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Influence of dwarf rootstocks on growth and vigour of popular cashew cultivars

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In spite of domestic production of 6.5 lakh tons and import of over 6.5 lakh tons, the total availability of raw cashew nuts is not able to keep pace with the requirements of cashew industry in India. Hence, there is a need to increase the domestic raw cashew nut production. Since the availability of cashew cultivating land area is limited in India, it would be a better idea to increase the plant density per unit area to increase the productivity of this crop. This necessitates the need for reducing the tree size and vigour for accommodating more plants per unit area. Breeding approaches to develop dwarf types would take long time on account of perennial nature as well as complex genetic composition in cashew. Use of dwarfing rootstocks is one of the means of control of tree size/vigour. Rootstocks are extensively being used to control tree size in apples (Ebel *et al*., 1999), peaches (Salvatierra *et al*., 1998) and plum (Deuyatov, 1996). However, the work on tropical fruits trees is limited and there are reports on mango (Cedeno-Maldonado *et al*., 1995) and avocado (Ben-Ya-acov *et al*., 1993). For a crop like cashew, accommodating more number of plants per unit area would double the present annual production (13-14 lakh tons) to meet the demand for the processing industries in India. Hence, this study was taken up involving dwarf types, available from germplasm of Directorate of Cashew Research, as rootstocks to find out their influence in reducing the vigour of the popular cashew cultivars.

The experiment was initiated with nursery trial in 2007 at Experimental Station of Directorate of Cashew Research (DCR), Puttur, Dakshina Kannnada District, Karnataka, India (12°45' N latitude, 75°4' E longitude and 90 m above MSL). The seeds of rootstock varieties, namely V-4 (control), NRC 492 and Taliparamba-1, were sown in nursery bags filled with 1:1:1 proportion of soil, sand and FYM. Two month old seedlings of dwarf rootstocks (NRC 492 and Taliparamba-1) were screened for dwarfness based on visual observations for plant height and internodal length, as the seedlings of dwarf types segregated for plant height. The two month old seedlings from variety V-4 and the dwarf types were used for soft wood grafting (wedge-cleft method) involving scions from varieties Ullal-3, VRI-3, NRCC selection-2 and Vengurla-4 (V-4). There were 12 different stionic combinations involving three types of rootstocks and 4 scion varieties. Grafting was done during July and August and success rate among different stionic combinations were recorded. The experiment with 12 treatments was replicated thrice with 6 plants per replication in randomized complete block design. The successful grafts were field planted at a closer spacing of 6m x 6m during 2008. In the field established plants, observations on plant height, number of leaves per shoot, leaf area, bark percentage of shoots, girth of stem below (root stock portion) and above (scion portion) the graft union, internodal length, canopy spread, stomatal count and yield per plant were recorded. The stomatal density was estimated from the lower surface of leaves by means of a quick fix film (Beakbaneand Majumder, 1975). The leaf area was measured using leaf area meter (CID, USA). The bark percentage was worked out by dividing the weight of bark by the total weight of shoot and multiplied by 100. For recording bark percentage 4 month old shoots of uniform length and weight were selected from each treatment. The data were analysed by AGRES software package.

All the stionic combinations, except the ones which involved Taliparamba-1 as rootstock, recorded nearly cent per cent grafting success whereas, the stionic combinations involving Taliparamba-1 as rootstock recorded around 50 per cent grafting success. The stionic combination of V-4 on NRC 492, VRI-3 on V-4, NRCC selection-2 on V-4 and V-4 on V-4 recorded 100 per cent grafting success. This clearly indicates the suitability of either V-4 or NRC 492 as rootstock in obtaining higher grafting success at nursery stage. This could be because the rootstocks with different genetic makeup may have influence on compatibility of scion materials (Hartmann and Kester, 1986). The field performance of different stionic combinations indicated the influence of rootstocks on growth and yield performance of popular scion cultivars of cashew. The stionic combinations had a significant influence on plant height during the first year and on number of leaves and leaf area during both the years of study (Table 1). The plant height was least in stionic combination of NRCC selection-2 grafted upon Taliparamba-1 rootstock during the first year in the field. The plant height was highest in stionic combination of VRI-3 grafted on NRC 492 rootstock during first year and Ullal-3 on NRC 492 rootstock during second year. The increment in plant height during the second year over the previous year was least in stionic combination of VRI-3 grafted on NRC 492 rootstock and increment was highest in stionic combination of NRCC selection-2 grafted upon Taliparamba-1 rootstock. This indicated that vigour reduction by dwarf rootstocks is variable depending on stionic combination and is not uniform among different stionic combinations. Similar observations were reported in kiwi fruit (Moeen-ud-din *et al*., 2001).

