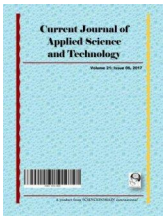

Current Journal of Applied Science and Technology

28(2): 1-6, 2018; Article no.CJAST.41932
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Response of M-9 and MM-106 Clonal Rootstocks on Productivity and Quality of New Apple Cultivars

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Authors' contributions

This work was actually carried out wholly by author RB while other authors helped in writing and data analysis.

Article Information

DOI: 10.9734/CJAST/2018/41932
Editor(s):
(1) Dr. Ahmed Fawzy Yousef, Associate Professor, Department of Geology, Desert Research Center, Egypt.
Reviewers:
(1) Raul Leonel Grijalva-Contreras, Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Mexico.
(2) Hidelblandi Farias de Melo, Rural Federal University of Pernambuco, Brazil.
Complete Peer review History: http://www.sciencedomain.org/review-history/25321

Original Research Article

Received 22nd March 2018
Accepted 6th June 2018
Published 29th June 2018

ABSTRACT

The study was undertaken to make a preliminary assessment for productivity and quality of new apple cultivars viz, Lal Ambri, Sunhari, Shireen, Firdous and Akbar on two M-9 and MM-106 clonal rootstocks respectively. The investigations were carried out at the Experimental Farm of SKUAST-Kashmir. An experiment was laid out in a randomised block design with ten treatment combinations. The results obtained revealed that the varieties raised on MM-106 rootstock resulted in higher plant height, per cent fruit set and fruit retention. And the plants which were raised on M-9 rootstock resulted in more plant girth, more spread, early fruit maturity, higher fruit weight and firmness. Among these tested varieties, Shireen performed better on M-9 rootstock as compared to other varieties.

Keywords: Clonal rootstocks; apple; yield; quality; cultivars; productivity.

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1. INTRODUCTION

Apple (*Malus* × *domestica* Borkh) occupies a significant place in the horticultural wealth of temperate zone. The productivity of apple in different hill states estimates 3.5 t/ha in Uttaranchal, 6.5 t/ha in Himachal Pradesh and 12 t/ha in Jammu and Kashmir which in contrast to Western Countries is very low where the yield potential accounts for about 30 t/ha. The growth and productivity of apple in Indian conditions can be optimised by replacing out-dated depleted standard Delicious cultivars by the improved high yielding cultivars and adopting standard clonal rootstocks instead of seedling stock in addition to improved management practices.

A significant contribution has been made by Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Shalimar by evolving and releasing new apple varieties namely Lal Ambri, Sunhari, Shireen, Firdous and Akbar. These varieties are known for their high-quality fruit, high yield potential and resistance to disease like a scab (*Venturia inaequalis*). These newly evolved varieties have so far been tested on seedling rootstock only. The vigorous seedling rootstock leads to more massive tree, which has long juvenility. 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 a few trees can be accommodated per hectare making the productivity less profitable. With stagnation in productivity, looming threat of imported fruits and land prices touching new peaks in the valley, it becomes imperative to go for high-density plantation for which change in rootstock from vigorous to size-controlling rootstock or clonal rootstock is a prerequisite [1].

Having realized this important constraint, an attempt was made to undertake studies on the performance of these varieties on dwarfing and semi-dwarfing clonal rootstocks like M-9 and MM-106 respectively at Shalimar campus. Clonal rootstocks which offer a viable solution to this problem have been used by the researchers and fruit growers in other temperate fruit growing countries [2]. These rootstocks can ensure better management and quality fruit production [3].

2. MATERIALS AND METHODS

2.1 Research Location and Climate

District Srinagar is situated between 35°T.5'-35°.7' North latitude and 74°.8'-74°.9' East longitude and at an altitude of 1500 meters above mean sea level, is flanked by lofty Himalayan ranges on South East and North East sides. At the base of these ranges towards the Northeast side lies the University campus about 15 km from the main city. The climate of the valley is temperate cum Mediterranean type. Winter is severe extending over 100days from the middle of December to March, during which the temperature often goes below the freezing point and the whole valley remains covered with snow. The valley is marked by extremes of temperature, ranging from a maximum of 35°C in summer to a minimum of -10°C in winter. The annual mean temperature is 15°C. The climate is cold and rainfall is optimum, well distributed about 80 cm per annum, mostly in the form of snow during winter and main rainfall is during March-April.

