The effect of Rootstocks on Bud-take and Bud Growth Vigour of Rose (*Rosa spp*) Cultivar 'First Red'

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ABSTRACT

A rootstock trial was conducted at Jomo Kenyatta University of Agriculture and Technology, Juja (Latitude 1° 05' S; longitude 37° 01' E) to investigate the success of the rootstock-scion combination and the vigour of the sprouted bud. Three rootstocks, namely *Rosa multiflora*, *Rosa indica* 'Major', and *Rosa canina* 'Inermis', were budded with scions of rose cultivar 'First Red' Bud union success significantly greater in *R. indica* 'Major' (90%) than in *R. multiflora* (71.3%), and *R. canina* 'Inermis' (55%), respectively. As the number of days from date of budding increased, significant differences were observed on growth performance of scion shoots. At 42 days, there were no significant differences in growth vigour of *R. multiflora* and *R. indica* 'Major' but both rootstocks were significantly different from *R. canina* 'Inermis'. At 63 days, *R. multiflora* had significantly longer stems than *R. indica* 'Major' and *R. canina* 'Inermis'. The number of harvested flowers per plant was significantly higher in *R. multiflora* than in *R. canina* 'Major' and *R. canina* 'Inermis'. The stem diameter and percent marketable blooms did not differ significantly in the various bud combinations. No significant differences were observed in the stem length in *R. multiflora* and *R. indica* 'Major', but *R. canina* 'Inermis' was significantly shorter. The number of days to first flower was significantly greater in *R. canina* 'Inermis' than for *R. indica* 'Major' and for *R. multiflora*.

KEY WORDS: Rosa spp, Rootstocks, Cultivar 'First Red', Bud growth vigour.

1.0 INTRODUCTION

As a pre-requisite for sustained growth of bushes in rose production, vigour and uniformity of starting material is essential. Such material can give an early return on the high investment needed to start a new rose enterprise. One of the important parameters of quality of planting material is vigour (Kader, 1998; Halevy, 1986), which subsequently influences the harvestable product. Early cropping or bloom date is also highly dependent on vigorous, healthy and uniform planting material (Arnold *et. al.,* 1992). Certain factors during propagation such as rootstock material exert some influence on the scion cultivar. In peach, the rootstock influences the growth, precocity, bloom date, fertility and yield of the scion cultivar (Beckman *et. al.,* 1992; Bernard, 1985, Layne 1987). Additionally, the water balance and the quantity of nutrients absorbed can be affected by the rootstock, particularly its growth (Alvino *et. al.,* 1991; Natali *et. al.,* 1985; Knowles *et. al.,* 1984). In roses just as in other crop species, while the horticultural performance of a rootstock may depend on the scion cultivar used, there is a mutual interaction between these two tissues (Halevy, 1986). This manifests itself in the successful bud union and eventual bud growth vigour. Bud compatibility and growth vigour of the scion cultivars can vary among different rootstocks.

Currently the rootstocks used for rose cultivars in Kenya should allow flexibility associated with the choice of a rootstock for its suitability for the scion cultivar and production location. In Juja, the most common rootstock used by commercial growers is *Rosa indica* 'Major'. Other rootstocks in use are *Rosa multiflora* and *Rosa canina* 'Inermis'. It is not clear why growers prefer *R. indica* 'Major'. Moreover, documented information on the performance of this rootstock compared with others is lacking. There is need to re-assess use of *R. indica* 'Major' especially with a view to providing the farmers with the best possible rootstock. This research was initiated to determine rootstock-scion combination and growth vigour of the scion cultivar in Rosa species. The results of a study are presented in this report and addresses the success of rootstock-scion combination and growth vigour of the sprouted buds of rose cultivar 'First Red' budded on three rootstocks, *R. multiflora, R. indica* 'Major' and *R. canina* 'Inermis'. The effects of the rootstocks on flower yield and quality were also investigated.

