

Grafting "Pioneer" plum cultivar on two different rootstocks 1-Effect of different rootstock and grafting technique on "Pioneer" plum cultivar seedlings

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ABSTRACT

The present investigation has been conducted during the two seasons of 2018-2019 in the experimental farm of El-Qanater Horticultural Research station, Kalubeia governorate, Egypt, on one years old seedling of "Pioneer" plum budded on Nemaguard with shield budding, Mariana with shield budding, Nemaguard with cleft grafting, Mariana with cleft grafting to study the effect of different method of grafting and reciprocal relationship between rootstock and sections and their effect on vegetative growth, flowering on Pioneer cultivar to select the best rootstock suitable for grafting. Results indicated that pioneer grafting on Nemaguard by shield budding had effectively on scion diameter, shoot and leaves numbers and leaf area compared with other treatments. Although, pioneer grafting on Mariana rootstock by shield budding had effectively on stock and scion diameter, leaves number and leaf area compared with cleft in the both seasons. Moreover, Mariana rootstock had effectively on Shoot length in both seasons and on shoot diameter in the second season compared to Nemaguard rootstock. This study observed that, teething in pioneer leaf on Mariana rootstock is fine saw and the leaf neck with red in shield budding grafting. Nemaguard stock by shield budding was effectively on nutritional status of grafting zone compared to Mariana stock except Cu. Anatomical study by longitudinal section in the grafting union of the plum plants without any incompatibility symptoms. Rerated to the previous study we recommended that grafting by shield budding between pioneer cultivar on Nemaguard rootstock gave the best result.

Keywords: Plum, Pioneer, Rootstocks, Grafting Technique

INTRODUCTION

Plum (*Prunus salicina* L.) is one of the deciduous fruit trees cultivated in Egypt. The total area planted with plum reached about 6650 feddan with annual production of about 16633 tons, (FAO, 2020; Ministry of Agriculture, and Land Reclamation Statistics 2020). The reduction in the cultivated area and average productivity could be due to the unfavorable weather conditions during blossoming, which resulted in decreasing insect activity and pollination, especially for self-incompatible varieties. Generally, most fruit trees are composed of two different parts; rootstock and scion. Rootstocks influence the growth and vigor, production, water relations, physiology and nutrient status of scion leaves grafted or budded onto them. (Sharma *et al.*, 2019). Pioneer is an early red –skinned plum variety. Skin is bright red and the flesh is pale yellow.

Pioneer was bred by infuriate in South Africa, released in 1995 (Maklad and Ismail, 2016). The Marianna 2624 plum rootstock is a vigorous seedling selection of the parent Marianna plum is widely used as a rootstock for plums and apricots, due to its resistance to root-knot nematodes and oak root fungus. The Nemaguard rootstock an excellent peach and stone fruit rootstock that is highly resistant to root-knot nematode. Trees grafted on Nemaguard are fairly tolerant of waterlogged soils, very resistant to cold and form vigorous, strong trees (Wafi, 1990). Sutter, (1994) reported that, grafting on rootstock has been shown as a valuable technique for improving fruit trees, making it possible to control such important factors as vigor, resistance to parasites, diseases, adverse environmental factors and adaptation to soil and climatic conditions.

Sinha *et al.*, (1976) working on vegetative propagation of almond on different rootstock, where almond cv. Nonpareil was budded in September or grafted in January onto 4 different rootstocks and survival percentages were taken after 6 months. They found that grafting gave higher percentage of success than budding. Marwad, (1989) found that, budding/grafting methods significantly affected take and survival percentage. The methods that gave high take and survival percentage with all tested almond rootstocks were chip budding in Aug. & sept. and cleft

