediate on the growth parameters of grafted trees, have shown that the intermediate, depending on its length, has a greater or lesser impact on precocity and vigour, noting that the length of the intermediate has led to reduced tree vigour and fruits production [6].

Moreover, it seems that the diameter and number of wooden vessels are the main characteristics of the rootstock that influences the vigour of grafted trees, the absolute values of the measured parameters being higher in trees that are being grafted with intermediate [29].

Hernández et al. (2010) analyzed the influence of rootstocks on flowering, trunk cross-section, yield and quality parameters of *Prunus armeniaca* L. fruits, grown in a Mediterranean agro-climatic environment, in an experimental orchard in the southeast Spain and showed that the rootstock had no significant influence on the number of flowers, but it induced a higher fruit weight, the weight of fruits being positively correlated with pulp production and negatively correlated with TCSA. Also, precocity and colour of fruit was influenced by the rootstock. Zhilong (2016) analyzed the effects of rootstocks on increasing nutrient absorption, accumulation and use, as well as the mechanism involved.

The aim of this study was to reduce the vigour of the grafted cultivar in order to setting-up the super-intensive plantations; to induce early fruiting and improve the quantity and quality of fruit.

Material and Method

The experiment on the studied material was set up at the Didactic Station, Banu Mărăcine of the University of Craiova, located in the southern extremity of Getic Plateau between the coordinates 44□19″ northern latitude and 23□48″ eastern longitude, at 6 km distance from Craiova.

Grafting was performed at the table, both of the intermediate on the two rootstocks by the improved copulation method, and also on the cultivar on the intermediate by the chip budding method. The rootstock seedlings were harvested in autumn after the leaves fell down in nursery of seedlings and were stratified, and before grafting they were pre-reinforced. The graft branches were harvested in autumn and stored in the refrigerator at 4°C. Both grafting methods, both in case of the intermediate on the two rootstocks (*Prunus cerasifera* and *Prunus armeniaca*) in improved copulation as well as of the cultivar on the intermediate using chip budding, were performed during 10-20 of March. The grafting of the intermediate on the rootstock and of the cultivar on the intermediate were carried out at the same time. The length of the intermediate was 20 cm. The same rootstock and cultivar were used as a control, but without the Rival intermediary. The experiment is of the three-factorial type, placed in a linear fashion (Table 1).

Table 1. Experimental variants

A Factor: generative rootstock	B Factor: cultivar	C Factor: grafting method	Variants
a1 – *Prunus cerasifera* a2 – *Prunus armeniaca*	b1 – Tuleu gras	c1 - improved copulation c2 - chip budding	Tuleu gras / Rival / *Prunus armeniaca* Tuleu gras / *Prunus armeniaca* Tuleu gras / Rival / *Prunus cerasifera* Tuleu gras / *Prunus cerasifera*

Maintenance work was carried out at regular intervals, such as removal of shoots from the rootstock, irrigation, fertilization, phyto-sanitary treatments. At the end of vegetation period, the following observations and determinations were made: diameter (mm) at the grafting point, diameter (mm) at 5 cm above the grafting point, diameter (mm) at 5 cm below the grafting point, the graft height. The electronic calliper with an accuracy of 0.01 mm was used to determine the diameter. The determinations were performed in both variants, ie with intermediate and without non-intermediate. The data obtained were processed using the statistical analysis program (Stat Point Technologies, Warrenton, VA, USA).

Results and Discussions

The rootstock improves plant vigour, it extends the vegetation period [15], productivity and fruit quality [12, 23, 30], extends fruit quality after harvest [37], increases tolerance to lower and higher temperatures

[15, 17], reduces stress caused by salinity and heavy metals [8, 11, 12, 20, 21, 26, 27, 33], increases resistance to floods [4], improves water use efficiency [5], it manages resistance to soil pathogens [2], manages resistance to nematodes [15], controls weeds and it produces new plant species [9].

Grafting with intermediate was performed in order to reduce the vigour of graft in order to intensify plum crops, early fruiting, increase productivity and fruit quality. The results obtained on the characteristics of the studied material are presented in table 2.

Table 2.