The number of leaves per shoot and leaf area were significantly influenced by different stionic combination. The stionic combination of VRI-3 grafted on NRC 492 rootstock recorded the highest number of leaves per shoot in the first year while, stionic combination of VRI-3 grafted on V-4 rootstock recorded highest number of leaves in the second year. The highest leaf area was recorded in a stionic combination of Ullal-3 grafted on V-4 rootstock during both the years of observation. The stionic combinations which involved Taliparamba-1 (dwarf type) as rootstock recorded lesser leaf area compared to other rootstocks. This is in accordance with the findings of Clearwater *et al*. (2006) who reported in kiwi fruit that scions on low-vigor rootstocks had lesser leaf area than scions on the most vigorous rootstocks. However, the canopy spread was influenced by the stionic combinations. Though not significant, the stionic combination of NRCC selection-2 grafted upon Taliparamba-1 rootstock recorded least canopy spread during both the years of observation. Similar findings in Kinnow mandarin were reported by Waqar Ahmed *et al*. (2006)

Table 1. Plant height, number of leaves, canopy spread and leaf area in different stionic combinations of cashew

Stionic combination (scion/stock)	Plant height (m)		Increment in height (m) over the previous	No. of leaves per shoot		Canopy spread (m)		Leaf area (cm^2)	
	I yr	II yr	year	I yr	II yr	I yr	II yr	I yr	II yr
Ullal-3/ V-4	3.00	3.39	0.39	10.49	8.28	3.14	3.73	101.93	135.13
VRI-3/V-4	2.98	3.20	0.22	15.11	10.79	2.53	2.66	78.05	102.26
Sel-2/V-4	2.60	3.29	0.69	13.61	9.83	3.00	3.57	80.56	90.72
V-4/V-4	3.00	3.42	0.42	13.83	9.17	2.81	3.33	77.89	102.84
Ullal-3/ NRC 492	3.14	3.88	0.74	12.28	8.80	3.33	3.53	82.67	125.03
VRI-3/ NRC 492	3.40	3.53	0.13	17.16	10.33	3.30	3.83	80.23	84.55
Sel-2/ NRC 492	2.55	3.23	0.68	13.66	9.16	2.65	3.36	72.15	93.04
V-4/ NRC 492	2.52	3.20	0.68	12.42	9.05	2.34	3.00	66.09	82.15
Ullal-3/ Taliparamba-1	3.00	3.68	0.68	10.41	7.99	2.66	3.34	74.93	102.56
VRI-3/ Taliparamba-1	2.34	2.53	0.19	14.60	10.49	2.16	2.62	63.41	101.39
Sel-2/ Taliparamba-1	1.86	2.87	1.01	11.00	10.50	1.83	2.49	63.44	82.58
V-4/ Taliparamba-1	2.50	2.71	0.21	9.33	10.00	2.06	3.12	68.42	77.17
CD at 5%	1.08	NS	-	4.22	1.39	NS	NS	13.99	29.76

who found out that canopy increment proved to be non-significant as affected by various rootstocks.

