PLUM GRAFTING WITH INTERMEDIARY INSIDE PROTECTED SPACES

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Keywords: Prunus, grafting methods, callusing

ABSTRACT

This research study was focused on observing the grafting behaviour of two plum varieties, ”Andreea” and ”Tuleu gras”, grafted in the chip budding and whip and tongue grafting, on Cherry plum T163 and Adaptabil, by using the variants with and without intermediary. The experiment was conducted inside protected spaces (greenhouses). After the period of callusing stimulation at the grafting point the biological material was removed and prepared for planting in the first field of the fruit nursery. At the end of the vegetation period in the first field of the fruit nursery, the determinations indicated that the grafting success rate in the case of Andreea variety grafted without intermediary on Cherry plum T163 by using the whip and tongue method was identical with the one identified after the callusing stimulation at the grafting point (100%), with high biological material increase.

INTRODUCTION

In horticulture, research is meant to discover new solutions allowing the obtaining of large quantities of high-quality fruit planting material in the shortest period of time possible at minimum costs and accessible prices for fruit growers. Grafting is a common practise for fruit tree breeding. The rootstocks used for a specific cultivation are close “relatives” of the specific culture or wild selections (especially in the case of genera), but grafting was also noticed among different families (Warschefsky et al., 2016). The use of rootstocks that control vigour is a method of promoting precocity, reduction of vigour and increase of productivity (Webster, 2004). Also, the grafting with intermediary was used to induce tolerance to cold, resistance to diseases and reduction of vigour (Rogers and Beakbane, 1957). The rootstock selection represents a powerful instrument for durable increase of fruit production as, while scion can be used to induce the proprieties of fruits, the adjustment to water deficit and high salinity, the tolerance of alkaline soils and agent susceptibility may be influenced by rootstock selection (Jensen et al., 2012; Marguerit et al., 2012; Tamura, 2012). Koepke et Dhingra (2013) support the idea that the rootstock controls several aspects of scion growth and physiology, including production and quality attributes, as well as the biotic and abiotic tolerance to stress. The study of somatogenetic interactions between rootstock and scion is a field that can bring vast improvement to the current agricultural environment during the next decade, where there is a need for durable production practises; the rootstock offers a non transgenic approach for a quick response to the changing environment and for an extension of the agricultural production of annual and perennial crops in the cases where grafting is a possible response to the world needs of food, fibres and fuel.

Callus genesis represents a healing process that may serve to the study of factors controlling tissue growth and differentiation of stem cells from mesenchymal cells (García-Aznar et al., 2007). Specialised literature includes many studies on several varieties that approach the callus genesis process both in vitro and in vivo, as well as the influence of growth regulators on such process. The genotype of plants may have significant effects on regeneration (Tican et al., 2008). Pérez-Jiménez and colab. (2014) indicate that in the case of *Prunus* variety the somatic organogenesis capacity is strongly influenced by the endogenous hormonal content of the genotypes under study. Also, the influence of genotype on the callus genesis is sustained by other authors as well, both in herbal and wooden varieties (Brits 1986; Bordallo et al. 2004; Tican et al. 2008; Menkesi et al. 2010; Kibbler et al. 2004).

This research study was focused on observing the grafting behaviour of two plum varieties, namely ”Andreea” and ”Tuleu gras”, which were grafted by two methods, chip budding and whip and tongue grafting, on two rootstocks, Cherry plum T163 and Adaptabil, by using the variants with and without intermediary and by applying thermal stimulation at the grafting point (heat callusing).