Variability of characteristics (diameter and height) of the material studied in the research area

Variants	Descriptive statistics	Diameter (mm)			Graft height (cm)
		At grafting point	At 5 cm above the grafting point	At 5 cm below the grafting point	
Tuleu gras – *Prunus cerasifera*	Mean ± SE	11.94 ± 0.42	6.63 ± 0.30	9.30±0.31	69.36 ± 5.52
	Standard Deviation	1.83	1.34	1.36	24.10
	Minimum/ Maximum	8.99/15.88	4.59/9.40	7.74/12.18	43/133
	Variation coefficient (CV %)	9.80	15.09	14.60	11.65
Tuleu gras – Rival – *Prunus cerasifera*	Mean ± SE	12.13 ± 0.25	6.90 ± 0.21	9.10 ± 0.22	69.88 ± 3.50
	Standard Deviation	1.08	0.92	0.94	14.85
	Minimum/ Maximum	10.41/14.32	5.23/8.36	7.69/11.27	50/98
	Variation coefficient	21.94	17.96	9.82	21.11
Tuleu gras – *Prunus armeniaca*	Mean ± SE	16.79 ± 0.41	19.02 ± 0.60	12.12 ± 0.27	105.24 ± 4.49
	Standard Deviation	2.06	3.00	1.35	22.48
	Minimum/ Maximum	11.80/21.36	12.91/24.66	10.36/15.68	61/135
	Variation coefficient	13.15	17.42	14.27	25.11
Tuleu gras – Rival – *Prunus armeniaca*	Mean ± SE	10.93 ± 0.41	8.35 ± 0.29	10.23 ± 0.26	84.96 ±3.76
	Standard Deviation	2.31	1.62	1.49	20.97
	Minimum/ Maximum	10.00/18.70	5.91/11.26	7.44/12.84	50/140
	Variation coefficient	15.92	13.99	9.40	17.35

The average values regarding the height of the studied material show significant differences depending on the generative rootstock used, so the average graft height was 84.96 cm in Tuleu gras-Rival-Prunus armeniaca variant and 105.24 cm in Tuleu gras-Prunus armeniaca, in comparison to the variants where the Prunus cerasifera generative rootstock was used, where the average height of graft reached 69.36 cm in the variant without intermediate, and 69.88 cm in the variant with intermediate. The variation limits regarding the graft height had values between 43-133 cm in Tuleu gras-Prunus cerasifera variant, between 50-98 cm in Tuleu gras-Rival-Prunus cerasifera variant, between 61-135 cm in Tuleu gras-Prunus cerasifera variant and between 50-140 cm in the variant with intermediate, respectively, Tuleu gras-Rival-Prunus cerasifera. The highest variation coefficient for the graft height was calculated for Tuleu gras-Prunus armeniaca variant (25.11%), followed by Tuleu gras-Rival-Prunus cerasifera variant (21.11%).

The vigour of fruit trees and vegetative growth is generally given by the size of trunk diameter. The determinations performed on the values of diameter, both at the grafting point., as well as at 5 cm above and 5 cm below the grafting point showed that the variant of Tuleu gras grafted with the Rival intermediate on the Prunus armeniaca generative rootstock had much lower average values (10.93 mm; 8.35 mm; 10.23 mm) than the variant of Tuleu gras grafted without intermediate on the Prunus armeniacagenerative rootstock (16.79 mm; 19.02 mm; 12.12 mm), which shows that the use of Rival intermediate led to a decrease in the diameter, implicitly of vigour.

The variation limits for the average diameter at the grafting point were between 10.18 - 18.70 mm in the variant of Tuleu gras grafted with an intermediate on Prunus armeniaca generative rootstock, between 11.80 - 21.36 mm in the variant of Tuleu gras without intermediate. Also the variation limits for the average diameter at 5 cm above and 5 cm below the grafting point were lower in the variant of Tuleu gras with intermediate compared to the variant of Tuleu gras without intermediate. Comparing the two generative rootstocks used, Prunus cerasifera and Prunus armeniaca, it is found that Prunus cerasifera rootstock determined an average value of diameter that is lower than the one determined by Prunus armeniaca generative rootstock, both at 5 cm above the grafting point and at 5 cm below the grafting point, which determines a lower vigour given by this generative rootstock used for grafting. Many scientific papers confirm the effectiveness of the intermediate to control tree vigour and, in some cases, to induce early fruiting and increased productive efficiency and fruit quality [25, 32, 36].

Di Vaio et al. (2009) showed that in apple tree the intermediate resulted in a lower vegetative growth by 50-80% compared to control plants, an increase in fruit

production and in average fruit weight, and an increase in the length of the intermediate led to a reduction in growth vigour of plants and the reduction of fruit production, the length of 10 cm of the intermediate being the one that gave the best results.
It is recommended to choose the intermediate according to agronomic factors, such as the distance from grafting point and the length of the intermediate [3, 24]. Other experiments have shown that the decrease in intermediate-induced growth depends on its vigour [16], on the rootstock, and on the cultivar used [31].

