Effect of Cutting Position, Auxins and Rootstocks on Flower Yield of Rose Cultivar 'Inca'

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ABSTRACT

This study was carried out to determine the effects of cutting position (top, middle and bottom), auxin concentration (control, 0.2%NAA and 0.4%IBA) and rootstock type ('Rosa progress' and 'Natal briar') on flower yield of rose cultivar 'Inca'. The experiment was factorial in a completely randomized design. Stem diameter increased acropetally in 'Natal briar' while in 'Rosa progress' basipetally. Rooting percentage also increased basipetally in both rootstocks. Top position recorded higher stem weight regardless of the type of rootstock used. Bottom position cuttings treated with auxins had higher stem length than the untreated cuttings. Top position cuttings treated with auxins exhibited higher number of harvestable stems than the untreated cuttings. Bottom position cuttings treated with 0.4% IBA recorded higher number of harvestable stems than 0.2% NAA treated cuttings. The total number of harvestable stems and stem length was higher for 'Rosa progress' than 'Natal briar'. 'Natal briar' recorded higher stem weight and rooting percentage than 'Rosa progress'. Bottom position cuttings of 'Rosa progress' treated with 0.4% IBA can be used for grafting 'Inca'.

Keywords: Rootstocks, Cutting position, 'Inca', Auxin

INTRODUCTION

Roses are one of the most economically important and favourite ornamental plant. Grafting remains a widely used technique in the production of several horticultural species including roses and therefore the use of rootstocks in propagation is a common practice. In a composite grafted plant, rootstocks may control many aspects of scion growth and physiology including yield and quality attributes as well as abiotic and biotic stress tolerance (Koepke and Dhingra, 2013). Many researchers have demonstrated the pivotal role of rootstocks in grafted/budded plants. For instance, rose cultivars Gold medal Whisky mac and Kardinal showed maximum growth and flowering when budded on Grussanteplitz as compared to Rosa bourboniana (Yuonis and Riaze, 2005). Rosa canina was found to be the best rootstock for grafting the Avalanch cultivar than R. manetti (Izadi, 2012). The rose rootstock 'Natal briar' represents 60-70% of the world-wide cultivated surface of grafted roses because it is easy to root, gives good stem length and head size. However, it is susceptible to nematodes and also sensitive to high boron level in the soil. The rootstock 'Rosa progress' is rarely used in grafting or budding and limited information is available about it. However, it has demonstrated high vegetative growth than 'Natal briar' when stem cuttings are used for propagation (Otiende *et al*., 2015). The cuttings are generally taken along the shoot of the rootstock and scion cultivar during grafting and a gradient may exists from the shoot apex to the bottom of the shoot in terms of woodiness and biochemical constituents that may affect rooting and field performance of cuttings obtained therein. Although several studies on ornamentals and fruits have been done on the nodal position of the cultivar and its relation to rooting (Bredmose *et al*., 1996; Zalesny *et al*., 2003), limited information is available on the effects of the nodal

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position of the rootstocks on yield performance of the scion in terms of flower yield and quality. Flower stem height is considered the most important factor for quality evaluation, however some other characteristics such as flower stem weight, quality index (Q.I) and flower stem diameter may also be included for quality determination (Nazari *et al*., 2009). De Vries and Dubois (1993) studying the relationship between position of the scion on the rose plant and subsequent shoot growth of the grafted plants, found that shoot yield increased basipetally. Bredmose *et al*., (1996) reported increased stem length with increasing distance from the apex. The necessity of exogenous auxin application such as IBA and NAA to induce root formation in cuttings has been reported in many species (Kumar and Singh, 2012; da Costa *et al*., 2013). The present study aimed at evaluating the flower quality of rose cultivar 'Inca' as influenced by the cutting position of *Rosa hybrida* rootstocks ('Rosa progress' and 'Natal briar') and auxin treatment.