grafting in Jan.& Feb. (Hartmann and Kester, 1975) summarized the sequence of events in the healing of a graft union in woody plants as follows (a) the outer exposed layers of cells in the cambial region of both scion and stock produce parenchyma cells, (b) certain cells of this newly formed callus which are in line with cambium layer of the intact scion and stock differentiate into new cambium cells, (c) these new cambium cells produce new vascular tissues, xylem towards the inside and phloem towards the outside. Mosse, (1962) and Errea *et al.*, (1994) mentioned that, the new vascular connections could be not well differentiated or weakly established has been postulated as the main reason for incompatibility in woody plants. Ermel *et al.* (1999) reported that, in these cases, an abnormal process of neocambium differentiation lead to a cambial involution and a lack of differentiation into new vascular elements, as has been pointed out for pear and quince grafts. Calcium is a constituent of cell wall and it is important in formation of cell membrane, Magnesium regulates the processes of photosynthesis and carbohydrate metabolism and also associated with protein synthesis (Sharma *et al.*, 2019) also, Copper ions included in the enzyme hydrolyzate compounds forming sugar (Iglal *et al.*, 1980). The aim of this investigation was to study the effect of different method of grafting on different rootstocks of Nemaguard and Marianna on the grafting union success and morphological characters for Pioneer plum cultivar.

MATERIAL AND METHODS

This investigation has been carried out on seedling "Pioneer" plum cultivar seedling budded on two rootstocks (Nemaguard and Mariana) by two types of grafting (shield and cleft scion) during the two successive seasons of 2018 and 2019 at El-Kanatr Horticulture Research station farm, Kalubeia Governorate, Egypt.

The seedling was one-year-old planted at 4x4 m apart under clay loamy soil conditions, subjected to flood irrigation system. Sixty trees were used for this study each treatment included 15 plants in three replications (5 plants for each replicate). The trees received the same cultural practices that are recommend by ministry of Agriculture and land Reclamation Complete randomized block design was applied for the experiment involved the following four treatments:

- 1- Pioneer scion budded on Nemaguard by shield budding method.
- 2- Pioneer scion budded on Mariana by shield budding method.
- 3- Pioneer scion grafting on Nemaguard by cleft grafting method
- 4- Pioneer scion grafting on Mariana by cleft grafting method.

The following studies were carried out for the studied seedling as following:

- 1- Morphological studies.
 - 1-1- Vegetative growth (stock and scion diameter (cm), shoot number, length and diameter (cm) and leaf number and area (cm²).
 - 2-1- Nutritional studies (Cu, Fe, Mg and Ca elements were estimated union zone, (Jones, 1976)
- 2- Anatomical studies

Statistical analysis:

Data from the parameters used for evaluating vegetative growth taken in both seasons were subjected to analysis of variance according to Snedecor and Cochran (1980). Differences between treatments were compared using Duncan's Multiple Range Test Duncan (1955).

RESULTS

Morphological studies:

1.1. Vegetative growth:

1- Stock and Scion diameter:

Data in **Table (1)** cleared that, both rootstocks had no effect on stock diameter during first season. While in the second season Nemaguard rootstock had significantly effect on stock diameter (4.59) as compared with Mariana rootstock (4.11). As shown shield budding was significantly effect on stock diameter (3.32 and 5.84) as compared with cleft grafting (1.60 and 2.86) in the both seasons respectively.

The interaction indicated that, in the first season the highest value (3.35) of stock diameter recorded by shield budding on Mariana rootstock while in the second season the highest value (6.60) of stock diameter was recorded by shield budding on Nemaguard rootstock.

Also, Table (1) cleared that pioneer grafted on Nemaguard rootstock effect significantly on scion diameter (1.90 and 3.70) in both seasons respectively as compared with Mariana rootstock. Shield budding was significantly effect on scion diameter (2.12 and 3.80) in both studied seasons respectively as compared with cleft grafting. Also, the highest values of scion diameter (2.17 and 4.47) were recorded by shield budding on Nemaguard rootstock in the two seasons, respectively.

Table 1. Effect of different rootstocks and grafting methods on stock and scion diameter on pioneer cultivar during 2018 and 2019 seasons.

Parameters	Stock diameter (cm)			Scion diameter (cm)		
	Shield	Cleft	Mean	Shield	cleft	Mean
Grafting Rootstock						
	First season; 2018					
Nemaguard	3.29	1.43	2.36	2.17	1.63	1.9
Marianna	3.35	1.76	2.56	2.07	1.37	1.72
Mean	3.32	1.6		2.12	1.5	
LSD at 5 % for:						
Rootstocks (A)	N. S			0.163		
Grafting (B)	0.4			0.163		
Rootstocks x grafting (A x B)	0.462			0.189		
	Second season; 2019					
Nemaguard	6.6	2.57	4.59	4.47	2.93	3.7
Marianna	5.08	3.14	4.11	3.13	2.43	2.78
Mean	5.84	2.86		3.8	2.68	
LSD at 5 % for:						
Rootstocks (A)	0.378			0.209		
Grafting (B)	0.378			0.209		
Rootstocks x grafting (A x B)	0.437			0.241		