2.2 Morphological and Growth Characteristics

The present investigations were carried out at the Experimental Farm of the Division of Fruit Science, Sher e Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar on five year old plants of apple varieties viz., Lal Ambri, Sunhari, Shireen, Firdous and Akbar, raised on two clonal rootstocks i.e. semi-dwarfing MM-106 and dwarfing M-9. The experiment was laid out in RBD (factorial) with 3 replications and two plants per plot Data on plant girth, plant height, plant spread, yield and quality of fruits were recorded as per standard procedures. Percentage of fruit set and fruit retention were calculated at the fruitlet stage by using the formula suggested by [4]. Fruit length and fruit diameter were measured in mm with the help of vernier callipers. Fruit weight was determined by individually weighing the fruits obtained from each experimental plant on a common monopan balance and the average weight was recorded. Fruit firmness was determined with the help of pressure tester at shoulder of the fruit and at different sites of fruit and then average firmness was recorded with pressure penetrometer. TSS of the fruits was recorded with the help of hand

refractometer. Titration method and values determined Titrable acidity were expressed as a percentage of malic acid [5] and total sugars were determined by Lane and Eynon Method [6]

3. RESULTS AND DISCUSSION

Clonal rootstocks were found to have a significant effect on plant girth. The maximum plant girth was observed in trees raised on dwarfing M-9 rootstock (Table1). Among the varieties, plant girth was found to be more in Lal Ambri. Interaction effect of rootstocks and variety showed maximum plant girth in Lal Ambri on M-9 rootstock. This may be due to the genetic nature of the dwarfing rootstock M-9 as the size of the plants raised on this rootstock is restricted which results in more accumulation of carbohydrates and increases the girth [7,8].

The plants recorded maximum plant height on semi dwarfing MM-106 rootstock and minimum on dwarfing rootstock M-9. Among the varieties, the maximum plant height was observed in Lal Ambri followed by Akbar, Sunhari and Shireen. The lowest value was recorded in firdous. Interaction effect of rootstock and variety showed maximum plant size in Lal Ambri on semi dwarfing MM-106 rootstock. This may be possibly due to the genetic natue of semi vigorous MM-106 rootstock. These results are in line with [9,10].

Plant spread was also significantly influenced by clonal rootstock. Maximum plant spread was observed in trees raised on dwarfing M-9 rootstock and minimum on MM-106 rootstock. Among the varieties, plant spread was highest in Lal Ambri. Interaction effect of rootstocks and variety showed maximum plant spread in Lal Ambri on dwarfing M-9 rootstock. This may be due to the plant architecture of the variety. More spread and canopy area on M-9 may be due to more lateral branches as compared to MM-106 where the trees attain upright branching pattern resulting in less spread and less canopy area. These results are in line with [11,7,12].

The clonal rootstocks significantly increased percent fruit set and fruit retention (Table 2). Semi-dwarfing MM-106 rootstock resulted in higher fruit set and fruit retention as compared to the dwarfing M-9 rootstock. Among varieties, highest fruit set and fruit retention were recorded in Akbar followed by Lal Ambri, Sunhari, Firdous and Shireen. Interaction effect of rootstocks and variety showed maximum fruit set and fruit retention in Akbar on semi-dwarfing MM 106 rootstock. These results are in agreement with [13]. Fruits of trees with semi-dwarfing MM-106 rootstock took a maximum number of days after full bloom to attain maturity whereas the trees raised on dwarfing M-9 rootstock took lesser number of days to attain this stage. The highest number of days were taken by Lal Ambri followed by Akbar, Sunhari, Firdous and Shireen. Among rootstocks and variety interaction, fruit maturity occurred earlier in Shireen on dwarfing M-9 rootstock. These results are in line with [14,15].

Fruit yield was higher in trees raised on MM-106 rootstock than on M-9 rootstock (Table3). Among varieties, highest fruit yield was recorded in Akbar followed by Lal Ambri, Sunhari, Firdous and Shireen. Interaction effect of rootstocks and variety showed highest fruit yield in Akbar on semi-dwarfing MM-106 rootstock. These observations are in agreement with [8,16].

Physical characteristics of fruits like fruit length, fruit diameter and fruit weight were highest on dwarfing M-9 rootstock. Fruit length and fruit diameter were the highest in Lal Ambri followed by Akbar, Firdous, Sunhari and Shireen. However, maximum fruit weight was recorded in Akbar followed by Lal Ambri, Sunhari and Firdous. Interaction of rootstock and varieties showed maximum fruit length and fruit diameter in Lal Ambri on MM-106 rootstock and maximum fruit weight in Akbar on M-9 rootstock. This may be possibly due to genetic nature of M-9 and MM-106 rootstock. These results are in conformity with [17,18].

Fruits harvested from the trees with M-9 rootstock observed to be more firm than the fruits harvested from MM-106 rootstock. Maximum fruit firmness was observed in Firdous followed by Akbar, Lal Ambri, Sunhari and shireen. Among the rootstocks and variety interaction, maximum fruit firmness was observed in Firdous on dwarfing M-9 rootstock. These results are in agreement with [3,19]

Rootstocks significantly influenced fruit TSS, fruit acidity and fruit sugars (Table 4). Maximum fruit TSS was recorded on MM-106 as compared to M-9 rootstock. Maximum fruit acidity was recorded in the fruits harvested from trees grafted on M-9 rootstock as a comparison to the fruits harvested from the trees worked on MM-106 rootstock. These results are in agreement with [20].