Stomatal density is used as an index to correlate with plant vigour. The stomatal density was significantly influenced by stionic combinations (Fig.1). The various stionic combinations, rootstocks and scion cultivars were compared for stomatal density. Among the stionic combinations, NRCC selection-2 as well as V-4 grafted on Taliparamba-1 rootstock recorded the highest stomatal density. The combination of Ullal-3 grafted on NRC 492 rootstock recorded least stomatal density. Among the rootstocks, Taliparamba-1 had highest stomatal density and V-4 had least density of stomata. Among the scion varieties, VRI-3 had highest stomatal density compared to other varieties. In the present study stomatal density was negatively associated with plant height as seen in case of dwarf rootstocks. Similar negative correlations have been reported earlier in cashew hybrids (Aneesa Rani *et al*., 2011) and avocado (Priego and Colin, 1987). The bark percentage in shoots of field planted cashew varied among different stionic combinations (Fig.2).The highest bark percentage was associated with the stionic combination of Ullal-3 grafted on V-4. The graft percentage was reduced when Ullal-3 was grafted on either NRC 492 or Taliparamba-1 rootstock. Similarly, Taliparamba-1 as a rootstock reduced the bark percentage in scion variety V-4 compared to V-4 grafted on its own root. This suggests the association between bark percentage and tree vigour as well as the role of rootstocks in altering the bark percentage of scion varieties in cashew. Similar relationships have been established

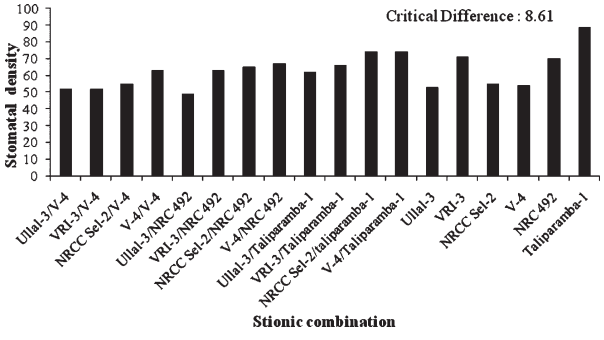

Fig. 1. Stomatal density in various stionic combinations (including rootstock and scion varieties)

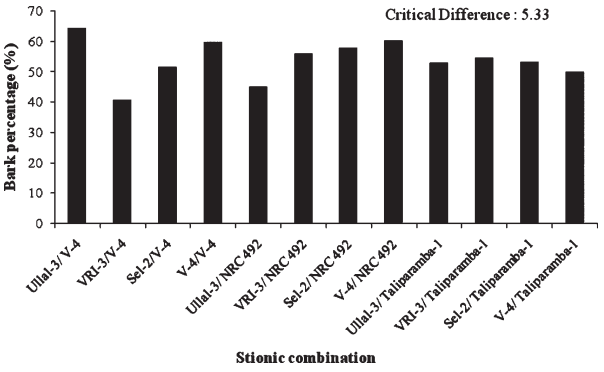

Fig. 2. Bark percentage among different stionic combinations

with respect to avocado rootstocks (Jimenez and Priego, 1987).

The influence of different stionic combinations on stem girth below and above the graft union as well as the internodal length is presented in Table 2. The stem girth and internodal length were not significantly affected by different stionic combinations. This in conformity with the findings of Moeen-ud-din *et al*. (2001) in kiwi fruit where the stem girth was not significantly influenced by rootstock. However, stionic combination of NRCC selection-2 grafted upon Taliparamba-1 rootstock recorded least stem girth below and above the graft union during both the years of study. The increment in stem girth below the graft union over the previous year was least in stionic combination of VRI-3 grafted on Taliparamba-1 rootstock. The increment in stem girth above the graft union over the previous year was least in stionic combination of NRCC selection-2 grafted upon Taliparamba-1 rootstock.

The internodal length of shoots under different stionic combinations decreased in the second year of observation over the first year. The scion varieties on dwarf rootstock (NRC 492 and Taliparamba-1) recorded lesser internodal length compared to scion varieties on vigorous rootstock (V-4). The highest decrease in internodal length was seen in the stionic combination of NRCC selection -2 grafted upon Taliparamba-1 rootstock closely followed by NRCC selection-2 grafted upon NRC 492 rootstock. The influence of rootstocks on internodal length have been reported in apples (Dodangeh *et al*., 2012) and grapes (Somkuwar *et al*., 2006).

