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Short communication

Root distribution pattern of pomegranate in different soil types

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ABSTRACT

Root distribution pattern forms the crux for optimum utilization irrigation, fertilizers and other inputs. Therefore, root distribution in terms of root weight and root activity (*i.e.* root length) in pomegranate cv. Bhagwa was studies in three different soil types on four-year-old trees of pomegranate. Roots were collected from six radial distances (0-30, 30-45, 45-60, 60-75, 75-90 and 90 cm and above) and seven depths (0-15, 15-30, 30-45, 45-60, 60-75, 75-90 and above 90 cm). It was observed that total quantity of feeder roots (diameter up to 5 mm) under shallow, medium deep and deep soil was 992.7, 1,100.0 and 1,176.3 g, respectively. Cumulative root length (activity) was the highest in medium deep soils (2,722.8 m) followed by shallow (2,332.4 m) and the lowest in deep soil (2,084.0 m). On weight basis, contribution of small roots (2 < to < 5 mm) in total weight was the highest whereas, on the basis of root length, contribution of very fine roots (< 0.5 mm) was exceptionally high compared to other categories of the roots. Root growth or root activity of pomegranate plants was better in shallow, light textured soils compared to deep, clayey soils. In these soils major portion of the root activity was observed in 0-60 cm radial distance and 0-45 cm vertical distance. In deep, clayey soils more or less uniform distribution of roots was observed up to 90 cm distance.

Key words: Pomegranate, root distribution, root activity, radial distance, soil types.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the most important, hardy fruit crops of arid to semi-arid regions of India. Due to increasing demand, the area under cultivation of pomegranate in India has grown by 10.73% during last seven years from 96.9 thousand ha to 107.3 thousand ha. It is being cultivated inadvertently in least promising soils and even on the hills, barren lands by digging pits, trenches of various sizes or on available lands without having any knowledge about its soil requirement in relation to root growth and its distribution.

Root distribution study is one of the important aspects of fruit trees, which have wide spread root system. The knowledge of root distribution pattern is helpful in economizing the use of inputs like fertilizers and irrigation. It is also important in surveying the new potential areas for commercial cultivation. The root distribution is influenced by number of factors such as tree age, season, rootstock, scion variety, soil texture, fertility, tillage, growing conditions and other cultural practices (Kotur, 3; Singh and Mishra, 4). In pomegranate, any systematic study was not done of this aspect. Hence, the study was done to find out root distribution pattern of pomegranate growing under different soil types.

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MATERIALS AND METHODS

The investigation was undertaken on 4-year-old plants of pomegranate cv. Bhagwa planted of 4.5 m × 4 m distance at the research farm of National Research Centre on Pomegranate, Solapur, Maharashtra during 2011-12. Three different soil types, *viz.* (1) Soil type 1: very shallow soil, 10 to 12 cm deep underlain by weathered rock, gravelly loam texture; (2) Soil type 2: medium deep soil, 35 to 40 cm deep underlain by weathered rock, clay texture; and (3) Soil type 3: Deep soil, 100 to 115 cm deep, clay textured soil were selected for study. Pomegranate seedlings were planted in the 1 × 1 × 1 m pits filled with pond soil. After three years of plantation, uniform and healthy trees having same vigour were selected for study under each soil types.

Though it was highly laborious and time consuming, in a maiden attempt two plants under each soil type were sacrificed and roots from each layer were manually excavated. Plants were cut to ground level and circles of 30, 45, 60, 75 and 90 cm radius were drawn away from the main stem of the plant, which demarcates the area between the circles in to 6 sectors, *i.e.* 0-30, 30-45, 45-60, 60-75, 75-90 and 90 cm and above. Each sector was excavated at seven different depths, *i.e.* 0-15, 15-30, 30-45, 45-60, 60-75, 75-90 and above 90 cm. Complete soil along with roots was removed from each layer / sector and collected in bags. The collected samples were washed with running water on a wire mesh, dipped in hydrogen