Shoot number, length and diameter:

Table (2) cleared that, pioneer grafted on Mariana rootstock effect significantly on shoot length (76.08 and 66.83 cm) as compared with Nemaguard rootstock (73.33 and 62.17) in both seasons, respectively. Data cleared that, during first season, shield budding effect significantly on shoot length (79.33 cm) as compared with cleft grafting (70.08 cm). while in the second season cleft grafting effect significantly on shoot length (71.50 cm) as compared with shield budding (57.50 cm).

In the first season, the highest values of shoot length (85.00 cm) were recorded by shield budding on Nemaguard rootstock while in the second season the highest values of shoot length (77.33 cm) were recorded by cleft grafting on Nemaguard rootstock as compared by the other treatments. Data in **Table (2)** indicate that, both stocks and methods grafted had no effect on shoot diameter during the first season. While, pioneer on Nemaguard by shield budding and on Mariana rootstock by cleft grafting was effected compared with other treatments without significant between them. In the second season Mariana had significant effect on shoot diameter. Moreover, shield budding gave higher value than cleft grafted. The interaction recorded that, pioneer on Mariana by shield budding was the highest significant value compared with the other treatments.

According to data in Table (2) pioneer grafted on Nemaguard rootstock affect significantly on number of shoots /plant (5.67 and 14.00) as compared with Mariana rootstock (4.00 and 14.00) in the two seasons, respectively. As cleared shield budding effect significantly on number of shoots/ plant (5.83 and 15.83) as compared with cleft grafting (3.83 and 11.67) in the two seasons, respectively. The highest values of shoots/plant (7.67) were recorded by Nemaguard rootstock with shield budding in the first season while in the second one the highest values of shoots/plant (16.67) were recorded by Mariana rootstock with shield budding as compared with the other treatments.

Table 2. Effect of different rootstocks and grafting methods on shoot number, length and diameter on pioneer cultivar during 2018 and 2019 seasons.

Parameters	Number of shoot/plant			Shoot length (cm)			Shoot diameter (cm)		
	Shield	cleft	Mean	shield	Cleft	Mean	shield	Cleft	Mean
First season; 2018									
Nemaguard	7.67	3.67	5.67	85.00	61.67	73.33	0.57	0.43	0.50
Marianna	4.00	4.00	4.00	73.67	78.50	76.08	0.47	0.57	0.52
Mean	5.83	3.83		79.33	70.08		0.52	0.50	
LSD at 5 % for:									
Rootstocks (A)	0.778			2.683			N.S		
Grafting (B)	0.778			2.683			N.S		
Rootstocks x grafting (A x B)	0.899			3.098			0.083		
Second season; 2019									
Nemaguard	15.00	13.00	14.00	47.00	77.33	62.17	0.37	0.43	0.40
Marianna	16.67	10.33	13.50	68.00	65.67	66.83	0.67	0.47	0.57
Mean	15.83	11.67		57.5	71.5		0.52	0.45	
LSD at 5 % for:									
Rootstocks (A)	0.693			2.613			0.049		
Grafting (B)	0.693			2.613			0.049		
Rootstocks x grafting (A x B)	0.8			3.017			0.057		

Leaf number and area:

Data in **Table (3)** showed that, pioneer grafted on Nemaguard rootstocks affect significantly on number of leaves /shoot (21.67 and 41.33) and leaf area (14.43 and 14.89) in the two seasons, respectively as compared with Mariana rootstock. Also, shield budding had a significant effect on number of leaf/shoot (23.17 and 49.17) and leaf area (14.19 and 15.44) in the two seasons, respectively as compared with cleft grafting. The highest values of number of leaves/ shoot (25.00 and 55.00) and leaf area (14.94 and 15.86) were recorded by shield budding on Nemaguard rootstock in the two seasons, respectively as compared with other treatments.

Nutritional status:

Data in **Table (4)** cleared that Nemaguard stock in was effectively on nutritional status of grafting zone compared to Mariana stock. Cleft grafting increased significantly the level of all elements expect Mg. Concerning the interaction, grafting pioneer on Nemaguard by shield budding gave the highest values of all elements except Cu by cleft grafting compared to other treatments.

