Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 3407-3410
Received: 13-01-2018
Accepted: 14-02-2018

JA Rather
Division of Fruit Science
Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

FA Misgar
Division of Fruit Science
Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

A Kumar
Division of Fruit Science
Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

JA Baba
Division of Fruit Science
Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Correspondence
JA Rather
Division of Fruit Science
Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Rootstock cultivar effect on nutrient variation and the correlation among leaf nutrients with apple fruit quality parameters

JA Rather, FA Misgar, A Kumar and JA Baba

Abstract
To investigate the influence of leaf nutrient concentrations among different exotic cultivars on various rootstocks for two consecutive years. The other goal of the experiment was to precise the time of leaf sampling in four apple cultivars. Among rootstocks MM_{106} had the highest level of nutrient concentrations whereas M_9 had the lowest. The exotic cultivars like Mollies Delicious and Vista Bella recorded highest leaf calcium and zinc content and minimum was observed in Cooper IV and Mollies Delicious indicating a definite effect of rootstocks on translocation of nutrients within the plant system. The seasonal variation of leaf calcium content on both rootstocks showed an increasing trend from 15th of May to 30th of July and leaf zinc content showed an increasing trend from 15th of May to 15th of July thereafter, it decreased slowly upto the end of vegetation season. The seasonal variation of nutrients in leaves indicate stability period of various nutrients like Ca and Zn in early maturing cultivars like Vista Bella and Mollies Delicious from 15th of June to 15th of July, while as in mid-season cultivars Starkrimson and Cooper IV the stability in nutrient concentration was recorded from 30th June to 30th of July indicating the appropriate leaf sampling period for these exotic cultivars as against the sampling time of existing cultivars which is from mid-July to mid-August under similar conditions fig.1. Various fruit chemical quality parameters like TSS and total sugar significantly effected by rootstocks MM_{106} recorded maximum TSS (14.53, 13.96 ^oB) and total sugar (11.44,11.99%) as compared with the lowest value (13.52, 13.19 ^oB) and (11.25 and 11.79%) observed in M_9 rootstock. Correlation studies were made in order to determine the relationship among leaf nutrients with chemical quality parameters. Significant and positive correlation was obtained between leaf nutrient content, TSS and total sugar. Though there was a significant correlation between different leaf nutrient contents and various chemical quality parameters these correlations were not strong enough with other quality parameters in respect of some nutrients.

Keywords: Root stock, apple, cultivar, Kashmir, temperate, nutrient

Introduction
In the last decades rootstocks brought about a revolution in fruit growing, completely changing the shape and methods of cultivation of apple orchards. These changes gradually appear also in the plantations of other species. The use of dwarf rootstock solved the issues connected with the too strong growth of trees, too late cropping and low yields from a surface area. The interest in breeding and use of new rootstocks constantly increases. The most popular and commonly used apple rootstock is M.9. It unites well with most cultivars, the trees grafted on it begin the stage of fruit bearing very early and the obtained apples are of very good quality. It should be used as a model in comparing the growth and yield of different rootstocks. Rootstocks directly affect the ability of plants to uptake the water and nutrients from the soil. They are also able to significantly affect the pattern of canopy development and functions such as photosynthesis (Richardson *et al.*, 2003) [17]. Besides giving anchorage to the tree, rootstock is also responsible for the absorption of water and nutrients, storage of photosynthates and synthesis of hormones making the scion part more tolerable. More than twenty horticultural characteristics are affected by the rootstock including leaf nutrient status, vigor and size, depth of rooting, cold tolerance, adoption to adverse soil conditions, disease resistance and fruit quality (Castle, 1987) [5]. Mineral nutrients are greatly influenced by rootstocks, similarly different scion varieties exhibit variable quantities of nutrients from different rootstocks.
Nutrients are essential for the productivity and quality of different fruits, hence the determination of nutritional needs for efficient production of high quality fruit is an important aspect of nutrient management for the orchardists. Leaf is the principle site of metabolism and the optimum concentrations of nutrient in the leaf at specific growth stage have positive relationship with the leaf nutrient content and yield. Among various approaches, leaf analysis has proved to be best for formation of proper fertilizer scheduling (Bould, 1966; Bhargava and

Chadha, 1993) [4, 3] and it gives accurate guide than soil analysis for predicting the nutrient needs of fruit trees (Sparks, 1968) [20].