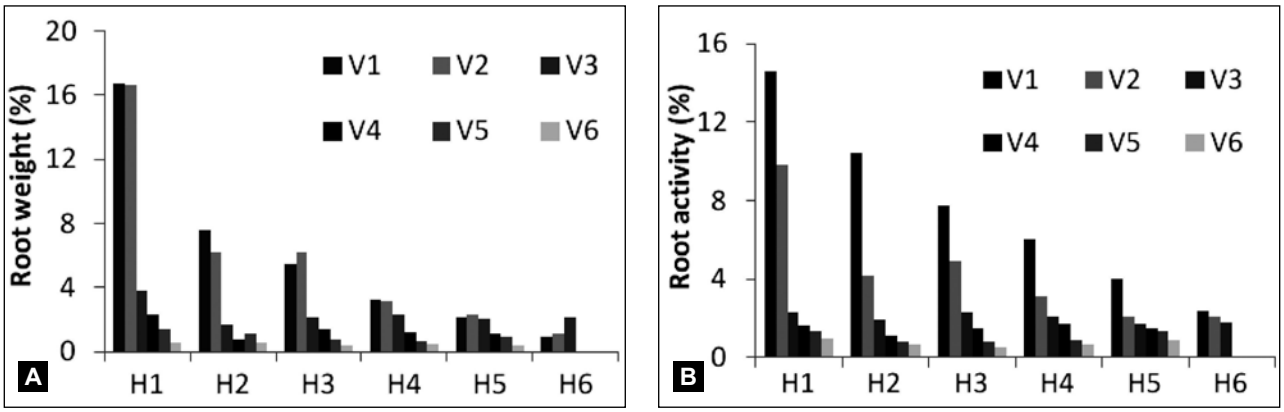
peroxide solution (5%) for 30 min. and rinsed in water to remove all the soil particles from the roots. The roots were then surface-dried under fan and graded on the basis of root diameter into six categories, *viz.* (i) very fine < 0.5 mm (ii) fine 0.5 < to < 2 mm (iii) small 2 < to < 5 mm (iv) medium 5 < to < 10 mm (v) large 10 < to < 20, and (vi) very large > 20 mm as per the standardized root nomenclature provided by International Society for Root Research (Bohm, 2). The graded samples were then put in the paper bag and dried in the oven at 60 ± 1°C for 72 h in order to get constant dry weight. Observations pertaining to root biomass and root length were recorded.

RESULTS AND DISCUSSION

In shallow, light textured soils, the highest roots were of 'small roots' category (48.3%) followed by fine root (39.5%) and very fine (12.2%) category (Fig. 1A). Root distribution (41.5%) in horizontal direction was concentrated in 0-30 cm soil layer and decreased with the increasing radial distance (17.9, 16.3 and 11.06% in 30-45, 45-60 and 45-90 cm distance, respectively). Urunov and Shapkin (7) have substantiated that main mass of root framework falls near the trunk of the apple trees. Roots under very fine grade were uniformly distributed up to 90 cm, while fine and small root were mostly concentrated in 0-60 cm radial distance from the main trunk. There was decrease in total quantity of roots with increasing depth from 36.15% at 0-15 cm to 2.38% in 75-90 cm soil depth. Vertically, 92.7% roots were concentrated in 0-60 cm soil depth. It was also observed that 86% of total very fine roots, 81.2% portion of total fine roots and 89.5% portion of total small roots were located in 0-45 cm soil depth.