Table 3. Effect of different rootstocks and grafting methods on Number of leaf /shoot and leaf area (cm²) on pioneer cultivar during 2018 and 2019 seasons.

Parameters	Number of leaf/shoot			Leaf area (cm) ²		
	Shield	Cleft	Mean	Shield	Cleft	Mean
First season; 2018						
Nemaguard	25.00	18.33	21.67	14.94	13.92	14.43
Marianna	21.33	14.67	18.00	13.44	12.74	13.09
Mean	23.17	16.50		14.19	13.33	
LSD 5% For :						
Rootstock	1.49			0.632		
Grafting	1.49			0.632		
Rootstock x grafting (A x B)	1.721			0.73		
Second season; 2019						
Nemaguard	55.00	27.67	41.33	15.86	13.93	14.89
Marianna	43.33	22.67	33.00	15.01	13.39	14.20
Mean	49.17	25.17		15.44	13.66	
LSD 5% For :						
Rootstock	1.614			0.58		
Grafting	1.614			0.58		
Rootstock x grafting (A x B)	1.864			0.67		

Table 4. Effect of different rootstocks and grafting methods on Nutritional status on pioneer cultivar during 2018 and 2019 seasons.

Parameters	Cu			Fe			Mg			Ca		
	shield	Cleft	Mean	shield	Cleft	Mean	shield	Cleft	Mean	shield	Cleft	Mean
Nemaguard	1.13	1.71	1.42	2.24	2.00	2.12	5.16	3.57	4.37	11.34	10.71	11.03
Marianna	1.09	1.16	1.13	1.65	2.08	1.87	3.38	3.94	3.66	7.93	9.98	8.96
Mean	1.11	1.44		1.95	2.04		4.27	3.76		9.64	10.35	
LSD at 5 % for:												
Rootstocks (A)	0.098			0.0696			0.11			0.1476		
Grafting (B)	0.098			0.0696			0.11			0.1476		
Rootstocks x grafting (A x B)	0.114			0.0804			0.127			0.1705		

Anatomical studies:

Anatomical studies were carried out on the grafting union. The union zone of grafted plants was taken and cut to two halves longitudinally across the union zone with a very thin saw. The cut surfaces were softened with soft sand glass paper, and the samples were examined with citoval the symptoms of success or failure of grafting and were illustrateand by photographs (Singer, 1997).

