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Influence of rootstocks on vegetative growth of Kinnow mandarin scion under rainfed areas

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Abstract

The study was installed at Rainfed Research Sub-station for Sub-tropical Fruits, Raya, SKUAST-Jammu to better understand and elucidate the effect of citrus rootstocks on vegetative growth of Kinnow mandarin cultivar in the pre-bearing stage. The experiment design was RBD randomized design in research farm under rainfed condition with four replications. The magnitude of scion growth revealed stimulated increase in percentage in rainy season between July–October compared to November–February in winter seasons under rainfed condition. The plant growth of Kinnow mandarin on *Jatti khatti* rootstock was better in terms of per cent increase in plant height (39.50%) in rainy and (18.60%) was register in winter season. Whereas the maximum plant spread [N-S (60.70) and E-W (59.56)] in rainy and [N-S (29.56) and E-W (27.20)] percentage increase in winter season was recorded on galgal rootstock. Results showed that an influence different type of rootstock has effect on evaluate scion and root diameter ration in kinnow mandarin budded plants. Maximum increment in scion (64.53%) and root diameter (60.36%) was recorded in *jatti khatti* and rough lemon budded rootstock plants. Whereas the lowest vegetative growth of scion (19.85%) and root diameter (18.85%) in rainy and (1.29%) and (1.12%) in the winter was observed in on carrizo citrange rootstock.

Keywords: Kinnow mandarin, vegetative growth, citrus rootstocks and rainfed condition

Introduction

Kinnow mandarin (*Citrus nobilis* L. × *Citrus deliciosa* T.) is the most important commercial citrus cultivar in central India. It was developed by H. B. Frost by crossing of King of orange (*C. nobilis*) X Willow leaf (*C. deliciosa*) at California citrus station in 1915. In India, total area under citrus 1078 thousand hectare with an annual production of 11147 thousand metric tonnes (Anonymous, 2015). Among various citrus cultivars, Kinnow fruit is the most significant and having major shares of total citrus production in India. It occupies a unique position among popular and extensively grown in tropical sub-tropical, arid, semi arid and foothills of Himalaya climatic regions. Kinnow is very popular fruits in citrus as due to higher productivity per unit. It is commercially grown in Punjab, Haryana, U.P., M.P., Jammu subtropics (J&K), Chhattisgarh and southern states of India. In Jammu and Kashmir State, Kinnow mandarin is a gaining more popularity day by day in Jammu subtropics areas and fruit growers getting more profit every year. Its plants can tolerate high temperature with the help of organic and inorganic mulches and 2-3 irrigation in a week during summer months. In Jammu regions, It is commercially cultivated in Jammu, Samba, Kathua, Udhampur, Rajouri and Ramban districts in irrigated as well as rainfed conditions etc. Role of rootstock in citrus is one of the most debatable and discussed issues and its selection is a major consideration under planning any citrus orchard. Selection of the right rootstock is fundamental to the success of the citrus orchard. Citrus rootstocks viz., Carrizo rootstock direct influence in soil pH and *Citrus aurantium* is resistance to gummosis, tolerant to salts and well suited for heavy moist soils. The rootstocks commonly used for raising Kinnow mandarin on rough lemon and *Jatti khatti*. The monopolised cultivation of Kinnow on *Jatti khatti* however, cannot be considered as an ideal rootstock for all set of agro-climatic conditions. Even in the traditional areas, diversification in rootstock is essential keeping in view the climate change, biotic and abiotic stresses. The significance of rootstock in citrus industry needs no emphasis, because rootstocks have perhaps contributed more than any factors to the success or failure of citrus orchards. Rootstock have had a substantial role in the development of the citrus industry in the world rootstock utilization has gain value both limiting and restricting factors of citrus production soil, climatic and pests etc., (Tuzcu *et al.*, 1992) [13].