MATERIALS AND METHODS

The planting materials were obtained from mother stock plants maintained at Finlay Flowers Company limited in Kericho, Kenya. The site lies on latitude 0^0 35' South, longitude 30^0 23' East at an altitude of 2100M a.s.l. The treatments consisted of three cutting positions of top, middle and bottom, two rootstocks of 'Rosa progress' and 'Natal briar' and two different auxins of 0.2%NAA and 0.4%IBA and the control (0%). The auxin levels were selected based on previous studies (Otiende *et al*., 2015) with self-rooted stem cuttings of the two rootstocks where different concentrations of IBA and NAA were used and the best concentration from each of the auxins that recorded higher growth performance was used in the grafting experiment. The scions with one node and one leaf (including 5-leaflet leaves) of *Rosa hybrida* cultivar 'Inca' were top grafted onto 5-cm length internode taken from the rootstocks 'Rosa progress' and 'Natal briar'. The rose cultivar 'Inca' used in this study is a standard type rose. The 18 treatments were factorially combined and laid out in a completely randomized design. Each experimental unit had 20 plants replicated three times. The basal ends of each of the grafts were dipped in the respective auxin treatments for 5 seconds before sticking in jiffy bags filled with sterilized coccus inside a greenhouse equipped with the misting and heating systems. Relative humidity was maintained at 85-90%, with minimum day and night temperature of 30-35^{o}C and 22-24^{o}C, respectively. Misting cycles of 10-30 minutes (day) and 1-2hrs (night) were maintained in the first 2 weeks and then gradually reduced to harden the plants. Misting was stopped completely at 4 weeks after planting. Light intensity was maintained at 300 watts/M^2 during the day throughout the growing period. Fertigation started 14 days after planting and every 4 days thereafter depending on measured electrical conductivity. Six rooted grafts from each treatment were transplanted at 35 days after planting on raised beds filled with pumice as a media in the greenhouse. The cultural practices such as fertigation, irrigation and disbudding commenced after transplanting. The first bending of the main shoot was done at 5 weeks after transplanting and subsequent bending was done on crooked and weak stems. Crop protection was provided against diseases and pests by foliar spray using appropriate insecticides and fungicides, as and when required. Harvesting started 3 months after transplanting and a flush lasted for 45 days. Harvesting the lateral shoots took place just above the second 5-leaflet set counted from the base. The experiment ran from December 2013 to August 2014. The data collected included rooting percentage that was obtained at 35 days after sticking, Number of harvested stems per flush per meter square was obtained by counting, stem diameter and length were measured using a caliper, stem weight using digital weighing balance and vase life was determined by computing the numbers of days the harvested flowers take in the preservative solution until the leaves and petals start fading.

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The data were statistically analysed using Analysis of Variance (ANOVA) and means separated using Least Significance Difference (LSD) at 5% level of probability using GENSTAT statistical package. Only the results that were significant are presented.

RESULTS

The rootstock and interaction between auxin and position significantly ($p \leq 0.05$) influenced the total number of harvestable stems of top grafted rose cultivar 'Inca'. Averaged across the auxins and cutting position, rose cultivar 'Inca' grafted on 'Rosa progress' had 1.3 times more stems than 'Natal briar' (Table 1). Top position cuttings not treated with auxin had significantly lower number of harvestable stems than the middle and bottom position cuttings (Figure 1). Bottom position cuttings treated with 0.2%NAA had significantly less number of stems than the control. Middle position cuttings treated with 0.2% NAA recorded fewer number of stems than 0.4%IBA treated cuttings but non significant from the control. Though cutting position had no significant effect on total number of harvestable stems, top position had fewer stems than middle and bottom positions.

The rootstock, cutting position and the interaction between auxin and position significantly ($p \leq 0.05$) influenced the stem length of grafted rose cultivar 'Inca'. Irrespective of cutting position and auxin concentration, the rootstock 'Rosa progress' exhibited significantly ($p \leq 0.05$) taller (76.31cm) shoots than the rootstock 'Natal briar' (72.34cm) (Table 1). Irrespective of auxin and rootstock, top position cuttings recorded taller stems than the bottom position cuttings (Table 2). Interaction between cutting position and auxin was significant for bottom position cuttings but non significant for top and middle position cuttings (Figure 2). Bottom position cuttings untreated with auxin had shorter stems than the auxin treated cuttings and no significant difference was noted between the 0.4% IBA and 0.2%NAA treated cuttings.