Material and Methods

The study was conducted at Central Institute of Temperate Horticulture Srinagar, India during the years 2013 and 2014. Four apple cultivars viz., Starkrimson, Cooper IV, Mollies Delicious and Vista Bella grafted on M_9 dwarf and MM_{106} semi vigrous rootstock was used in the study. Leaf samples were taken in eight different seasons (15th of May, 30th of May, 15th of June, 30th of June, 15th of July, 30th of July, 15th of August and 30th of August). Before analysis, samples were washed thoroughly with fountain water, dilute acid (0.2 N HCl) and distilled water to remove surface residues, then they kept at 65±5°C until they reached to stable weight. Calcium and zinc concentrations were determined using atomic absorption spectrophotometry (Kacar and Katkat, 1995) [12]. The TSS of fruit were determined with the help of a Bausch and Lamb hand refractomemter and subsequent corrections were made with the help of temperature correction chart at 20 ºC room temperature (AOAC, 1990) [1]. Titratable acidity was estimated by titrating 2 ml of juice against N/10 NaOH solution using 0.1 per cent phenolphthalein solution as an indicator and the end point was determined by the appearance of persistence pink color for five seconds (AOAC, 1990) [1]. Total sugar was estimated by the method of (Harminder and Dhillon, 2007) [11]. Analysis of variance was performed on the data obtained from the treatments. The level of the significance (LSD at $P< 0.05$) was used in the SAS to test significance.

Results and Discussion

Calcium: Taking rootstock into consideration, significantly high leaf calcium content was recorded in trees on MM_{106} rootstock compared to M_9 rootstock during the study period. Leszczy_ski and Sadowski (1990) [14] reported that the effect of rootstock is due to the genetically determined ability of absorption of a particular nutrient. There could be lower leaf nutrient concentrations due to less vigour of trees on M_9 rootstocks, dwarf rootstocks such as M_9 and M_{26} because they have smaller root systems, so it can be the major reason for having lower nutrient compared to others (Fallahi *et al*., 2001) [10]. Among different cultivars, significantly maximum leaf calcium content was recorded in Mollies Delicious cultivar, while as minimum recorded in Cooper-IV. Leaf calcium content also varied significantly within different sampling dates and recorded maximum leaf calcium content on 30th of July and minimum on 15th of May. Similarly, leaf calcium content on both rootstocks showed an increasing trend from 15th of May to 30th of July, thereafter, it decreased slowly upto 30th of August. Nachtigall and Dechen (2006) [15] who reported that leaf calcium increased from May to September initially and decrease after this period. Chuntanaparb and Cummings (1980) [6] and Diver *et al*. (1984) [7] also reported that calcium is a component of calcium pectate, a constituent of cell walls and in addition, Ca is a co-factor of certain enzeymatic reactions, recently, it has been determined that Ca is involved in the intimate regulation of cell processes mediated by a molecule called calmodulin. The stability period of leaf calcium content in early maturing cultivar Vista Bella on 15th of June to 15th of July and Mollies Delicious on 30th of June to 30th of July, whereas in mid season cultivars Starkrimson and Cooper IV stability was recorded on 15th of July to 15th of August, indicating a proper time for leaf sampling in early and mid season cultivars in respect to leaf calcium content fig.1. The present investigations are in line with those of Verma and Bhandari (1990) [21] who recorded the nutrient content of apple leaves follows stability during August.

Zinc: The maximum leaf zinc content was recorded in tree on MM_{106} rootstock compared to M_9. The reduction of zinc uptake capacity was associated in M_9 with its smaller root system that shows very convoluted xylem vessels that act as filters, hence influencing the balance of different solutes reaching its scion (Webster, 2004) [22]. Among the cultivars significantly maximum leaf zinc content was recorded in Vista Bella cultivar, while as minimum was recorded in Mollies Delicious cultivar during the study period. Likewise the leaf zinc content of apple trees varied significantly within different sampling dates and recorded maximum leaf zinc content on 30th of June and minimum on 30th of August and 15th of May. Leaf zinc content increased from 15th of May to 30th of June, thereafter it decreased upto 30th of August, leaf zinc content showed an increasing trend from 15th of May to 15th of July thereafter it decreased up to 30th of August. Kucukyumuk *et al*. (2012) [24] reported that July and August sampling period had the highest zinc concentrations compared to the other leaf collection times. The stability period of leaf zinc content in early maturing cultivar *viz*, Vista Bella and Mollies Delicious was observed on 15th of June to 15th of July whereas, in mid season cultivars like Starkrimson and Cooper IV it was observed on 30th of June to 30th of July indicating a proper time for leaf sampling in early and mid season cultivars with respect to leaf zinc content Fig.2.