Root activity in terms of length indicates that it has been mainly governed by very fine roots (66.06%) followed by fine roots (28.66%), while, contribution of small roots (5.29%) was very low (Fig. 1B). In horizontal spread, major root activity (30.77%) was observed in 0-30 cm radial distance followed by 19.04% in 30-45 cm. Thus, 82.16% of root activities were concentrated in 0-75 cm radial distance from the main stem of the plant. Activity of very fine roots was observed even up to 90 cm radial distance while activity of fine and small root were as mainly confined in 0-60 cm circle away from the main stem. In vertical direction, 45.21% root activity was concentrated in 0-15 cm soil depth followed by 26.18% in 15-30 cm, which shows that nearly 83.55% root activity was intense in 0-45 cm soil depth. Total very fine roots (79.4%) and total small root (73.6%) activity was observed in 0-30 cm soil depth. The influence of soil depth on volume of fibrous and thin roots was significantly observed in litchi were maximum in 0-30 cm soil depth (Agnihotri *et al*., 1).

Root distribution pattern in medium deep, clayey textured soil on weight basis (Fig. 2A) indicated that majority of the roots were of 'small roots' category (52.95%) followed by fine roots (37.33%). In horizontal direction, the roots (42.2%) were mainly concentrated in 0-30 cm soil layer followed by 19.4% in 30-45 cm circle away from the trunk of the plant. Roots (84.74%) were concentrated in 0-75 cm circle away from the main trunk of the plant. Radial distribution of very fine roots was uniform even up to 90 cm; while fine and small root were concentrated in 0-60 cm radial distance. In vertical direction, 40.06% roots were concentrated in 0-15 cm soil depth followed by 30.43% in 15-30 cm. soil depth. It means that nearly



H: horizontal root spread in soil between H1: 0 - 30 cm, H2: 30 - 45 cm, H3: 45 - 60 cm, H4: 60 - 75 cm, H5: 75 - 90 cm, H6: above 90 cm; V: vertical root spread in soil between V1: 0 - 15 cm, V2: 15 - 30 cm, V3: 30 - 45 cm, V4: 45 - 60 cm, V5: 60 - 75 cm, V6: 75 - 90 cm.

Fig. 1. Root distribution pattern of pomegranate on shallow, light textured soil in term of A. root weight (%) and B. root length / activity (%).

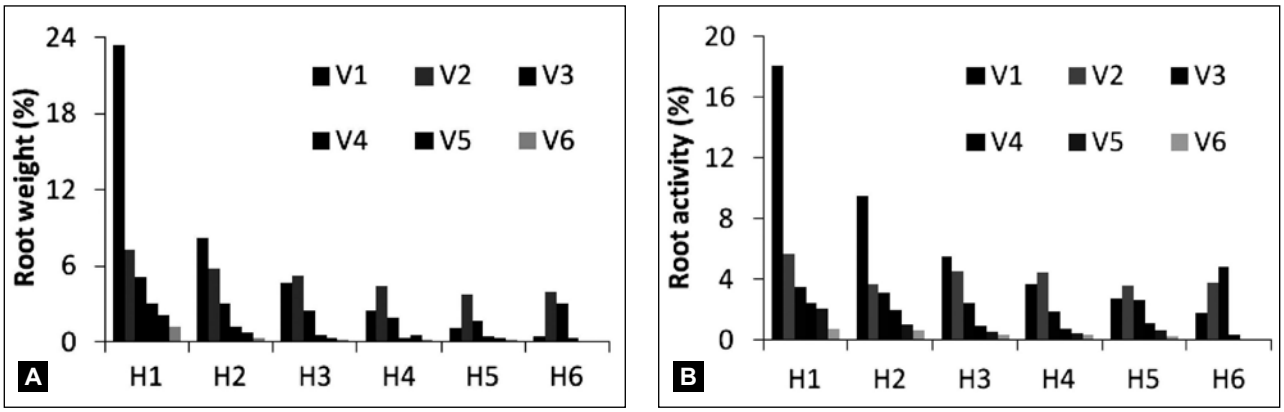
93.62% roots were concentrated in 0-60 cm depth. It was also found that, 85.7, 85.8 and 89.7% portion of total very fine, fine and small roots, respectively, was concentrated in 0-45 cm soil depth.