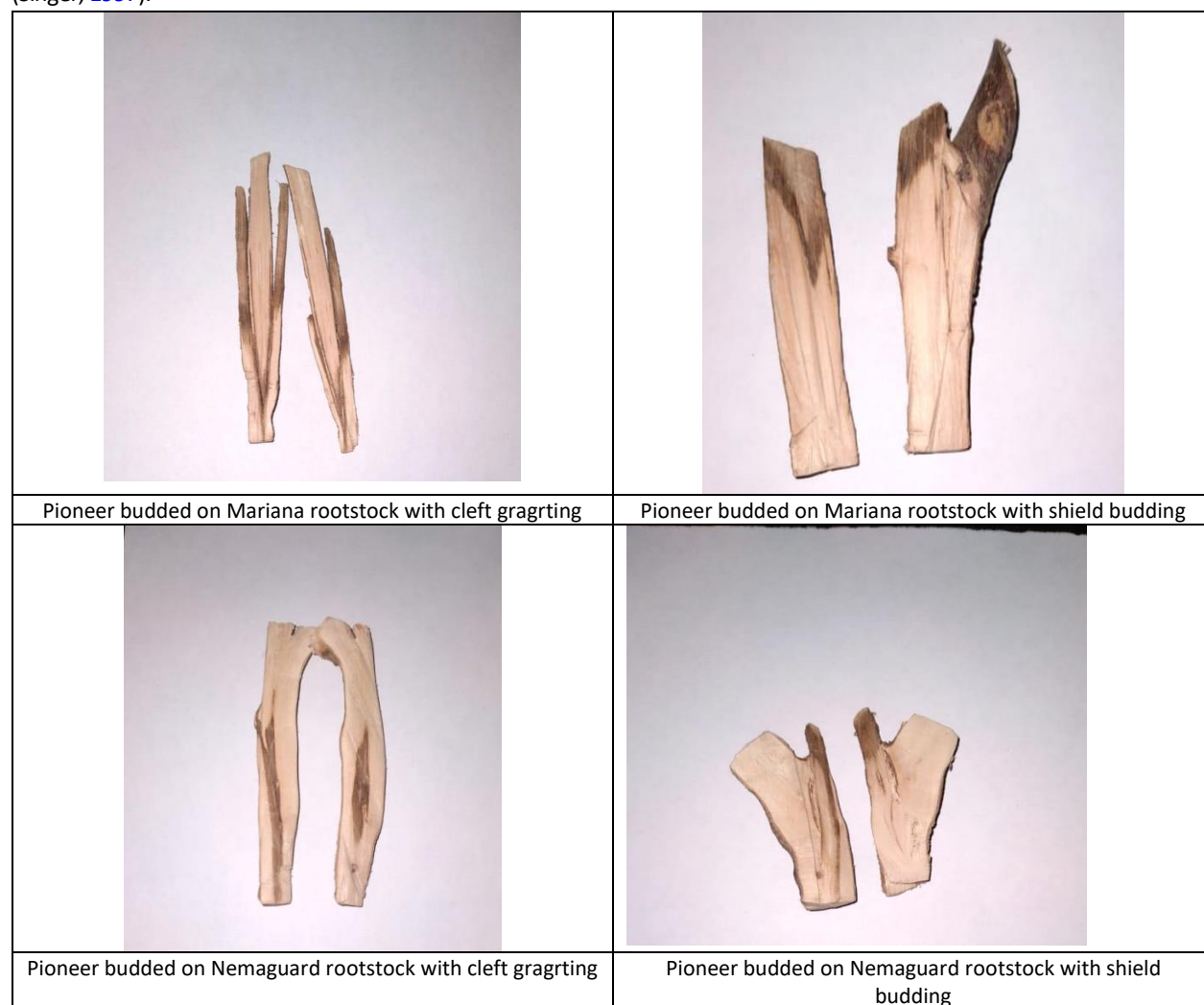


Fig. 1. The longitudinal sections in the graft union of the plum plants. It is obvious from the data aforementioned and the binocular examination of graft unions without any incompatibility symptoms

DISCUSSION

Our findings agree with Czarnecki (1987) reported that shield budding on apple trees had no influence on length and thickness. Also, Sinha (1976) on Almond found that grafting gave higher percentage of success than budding. Osman (1986) found that cleft grafting on guava gave the shortest length compared with other treatments; Eassa (2012) on Almond found that, using Nemaguard peach rootstock recorded significantly the highest values of the growth parameters, Wasfi (1990) the growth rate of "Anna" apple plants were highest on MM.109 lowest on MM.106 and intermediate on MM.111; Soaad *et al.*, (2015) growth parameter of "Le-Conte" cv. trees affected by budding on different rootstock.

These results were agree with, Dozier *et al.* (1983) concluded that, growth and vigour of the plum tree is also influenced by the rootstock used, Osman (1986) found that, cleft grafting on guava gave the shortest length compared with other treatments, Eassa (2012) on Almond found that, using Nemaguard peach rootstock recorded significantly the highest values of the growth parameters

On the other hand, Czarnecki (1987) reported that shield budding on apple trees had no influence on length and thickness, Sinha (1976) on Almond found that grafting gave higher percentage of success than budding. Also, Lewko *et al.* (2006) reported that, vigorous of rootstock was assessed by rootstock and scion diameter, shoot length and shoot mass on pear trees.

In present assay, our results agree with (Osman, 1986) found that cleft grafting on guava gave the shortest length compared with other treatments, (Eassa, 2012) on Almond found that, using Nemaguard peach rootstock recorded significantly the highest values of the growth parameters, Also, (Sharma *et al.*, 2004) recorded higher leaf area in Non Pareil almond when raised on wild peach than bitter almond rootstocks.