MATERIAL AND METHOD

The experiment was conducted at SCDP RM. Vâlcea in the spring of 2020, by mass grafting of two plum varieties named ”Andreea” and ”Tuleu gras”, on two rootstocks (Cherry plum T163 and Adaptabil), with intermediary (Plamval), as well as intermediary free, by applying two grafting methods, chip budding and whip and tongue grafting, respectively (table 1). In order to get a good grafting success rate, the grafted biological material was subjected to a 15-day process of thermal stimulation at the grafting point inside protected spaces (greenhouses) with controlled temperature and humidity. After the callusing stimulation at the grafting point the biological material was removed and prepared for planting in the first field of the fruit nursery. Before being planted in the first field of the fruit nursery several determinations were made with regard to the quantity and grafting success rate of the biological material remained after the callusing stimulation at the grafting point. Later on, several determinations were made concerning the growth and development of the biological material in the first field of the fruit nursery: the rootstock diameter at 5 cm below the grafting point (mm); the diameter at rootstock / intermediary grafting point (mm); the rootstock / intermediary ratio (mm); the diameter at the grafting point (intermediary / variety) or (rootstock / variety) (mm); the variety diameter at 5 cm above the grafting point (mm); the scion (variety) height in cm.

RESULTS AND DISCUSSIONS

The discovery of new, simple and modern technologies to be used in order to obtain large quantities of fruit planting material in the shortest time possible at low costs represents a must for the development of the Romanian fruit growing field. The rootstock improves plant vigour, extends the vegetation period (Lee et al., 2010), the fruit productivity and quality (Huang et al., 2011; Rouphael et al., 2010; Tsaballa et al., 2013), extends the quality of fruits after harvesting (Zhao et al., 2011), increases the tolerance to low and high temperatures (López-Marín et al., 2013; Li et al., 2016), reduces the stress caused by salinity and heavy metals (Santa-Cruz et al., 2002; Estañ et al., 2005; Albacete et al., 2009; Schwarz et al., 2010; Huang et al., 2013; Wahb-Allah, 2014; Penella et al., 2015, 2016), increases resistance to floods (Bhatt et al., 2015), improves water use efficiency (Cantero-Navarro et al., 2016), manages the resistance to soil pathogens (Arwiyanto et al., 2015), manages the resistance to nematodes (Lee et al., 2010), controls weed growing (Louws et al., 2010) and produces new plant species (Fuentes et al., 2014).

Table 2 shows data on the grafting success rate after callusing stimulation and the viable biological material rate at the end of the vegetation period in the first field of the fruit nursery for all of the biological combinations under experiment. The largest quantity of biological material resulted from callusing stimulation at the grafting point was noticed in the case of ”Andreea” plum variety grafted on Cherry plum T163, by whip and tongue grafting method with no intermediary, and 100% grafting success rate. The lowest grafting success rate (34%) was recorded in the case of Tuleu gras/ Cherry plum T163 with 34 pieces of biological material. Several research studies confirmed the efficiency of the intermediary in controlling fruit tree vigour and, in certain cases, inducing early fructification, increased productive efficiency and fruit quality (Vercammen et al., 2007; Samad et al., 1999; Webster, 1995). Di Vaio and colab. (2009) indicated that in the case of apple, the intermediary determined a 50—80% less vegetative increase compared to control plants, an increase of fruit production and average weight, while the intermediary length determined the reduction of the plant growth vigour and of the fruit yield, the best results being obtained by the 10-cm long intermediary. It is advisable to choose the intermediary according to agronomic factors, such as the total distance to the grafting point and the intermediary length. (Beakbane and Rogers, 1956; Rufato et al., 2001). Other experiments indicated that the drop of the increase induced by the intermediary also depends on its vigour (Lockard et Lasheen, 1971), on the rootstock and the used variety (Tukey, 1943). In the case of the biological material grafted with Plamval intermediary the largest quantity and highest grafting success rate (87%) was obtained for Tuleu gras plum variety grafted on Adaptabil rootstock with Plamval intermediary (87 pieces out of 100). At the end of the vegetation period in the first field of the fruit nursery one could notice that, as result of the measurements made, the grafting success rate was identical with the case of Andreea variety grafted on Cherry plum T163 intermediary free, by whip and tongue grafting with the one identified in this variety after the callusing stimulation at the grafting point, the biological material recording significant increases.