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Kinnow mandarin is one of the most popular fruits among due to its high yield, high processing quality, fresh consumption, aromatic flavor and better adaptation to agro-environmental conditions. Even in the traditional areas, diversification in rootstock is essential keeping in view the climate change, biotic and abiotic stresses. The significance of rootstock in citrus industry needs no emphasis, because rootstocks have perhaps contributed more than any factors to the success or failure of citrus orcharding. Several studies have indicated profound influence of rootstocks on scion cultivars including plant stature, physiological parameters, yield and leaf level nutrients (Aviles *et al.*, 2011; Awasthi *et al.*, 2015; Goswami *et al.*, 2001; Sharma *et al.*, 2002)^[2, 3, 7, 11].

Materials and methods

Study site description

Present study was carried during 2017-18 at the experimental field of Rainfed Research Sub-Station for Sub-tropical fruits Raya, Jammu, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The experimental field is situated at an elevation of 332 m above mean sea level and lies between 32°39" North latitude and 0 74 53" East longitude. The climate of experimental site is sub-tropical with hot and dry in summer season, hot and humid in rainy season and cold in the winter months. The climate of location is mild with moderate dry summer and cold winters. The precipitation of annually 1100 mm occurs other than about 70 to 80 per cent from July to September and with a very high intensity, frequency, erratic pattern distribution space leads to moisture stress condition during the major part of the year. The mean daily maximum temperature during May and June ranges between 35.3 °C. to 40.0 °C. and the minimum temperate ranges between (2.0 °C. to 25 °C) during the months of November to March. During the monsoon period relative humidity is high varies from 75% to 85%.

Experimental design and treatments

A study was carried out on citrus rootstocks of Kinnow mandarin cultivar in the pre-bearing stage at Rainfed Research Sub-station for sub-tropical fruits Raya, Sher-e-Kashmir University of Agricultural Sciences and Technology Jammu during 2017-18. The site of experimentation was laid in the fruit research farm. Fruits were procured from PAU, Ludhaina, Punjab, India. After that seed was washed thoroughly, treated with a fungicide and surface dried. The date of seed sowing was start in ending, January under playhouse. Citrus rootstock seeds are relatively short-lived, only retaining viability for 5-10 days. Dry seeds were sown during evening hours and slight irrigation was applied through water canes as per requirement. After retaining pencil thick of different rootstocks were propagated with kinnow mandarin scion bud wood during rainy season and transplanted in the month of February. The experiment was laid out in a randomized block design with Nine treatments and four replications. The effect of various rootstocks *viz.*, T₁= Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.), T₂= Sour orange (*Citrus aurantium* L.) T₃= Karna

khatta (*Citrus karna* Raf.), T₄= Gargal (*Psidolimon*), T₅= Rangpur lime (*Citrus limonia* [L] Osb.), T₆= Rough lemon (*Citrus jambhiri* Lush.), T₇= Jatti khatti (*Citrus jambhiri* Lush) T₈ = Cleopatra (*Citrus reshni*) and T₉= sweet lime (*Citrus limettoides*). Plant materials for the experiment consisted of three-year-old non-bearing plants of Kinnow budded on nine rootstocks, and the budded plants were planted during the year 2016 at RRSS, Raya. Plant growth in terms of plant height (m), stock diameter (mm), scion diameter (mm), root diameter and scion and root diameter were recorded. Plant height was determined by measuring the distance from the ground to the top of the plant with the help of measuring scale. Plant spread (N-S) and (E-W) was recorded with the help of meter scale Scion diameter was taken at fixed height 10 cm above the graft union and trunk diameter 10 cm below the graft union. The scion: rootstock ratio was calculated by dividing the scion value with rootstock value. The data recorded on different vegetative parameters were compared in terms of per cent increase by calculating the growth difference between July- October and November- February.

