Original Research Article

The influence of dwarfing interstock on biometric growth parameters of apple.

Abstract

In Kashmir valley most of the temperate fruit crops are grafted on the seedling rootstocks except apple which is also propagated through the clonal rootstocks. There is not a single rootstock which can be considered as ideal withspecific traits.Every rootstock has certain advantages and disadvantages. Apple trees grown on seedling rootstock often develop into large and vigorous trees making its management difficult. By using vigorous rootstocks only few trees can be accommodated per hectare making the productivity less profitable.Several dwarfing rootstocks of apple are available which need support system and incur heavy investment during orchard establishment. It would be ideal to obtain a tree with very good root system, to avoid the need for supporting systems and also with a low height, which can be achieved using the interstem.Therefore, in the present investigation M9 clonal interstem comprised of 2,4,6 and 8inches lengthwere grafted between seedling rootstock and scion of two cultivars i.e., Red Delicious and American Apirouge which are most common and predominant cultivars in orchards. The average sapling height was to the tune of 38.85cm and 41.01 cm in Red Delicious and American Apirouge during first year of study.There was a progressive increase in the height of plant with decreasing interstem length. In both the apple cultivars stem diameter increased with decrease in interstem length but was lower than control during both the years of study, The rootstock influences the biometric parameters of the grafted trees.The results showed that increased interstem length significantly decreased sapling height and growth whereas, days taken to sprouting and survival per cent were non significant. Thus, it appeared as if the dwarfing rootstock genotype used as an inter-stem functioned as a kind of physical restriction to water movement and probably reduced the hydraulic conductance of the whole tree.

Key words: Apple,M9,interstem, growth parameters, seedling rootstock

Introduction:

The common domesticated apple is putatively an interspecific hybrid complex, usually designated *Malus* × *domestica* Borkh. The origin and ancestry of the *M.* × *domestica*complex remain unknown. Borkhausen, when first describing M. × domestica in 1803, believed it originated as a hybrid derived from *M. sylvestris* Mill., *Malus dasyphyllus* Borkh. (a synonym for M. pumila) and *Malus praecox* Borkh. (a synonym for M. sylvestris var. praecox (Pall.) Ponomar.) (Korban and Skirvin, 1984). Currently, however, *Malus sieversii* (Ledeb.) Roem. is hypothesized as the key species in its origin.

An apple a day keeps the doctor away. This old adage exhibits the significance and the nutritive importance of apple in human diet. In Kashmir valley in spite of prominent

positionofappleinnutritional,ecologicaland socio-economic profile, the potential of apple sector is not commensurate with the actual available potential. Apple trees grown on seedling rootstock often tend to develop into large and vigorous trees making its management difficult. There is more competition between vegetative growth and fruit production within these trees and their internal self-shading makes them more vulnerable to various diseases. By using vigorous rootstocks, only few trees can be accommodated per hectare making the productivity less profitable.In fact apple industry is yet tocome to its full strength so it has become imperative to go for high-densityplantation and to achieve it change in from vigorous to size controlling rootstock is a prerequisite. In Kashmir valley the clonal rootstocks were first introduced at Advanced Centre for Horticulture Development (ACDH), Zainapora, formerly known as Indo-Bulgarian Project during the year 1989-90. ACDH acts as source for all clonal rootstocks of apple and from there rootstocks are distributed to other parts of valley. The commercial growers use sizecontrolling dwarfing rootstocks planted at high densities that brings the grafted scion into fruit production within 2 to 3 years after planting. Greater light penetration in these high-density orchards increases tree health and precocity, return bloom, fruit size and quality.

The increasing tendency to use size controlling rootstocks led to low tree heights but do not ensure good root system, which implies using support system on one hand and fertilization-irrigation on the other hand. The rootstock is important not only to adjust the height, but also to capitalize some terrains that are less favorable for other crops. Usually, low height rootstocks are sensitive to soil conditionsandthey need more nutrition and water in the superficial soil layers. The seedling rootstocks on the other hand impart vigour and also make the scion to come into bearing late i.e., vigorous rootstocks influence tree vigor and intensity of vegetative growth. It would be ideal to obtain a tree with very good root system to avoid the need for supporting systems and also with a low height, which can be achieved using the interstem. The use of grafting intermediaries for fruit trees led to lower tree heights when vigorous varieties and rootstocks are used, and the yield are different according to the rootstock and interstem combination (Samad *et al*. 1999). Thus the present investigation was carried out to gain insight on use of clonal M9 interstem between vigorous rootstock and two prominent scion cultivars (Red Delicious and American Apirouge) and its effect on biometric growth parameters.