2.0 MATERIALS AND METHODS

Rootstock Preparation and Rooting

Rootstock materials were collected from three rose species, namely *R. indica* 'Major', *R. multiflora* and *R. canina* 'Inermis', grown at Kenya Agricultural Research Institute, Tigoni. The cuttings were obtained from current seasons' growth and varied in size from 10-12cm long and 4-8mm in diameter and included at least two buds. The difference in size was as a result of the differences in internode length of the various species. The rootstock cuttings were then dipped into buckets containing water to prevent water loss. After 3 hours, the cuttings were inserted into moist sand medium (at the proximal end) contained in plastic trays, slightly watered and taken into cold store (2°C) for three days to undergo chilling, which stimulates adventitious bud activity of cuttings.

After three days, the rootstock cuttings were removed from cold storage and immersed in water at room temperature for several hours to hydrate. The cuttings were then treated with 2% Indole Butyric Acid (IBA) in talc powder for acceleration of root formation. The treated cuttings were then placed in a propagation bench and covered with double layered polyacryl material. The rooting medium was a mixture of sand and vermiculite (1:1 $^{v}/_{v}$). The planting density was about 100 cuttings per m^2. The relative humidity in the propagation bed was kept at about 90-95% by automatically misting several times a day to prevent dehydration and aid in bud initiation. The temperature within the cover ranged between 21-23 °C.

After 2-3 buds had sprouted, misting was stopped and overhead irrigation using a watering can was done daily. Routine pest and disease control and weeding were done as necessary. Dry cuttings that were unable to sprout buds were removed and discarded. A dilute solution of liquid fertilizer containing N: 150, P: 20, and K: 100 ppm was applied once weekly.

Four months after sprouting of buds, the plants were ready to be budded. The plants were removed from the propagation beds and potted one per 18cm diameter standard plastic pot. The medium in the plastic pot consisted of soil: sand mixture in equal ratio, amended with leaf mold compost.

Preparation of Scion Material and Budding

Scion materials of rose cultivar 'First Red' were collected at the stage of a just opening flower, with full-grown leaves. They were bundled together, wrapped with parafilm and carefully packed into cartons. They were then placed in cold storage (1-2 °C) for a period of 3 weeks to induce dormancy and to prevent premature growth and subsequent desiccation in scions. After 3 weeks of storage, the scions were removed from the cold store, carton boxes opened and sprayed with tap water to invigorate them. They were then stored at 16-21 °C overnight for conditioning. The following day, a dormant bud, with about 1cm of a stem above it was removed from the scions. The bud was joined to the rootstock using the T-budding method. One hundred and twenty plants were budded per rootstock type.

Three weeks after budding, the parafilms were unwrapped. The shoots above the union were partially severed, and the top portions bent over to force new growth of buds. In another six weeks, the aerial part of the rootstock was completely removed leaving the buds to grow. The plants were watered daily to container capacity. A nutrient stock solution containing (ppm) N: 200, K: 150, P: 20, Mg: 25, Ca: 80, Fe: 2.6, B: 0.5, Mn; 0.45, Zn: 0.05, Cu: 0.002 and Mo: 0.01 was prepared and applied manually using a watering can at two day intervals.

A completely randomized block design was adopted in the experimental layout with rootstocks forming the treatments. Four blocks were established, the pots being arranged in the blocks on the third week from budding. Each block consisted of ten plants of each treatment, replicated three times. Border plants were placed all round the treatment plants.

Data collection and analysis

Observation for the successful union was assessed by the ability of a scion bud to remain attached to the rootstock material. From date of budding, measurements of bud growth in length (cm) were made on the stems at 21, 42 and 63 days to determine the growth vigour. Visual appraisal of the shoot vigour was also carried out (Ohkawa 1986). Data collection on stem length and diameter, and total marketable blooms commenced 3 months from the date of budding and continued for a period of 10 months. Since the bud combinations of various rootstocks started blooming at different times, the Weighted Harvest Index (WHI) was calculated using the formula: Σ (yxno)/ Y (Caruso, *et al.*, 1996), where y = stems per single harvest; no = number of days since first harvest, and Y = total harvested stems. The data was analyzed using ANOVA and means were separated by Duncan's multiple range test (5% level).