Results and Discussion

Different rootstock genotypes were observed on kinnow mandarin grafted for plant, height, plant canopy, scion and root diameters and their ration in rainy and winter seasons

Plant height (%)

It was clear in (fig No.1) that influence of various rootstocks on Kinnow mandarin scion under rainfed conditions in rainy and winter seasons. The maximum plant height 39.50% was increase in Jatti khatti (*Citrus jambhiri* Lush) followed by Rough lemon (*Citrus jambhiri* Lush.) 38.60%, Rangpur lime (*Citrus limonia* [L] Osb.) in 38.40%, gargal (*Psidolimon*) in 38.00%, Sour orange (*Citrus aurantium* L.) in 37.50%, sweet lime (*Citrus limettoides*) in 35.90%, Karna khatta (*Citrus karna* Raf.) in 31.50%, and Cleopatra (*Citrus reshni*) in 25.50%. Whereas the lowest value 18.50% was recorded in Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] rootstock during rainy season. Similar Patten was reported during winter season the maximum average plant height 18.60% was increase in Jatti khatti (*Citrus jambhiri* Lush) followed by rough lemon (18.00%), Rangpur lime (*Citrus limonia* [L] Osb.) in 17.50%, gargal (*Psidolimon*) in 16.50%, Sour orange (*Citrus aurantium* L.) in 15.50%, sweet lime (*Citrus limettoides*) in 14.90%, Karna khatta (*Citrus karna* Raf.) in 14.90%, Cleopatra (*Citrus reshni*) in 12.20%. The minimum plant height 6.50% was increase on Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] rootstock propagated plants. The impact of citrus rootstocks is most commonly associated with plant stature, physiological (biotic and abiotic stresses) flowering, fruiting plants from controlling scion vigour (Goswami *et al.*, 2001)^[7] and its effect on different philological and biochemical parameters causing different in plant growth, productivity and fruit quality (Dubey and Sharma, 2016)^[5].

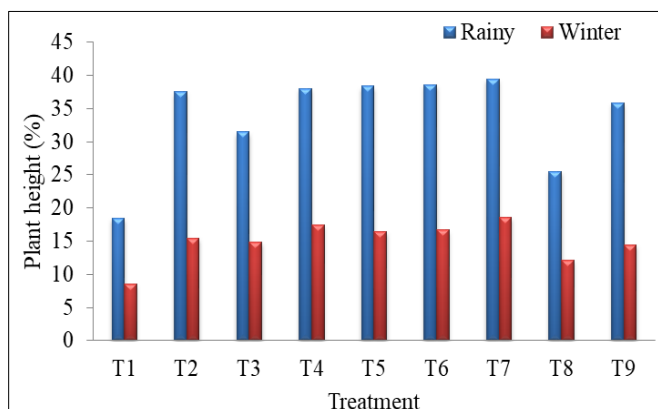


Fig 1: Effect of rootstocks on plant height (%) of Kinnow Mandarin under rainfed condition; T₁= Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.), T₂= Sour orange (*Citrus aurantium* L.) T₃= Karna khatta (*Citrus karna* Raf.), T₄= Gargal (*Psidolimon*), T₅= Rangpur lime (*Citrus limonia* [L] Osb.), T₆= Rough lemon (*Citrus jambhiri* Lush.), T₇= Jatti khatti (*Citrus jambhiri* Lush), T₈= Cleopatra (*Citrus reshni*) and T₉= sweet lime (*Citrus limetoides*).

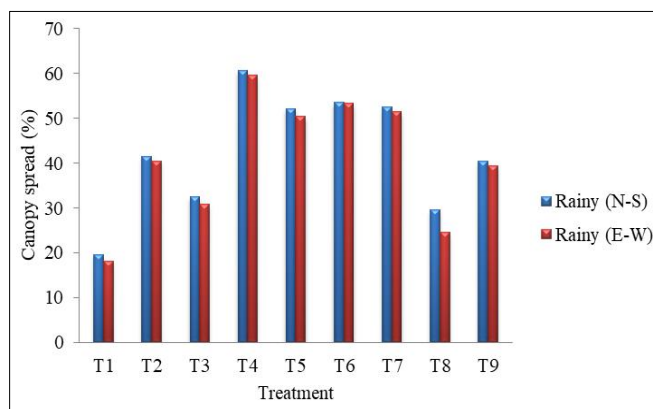


Fig 2: Effect of rootstocks on canopy spread (%) in the rainy season of Kinnow Mandarin under rainfed condition; T₁= Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.), T₂= Sour orange (*Citrus aurantium* L.) T₃= Karna khatta (*Citrus karna* Raf.), T₄= Gargal (*Psidolimon*), T₅= Rangpur lime (*Citrus limonia* [L] Osb.), T₆= Rough lemon (*Citrus jambhiri* Lush.), T₇= Jatti khatti (*Citrus jambhiri* Lush), T₈= Cleopatra (*Citrus reshni*) and T₉= sweet lime (*Citrus limetoides*).