The interaction between the rootstock and position was significant ($p \leq 0.05$) for stem diameter and rooting percentage of grafted rose cultivar '(Figure 3). In 'Natal briar' top position cuttings recorded significantly higher stem diameter than bottom position cuttings. Bottom position cuttings exhibited significantly higher stem diameter than top position cuttings in 'Rosa progress'. However, middle position had comparable stem diameter to top and bottom position cuttings in both rootstocks (Figure 3). The rooting percentage significantly increased basipetally in both rootstocks (Figure 4).

The rootstock and cutting position had significant ($p \leq 0.05$) effect on stem weight and rooting percentage of grafted rose cultivar 'Inca'. Irrespective of cutting position and auxin concentration, the rootstock 'Natal briar' recorded higher stem weight and rooting percentage than the rootstock 'Rosa progress' (Table 1). Irrespective of auxin and rootstock, top position cuttings recorded significantly higher stem weight than the middle cuttings but non significant from bottom position (Table 2).

Table 1. Effect of rootstocks on yield performance of grafted *Rosa hybrida* cultivar 'Inca'

Rootstock	*Rooting (%)*	*Stem No*	*Stem Length (cm)*	*Stem Diameter (cm)*	*Stem Weight (g)*
Rosa progress'	62.5	12.59	76.31	1.48	38.47
'Natal briar'	84.0	9.89	72.34	1.48	42.76
LSD	7.15*	2.65*	2.35*	NS	3.07*

NB: LSD= Least significant difference, NS=Not significant, * and ** probability level at 0.05 and 0.001 respectively.

Table 2. Effect of cutting position on yield performance of grafted *Rosa hybrida* cultivar 'Inca'

Cutting Position	*Rooting (%)*	*Stem No*	*Stem Length (cm)*	*Stem Diameter (cm)*	*Stem Weight (g)*
Top	56.3	9.83	76.50	1.44	43.29
Middle	74.4	12.22	74.41	1.50	38.62
Bottom	88.91	11.67	72.07	1.48	39.95
LSD	8.76*	NS	2.88*	NS	3.76*

NB: LSD= Least significant difference, NS=Not significant, * and ** probability level at 0.05 and 0.001 respectively.

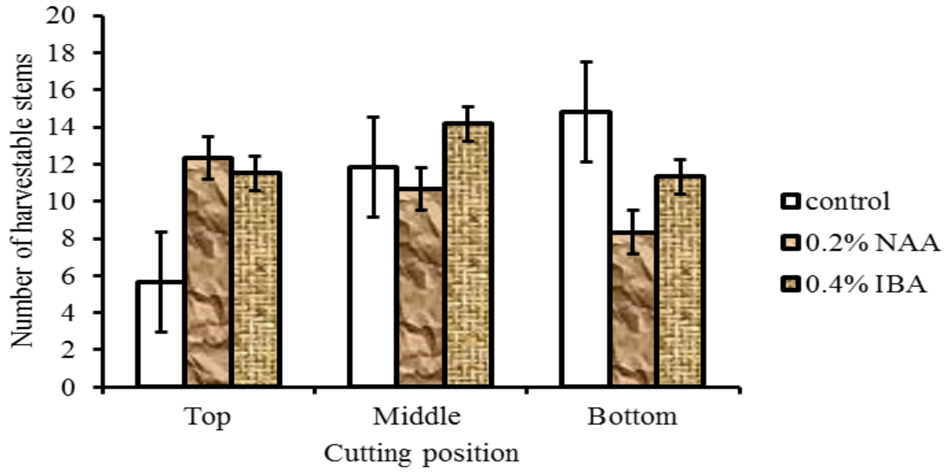

Figure 1. Effect of auxin and cutting position on number of harvestable stems

Figure 2. Effect of auxin and cutting position on stem length (cm)