In this soil, activity of the roots (Fig. 2B) was mainly governed by very fine roots (60.58%) followed by fine roots (33.10%), while contribution of small roots was very low (6.32%). In horizontal direction, most of the root activity (32.57%) was concentrated in 0-30 cm distance followed by 19.9%, in 30-45 cm distance. It amounts to 78.3% of root activities in 0-75 cm radial distance from the main stem of the plant. Activity of the very fine roots was uniform up to 90 cm and for fine and small root, it was up to 0-60 cm away from the main stem. In vertical direction, 41.20% root activity were concentrated in 0-15 cm soil depth followed by 25.70% in 15-30 cm, 18.53% in 30-45 cm, afterwards it drastically reduced to 7.53% in 45-60 cm depth. It means that nearly 92.9 percent root activities were confined to 0-45 cm vertical soil depth only. Similarly, it was observed that 67.3% portion of total very fine roots, 65.0% of total fine roots and 72.3% of total small roots were concentrated in 0-30 cm vertical soil depth.

Root distribution pattern in terms of root weight under deep, clayey soil on weight basis indicated that majority of the roots were of 'small roots' category (60.98%) followed by fine roots (33.76%) and very low (5.26%) under very fine category (Fig. 3A). In this soil type, roots were uniformly distributed up to 90 cm radial distance. In 0-30 cm soil layer 28.33% roots were found while it was 17.5, 16.17, 13.13, 10.76 and 14.10% in 30-45, 45-60, 60-90 and above 90 cm soil layer, respectively. In horizontal direction, roots under very fine and fine category were uniformly distributed up to 90 cm, while majority of the roots under small root category were confined in 0-60 cm distance from the trunk of the plant. Root distribution in vertical direction revealed that all the roots were uniformly (25.5 to 26.04%) distributed within 0-45 soil depth, below which it reduced to 11.76 and 6.03% in 45-60 and 60-75 cm soil depth. It was also observed that roots under very fine category were uniformly distributed even up to 90 cm depth, while roots under fine and small category were confined to 0-60 cm soil depth.

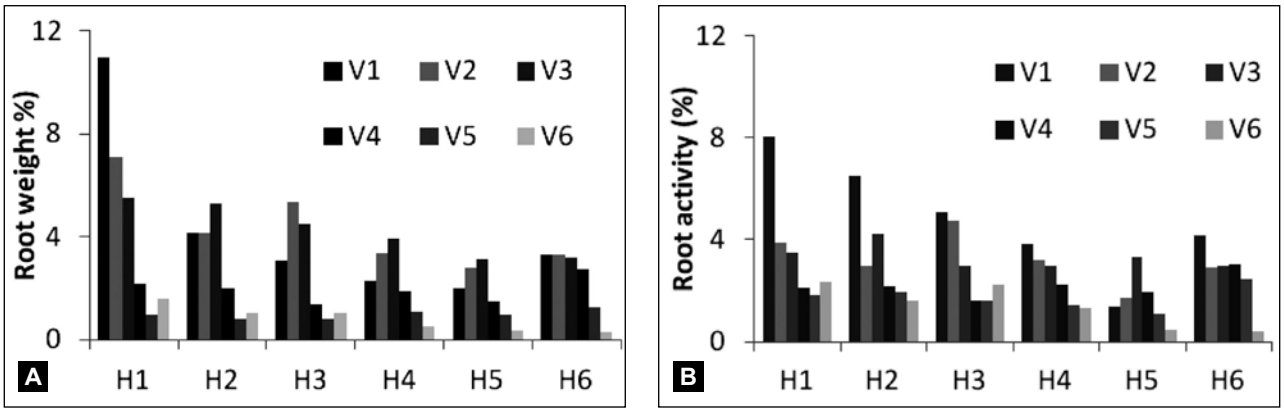
The results revealed that in this soils, activity of the roots were mainly governed by fine roots (48.01%) followed by very fine roots (44.22%), while contribution of small roots was very less (7.77%) (Fig. 3B). Unlike other soils, activity of all categories of the roots was uniformly distributed up to 90 cm radial distance. In vertical direction also sufficient root activity was observed in the soil up to 90 cm depth. Highest root activities (28.89%) were observed in 0-15 cm soil depth followed by 19.43% in 15-30 cm, 19.90% in 30-45 cm, 13.07% in 45-60 cm and 10.37% in 60-75 cm depth.