Plant spread (%)

The data revealed in (Fig No. 2) that the impact of various root stock on kinnow mandarin scion has shown increase the plant spread [N-S and E-W] in both seasons under rainfed condition. During the investigation it was observed that the maximum plant spread [N-S (60.70%) and E-W (59.56%)] was increase in gargal (*Psidolimon*) rootstock followed by Rough lemon (*Citrus jambhiri* Lush.) [N-S (55.50%) and E-W (53.35%)], Rangpur lime (*Citrus limonia* [L] Osb.) [N-S (52.20%) and E-W (50.40%)], Jatti khatti (*Citrus jambhiri* Lush) [N-S (52.50%) and E-W (51.50%)], Sour orange (*Citrus aurantium* L.) [N-S (41.50%) and E-W (40.50%)], sweet lime (*Citrus limetoides*) [N-S (39.50%) and E-W (34.50%)], Cleopatra (*Citrus reshni*) [N-S (35.50%) and E-W (34.50%)]. Whereas the lowest plant spread [N-S (19.50%) and E-W (18.50%)] was registered in Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.) Rootstock in rainy season. The long term effect of rootstock on leaf nutrient levels have been studied for different climatic condition across the world (Georgiou, 2002)^[6]. The ability of citrus rootstocks to control tree size, vigour and precocity has been exploited for suitability particularly climatic condition. (Sharma *et al.*, 2002)^[11]

Similar trend was noticed in winter season that the kinnow mandarin scion had shown less effect on plant spread both the direction as compared to rainy season under rainfed conditions. The maximum plant spread [N-S (29.27%) and E-W (27.20%)] was recorded in those plants which were propagated with gargal (*Psidolimon*) rootstock under rainfed condition followed by Rough lemon (*Citrus jambhiri* Lush.) [N-S (28.50%) and E-W (27.50%)]. The lowest value of plant spread [N-S (8.50%) and E-W (8.50%)] of kinnow mandarin spread was registered in those plants which were propagated on Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.) During the investigation in the winter season. Anon *et al.*, 2007^[1] reported that kinnow was grafted on three different rootstock and maximum vigorous growth in height and spread in rough lemon

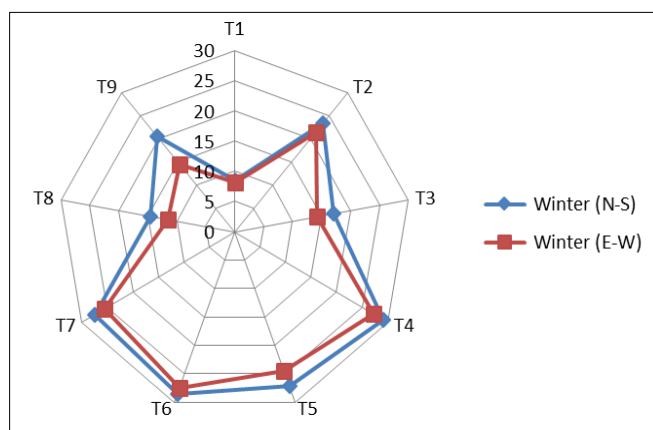


Fig 3: Effect of rootstocks on Canopy spread (%) in the winter season of Kinnow mandarin under rainfed condition; T₁= Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.), T₂= Sour orange (*Citrus aurantium* L.) T₃= Karna khatta (*Citrus karna* Raf.), T₄= Gargal (*Psidolimon*), T₅= Rangpur lime (*Citrus limonia* [L] Osb.), T₆= Rough lemon (*Citrus jambhiri* Lush.), T₇= Jatti khatti (*Citrus jambhiri* Lush), T₈= Cleopatra (*Citrus reshni*) and T₉= sweet lime (*Citrus limetoides*).