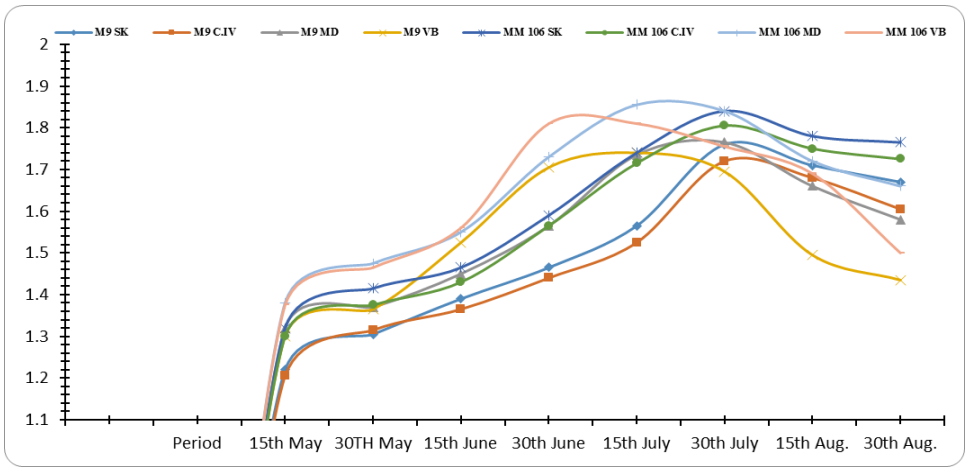

Fig 1: Seasonal variations of leaf calcium

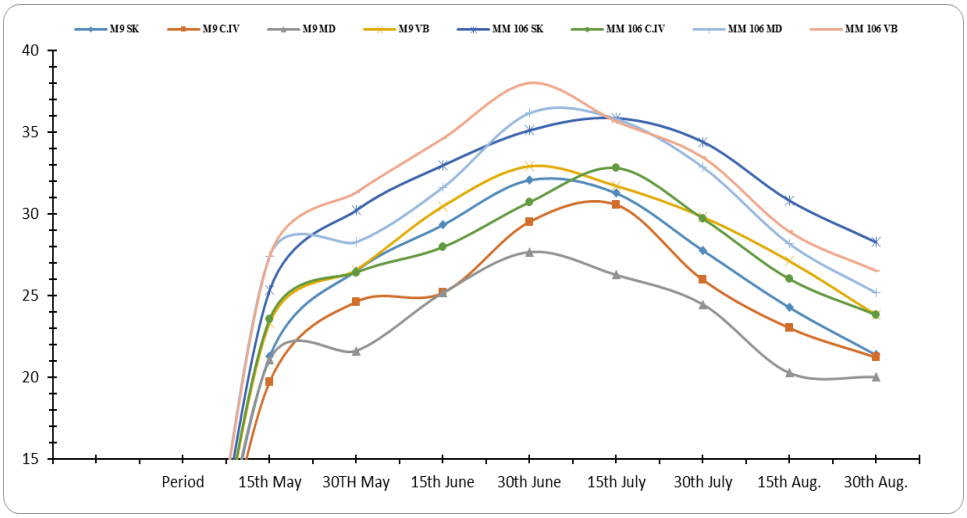

Fig 2: Seasonal variations of leaf zinc

Total soluble solids (TSS) and Titrable acidity

The total soluble solid content of various cultivars of apple showed a significant difference among rootstocks. Starkrimson produced the maximum TSS (15.06 and 14.58 ºB) and Vista Bella produced the lowest TSS (12.76 and 12.63 ºB) during both the years of studies. Among the rootstocks MM_{106} recorded maximum TSS (14.53, 13.96 ºB) as compared with the lowest value observed in M_9 rootstock (13.52 and 13.19 ºB). Total sugar did not reveal any significant difference, maximum total sugar (11.44 and 11.99%) was recorded on MM_{106} rootstock as compared with minimum M_9 rootstock (11.25 and 11.79%). Among the cultivars Starkrimson observed maximum total sugar (13.61 and 14.35%) where as minimum was recorded in Vista Bella (8.96 and 9.16%) on both rootstocks during both the years of study. Dolp and Probsting (1989) [8] observed a significant variation on both rootstocks, these results are in agreement with Orazem *et al*., (2011) [16] in respect of sugars and acids a balanced sugar to acid ratio in apple fruit could provide sweet but refreshing taste. Titrable acidity showed a non significant effect of rootstocks among the cultivars Vista Bella recorded the maximum acidity (0.16 and 0.15%) were as the Cooper IV showed the lowest acidity on both the rootstocks during both the years of studies. Sekse (1992) [18] and Skrzynski and Gastol (2007) [19] reported that *Malus* (vigorous) rootstock significantly increased acidity in comparison to MM_{106} semi vigorous rootstock in both the seasons. EL. Sabagh (2012) [9] reported that the lower fruit acidity was obtained from Anna apple trees grown on two different rootstocks, while several fruit quality parameters were enhanced by Polish rootstocks, the latter may occur only when appropriate acid content is maintained. Zekri (2000) [23] also reported that higher the Brix acid ratio the earlier is the fruit maturity.