3.0 RESULTS AND DISCUSSION

The rootstock type affected bud combination and vigour of the scion buds. Bud union success was significantly greater in *R. indica* 'Major' (90%) than in *R. multiflora* (77.8%) and *R. canina* 'Inermis' (55%), respectively (Table 1). As the number of days from date of budding increased, differences were observed on the growth performance of scion shoots (Table 1). At 63 days, *R. multiflora* had significantly longer stems than *R. indica* 'Major' and *R. canina* 'Inermis' suggesting vigorous growth of the shoots (Table 1). The growing shoots of *R. multiflora* were very vigorous with shiny leaves compared to other rootstocks resulting in early blooming (Table 1 and 3). Visual appraisal of the growing shoots indicated strong, middle-strong, and middle-weak (Ohkawa, 1986) for *R. multiflora, R. indica* 'Major' and *R. canina* 'Inermis', respectively (Table 1).

Table 1. The effect of three rootstocks on bud-take and shoot growth of rose cultivar 'First Red'

Rootstock	Bud union success(%)*	Scion bud growth: In length (cm) Days after budding			Vigour rating ^{z}(after 60 days)
		21	42	63	
Rosa multiflora	77.8b	0.84a	7.50a	18.30a	Strong
Rosa indica 'Major'	90a	1.00a	7.00a	14.20b	Middle-strong
Rosa canina 'Inermis'	55c	0.81a	5.01b	13.80c	Middle-weak

Mean separation in columns by Duncan's multiple range test at $p \leq 0.05$; ^{z}visual appraisal of growing scion shoots (Ohkawa, 1986); *Irrespective of rootstock used, some buds of scion cultivar 'First Red' sprouted but later were 'arrested' (became dormant). Most of arrested buds became necrotic with a few resuming active growth.

The rootstock type affected number of flowers per plant and stem length. The number of flowers per plant was significantly greater in *R. multiflora* than in *R. indica* 'Major' and *R. canina* 'Inermis' (Table 2). No significant difference was observed between *R. indica* 'Major' and *R. canina*. The stem length in *R. canina* 'Inermis' was significantly shorter than in the other rootstocks (Table 2). The stem diameter did not differ significantly in the various bud combinations (Table 2).

Table 2. Productive and quality characteristics of rose cultivar 'First Red' budded on three rootstocks

Rootstock	Number of flowers per Plant. (10 month mean)	Cut flower Quality (10 month Mean)	
		Stem length (cm)	Stem diameter (mm)
Rosa multiflora	28.9a	59.20a	5.37a
Rosa indica 'Major'	26.2b	58.10ab	5.12a
Rosa canina 'Inermis'	24.1b	55.72b	5.12a

Mean separation in columns by Duncan's multiple range test at $p \leq 0.05$.

Flowering occurred significantly earlier on scions budded on *R. multiflora* and *R. indica* 'Major' compared to those budded on *R. canina* 'Inermis' (Table 3). There was no significant difference in the number of days to first flower in *R. multiflora* and *R. indica* 'Major'. There were no significant differences for percent marketable blooms per plant among the various rootstocks (Table 3). However, *R. canina* 'Inermis' had a slightly lower percent marketable blooms than the other rootstocks, showing a higher proportion of discards/malformed stems (blind shoots, twisted/ weak stems etc.) than other rootstocks.

Table 3. Flowering time and yield of rose cultivar 'First Red' budded on three rootstocks.

Rootstock	Number of days to first flower (from date of budding)*	Marketable blooms per plant (%)^{y}
Rosa multiflora	87a	99.3a
Rosa indica 'Major'	92a	99.1a
Rosa canina 'Inermis'	101b	98.3a

Mean separation in columns by Duncan's multiple range test at $p \leq 0.05$. *WHI Weighted harvest index. y Discards included blind shoots, twisted/crooked or very weak stems.