Scion diameter (%)

It was clear in fig 4 that in rainy season, the maximum increment in scion diameter was recorded in T₇ (64.53%) followed by T₆ (64.10%) T₅ (63.45%), T₄ (52.68%), T₂ (50.88%), T₉ (50.10%) T₃ (48.95%) T₈ (37.38%). Whereas the lowest scion diameter value (19.85%) was reported in T₁. In the winter season the maximum scion diameter increment was registered in T₇ (3.84%) followed by T₅ (3.06%), T₆ (2.76%), T₄ (2.15%), T₂ (2.12%), T₃ (2.10%), T₉ (1.93%), T₈ (1.63%). Meanwhile the minimum increment was noticed in T₁ (1.29%) during investigation.

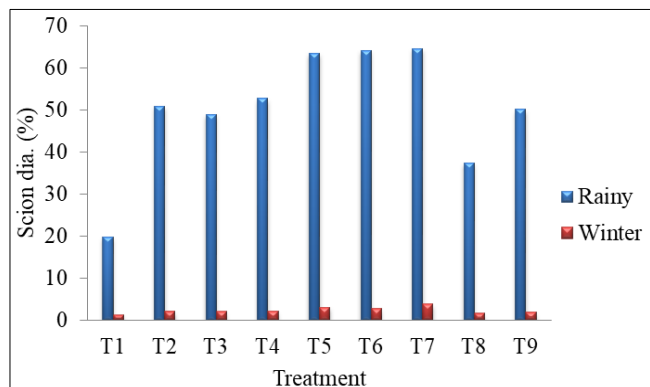


Fig 4: Effect of rootstocks on scion diameter (%) of Kinnow mandarin under rainfed condition; T₁= Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.), T₂= Sour orange (*Citrus aurantium* L.) T₃= Karna khatta (*Citrus karna* Raf.), T₄= Gargal (*Psidolimon*), T₅= Rangpur lime (*Citrus limonia* [L] Osb.), T₆= Rough lemon (*Citrus jambhiri* Lush.), T₇= Jatti khatti (*Citrus jambhiri* Lush), T₈ = Cleopatra (*Citrus reshni*) and T₉= sweet lime (*Citrus limettoides*)

Root diameter (%)

It was clear in fig 5 that the maximum increment of root diameter in T₇ (61.83%) was recorded in rainy season followed T₆ (60.36%), T₅ (60.35%), T₄ (51.68%), T₂ (50.58%), T₃ (45.85%), T₉ (45.46%), T₈ (34.25%), and lowest value was noticed in T₁ (18.85%). In the winter season, the maximum root diameter percentage was noticed in T₇ (2.95%) followed by T₆ (2.85%), T₅ (2.55%), T₄ (2.35%), T₂ (2.10%), T₃ (2.05%), T₉ (1.95%), T₈ (1.55%) and was lowest in T₁ (1.12%). Different in foliar micronutrients content has also been reported earlier due to rootstocks in different fruit crops which vary with the nutrient absorption capacities through roots (Georgiou, 2002 and Kayon, 2008) [6, 9]. Rootstocks are studied extensively and often are sold with a complete guide to their ideal soil and climate. Jaskarni *et al.*, (2002) [8] detailed that diploid Kinnow trees were larger in spread than tetraploid. Singh *et al.*, (2002) [12] revealed that Rangpur lime root stock reduced size of the tree.