Materials and Methods:

One year old seedling rootstocks of apple of uniform thickness were planted at a spacing of 0.5x3.0 sq.ft in nursey at Experimental Farm of Division of Horticulture FOA Wadura SKUAST Kashmir. The composite trees were prepared as rootstock grafted with interstem of M9 clonalrootstock.The M9 clonal rootstock (interstem) comprised of 2,4,6 and 8 inches length grafted between seedling rootstock and scion. Red Delicious and American Apirouge which are most common and predominant cultivars in farmers orchards were used as scion for grafting. The control treatment consist of grafting scion on seedling rootstock without using interstock. Cleft grafting method was used in the spring for preparation on composite trees.The culture

technology that form the plant nursery was the specific one, based on taking care of the trees, maintaining a clean soil, ensuring water and nutrition. The material used for grafting both the graft and the rootstock, were healthy free from disease and raised in the nursery.In order to find the influence of the rootstock on the vigor of trees grafted with and without interstock, several measurements regarding biometric indicators were made includingscion diameter, tree height of the sapling, leaf area and survival percentage.

Results and Discussion:

The results showed that interstock length significantly affected growth parameters as sapling height,diameter of scion and leaf size (Table 1). The interstock length of 8 inches significantly decreased sapling height in two cultivars during both the years of study.The average sapling height was to the tune of 38.85cm and 41.01cm in Red Delicious and American Apirouge during first year of study. There was a progressive increase in the height of plant with decreasing interstem length. The lowest interstem length of 2 inches registered stem length of 45.77 and 47.14cm in Red Delicious and American Apirouge during first year but was statistically significant compared to control. Similar trend was observed in stem height of sapling during next year in both the cultivarsrespectively.Asis obvious from Table-1, thestem diameter significantly decreased by interstock length as compared with thecontrol. Significant differences were found betweenstem diameter (11.10mm)and (12.40mm) under interstock length of 8 inches while as control produced girth of 15.83and 16.07mm in Red Delicious and American Apirouge respectively in the first year.In both the apple cultivars stem diameter increased with decrease in interstem length but was lower than control during both the years of study.These results are also in conformity with the findings of Tworkoskiand Miller, 2007. Tombesi*et.al.,* (2010) also reported that the use of two vigorous rootstocks, A2 and MM111, with grafting intermediary B9 showed reduction in tree vigor compared to MM106 and a better ramification andformation of fruit buds capacity during the grafting year, the trees looking as knipp-typed ones.In general, dwarf interstock betweenscion and more vigorous rootstock decreased sapling and scion growth in both cultivars. Theseresults are also in agreement with previous reports by Rozpara*et al.*, 1990and Marcon Filho *et al.*, 2010).

The results showed that number of leaves were significantly affected by interstockin both the cultivars. The grafts having 2 ,4,6 and 8 inches interstock lengthsignificantly reduced leaf number in comparison to control (Table-1). The number of leaves inRed Delicious and American Apirouge was lower at 8 inchesinterstocklength (19.85 and 20.29 Nos.)during first year and 22.21 and 23.25 no's in following year.The interstock length of 6 inches resulted in 21.77and 23.33 number of leaves during first year and. 24.36 and 24.57 no'sduring following yearin Red Delicious and American Apirouge respectively.The highest number of leaves 27.62 and 30.34 was registered in first year and 31.38 and 32.12 during second year under control in Red Delicious and American Apirouge respectively.These results are in agreement with previous findings (Samad *et al* 1999; Wertheim & Webster 2005; Di Vaio *et al* 2009; Marcon Filho *et al* 2019). Karlidag*et.al*.,(2014) reported that the interstock length of 30 cm significantly decreased

sapling height in both cultivars ($p<0.05$). The average stem diameter was between 9.7 mm and 10.6 mm in 30 cm length and in the control (no interstock) in Golden Delicious, respectively, while it was between 9.3 mm and 10.2 mm in 30 cm length and in the control in Granny Smith, respectively.Growth reduction in both sapling and treecould be related to distribution of mineral and planthormones in whole plant. Rozpara*et al.,* (1990)reported that the interstock could modify contentof mineral nutrients in the plants and the reductionof the vegetative growth in these plants could becaused especially by the reduction in potassiumcontent. On the other hand, Richards *et.al*.,(1986)and Li *et.al.,* (2012) suggested that dwarf interstockdecreased the transport of plant hormones suchas auxins, gibberellins and cytokinins in bothrootstock and scion.

In apple cultivars, interstem of varying lengths was significant in decreasing leaf area duringfirst year of investigation (Table-2). Interstemat the maximum length of 8inches resulted in the lowest leaf area (21.61 cm^2 and 21.72 cm^2) during first year in Red Delicious and American Apirouge respectively. Similarly, leaf area to the tune of 22.75 and 22.93 cm^2 was obtained with 6 inches interstem length followed by 4 inches length that recorded leaf area of 23.10 and 23.66 cm^2. Red Delicious and American Apirougeexhibited anon significant trend in leaf area during second year of study. The maximum leaf area was found in control during first year of study. Days taken to sprouting and survival per cent of Red Delicious and American Apirouge exhibited a non significant trend with use of interstem (Table-2).The rootstock influences the biometric parameters of the grafted trees.The results showed that increased interstem length significantly decreased sapling height and growth but was non-significant in days taken to sprouting and survival per cent. Thus, it appeared as if the dwarfing rootstock genotype used as an inter-stem functioned as a kind of physical restriction to water movement and probably reduced the hydraulic conductance of the whole tree. If this is correct, according to the Hagen–Poiseuille law, the interstem effect should depend on its length, doubling thelength should halve the hydraulic conductance. This may partly explain why Parry and Rogers (1972)working with dwarfing apple rootstock genotypes, reported that a 35 cm interstem piece had a greaterdwarfing effect than a 5 cm interstem and similar results were reported by Di Vaio *et al.* (2009). It mayalso explain why the vigour-reducing effect of dwarfing rootstock genotypes used as inter-stems is generallyintermediate between the vigour obtained from using vigorous versus dwarfing genotypes as rootstocks.