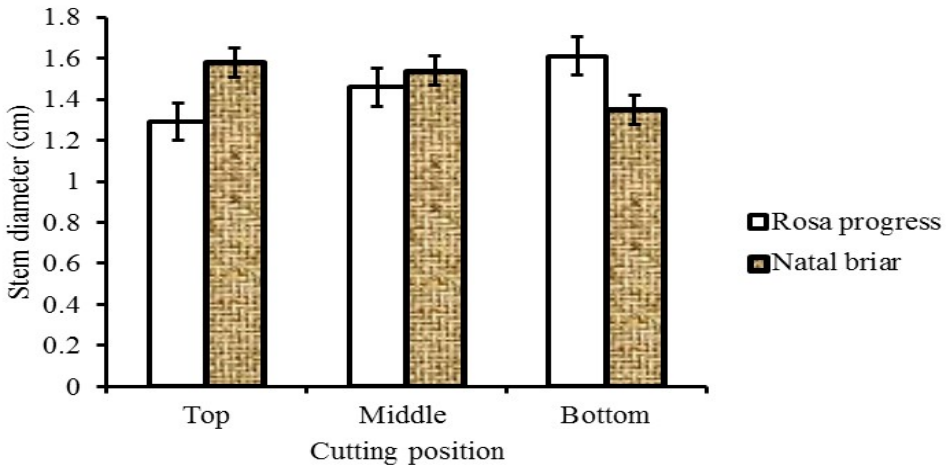

Figure 3. Effect of rootstock and cutting position on stem diameter (cm)

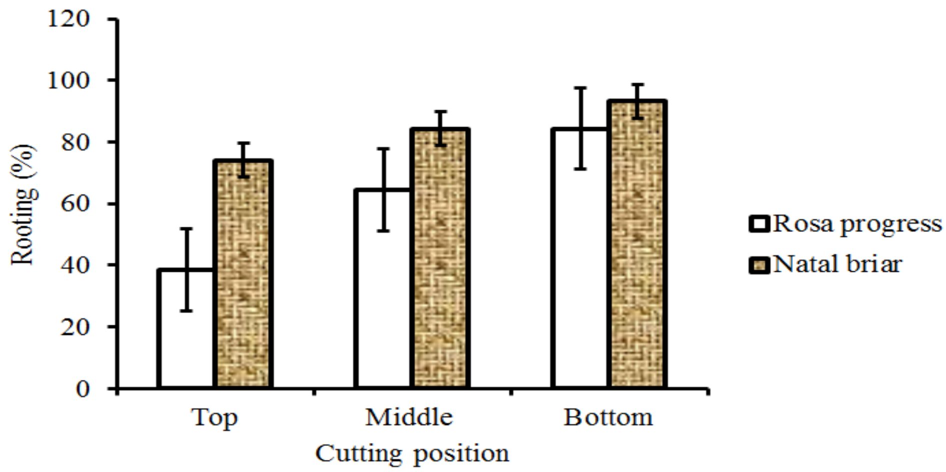

Figure 4. Effect of rootstock and cutting position on rooting (%)

DISCUSSION

The results showed that the cultivar 'Inca' grafted on the rootstock 'Natal briar' produced higher stem weight than the rootstock 'Rosa progress'. Total number of harvestable stems and stem length of the cultivar 'Inca' was higher for 'Rosa progress' than 'Natal briar'. The variation could be due to genetic difference of the two rootstocks that was transferred to the cultivar 'Inca' through the graft union. Rootstocks may affect either directly or indirectly scion characteristics such as vigor, nutrient status, flower yield and quality and stress tolerance (Koepke and Dhingra, 2013). The effect of rootstock on vigour of the scion has been reported in *Protea spp* (Ben-jaacov *et al*., 1991) and Rosa *spp* (Younis and Riaze, 2005; Izadi, 2012). However, De Vries, (1993) found that plant vigour of different clones grafted on seedlings of *Rosa amino* was mainly determined by the scion and to a lesser extent by the rootstock. Harvestable stems were based on strong and straight stems. The weak and crooked stems were bent to supply photosynthates to the new bottom- breaks. In our previous experiment involving the use of stem cuttings, the rootstock 'Rosa progress' had higher vegetative growth compared to 'Natal briar' (Otiende *et al*., 2015). The faster growth rate trait of 'Rosa progress' was probably transferred into the cultivar 'Inca' contributing to high number of harvestable stems and stem length. The rootstocks vigorous root system increases the efficiency of water and nutrient consumption resulting in enhanced growth and yields. Varies and Dubois, (1990) reported that in grafted plants, vigor of the genotype used as

