International Scholars Journals

African Journal of Wood Science and Forestry ISSN 2375-0979 Vol. 11 (4), pp. 001-004, April, 2023. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

The impact of different soil types, including organic and inorganic soils, on the success of root emergence in spring rings

Hani A AL-Zalzaleh

Arid land Agriculture and Greenery Department, Kuwait Institute for Scientific Research, P.O. Box 24885, Safat 13109, Kuwait. E mail: ahr96ha@yahoo.com.

Accepted 9 February, 2023

A glasshouse experiment was conducted to determine the effect of soil types on the emergence of Eucalyptus viminalis in spring ring containers. Five inorganic soils such as 100% clay, 100% sand, 85% sand and 5% clay, 70% sand and 30% clay, and 55% sand and 45% clay and, three organic soils like medium nutrient and medium texture compost, medium nutrient and coarse texture compost, medium nutrient and fine texture compost were used for the study. Characters observed were the total numbers of roots (TR) and the number of roots emerging through the spring rings (ER) after destructive harvest. The ratio for the weight of emerged roots to the weight of total number of root (ER : TR) was calculated. Morphological observations reveal that air pruning in spring ring containers seemed to be encouraging the formation of new roots. The results showed that that there was no significant difference between the soil types on the total number of roots as well as the number of roots emerged through the holes of the spring rings. The weight ratio of emergent roots to the total number of roots also did not vary significantly. Despite the differences in the soil type similarity was observed in root performance in the E. viminalis seedlings. Overall, the soils used did influence neither the total number of roots nor the emergence of roots through the container openings.

Key words: organic soils, root growth, inorganic soils, root growth, spring rings, soil types.

INTRODUCTION

There are both biotic and abiotic factors that affect the successful growth and establishment of plants in the soil. The root system is the main organ for water and nutrient absorption. Nambiar (1980) recognize the effects of size, form, distribution and the physiological condition of the seedling root system can have a strong influence on the survival and early growth of seedlings transplanted to field environments. It is often suggested that rapid tree reestablishment upon transplanting is encouraged by a large number of root tips (Appleton, 1995). However the relationship is not simple and involves two-way feedback. Brown and Scott (1984) argue that amount of the total root system which is actively growing and elongating may be more valuable as an indicator of how well a plant is performing than the use of other root parameter.

Formal studies of root distributions have occurred more than 250 years ago (Hales1727). In spite of the long history of root study, our understanding of root distribu-tions, and the below ground process in general, remains adequate. Many authors recognize the effects of soils on root growth (Lucas, 1987; Lake, 1987). The growth, proliferation and extensiveness of the root system largely depend on both soil physical and chemical properties. The rate and pattern of root growth in the soil vary with the soil physical, chemical, and microbiological properties such as texture, structure, strength, water content, oxy-gen supply rate, temperature, pH and pathogens (Brown and Scott, 1984). In addition, chemicals such as salts, toxic materials and herbicides influence root growth (Gregory, 1987).

It is well known that different soil types and their properties are an important factor in determining the rooting habit of a tree. While published data are plentiful, studies of mature tree root systems that have been uprooted are few. Due to logistical problems, excavations have been restricted to a limited number of species and soil types (Sutton, 1991) . It has been stated that the physical properties of the soil can modify root diameter, development of root hairs and the branching pattern of lateral roots (Lucas, 1987). Organic matter in the soil largely influences the soil physical and chemical pro-perties and thereby indirectly affects root development.

Furthermore, soil particles influence root penetration and elongation (Armitage, 1985) . Of course rooting habits and development of roots also vary according to the plant species (Armitage, 1985) and genetic differences in species (Klepper, 1987).

The challenge facing nursery growers producing trees is to not only optimize canopy growth but to ensure that the root and shoot system have been managed to ensure that they don't have a negative impact on long-term growth and even survival. Container production systems can be quite successful but nevertheless there still re-main a number of very serious concerns about the quality of the root systems of many that are being produced by many container nurseries. Spring ring containers are designed to encourage roots to proliferate and root tips are encouraged to grow towards the holes. Spring ring containers allow roots to be air pruned by using openings in the sides or the base of containers. Root tips reaching such openings are dried out and stop growing. Such containers are designed to prevent the development of circling roots and have been shown to alter the growth and distribution of roots within the root ball (Whitcomb 1981; Arnold and MacDonald 1999). A growing tree will send roots far into the surrounding soil. The development of the tree root architecture is influenced by both the tree species (Toomey, 1929) and a range of soil conditions. The suc-cess of strategy may be influenced by the tendency for root branching that is encouraged by the growing media. In this study the number of roots emerging through the holes of spring rings was studied relative to variation in the soil mix used for growing Eucalyptus viminalis. Typi-cally trees have relatively shallow but widespread root systems (Dobson and Moffat, 1993; Dobson, 1995). This paper focuses on the relationship between the amount of extending roots and the soil type of tree seedlings grown in the spring rings.