Table 2. Stem girth and internodal length in different stionic combinations in cashew

Stionic combination (scion/stock)	Stem girth below graft union (cm)		Increment in girth below union	Stem girth above graft union (cm)		Increment in girth above union	Inter nodal length (cm)		Increase/ decrease in internodal
	I yr	II yr	(cm)	I yr	II yr	(cm)	I yr	II yr	length
Ullal-3/ V-4	12.55	25.03	12.48	10.80	21.58	10.78	3.17	2.29	-0.88
VRI-3/V-4	11.28	22.83	11.55	9.50	19.91	10.41	2.67	2.57	-0.10
Sel-2/V-4	11.30	23.00	11.70	9.94	20.94	11.00	2.95	2.32	-0.63
V-4/V-4	12.16	24.28	12.12	10.83	22.19	11.36	2.73	2.23	-0.50
Ullal-3/ NRC 492	13.50	26.83	13.33	12.23	23.82	11.59	3.24	1.67	-1.57
VRI-3/ NRC 492	12.66	26.45	13.79	10.99	23.15	12.16	2.72	1.35	-1.37
Sel-2/ NRC 492	10.14	21.59	11.45	8.97	18.82	9.85	3.01	1.32	-1.69
V-4/ NRC 492	12.03	21.45	9.42	9.79	19.31	9.52	2.59	1.34	-1.25
Ullal-3/ Taliparamba-1	12.08	23.72	11.64	7.61	21.00	13.39	3.22	1.52	-1.70
VRI-3/ Taliparamba-1	11.75	20.18	8.43	10.27	17.77	7.50	2.71	1.51	-1.20
Sel-2/ Taliparamba-1	8.25	17.17	8.92	6.75	13.00	6.25	3.25	1.52	-1.73
V-4/ Taliparamba-1	9.66	18.33	8.67	7.66	15.17	7.51	2.87	1.48	-1.39
CD at 5%	NS	NS	-	NS	NS	-	NS	0.90	-

The different stionic combinations significantly influenced the yield of cashew in the first harvest (Fig. 3). Among the different stionic combinations, the combination of VRI-3 grafted on NRC 492 rootstock recorded the highest nut yield in first harvest closely followed by Ullal-3 grafted on NRC 492 rootstock. The yield performance of popular varieties varied based on the rootstocks. This clearly indicates the role of rootstocks on yield performance in cashew. Similar findings in apple (El-Shammaa *et al*., 2011) and mandarin (Demirkeser *et al*., 2009) have been reported.

Based on the study it can be concluded that dwarf rootstocks hold potential in reducing the vigour of popular vigorous cultivars of cashew through reduction in plant height, leaf area and internodal length. This technique can be potentially employed in establishing high density planting systems to realize high crop production per unit area. NRC 492 as a rootstock can be further employed to realize higher nut yield from scion cultivars in the initial years of plantation.

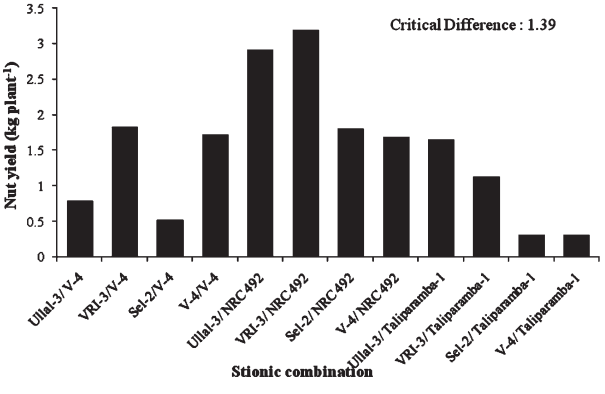

Fig. 3. Nut yield (kg plant^{-1}) in various stionic combinations

References

Aneesa Rani, M.S., Kumar, N. and Marimuthu, R. 2011. Evolving cashew F1 hybrids suitable for high density planting system. *Indian Journal of Horticulture* **68**(2): 152-155.