Following the determinations made, it was found that the intermediary had a positive influence on the vigour of graft growth, giving it a low growth vigour.
In order to verify some criteria among the characteristics of the studied material, the correlation coefficient was determined between: diameter at grafting point and graft height, diameter at 5 cm above the grafting point and graft height, diameter at 5 cm below the grafting point and graft height, the correlation between the three diameters and the number of shoots, the correlation between the three diameters (at the grafting point, at 5 cm above and at 5 cm below the grafting point) and the total length of the shoots (Table 3).

Table 3

Correlation coefficient in characteristics of the material studied *

Characteristics/ Variants	H				No. of shoots				Total length of shoots			
	V1	V2	V3	V4	V1	V2	V3	V4	V1	V2	V3	V4
DP	0.83	0.70	0.48	0.66	0.32	0.30	-0,12	0.06	0.47	0.38	0.15	0.19
DDP	0.87	0.75	0.71	0.73	0.41	0.31	0,03	0.02	0.61	0.45	0,44	0.20
DSP	0.81	0.61	0.51	0.69	0.38	0,24	0.04	0.01	0.47	0.33	0.22	0.14
No. of shoots / Total length of shoots	V1				V2				V3			V4
	0.80				0.90				0.70			0.76

*DP: Diameter at grafting point; DDP: Diameter at 5 cm above grafting point; DSP: Diameter at 5 cm below grafting point; V1: Tuleu gras – Prunus cerasifera; V2: Tuleu gras – Prunus armeniaca; V3: Tuleu gras – Rival – Prunus cerasifera; V4: Tuleu gras – Rival – Prunus armeniaca

According to the data obtained, it is found that there are positive correlations between the three diameters (at the grafting point, at 5 cm below the grafting point and at 5 cm above the grafting point) and the graft height in all variants analysed. The values of the correlation coefficient in the grafted variants without intermediate, Tuleu gras / Prunus cerasifera and Tuleu gras/Prunus armeniaca are: between the diameter at grafting point and the graft height (r = 0.83; r= 0.70); between the diameter at 5 cm above grafting point and graft height (r = 0.87; r = 0.75); between the diameter at 5 cm below the grafting point and the graft height (r = 0.81; r = 0.61). Significant correlations were also calculated between the number of shoots and total length of shoots, in all four variants analyzed (r = 0.80; r = 0.90; r = 0.70; r = 0.76).

Conclusions

The determinations made on the values of diameter, both at the grafting point and at 5 cm above and at 5 cm below the grafting point showed that the variant of Tuleu gras grafted with the intermediate Rival on Prunus armeniaca generative rootstock had much lower average values than the variant of Tuleu gras grafted without an intermediate on Prunus armeniacagenerative rootstock, which shows that the use of Rival intermediate led to the decrease of diameter, implicitly of vigour; therefore, the intermediate had a positive influence on the graft growth vigour, giving it a small growth vigour.
Comparing the two generative rootstocks used, Prunus cerasifera and Prunus armeniaca, it is found that Prunus cerasifera rootstock determined an average value of diameter which is lower than the one determined by Prunus armeniaca generative rootstock, both at 5 cm above grafting point and at 5 cm below grafting point, which determines a lower vigour given by this generative rootstock used for grafting.
The highest length of shoots' growth was recorded in the variants grafted on Prunus armeniaca generative rootstock, with and without the Rival intermediate.

References

1. Alfonso Albacete , Cristina Martínez-Andújar, Michel Edmond Ghanem, Manuel Acosta, José Sánchez-Bravo, María J Asins, Jesús Cuartero, Stanley Lutts, Ian C Dodd, Francisco Pérez-Alfocea (2009). Rootstock-mediated changes in xylem ionic and hormonal status are correlated with delayed leaf senescence, and increased leaf area and crop productivity in salinized tomato. Plant, Cell & Environment, 32(7), 928-938.
2. Arwiyanto, T., Lwin, K., Maryudani, Y., and Purwantoro, A. (2015). "Evaluation of local Solanum torvum as a rootstock to control of Ralstonia solanacearum in Indonesia," in