MATERIALS AND METHODS

The experiment was conducted at the glass house number 7 located in the school of plant sciences of the Kuwait University on February 10th 2007 and ending on September 10th 2007. E. viminalis was selected for the study because of its extensive root system and tolerance to the adverse climatic conditions prevailing in Kuwait. In this experiment, the seeds were germinated in plug cells and the resultant seedlings grown for 10 weeks were planted into spring ring containers containing eight different soils. There were 120 rectangular openings around the sidewall of the containers. Each opening had a dimension of 7.3 x 3 mm. Regular nursery routine was practiced. Plants were irrigated daily by hand. The containers were rotated once a week to allow the plants to receive equal sunlight.

TREATMENTS

Five inorganic soils such as 100% clay, 100% sand, 85% sand and 15% clay, 70% sand and 30% clay, 55% sand and 45% clay were used. Three organic soils (based on the Fisons Levington series) were used, as follows.

M_2 --- Medium nutrient and medium texture compost.
C_2 --- Medium nutrient and coarse texture compost.
F_2 --- Medium nutrient and fine texture compost.

Experimental design

The experiment was laid out as randomized complete block design with five replications. Data were subjected to analysis of variance using the SAS statistical package (SAS Institute of Inc Cary, NC) to test differences in the characteristics measured due to soil differences. The probabilities of significant differences (P), least significant differences (LSD) were computed in order to contrast the means of different soil treatments.

Morphological characters observed

Observations were assessed for the root system after washing the soil out for the samples irrespective of all the treatment combi-nations and were taken as a reference.

Parameters measured

In this study only underground parameters were recorded. Destructive harvesting was made to record the characters for the samples. The plants were cut down to the basal part of the collar region upper to the soil medium of the container. The roots were carefully removed by breaking the container and the adhering soil is removed by washing with water. A sieve was used to collect the washed out roots. The characters observed were the total numbers of roots (TR) and the number of roots emerging through the spring ring openings for each treatment(ER).The roots were cut down to the base and weighed to get the average weight of emerged as well as total roots. Then the ratio for the emerged roots to the total number of root (ER: TR) was calculated. The roots having a diameter greater than or equal to 1mm was counted for calculating the number of roots for both emergent as well as total number of roots.

RESULTS

Morphological assessment

The effect of air pruning in spring ring containers seemed to be encouraging the formation of new roots (TR and ER). When the roots emerging through the spring rings reach the base of the container they split into multiple roots. Another concept shown to have considerable potential is containers that allow roots to be air pruned by using openings in the sides of the containers. Such containers are designed to prevent the development of circling roots and have been shown to alter the growth and distribution of roots within the root ball (Whitcomb1981; Arnold and MacDonald 1999) . Generally the harvested samples of roots did not differ from each other in their appearance.

Total number of roots harvested (TR)

The table showed that there was no significant difference between the soil types on the total number of roots. Even

Table 1. The effect of different soil types on the emergence of roots.

Soil Type	TR	ER	ER: TR (%)
100% Clay	10	3	10.6
100% Sand	12	3	12.2
85% Sand:15%Clay	10	4	10.6
70% Sand:30% Clay	8	2	6.6
55%Sand:45%Clay	11	6	11.4
Medium nutrient and Coarse texture compost	8	4	8.6
Medium nutrient and Fine texture compost	9	5	7.0
Medium nutrient and Medium texture compost	10	7	10.8

P Value for RN = 4.9, ER = 4.3, E: TR = 4.0.
NS- Not significant.

though there is no statistical difference between the treatments, plants grown in soil with 100% sand, and plants grown in soil with ratio of 55% sand and 45% clay produced more roots than plants grown in the other soil types.

The number of roots emerging through the spring Ring containers (ER)

The analysis of variance for the effect of soil type on the amount of emergent roots showed that there was no significant influence. Data indicated that the highest number of roots emerged through the holes of the spring rings was observed in the plants grown in Medium nutrient and medium texture compost than plants grown in other soil types . However, soil with 70% sand and 30% clay produced the lowest number of roots emerged through the openings.

Emergent: Total Root Ratio (ER: TR)

No statistical significant difference was observed between soil types in the ratio of emerged roots to the total number of roots, although 100% sand showed the highest result.

DISCUSSION

The present study was performed out find if different soil types and organic soil could have some influence on amount of root number and root emergence through the openings offspring rings in E. viminalis seedlings. To achieve this only the underground plant parameters were measured after the destructive harvest. Destructive sampling procedures are the best approaches for evaluating real interactions between plant roots and their soil environment (Smucker, 1984).