Maximum fruit sugars were recorded on MM-106 rootstock as compared to M-9 rootstock. Among the varieties, highest TSS was recorded in Lal Ambri followed by Shireen, Akbar, Sunhari and Firdous. Maximum fruit acidity was recorded in Firdous on M-9 rootstock and maximum fruit sugar was recorded in Lal Ambri on semi-dwarfing rootstock. These results are in line with [21].

Table 1. Effect of rootstocks on plant girth, plant size and plant spread of new apple varieties

Rootstock/ Variety	Plant girth (cm)		Plant height (cm)		Plant spread (cm)	
	M-9	MM-106	M-9	MM-106	M-9	MM-106
Lal Ambri	17.66	17.44	194.14	216.30	178.97	172.18
Sunhari	16.99	17.08	195.91	212.92	171.62	168.05
Shireen	14.90	15.91	196.32	208.09	172.15	166.07
Firdous	15.01	13.75	193.04	204.68	168.90	163.34
Akbar	15.90	14.82	192.24	209.33	170.77	168.81
$CD_{0.05}$ Rootstock		0.48		0.51		0.29
Variety		0.76		0.81		0.47
Rootstock x variety		1.08		1.14		0.66

Table 2. Effect of rootstocks on percent fruit set, fruit retention and fruit maturity of new apple varieties

Rootstock/ Variety	Percent fruit set (%)		Fruit retention (%)		Fruit maturity (DAFB upto date of harvesting)	
	M-9	MM-106	M-9	MM-106	M-9	MM-106
Lal Ambri	79.89	82.09	62.09	60.09	173.65	179.65
Sunhari	74.81	75.98	51.95	57.04	136.73	146.76
Shireen	65.77	70.77	44.15	48.75	115.31	119.67
Firdous	68.75	72.62	47.95	51.08	118.66	121.69
Akbar	81.62	87.75	67.05	70.82	157.87	163.70
$CD_{0.05}$ Rootstock		0.23		0.28		0.26
Variety		0.37		0.22		0.42
Rootstock x variety		0.52		0.32		0.60

Table 3. Effect of rootstocks on yield and physical characteristics of fruits of new apple varieties

Rootstock Variety	Fruit Yield (Kg/tree)		Fruit length (mm)		Fruit Diameter (mm)		Fruit Weight (g)		Fruit Firmness ($lb/inch^2$)	
	M-9	MM-106	M-9	MM-106	M-9	MM-106	M-9	MM-106	M-9	MM-106
Lal Ambri	11.89	12.20	73.58	77.04	78.91	80.95	220.16	216.41	18.91	18.24
Sunhari	9.06	11.06	71.17	73.21	72.14	77.04	205.02	208.33	18.08	17/62
Shireen	7.40	6.90	70.21	72.18	71.62	76.14	202.07	204.44	17.62	16.79
Firdous	7.82	8.78	72.18	74.14	74.04	78.81	215.02	210.41	21.98	21.07
Akbar	17.60	18.52	72.99	75.24	76.24	79.95	228.16	225.54	20.77	19.78
$CD_{0.05}$ Rootstock		0.68		0.32		0.21		0.20		0.24
Variety		1.07		0.88		0.33		0.32		0.38
Rootstock x variety		1.52		0.72		0.47		0.46		0.54

Table 4. Effect of rootstock on chemical characteristics of fruits of new apple varieties

Rootstock/ Variety	TSS (%)		Acidity (%)		TSS/acid ratio		Fruit sugars (%)	
	M-9	MM-106	M-9	MM-106	M-9	MM-106	M-9	MM-106
Lal Ambri	12.35	13.61	0.189	0.165	59.72	70.25	7.41	8.16
Sunhari	11.21	12.27	0.195	0.203	57.32	62.40	6.72	7.36
Shireen	12.11	12.41	0.194	0.194	58.22	64.31	7.26	7.44
Firdous	10.64	11.44	0.203	0.203	56.78	60.78	6.38	6.86
Akbar	12.12	12.98	0.192	0.188	58.24	66.63	7.27	7.78
$CD_{0.05}$Rootstock		0.42		0.004		0.33		0.52
Variety		0.66		0.006		0.53		0.83
Rootstock x variety		0.94		0.010		0.75		1.17

4. CONCLUSION

From the foregoing discussion, it is concluded that with the exception of Shireen, all other varieties performed better with respect to yield and quality of fruit on MM-106 rootstock. However, Shireen performed better in these parameters on M-9 rootstock.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/25321