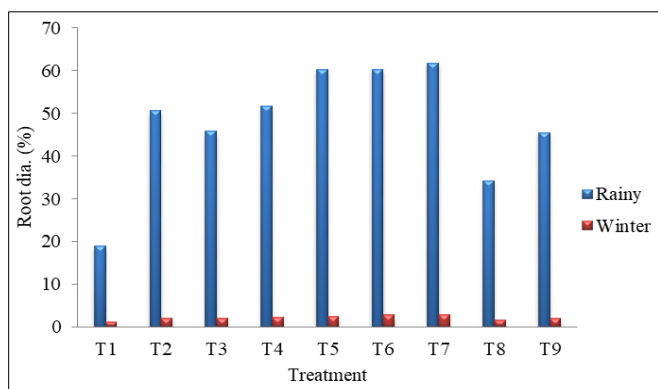


Fig 5: Effect of rootstocks on root diameter (%) of Kinnow mandarin under rainfed condition; T₁= Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.), T₂= Sour orange (*Citrus aurantium* L.) T₃= Karna khatta (*Citrus karna* Raf.), T₄= Gargal (*Psidolimon*), T₅= Rangpur lime (*Citrus limonia* [L] Osb.), T₆= Rough lemon (*Citrus jambhiri* Lush.), T₇= Jatti khatti (*Citrus jambhiri* Lush), T₈ = Cleopatra (*Citrus reshni*) and T₉= sweet lime (*Citrus limettoides*)

Scion and root diameter ration

It was clear in fig 6 that the maximum increment in scion and root diameter ration was registered in T₉ (1.10) followed by T₈

(1.09), T₃ (1.07), T₆ (1.06), T₅ (1.05), T₁ (1.05), T₇ (1.04), T₄ (1.02) and was lowest value in T₂ (1.01). However, in the winter season the maximum of scion and root diameter ration was in T₇ (1.30) followed by T₅ (1.20), T₁ (1.15), T₈ (1.05), T₃ (1.02), T₂ (1.01), T₉ (0.99), T₆ (0.97) and was lowest value in T₄ (0.91). Choice of rootstock is important aspect in fruit crops especially in citrus because scion cultivars respond variously to growth, quality and nutrients rootstocks may affect the capability of plants to take up water, nutrients etc. Kumar *et al.*, (1994) [10] reported that dynamic rootstocks are required under arid environmental conditions, to give a boost to citrus trees. buildup when grown on varied rootstocks. Sometimes plant nutrient concentrations may fluctuate even if they are grown under same conditions (Bergmann, 1992) [4].

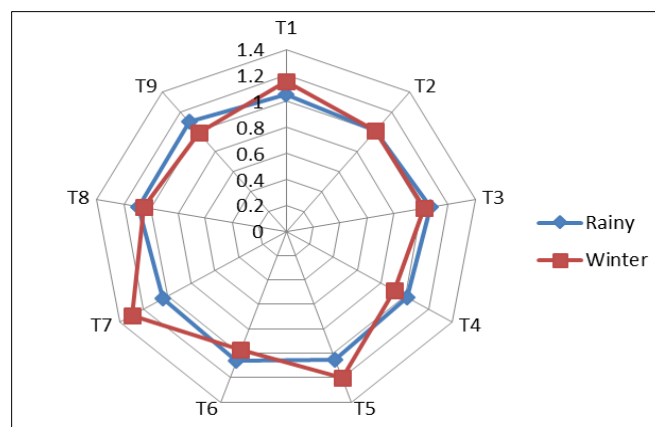


Fig 6: Effect of rootstocks on scion/ stock ration of Kinnow mandarin under rainfed condition; T₁= Carrizo citrange (*Citrus sinensis* [L.] Osb. × *Poncirus trifoliata* [L.] Raf.), T₂= Sour orange (*Citrus aurantium* L.) T₃= Karna khatta (*Citrus karna* Raf.), T₄= Gargal (*Psidolimon*), T₅= Rangpur lime (*Citrus limonia* [L] Osb.), T₆= Rough lemon (*Citrus jambhiri* Lush.), T₇= Jatti khatti (*Citrus jambhiri* Lush), T₈ = Cleopatra (*Citrus reshni*) and T₉= sweet lime (*Citrus limettoides*)

Conclusion

In conclusion, citrus rootstock have good compatibility between both, scion and rootstock on kinnow mandarin scion and has major effect in vegetative characters *viz.*, plant height, plant spread, scion and root diameter ration. So judicious selection of rootstocks leads to success of citrus plantation under rainfed or *kandi* areas.

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