Correlation: Leaf calcium content recorded a positive correlation (0.460, 0.486) with total soluble solids (0.202, 0.200) with total sugar. Leaf zinc content showed a positive correlation between total soluble solids on both rootstocks. However, total sugar showed a negative correlation with both the rootstocks. Leaf zinc content at various sampling dates in various cultivars on different rootstocks exhibited a significant difference with TSS and total sugar (Table 1). Leaf calcium indicated significant variations in fruit quality and can be due to its role in the synthesis of pectic substances that provide strength to cell wall and there by enhance fruit quality, calcium acts as cofactor of enzymes and is essential for cellular organization and is component of chromosomes. Similar observations were also reported by Kumar *et al*. (2007) [13]. This could be due to its role in metabolism of plants especially as an activator of enzymes and precursor of auxins. It also functions in enzyme activation which play important role in protein synthesis and carbohydrate metabolism. These results are in confirmation with the findings of Babu and Yadav (2005) [2].

Table 1: Rootstock and varietal effect on Chemical parameters of apple

Treatment	Total soluble solids (ºB)						Titrable acidity (%)					
	Year 2013			Year 2014			Year 2013			2014		
	Rootstock		Mean	Rootstock		Mean	Rootstock		Mean	Rootstock		Mean
	M_9	MM_{106}		M_9	MM_{106}		M_9	MM_{106}		M_9	MM_{106}	
SK	14.50	15.63	15.06	14.16	15.00	14.58	0.14	0.15	0.15	0.14	0.14	0.14
C.IV	13.46	13.93	13.69	12.90	13.23	13.06	0.12	0.12	0.12	0.13	0.13	0.13
MD	14.16	15.03	14.59	14.36	15.00	14.68	0.14	0.14	0.14	0.15	0.14	0.15
VB	11.96	13.56	12.76	11.36	12.63	11.99	0.15	0.18	0.16	0.15	0.15	0.15
Mean	13.52	14.53	14.02	13.19	13.96	13.57	0.14	0.15	0.14	0.15	0.14	0.14
CD ($p \leq 0.05$) 2013= R 0.75 V 1.06 RXV 1.50 2014= R NS V 1.33 RXV 1.88 Legend= SK= Starkrimson C.IV= Cooper IV MD= Mollies Delicious VB= Vista Bella R= Rootstock, V= variety,							2013= R NS V NS RXV NS 2014= R NS V NS RXV NS					

Table 2: Correlation (r-value) between leaf nutrient content on fruit chemical parameters of apple

Treatment	Total sugar %						Correlation (r-value)				
	Year 2013			Year 2014			Nutrient	M9	MM106	TSS (B%)	Total Sugar
	Rootstock		Mean	Rootstock		Mean					
	M_9	MM_{106}		M_9	MM_{106}						
SK	13.20	14.03	13.61	14.20	14.50	14.35	Calcium	1	.766*	.460	.486
C.IV	10.96	11.50	11.23	11.20	12.0	11.6		.766*	1	.202	.200
MD	11.16	12.03	11.59	12.40	12.50	12.45	Zinc	1	.766*	.459	.421
VB	9.70	8.23	8.96	9.36	8.96	9.16		.766*	1	-.076	-.142
Mean	11.25	11.44		11.79	11.99						
CD ($p \leq 0.05$) 2013= R NS V 1.32 RXV Ns 2014= R NS V 1.24 RXV 1.75 Legend= SK= Starkrimson C.IV= Cooper IV MD= Mollies Delicious VB= Vista Bella R= Rootstock, V= variety,							** Correlation is significant at the 0.01 level * Correlation is significant at the 0.05 level				