On the other hand, (Czarnecki 1987) reported that shield budding on apple trees had no influence on length and thickness. Also, (Sinha 1976) on Almond found that grafting gave higher percentage of success than budding. Moreover, the concentration of Ca was higher significant in pioneer grafting on Nemaguard by shield budding than cleft grafting. However, pioneer on Mariana by cleft grafting was effectively than shield budding on all elements concentration. Calcium is a constituent of cell wall and is important in formation of cell membrane (Sharma *et al.* 2019), Calcium is necessary for cell to divide indirectly. It is believed that Ca has a role in chromatin or mitotic spindle organization. Therefore, in the case of Ca deficiency in the plant cell division occurs in an abnormal manner, due to the fact that Ca deficiency affects the structure and stability of chromosomes. As it turns out, the nucleic acid molecules are bound by divalent cations such as calcium (Eglal *et al.*, 2000).

These results agree with Wasfi (1990) who reported that, leaf Ca content of "Anna" apple plants on MM109 was almost the same as budded on mm.111 while plants on MM.106 contained significantly higher leaf Ca levels. Also, Garb (2000) and Zayan *et al.*, (2002) reported that "Anna" apple trees budded on MM.106 rootstock had higher Ca leaf content than those budded on Malus, in sand soil, Gaber *et al.*, (2006) reported that MM106 rootstock increased leaf Fe content of "Anna" apple.

CONCLUSION

The results showed that the rootstocks strongly affected growth parameters number (shoots and leave), shoot length and grafted zone mineral (Ca, Mg, Fe and Cu) content. Grafting "Pioneer" on Mariana by two grafted methods was successful without any problem compared to Nemagard shield budding was effectively with two stocks compared to cleft grafting. The results showed that, the rootstocks and different graft methods strongly. Moreover, preference was for Nemagard stock, on the other hand, cleft grafting with Nemagard cleared that, Scion thickness was higher than stock thickness during two seasons due to decrease Ca concentration of grafted zone, this phenomenon may due to separation scion from stock on the long term. Related to the previous study we recommended that grafting by shield budding with pioneer cultivar on Nemaguard rootstock which gave the best result.

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تطعيم صنف البرقوق "بايونير" على جذرين مختلفين 1- تأثير تقنية الجذر والتطعيم المختلفة على شتلات صنف البرقوق "بايونير"

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اجريت هذه الدراسة بمزرعة محطة القناطر الخيرية بمحافظة القلوبية خلال موسمي الزراعة 2018-2019 علي شتلات برقوق "بايونير" عمر سنة منزرعة في ارض طينية طمية تم تطعيمها علي اصلين (نيماجارد ، ماريانا) وطريقتين تطعيم ((العين ، والقلم) علي مسافة 4*4 م تحت نظام الري بالغمر وكانت المعاملات كالاتي:بايونير علي نيماجارد بالعين بايونير علي ماريانا بالعين و بايونير علي نيماجارد بالقلم ،بايونير علي ماريانا بالقلم وعمل قطاع تشريحي لمنطقة التطعيم لكلا الاصلين تحت ظروف طريقتي التطعيم لدراسة تأثير طرق مختلفة من التطعيم والعلاقة بين الاصول والطعم علي النمو والتزهير وتفسير التوافق من عدمه واختيار الاصل الافضل للتطعيم ، ولقد اشارت النتائج الي ان تطعيم البايونير علي النيماجارد بالعين كان أكثر تأثيرا علي سمك الطعم ، عدد الافرع والاوراق ، مساحة الورقة في الموسمين وكذلك أكثر تأثيرا علي الحالة الغذائية لمنطقة التطعيم مقارنة بالماريانا ماعدا عنصر النحاس في الموسمين مقارنة بالمعاملات الاخرى.

ايضا تطعيم البايونير علي الماريانا بالعين كان أكثر تأثيرا علي سمك (الاصل والطعم) عدد الاوراق ومساحة الورقة مقارنة بالقلم في الموسمين. كما وجد ان أصل الماريانا أكثر تأثيرا علي طول الفرع في الموسمين وعلي قطر الفرع في الموسم الثاني مقارنة بالنيماجارد. هذه الدراسة لاحظت ان التسنين في ورقة " البايونير" علي الاصل الماريانا كان ادق عن النيماجارد وان عنق الورقة ذات لون احمر في حالة التطعيم بالعين . اظهرت الدراسة التشريحيه بعمل القطاع الطولى في منطقة التطعيم عدم ظهور ظاهرة عدم التوافق. لذلك توصي الدراسة باستخدام اصل النيماجارد لتطعيم بالعين صنف البايونير للحصول علي افضل النتائج.

الكلمات المفتاحية: البرقوق , البيونير , الاصول , التطعيم