Beakbane, A.B. and Majumder, P.K. 1975. A relationship between stomatal density and growth potential in apple rootstocks. *Journal of Horticultural Science* **50**: 285-289.

Ben-Ya-acov, A., Michelson, E. and Sela, I. 1993. Rootstock effect on avocado vigor and productivity. *Acta Horticulturae* **349**: 191-195.

Cedeno-Maldonado, A., Reyes-Soto, I., Perez-Lopez, A. and Lopez-Garcia, J. 1995. Development of combinations of scion-rootstocks in order to reduce the size of mango trees (*Mangiferaindica* L). *Tropical Fruits Newsletter* **14**: 8-9.

Clearwater, M.J., Seleznyova, A.N., Thorp, T.G., Blattmann, P., Barnett, A.M., Lowe, R.G. andAustin, P.T. 2006. Vigor-controlling rootstocks affect early shoot growth and leaf area development of kiwi fruit. *Tree Physiology* **26**(4): 505-15.

Demirkeser, T.H., Kaplankýran, M., Toplu, C. and Yýldýz, E. 2009. Yield and fruit quality performance of Nova and Robinson mandarins on three rootstocks in Eastern Mediterranean. *African Journal of Agricultural Research* **4**(4): 262-268.

Dodangeh, M.R., Shakouri, M.J., Hamzehei, Z. and Dadashpour, A. 2012. *Indian Journal of Science and Technology* **5**(1): 46-48.

Deuyatov, A.S. 1996. Root system of plum trees on standard and dwarfing rootstocks. *Fruit- Varieties Journal* **50**(4): 229-235.

Ebel, R.C., Caylor, A., Pitts, J. and Wilkins, B. 1999. Performance of Golden Delicious cv Smoothee on dwarfing rootstocks and inter stems in a hot, humid climate. *Fruit–Varieties Journal* **53**(4): 215-221.

El-Shammaa, M.S., Mansour, A.E.M., Cimpoies, G.P., Nageib, M.M. and Saleh Malaka. 2011. Effect of rootstocks on flowering, yield and fruit quality of anna apple trees (*Malus domestica*, Borkh). *Research Journal of Agriculture and Biological Sciences* **7**(2): 190-195.

Hartmann, H.T. and Kester, D.E. 1986. *Plant Propagation-Principles and Practices* (4th Edn). Printice Hall of India Pvt. Ltd, New Delhi, India.337-338 pp.

Jimenez, A.L. and Priego, A.B. 1987. Selection of dwarfing rootstocks of avocado *(Persea americana* Mill.). *California Avocado Society 1987 Yearbook.* **71**: 225-234.

Moeen-ud-din, Ibrahim, M. and Khan, A.S. 2001. A study on stionic interaction of kinnow. *International Journal of Agriculture and Biology* **3**(1): 57-60.

Priego, A.B. and Colin, S.S. 1987. Stomatal density and its relationship to growth habit in avocado. *South African Avocado Growers' Association Yearbook*. **10**: 66-67.

Salvatierra, M.A.G., Gemma, H. and Iwahori, S. 1998. Partitioning of carbohydrates and development of tissues in the graft union of peaches grafted on *Prunus tomentosa* rootstock. *Journal of Japanese Society for Horticultural Science* **67**(4): 475-482.

Somkuwar, R.G., Satisha, J. and Ramteke, S.D. 2006. Effect of different rootstocks on fruitfulness in Thompson Seedless (*Vitis vinifera* L.) grapes. *Asian Journal of Plant Sciences* **5**: 150-152.

Waqar Ahmed, M.A., Pervez, M., Amjad, M., Khalid, C., Ayyub, M. and Azher Nawaz, M. 2006. Effect of stionic combination on the growth and yield of kinnow mandarin. *Pakistan Journal of Botany* **38**(3): 603-612.

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