Proceeding of the First International Symposium on Vegetable Grafting. Acta Horticulturae, Vol. 1086, eds Z. Bie Y. Huang, and M. A. Nawaz (Wuhan), 101–106.
3. Beakbane, A.B., Rogers, W.S., 1956. The relative importance of stem and root indetermining rootstock influence in apples. J. Hortic. Sci. 31 (2), 99–110.
4. Bhatt, R. M., Upreti, K. K., Divya, M. H., Bhat, S., Pavithra, C. B., & Sadashiva, A. T. (2015). Interspecific grafting to enhance physiological resilience to flooding stress in tomato (Solanum lycopersicum L.). Scientia Horticulturae, 182, 8-17.
5. Cantero-Navarro, E., Romero-Aranda, R., Fernández-Muñoz, R., Martínez-Andújar, C., Pérez-Alfocea, F., & Albacete, A. (2016). Improving agronomic water use efficiency in tomato by rootstock-mediated hormonal regulation of leaf biomass. Plant Science, 251, 90-100.
6. Di Vaio C, Cirillo C, Buccheri M, Limongelli F. 2009. Effect of interstock (M.9 and M.27) on vegetative growth and yield of apple trees (cv 'Annurca'). Scientia Horticulturae 119: 270–274.
7. Ercisli, S., Esitken, A., Orhan, E. Ozdemir, O. (2006):Rootstocks used for temperate fruit trees in Turkey: an overview.Sodininkyste ir Darzininkyste,25:27–33.
8. Estan, M. T., Martinez-Rodriguez, M. M., Perez-Alfocea, F., Flowers, T. J., & Bolarin, M. C. (2005). Grafting raises the salt tolerance of tomato through limiting the transport of sodium and chloride to the shoot. Journal of experimental botany, 56(412), 703-712.
9. Fuentes, I., Stegemann, S., Golczyk, H., Karcher, D., & Bock, R. (2014). Horizontal genome transfer as an asexual path to the formation of new species. Nature, 511(7508), 232-235.
10. Hernández, F., Pinochet, J., Moreno, M. A., Martínez, J. J., & Legua, P. (2010). Performance of Prunus rootstocks for apricot in Mediterranean conditions. Scientia Horticulturae, 124(3), 354-359.
11. Huang, Y., Bie, Z. L., Liu, Z. X., Zhen, A., & Jiao, X. R. (2011). Improving cucumber photosynthetic capacity under NaCl stress by grafting onto two salt-tolerant pumpkin rootstocks. Biologia Plantarum, 55(2), 285-290.
12. Huang, Y., Bie, Z., Liu, P., Niu, M., Zhen, A., Liu, Z., ... & Wang, B. (2013). Reciprocal grafting between cucumber and pumpkin demonstrates the roles of the rootstock in the determination of cucumber salt tolerance and sodium accumulation. Scientia Horticulturae, 149, 47-54.
13. Jensen, P. J., Halbrendt, N., Fazio, G., Makalowska, I., Altman, N., Praul, C., ... & McNellis, T. W. (2012). Rootstock-regulated gene expression patterns associated with fire blight resistance in apple. BMC genomics, 13(1), 9.
14. Koepke, T., & Dhingra, A. (2013). Rootstock scion somatogenetic interactions in perennial composite plants. Plant cell reports, 32(9), 1321-1337.
15. Lee, J. M., Kubota, C., Tsao, S. J., Bie, Z., Echevarria, P. H., Morra, L., & Oda, M. (2010). Current status of vegetable grafting: Diffusion, grafting techniques, automation. Scientia Horticulturae, 127(2), 93-105.
16. Lockard, R.G., Lasheen, A.M., 1971. Effect of rootstock and length of interstem ongrowth of one year old apple plants in sand culture. J. Am. Soc. Hortic. Sci. 96 (1),17–20.
17. López-Marín, J., González, A., Pérez-Alfocea, F., Egea-Gilabert, C., & Fernández, J. A. (2013). Grafting is an efficient alternative to shading screens to alleviate thermal stress in greenhouse-grown sweet pepper. Scientia Horticulturae, 149, 39-46.
18. Marguerit, E., Brendel, O., Lebon, E., Van Leeuwen, C., & Ollat, N. (2012). Rootstock control of scion transpiration and its acclimation to water deficit are controlled by different genes. New Phytologist, 194(2), 416-429.
19. Necas T., Krska B., 2013. Propagation of different stone fruit rootstocks using softwoord and hardwood cuttings. Acta horticulturae, 127-138 April 2013.
20. Penella, C., Landi, M., Guidi, L., Nebauer, S. G., Pellegrini, E., San Bautista, A., ... & Calatayud, A. (2016). Salt-tolerant rootstock increases yield of pepper under salinity through maintenance of photosynthetic performance and sinks strength. Journal of plant physiology, 193, 1-11.
21. Penella, C., Nebauer, S. G., Quinones, A., San Bautista, A., Lopez-Galarza, S., & Calatayud, A. (2015). Some rootstocks improve pepper tolerance to mild salinity through ionic regulation. Plant science, 230, 12-22.
22. Rogers WS,Vyvyan MC. 1934.Rootstock and soil effect on appleroot systems.Journal of Pomology and Horticultural Science12: 110 – 150.
23. Rouphael, Y., Schwarz, D., Krumbein, A., & Colla, G. (2010). Impact of grafting on product quality of fruit vegetables. Scientia Horticulturae, 127(2), 172-179.
24. Rufato, L., Rossi, A., Kersten, E., Cancan, C., De Rossi, A., 2001. Reduction of initialgrowth of plants of apple (Malus domestica Borckh) 'Imperial Gala' with EM9interstock. Revista Brasileira de Fruticultura 23 (1), 172–174
25. Samad, A., Mcneil, D.L., Kham, Z.U., 1999. Effect of interstock bridge grafting (M9dwarfing rootstock and same cultivar cutting) on vegetative growth, reproduc-tive growth and carbohydrate composition of mature apple trees. Sci. Hortic. 79,23–38.