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rootstock is transmitted to the scion and thus influences growth and productivity of the scion. Lee and Oda, (2003) reported different responses of vegetative growth of the grafted combinations to be related to vigour of the rootstocks and compatibility of rootstocks and scion. Other researchers attributed this to several factors such as increase in cytokinin production (Salehi *et al*., 2010), higher rootstock activity (Salehi *et al*., 2009) and increased synthesis of plant growth substances (Yetisir and Sari, 2003).

Fresh stem weight is a function of stem diameter, length and thickness of the leaves. Morphologically 'Natal briar' has thicker stems and broader leaves than 'Rosa progress'. These traits presumably contributed partly to higher fresh stem weight observed in 'Natal briar', though, stem length was shorter compared to 'Rosa progress'. The rootstock 'Natal briar' likely invested more energy in the development of the roots that ensured much supply of water and mineral nutrients to the developing shoot. It is generally accepted that the root and shoot are interdependent with respect to supply of water, mineral nutrients, carbohydrates and biochemical signals. Top position recorded higher stem weight than the middle position irrespective of the rootstocks. Stem diameter also increased acropetally in 'Natal briar'. This may be explained by juvenility factors such as actively differentiating tissues (Tchoundjeu and Leaky, 2001) and high IAA concentration (Hartman *et al*., 2002) that promotes root formation in top position cuttings. The formed roots enhanced the uptake of water and mineral nutrient and production of cytokinins required for shoot growth and development. The stem diameter increased basipetally in 'Rosa progress' and could be attributed to large area of the bottom cuttings for storage of nutrients required for enhanced root development (Aini *et al*., 2010). Saifuddin *et al*., (2013) reported higher physiological activities in bottom position cuttings than apical cuttings and associated the increase in photosynthetic rate to the presence of carbohydrate content in stem and water absorption capacity by produced roots. Lack of rootstock effect on stem diameter of grafted 'Inca' was inconsistent to the findings of Fuchs, (1994) on 'Caramia' rose and *Rosa canina* 'Inermis' rootstocks.

Bottom position cuttings treated with 0.2%NAA had lower number of harvestable stems than the control and 0.4%IBA. The differences between the auxins could be related to other factors such as higher stability and a slow rate of conjugation of IBA, so that the free IBA required to induce rooting will be available over a longer period of time than IAA or NAA (Krisantini *et al*., 2006). Top position cuttings untreated with auxin had significantly lower number of harvestable stems than the treated cuttings. For the stem length, bottom position cuttings untreated with auxin had significantly lower stem length than the treated cuttings. Auxins are known to promote adventitious root development. The promotive effect of IBA on the vegetative growth may be caused by the enhancement of rooting percentage and root growth on the treated cuttings which lead to more uptakes of water and nutrients from the growing medium. Auxin application to the cutting and subsequent rooting may result in the increase of sprouting; this indirect effect of auxin on sprouting highlights the role of certain materials produced in roots especially cytokinins responsible for sprouting.

CONCLUSION

Cutting position of the rootstock and auxin treatment influenced rooting and flower yield of rose cultivar 'Inca'. The cuttings for grafting 'Inca' can be obtained from the bottom position cuttings of 'Rosa progress' and treated with 0.4% IBA. Auxins promote adventitious root formation and the roots supply the nutrients and hormones that regulate shoot growth. The high numbers of harvestable stems and stem length of 'Inca' grafted on the rootstock 'Rosa progress' may indicate high economic returns than the rootstock 'Natal briar'. The longer stems can be cut to meet the desired market demands thus may have a broader market scope

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than 'Natal briar'. The high stem weight of the rootstock 'Natal briar' may indicate higher freight charges, though they can withstand breakages during post harvest handling.

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