In this trial, however, despite the differences in the soil type similarity was observed in root growth in E. viminalis seedlings. Overall, the soils did influence neither the total number of roots nor the emergence of roots through the container openings. The Table 1 showed that for Eucalyptus planted in soil with ratio of 55% sand and 45% clay yielded more roots than other soils used. The 100% sand showed a tendency for more root emergence from the spring ring containers. Generally sand or gravel does not favor branched root growth and loamy soils are generally the most favorable for root proliferation (Klepper, 1987). Irrespective of all the treatments the ratio of emerged roots to the total number of roots also did not vary significantly indicates that soil types have no influence in root growth. In this study the morphological assessment agrees with these findings. Root morphology had the same appearance for all samples in terms of apparent density and direction. Drought hardy seedlings often have deep root systems and wider ranging laterals (Buijtmen et al., 1976) and encouraging the right growth form may be important for transplant survival as well as increasing nutrient absorption due to the number and distribution of feeding roots (Bould, 1970). Probably this generalization does not apply to container grown plants where patterns of aeration and root development will differ dramatically from field soils. Moreover, the soil physical properties such as soil aeration, porosity are not influencing much if the plants are growing in containers. The pore size of the soil determine root branching and elongation in container grown plants (Cannell, 1986).

However it is possible that the duration of the experiment is not enough for differences to become apparent. A further detailed investigation is needed in this aspect including more treatment combinations.

Conclusion

Based on the investigation of root growth characters on the spring ring containers for various soil types , the following conclusions can be reached: Despite the differences in soil types no significant changes was observed in root growth. Organic and inorganic combinations of soils did not influence the root growth for shorter durations. The duration of the experiment was too less to interpret quantitatively the difference in root characters for total as well as emergent roots.

ACKNOWLEDGMENT

The author would like to thank Kuwait University and Kuwait Institute for Scientific Research for providing the infrastructural facilities and encouragement.

REFERENCES

Appleton BL (1995). New nursery production methods lead to tree circling reduction or elimination. Arboric. J., 19: 161-174.
Armitage FB (1985). Irrigation forestry in arid and semiarid. Ottawa International Research Center, pp: 164-168.
Arnold MA, McDonald GV (1999). Accelerator containers alter plant growth and the root zone environment. J. Environ. Hort., 17(4): 168-173.
Bould C (1970). The nutrition of fruit trees. Physiology of fruit trees. Academic press. pp. 223-234.
Brown DA, Scott HD (1984). Dependence of crop growth and yield on root development and activity. In: Roots, nutrient and water influx and plant growth. Barber SA, Bouldin DR Eds. Soil Sci. Soc. Am., pp. 101-136.
Buijtenen JP, Bilan VM, Zimmerman RH (1976). Morpho physiological characteristics related to drought resistance in Pinus taedaa, In: Tree physiology and yield improvement .Cannell MGR, Last FT. Academic press. pp. 349-359.
Cannell MGR (1986). Physiology of trees in relation to yield improvement. PhD thesis, University of Reading, United Kingdom.
Carbon BA, Bartle GA, Murray AM, Macpherson DK (1980). The distribution of root length and the limits to flow of soil water to roots in a dry scelorophyll forest. For.Sci., 26(4): 656-664.
Dobson M (1995). Tree root systems. Arboriculture Research and Information, Note 130. Arboricultural Advisory and Information Service, Farnham, pp. 162-164.
Dobson MC, Moffat AJ (1993).The potential for woodland establishment on landfill sites. HMSO, London, pp. 88-93
Gregory PJ (1987). Development and growth of root systems in plant communities. In: Root development and function, Seminar Series 30. Gregory PJ, Lake JV, Rose DA eds. Cambridge University Press, pp: 147-166.
Hales S (1727). Vegetable statistics, Current edition (1961). London Scientific Guild, London.
Klepper B (1987). Origin, branching and distribution of root systems. In: Root development and functions, Seminar Series 30. Gregory PJ, Lake JV, Rose A eds. Cambridge University Press, pp. 167 -176.
Lake JV (1987). Interaction in the physical environment of plant roots In: Root development and function, Seminar Series 30. Gregory PJ, Lake JV, and Rose DA. Cambridge University Press, pp 88-93.
Lucas WJ (1987). Functional aspects of cells in root apices. In: Root development and function, Seminar Series 30. Gregory PJ, Lake JV, Rose DA eds. Cambridge University Press, pp. 27-52.
Nambiar SEK (1980). Root configuration and root regeneration in Pinus radiata seedlings. N. Z. For. Sci., 10(1): 249-262.
Smucker AJM (1984). Carbon utilization and losses by plant root system, In: Root nutrient and water influx in plant growth. Barber SA, Boulden DR eds, ASA special Publication, 49: 27-46.
Sutton RF (1991).Soil properties and root development in forest trees: a review. Forestry Canada Information Report O-X-413.Great Lakes Forestry Centre, Ontario. pp. 653-658.
Toumey JW (1929). Initial root habit in American trees and its bearing on regeneration. In: Proceedings of the International Congress of Plant Sciences. Duggar BM, George B eds. Ithaca, New York, pp. 713-728.
Whitcomb CE (1981). A vertical air root pruning container. Combined Proc. Int. Plant Propagators Soc., 1(31): 591-596.