26. Santa-Cruz, A., Martinez-Rodriguez, M. M., Perez-Alfocea, F., Romero-Aranda, R., & Bolarin, M. C. (2002). The rootstock effect on the tomato salinity response depends on the shoot genotype. Plant Science, 162(5), 825-831.
27. Schwarz, D., Rouphael, Y., Colla, G., & Venema, J. H. (2010). Grafting as a tool to improve tolerance of vegetables to abiotic stresses: Thermal stress, water stress and organic pollutants. Scientia Horticulturae, 127(2), 162-171.
28. Tamura, F. (2012). Recent advances in research on Japanese pear rootstocks. Journal of the Japanese Society for Horticultural Science, 81(1), 1-10.
29. Tombesi S,Johnson RS,Day KR,DeJong TM. 2010. Relationshipsbetween xylem vessel characteristics, calculated axial hydraulicconductance and size-controlling capacity of peach rootstocks.Annals of Botany105: 327 – 331.
30. Tsaballa, A., Athanasiadis, C., Pasentsis, K., Ganopoulos, I., Nianiou-Obeidat, I., & Tsaftaris, A. (2013). Molecular studies of inheritable grafting induced changes in pepper (Capsicum annuum) fruit shape. Scientia Horticulturae, 149, 2-8.
31. Tukey, H.B., 1943. The dwarfing effect of an intermediate stem-piece of Malling IXapple. Proc. Am. Soc. Hortic. Sci. 42, 357–364.
32. Vercammen, J., van Daele, G., Gomand, A., 2007. Can fruit size and colouring ofJonagold be improved by an interstock? Acta Hortic. 732, 165–170.
33. Wahb-Allah, M. A. (2014). Effectiveness of grafting for the improvement of salinity and drought tolerance in tomato (Solanum lycopersicon L.). Asian Journal of Crop Science, 6(2), 112-122.
34. Warschefsky, E. J., Klein, L. L., Frank, M. H., Chitwood, D. H., Londo, J. P., von Wettberg, E. J., & Miller, A. J. (2016). Rootstocks: diversity, domestication, and impacts on shoot phenotypes. Trends in plant science, 21(5), 418-437.
35. Webster AD. 2004.Vigour mechanisms in dwarfing rootstocks fortemperate fruit trees.Acta Horticulturae658: 29 – 41.
36. Webster, A.D., 1995. Rootstock and interstock effects on deciduous fruit tree vigour,precocity and yield productivity. N.Z. J. Crop Hortic. Sci. 23, 373–382.
37. Zhao, X., Guo, Y., Huber, D. J., & Lee, J. (2011). Grafting effects on postharvest ripening and quality of 1-methylcyclopropene-treated muskmelon fruit. Scientia horticulturae, 130(3), 581-587.
38. Zhilong B., 2016. Grafting: a technique to modify ion acumulation in Horticultural crops. Front Plant Sci 2016; 7:1457.