Greenhouse roses are generally propagated by budding or grafting on different rootstocks (Hasek, 1968; Holley, 1968) but little is known on rootstock effects on shoot growth. This research sought to compare the influence of different rootstocks on bud union success/bud-take ('strike'), bud growth vigour, yield and quality of rose 'First Red'. The rootstock type influenced bud combination and subsequent bud growth vigour of the scion cultivar (Table 1). *R. indica* 'Major' gave the highest number of bud sprouts (90%), whereas *R. canina* 'Inermis' generated the least (55%). The variation in the performance of bud combination among rootstocks might be related to species (Lee and Zieslin, 1978), cambial activity (Lahrop and Mecklenburge, 1971; Lee and Hackett, 1976; Richardson, 1958; and William, 1972), phenomenon of juvenility (Hartman *et al*, 1997), or physiological stages of scion bud (Lee and Hackett, 1976; Lee *et al.*, 1974; Halevy, 1986; and Ohkawa, 1986), which have been suggested to be controlling factors in bud combination. Interactions between rootstocks and scion cultivars affect rootstock-scion compatibility and this has been the subject of numerous studies even in other crop species (Layne *et al.*, 1976; Yadava and Doud, 1989). Moreover, environmental factors such as temperature and humidity were not controlled during experimentation and these would have influenced bud compatibility (Chadwick, 1985).

The data in Table 1 shows that the type of rootstock affected the vigour of the scion cultivar. These results indicate the importance of the root system in shoot growth and the possible influence on the development of the top of the plant, which could be related to translocation of substances or growth regulator activity (Lee and Zieslin, 1978). Variations in translocation rate of substances from the root system through the bud union with different vascular connections into the shoot system could be involved in the differential rootstock effect on the scion cultivar. Rootstock-scion combination influenced assimilate accumulation and partitioning and thus vegetative growth of trees in peach (Glenn and Scorza, 1992; Caruso *et al.*, 1997), French prune (Ryugo *et al.*, 1977) and apple (Brown *et al.*, 1985; Stutte, *et al.*, 1994).

In the study, the rootstock type influenced the flowering time (number of days to first flower), stem length and number of flowers/plant (Table 2 and 3). Generally, *R. multiflora* gave the best performance in flowering time, stem length and number of flowers/plant compared to *R. indica* 'Major' and *R. canina* 'Inermis'. Yield efficiency (percent marketable blooms) did not differ for the various *rootstocks*. It is most likely that the intense vegetative growth that occurred soon after bud break in scions budded on *R. multiflora* is associated with an extensive drainage of growth substances from the root system, or improved nutrient uptake or the photosynthetic activity of the scion cultivar. Thus, possibly, the positive effect of root system activity of rootstock is that it imparts a favourable growth influence on the scion cultivars. In peach, rootstock affected bloom date and productivity of trees (Caruso *et. al.,* 1997; Beckman *et. al.,* 1992; Bernard, 1985; and Layne, 1987). As confirmed in our study, rootstocks which impart vigorous growth to the scion cultivar direct a higher percentage of assimilates to the growing shoots, thus improving overall production (Allan *et al.,*1993; Caruso *et al.,*1995).

Generally, the flowering time, yield and quality of flowers in *R. Multiflora* and *R. indica* 'Major' did not differ significantly. However, *R. multiflora* had better performance in these parameters. Shoot growth of *R. multiflora* was significantly vigorous. The study then provides information which indicate that although *R. multiflora* did not differ significantly in yield and quality parameters compared to *R. indica* 'Major', it is a superior rootstock in Juja locality. *R. indica* 'Major' may be recommended as an alternative rootstock for the rose cultivar 'First Red' for Juja although its performance is slightly lower than that of *R. multiflora* for most parameters except in bud union success where it was superior. The inferior performance of scions budded on *R. canina* 'Inermis' indicate that this rootstock is unsuitable for Juja. Since it takes long to test rootstocks adequately, more research is needed to further illustrate the exact differences between *R. multiflora* and *R. indica* 'Major' rootstocks e.g. on the effect of either on the nutritional status of the scion cultivar or patterns of nutrient uptake from the growth media for the two different rootstocks.

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