Table 3 shows data concerning the growth and development of the biological material in the first field of the fruit nursery grafted inside protected spaces (greenhouses). The lowest and the highest value of the rootstock diameter at 5 cm below the grafting point (7.9 mm and 12 mm) were obtained in the case of Andreea / Cherry plum T163 and Andreea /Plamval / Cherry plum T163 respectively. The diameter at the rootstock / intermediary grafting point was 13 mm in the case of Andreea / Plamval / Cherry plum T163 and 11.4 mm for Tuleu gras/ Plamval /Cherry plum T163. The biggest intermediate diameter (11mm) was obtained in the case of Andreea/ Plamval/Cherry plum T163. The diameter at the grafting point (intermediary/variety) or (rootstock/ variety) was between 8.2 mm (Tuleu gras/ Cherry plum T163) and 14 mm (Andreea/Plamval/Cherry plum T163), while the variety diameter at 5 cm above the grafting point was between 5.3 mm (Tuleu gras/ Adaptabil in whip and tongue grafting) and 7.1 mm (Tuleu gras/ Adaptabil în Chip budding). The height of the scion (variety) varied between 34.2 cm (Tuleu gras/ Cherry plum T163 in whip and tongue grafting) and 66 cm (Tuleu gras / Adaptabil in whip and tongue grafting). One may notice that the best results were obtained with Andreea variety that was grafted on Cherry plum T163 rootstock.

CONCLUSIONS

The largest quantity of biological material resulted from callusing stimulation at the grafting point was noticed in the case of the intermediary free grafting of ”Andreea” plum variety and Cherry plum T163, by using the whip and tongue grafting method, with 100% grafting success rate. In the case of grafting performed by using Plamval as intermediary the highest grafting success rate was observed at Tuleu gras on Adaptabil rootstock (87%). At the end of the vegetation period in the first field of the fruit nursery the determinations made indicated that the grafting success rate of Andreea variety grafted on Cherry plum T163, intermediary free, by whip and tongue grafting method, was identical with the grafting success rate of this variety identified after the callusing stimulation at the grafting point (100%), the biological material recording significant increase. One may notice that the best results were obtained for Andreea variety grafted on Cherry plum T163 rootstock.

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Table 1

Experimental varieties and quantity of biological material obtained

No.	Biological combination (variety / intermediary / rootstock) or (variety / rootstock)	Grafting methods used	Quantity of grafted biological material (pieces)	Period of callusing stimulation at grafting point
1.	Andreea/Plamval/ Cherry plum T163	Chip budding / whip and tongue grafting	100	16 – 31 March 2020 15 stimulation days
2.	Andreea/Plamval/Adaptabil		100	
3.	Andreea/ Cherry plum T163	Whip and tongue grafting	100	
4.	Andreea/ Cherry plum T163	Chip budding	100	
5.	Andreea/Adaptabil	Whip and tongue grafting	100	
6.	Andreea/Adaptabil	Chip budding	100	
7.	Tuleu gras /Plamval/Cherry plum T163	Chip budding / Whip and tongue grafting	100	
8.	Tuleu gras /Plamval/ Adaptabil		100	
9.	Tuleu gras/ Cherry plum T163	Whip and tongue grafting	100	
10.	Tuleu gras/ Cherry plum T163	Chip budding	100	
11.	Tuleu gras/ Adaptabil	Whip and tongue grafting	100	
12.	Tuleu gras/ Adaptabil	Chip budding	100	

Table 2

Percentage of viable grafting and percentage of viable biological material at the end of the vegetation period in the first field of the fruit nursery