Conclusion:

The present investigation was carried out to gain insight on use of clonal M9 interstem between vigorous rootstock and two prominent scion cultivars (Red Delicious and American Apirouge).The interstem influenced the biometric parameters of the grafted plants. There was a progressive increase in the height of plant with decreasing interstem length. The interstock length of 8 inches significantly decreased sapling height in two cultivars during both the years of study. The average sapling height was to the tune of 38.85cm and 41.01 cm in Red Delicious and American Apirouge during first year of study and same trend found during the second year. In both the apple cultivars stem diameter increased with decrease in interstem length but was lower than control during both the years of study. The results showed that increased interstem length significantly decreased sapling height and growth but was non-significant in days taken to sprouting and survival per cent.

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Table-1.Effect of inter -stem length on growth of grafted plant.

Treatments	Height of the sapling (cm)				Dia. of the Scion(mm)				NO. of leaves(No.)			
	1st year		2nd Year		1st year		2nd Year		1st year		2nd Year	
	V 1	V2	V 1	V2	V 1	V2	V 1	V2	V 1	V2	V1	V2
T1	38.85	41.01	41.06	43.96	11.10	12.40	12.37	13.63	19.85	20.29	22.21	23.25
T2	41.28	43.81	42.27	45.03	13.15	13.80	14.46	15.48	21.77	23.33	24.36	24.57
T3	42.93	45.60	44.18	48.40	14.92	15.12	15.61	15.88	23.68	24.65	26.01	27.15
T4	45.77	47.14	47.24	52.05	15.11	15.27	15.82	16.19	25.16	26.59	27.71	28.33
T5	52.68	56.03	54.63	58.61	15.83	16.07	16.33	16.65	27.62	30.34	31.38	32.12
CD	2.05	1.30	4.60	2.63	0.919	0.695	1.41	0.92	1.070	1.084	2.12	2.48
SE(M)	0.620	0.395	1.390	0.796	0.278	0.210	0.428	0.280	0.325	0.327	0.641	0.75
CV	2.425	1.465	5.294	2.78	3.428	2.499	4.968	3.118	2.383	2.264	4.21	4.79

Treatment symbols:

T_1–Grafting of apple M9as interstock (8” length)
T_2-Grafting of apple M9as interstock (6”length)
T_3-Grafting of apple M9as interstock (4” length)
T_4-Grafting of apple M9as interstock (2” length)
T_5-Budding on seedling rootstock (no interstem)

Table-2.Effect of inter -stem length on leaf size,days to sprouting and survival (%) of grafted plant.

Treatments	Leaf Size (cm^2)				Days taken to sprouting(No.)				Survival (%)			
	1st year		2nd Year		1st year		2nd Year		1st year		2nd Year	
	V 1	V2	V 1	V2	V 1	V2	V 1	V2	V 1	V2	V1	V2
T1	21.61	21.72	23.11	24.24	25.47	26.33	24.9	26.08	94.80	96.22	93.09	96.09
T2	22.75	22.93	23.77	24.37	24.89	26.43	24.58	25.90	95.56	95.92	92.77	95.36
T3	23.10	23.66	23.83	24.41	25.55	27.16	24.93	25.69	96.68	96.20	93.43	95.27
T4	23.47	24.53	23.88	24.53	25.33	27.40	24.51	25.89	95.47	95.08	93.62	94.67
T5	23.62	24.59	23.92	24.59	24.61	25.43	24.73	26.03	96.07	97.15	93.59	94.38
CD	1.210	0.899.	N.S	N.S.	N.S.	N.S.	N.S.	N.S.	NS	NS	N.S.	N.S.
SE(M)	0.365	0.271	0.483	0.151	0.381	0.504	0.456	0.741	0.700	0.774	0.531	1.168
CV	2.762	2.001	3.532	1.070	2.624	3.258	3.194	4.949	1.266	1.395	0.986	2.126

Treatment symbols:

T_1–Grafting of apple M9as interstock (8” length)
T_2-Grafting of apple M9as interstock (6”length)
T_3-Grafting of apple M9as interstock (4” length)
T_4-Grafting of apple M9as interstock (2” length)
T_5-Budding on seedling rootstock (no interstem)