References

1. AOAC. Official and tentative methods of analysis. Association of Official Agricultural Chemists. 15th edition. Washington, DC, USA, 1990, 484.
2. Babu KD, Yadav DS. Foliar spray of micronutrients for yield and quality improvement in Khasi mandarin (*Citrus reticulate* Blanco.). Indian Journal of Horticulture. 2005; 62:280-281.
3. Bhargava BS, Chadda KL. Leaf nutrition guide for fruit crops in Advances in Horticulture (Eds. K. L. Chadda and O. P. Pareek) Malhutra Publishing House New Delhi 1993; 2:973-979.
4. Bould C. Leaf analysis of deciduous fruits. In: Temperate to Tropical fruits. (Eds. N. F. Childers). The State Univ., New Brunswick, N. J, USA Inc. 1966, 651-684.
5. Castle WS. *Citrus rootstocks*. John Wiley and Sons, New York 1987, 361-399.
6. Chuntanaparb N, Cummings G. Seasonal trends in concentration of nitrogen, phosphorus potassium, calcium and magnesium in leaf portions of apple, blueberry, grape and peach. Journal of the America Society for Horticultural Science. 1980; 105:933-935.
7. Diver SG, Smith MW, Mc-New RW. Influence of fruit development on seasonal elemental concentrations and distribution in fruit and leaves of pecan. Communication in Soil Science and Plant Analysis 1984; 15(6):613-637.
8. Dolp CA, Probsting EL. Root confinement affects growth and physiology of sweet cherry and apple. 50th ASHS annual meeting. Tulsa, Oklahama, USA, 1989.
9. El Sabagh AS, Othman SA, Alabdaly AN. Performance of anna apple cultivar grown on two different rootstocks in response to hydrogen cyanamide winter spraying. World Journal of Agricultural Sciences. 2012; 8(1):01-12.
10. Fallahi EC, Hun IJ, Neilsen HG, Colt WM. Effects of three rootstocks on photosynthesis, leaf mineral nutrition and vegetative growth of BC-2 Fuji apple trees. Journal of Plant Nutrition 2001; 24(6):827-834.
11. Harminder K, Dhillon WS. Laboratory techniques in horticulture (Practical Manual). Artcave Printer 2007, 20.
12. Kacar B. Soil Analysis. Ankara University Faculty of Agriculture. Ankara, Turkey 1995; 3:150.
13. Kumar TS, Kumar J, Kumar M. Effect of leaf nutrient status on yield and quality of Kiwi fruit (*Actinidia deliciosa* Chev.) Indian Journal of Horticulture. 2007; 64:77-78.
14. Leszczy SA, Sadowski A. Response of apple rootstocks and of apple maiden trees to different levels of potassium supply in sand culture. Acta Horticulturae. 1990; 274:277-286.
15. Nachtigall GR, Dechan AR. Seasonality of nutrients in leaves and fruits of apple trees. Science Agric. (Piracicaba, Braz.). 2006; 63(5):493-501.
16. Orazem P, Stampar F, Hudina M. Quality analysis of 'Redhaven' peach fruit grafted on 11 rootstocks of different genetic origin in a replant soil. Food Chemistry 2011; 124(4):1691-1698.
17. Richardson APM, Anderson P, Dawson T, Watson M. How do rootstocks affect canopy development. Hort. Research Kerikeri Research Centre, New Zealand, 2003.
18. Sekse L. Changes in the content of soluble solids and titratable acids in apples during and storage. Norw. Journal of Agricultural Science. 1992; 6:111-119.
19. Skrzynski J, Gastol M. The effect of rootstock on the fruit characteristic attributes of 'Jonica' apples. Vegetable Crops Research Bulletin. 2007; 66:171-176.
20. Sparks D. Changes in potassium status of the catkins, leaves, shoots and branches of non-fruiting mature pecan trees, *Carya illonoensis*, Koch Stuart as function of physiological development. Proceedings of the American Society for Horticultural Sciences. 1968; 93:215-223.
21. Verma KS, Bhandari AR. Standardization of leaf sampling techniques for macro nutrient elements in temperate peaches. Indian Journal of Horticulture. 1990; 47(2):140-153.
22. Webster AD. Vigour mechanisms in dwarfing rootstocks for temperate fruit trees. Acta Horticulturae. 2004; 658:29-41.
23. Zekri M. Evaluation of Orange Trees Budded on Several Rootstocks and Planted at High Density on Flatwoods Soil. Proceeding of American Society for Horticultural Science, 2000, 113.
24. Kucukyumuk Z, Kucukyumuk C, Erdal I, Eraslan F. Seasonal variations and different irrigation programs on nutrient concentrations of 'Starkrimson Delicious' apple variety. World Academy of Science, Engineering and Technology. 2012; 71:223-226.