Comparison of distribution of various categories of the roots on weight basis grown under different soil types revealed that, contribution of roots under very fine category was highest in shallow soil (12.2%) followed by medium deep (9.72%) and was lowest in deep soil (5.26%). Share of small size roots was highest in deep soils (60.98%) followed by medium deep (52.05%) and was lowest (48.29%) in shallow light texture soil. While share of fine roots was more or less same in all three types of soils. Comparison of root distribution in vertical direction revealed that in shallow and medium deep soils, majority of the roots were concentrated up 45 cm depth while in case of deep soil it extends further up to 60 cm.



H: horizontal root spread in soil between H1: 0 - 30 cm, H2: 30 - 45 cm, H3: 45 - 60 cm, H4: 60 - 75 cm, H5: 75 - 90 cm, H6: above 90 cm; V: vertical root spread in soil between V1: 0 - 15 cm, V2: 15 - 30 cm, V3: 30 - 45 cm, V4: 45 - 60 cm, V5: 60 - 75 cm, V6: 75 - 90 cm.

Fig. 2. Root distribution pattern of pomegranate on medium deep, clay textured soil in term of A. root weight (%) and B. root length / activity (%).



H: horizontal root spread in soil between H1: 0 - 30 cm, H2: 30 - 45 cm, H3: 45 - 4 60 cm, H4: 60 - 75 cm, H5: 75 - 90 cm, H6: above 90 cm; V: vertical root spread in soil between V1: 0 - 15 cm, V2: 15 - 30 cm, V3: 30 - 45 cm, V4: 45 - 60 cm, V5: 60 - 75 cm, V6: 75 - 90 cm.

Fig. 3. Root distribution pattern of pomegranate on deep, clay textured soil in term of A. root weight (%) and B. root length / activity (%).

Distribution of roots in horizontal direction revealed that majority of the roots (75.7 & 74.8%, respectively) were concentrated in 0-60 cm distance in shallow and medium deep soil while in case of deep clayey soil it extend further up to 90 cm or more also. Comparison of root activities under different soil types revealed that, activity of very fine roots were highest in shallow soil (66.06%), followed by medium deep soil (60.58%) and was lowest in deep, clayey soil (44.22%). Amongst different categories of roots, activity of fine roots was highest in deep soils (48.01%) followed by medium deep (33.1%) and was lowest (28.66%) in shallow light texture soil. Similar trend was observed in case of small roots. Root activity horizontal direction revealed that in shallow and medium deep soil majority of the roots activity (67.58 & 66.74%, respectively) were concentrated in 0-60 cm distance while in case of deep clayey soil it extend further up to 90 cm. Root activities in vertical direction revealed that in shallow and medium soil, majority of the root activity (83.55 and 85.43%, respectively) has been confined to 45 cm depth, while in case of deep soil it further extended up to 75 cm.

The weight of total quantity of roots (diameter up to 5 mm) under shallow, medium deep and deep soil was 992.7, 1100.0 and 1176.3 g, respectively. Cumulative root length (activity) was highest in medium deep soils (2722.8 m) followed by shallow (2332.4 m) and deep soil (2084.0). Increasing the radial distance from the tree trunk decreased the dry weight of all categories of roots in shallow and medium deep soil. Similarly, increasing the soil depth from surface decreased the dry weight the roots in all soil types. These findings are in accordance with the findings of Patel (5) and Mishra *et al*. (4) in case of citrus fruit crops.

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