No.	Biological combination (variety/intermediary/rootstock) or (variety / rootstock	Grafting methods used	Quantity of grafted biological material (pcs)	Viable biological material after the callusing stimulation that was planted in the first field of the fruit nursery		Viable biological material at the end of the vegetation period in first field of the fruit nursery	
				Quantity (pcs)	Viability percentage (%)	Quantity (pcs)	Viability percentage (%)
1.	Andreea/Plamval/Cherry plum T163	Chip budding / whip and tongue grafting	100	60	60.00	54	54.00
2.	Andreea/Plamval/Adaptabil		100	60	60.00	34	34.00
3.	Andreea/Cherry plum T163	Whip and tongue grafting	100	100	100.00	100	100.00
4.	Andreea/Cherry plum T163	Chip budding	100	54	54.00	34	34.00
5.	Andreea/Adaptabil	Whip and tongue grafting	100	74	74.00	47	47.00
6.	Andreea/Adaptabil	Chip budding	100	47	47.00	34	34.00
7.	Tuleu gras /Plamval /Cherry plum T163	Chip budding / whip and tongue grafting	100	74	74.00	60	60.00
8.	Tuleu gras /Plamval/ Adaptabil		100	80	80.00	34	34.00
9.	Tuleu gras/Cherry plum T163	Whip and tongue grafting	100	87	87.00	87	87.00
10.	Tuleu gras/Cherry plum T163	Chip budding	100	34	34.00	27	27.00
11.	Tuleu gras/ Adaptabil	Whip and tongue grafting	100	74	74.00	34	34.00
12.	Tuleu gras/ Adaptabil	Chip budding	100	40	40,00	34	34,00

Table 3

Growth and development of the grafted biological material in the first field of the fruit nursery inside greenhouses

No	Biological combination (variety/intermediary/rootstock) or (variety / rootstock)	Grafting method used	Growth and development of the biological material in the first field of the nursery						
			Rootstock diameter at 5 cm below the grafting point (mm)	Diameter at grafting point rootstock / intermediary (mm)	Intermediary diameter (mm)	Rootstock / intermediary ratio	Diameter at grafting point (intermediary/variety) or (rootstock/ variety) (mm)	Variety diameter at 5 cm above the grafting point (mm)	Scion (variety) height (cm)
0	1	2	3	4	5	6	7	8	9
1	Andreea/Plamval/Cherry plum T163	Chip budding/ whip and tongue grafting	12.0±0.53	13.0±1.03	11.0±1.02	1.09	14.0±2.69	5.8±1.99	37.4±16.69
	Andreea/Plamval/Adaptabil		9.5±1.00	11.7±1.36	9.5±0.68	1.00	13.0±1.14	5.9±0.35	64.0±21.21
	Andreea/Cherry plum T163	Whip and tongue grafting	10.0±0.79	-	-	-	12.2±2.32	6.5±0.85	63.0±7.58
	Andreea/Cherry plum T163	Chip budding	7.9±0.29	-	-	-	8.4±1.03	6.9±1.31	55.0±10.00
	Andreea/Adaptabil	Whip and tongue grafting	10.3±0.78	-	-	-	12.5±2.31	7.0±0.90	65.0±7.60
	Andreea/Adaptabil	Chip budding	9.0±0.51	-	-	-	10.8±1.06	6.8±1.23	60.0±5.00
2	Tuleu gras/ Plamval /Cherry plum T163	Chip budding/ whip and tongue grafting	9.5±1.08	11.4±1.08	8.2±1.69	1.16	11.2±1.40	5.0±1.08	50.0±30.82
	Tuleu gras/ Plamval / Adaptabil		9.3±1.00	11.2±1.49	8.0±0.68	1.16	11.0±1.05	5.1±0.35	45.0±21.21
	Tuleu gras/ Cherry plum T163	Whip and tongue grafting	11.2±0.46	-	-	-	12.0±2.28	5.0±1.08	34.2±13.65
	Tuleu gras/ Cherry plum	Chip budding	8.0±0.89	-	-	-	8.2±2.48	7.0±1.49	57.0±20.79
	Tuleu gras/ Adaptabil	Whip and tongue grafting	9.1±0.56	-	-	-	10.7±1.06	5.3±0.60	66.0±11.40
	Tuleu gras/ Adaptabil	Chip budding	8.4±1.61	-	-	-	8.5±1.49	7.1±0.78	56.0±10.83