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Soil Moisture Status in Eucalypts based Agroforestry System in Semi-Arid Region of Haryana

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ABSTRACT: Agroforestry systems have substantially altered soil properties in both surface and sub-surface layers. Information on the effect of Eucalypts based agroforestry on the status of soil moisture content is minimal. The present study investigated changes in soil moisture stauts under eucalypts (*Eucalyptus tereticornis*) based agroforestry and monocropped systems (sole barley and mustard) in semi-arid region of Haryana. During this study, we quantified the stauts of soil moisture content at different distances from tree line (1.5m, 2.5m and 3.5m). The maximum moisture content (20.3 %) was observed at 30-45 cm soil depth at 3.5 m away from tree line after 7 days of 1st irrigation. Whereas, mustard and barley intercropped with eucalypts exhibited minimum moisture content (5.2 %) at 0-15 cm soil depth at 1.5 m distance from tree line before 2nd irrigation.

Keywords: Agroforestry, soil moisture, tree line distance, soil depth, irrigation

INTRODUCTION

Agroforestry is an integrated land-use system approach (Aryal *et al.,* 2019), different from the sum of its two major components, viz., agriculture and forestry (Nair *et al.*, 2021). The specific advantages of this system can be environmental, social and economic (Wato and Amara, 2020). Due to overexploitation, unscientific collection, and illegal export, the genetic resources of valuable crops are getting exhausted very fast. The crops are being cultivated along with the trees under agroforestry systems to overcome this situation (Elevitch *et al.,* 2018). Growing trees on agricultural fields, combined with agricultural crops to augment biomass production per unit area, is becoming popular among farmers (Zahoor *et al.,* 2021). Agroforestry occupies 25.32 million hectares (mha) or 8.2% of the total geographical area in India (Dhyani *et al.*, 2013) and its area is expected to increase after the implementation and adoption of National Agroforestry Policy, 2014. These systems emerge as an option for crop diversification in north-west India by enhancing productivity, net profitability mitigating climate change (Chaudhari *et al.,* 2014). Eucalypts (*Eucalyptus tereticornis*) block plantation dominates in the semi-arid region of north-western India. Trees combined with farmland tend to improve the ecosystem by regulating the site's microclimate and changing physical structure, infiltration capacity (Lozano Olivério *et al.,* 2021), moisture regime and other chemical properties of soils. The soil water content in agroforestry systems is influenced by microclimatic conditions such as solar radiation, wind speed and rainfall (Bosi *et al.*, 2020). In addition, by reducing solar radiation, shade affects microclimatic variables (Yang *et al.,* 2021), including air and soil temperatures, relative humidity, soil moisture (Pezzopane *et al.,* 2015), and evapotranspiration (Lin *et al.,* 2010), thereby influencing crop growth (Bosi *et al.,* 2014). Non-uniform soil variations (Arora *et al.,* 2021) and competition for water have been observed in agroforestry systems in which eucalypts is integrated with annual crops and pastures. Eucalypts based agroforestry system uptake more moisture and lead to greater competition between trees and crops, especially under dry conditions (Madalcho *et al.,* 2019). The balance between soil moisture supply and consumption by plants is of great importance for sustainable and healthy ecosystems, especially in water-limited regions. Keeping in view, the present study was conducted to quantify the status of soil moisture under eucalypts based agroforestry system in semi-arid ecosystem.

MATERIALS AND METHODS

The present investigation was conducted at Research field of Department of Forestry, CCS HAU, Hisar, which is located at 29° 09' N latitude and 75° 43' E longitude, with 215.2 m above mean sea level in southern Haryana. This region has a subtropical climate with an average annual rainfall of 350-400 mm, most of which falls during the monsoon season (July to September). In December and January, the minimum temperature reaches upto 0°C, while the highest temperature upto 45°C due to hot and sunny days in May and June. In this experiment, barley and mustard were grown in interspaces with already established 2.8-year-old *Eucalyptus teriticornis* plantation at 7×3 m spacing. Barley and mustard (without trees) formed as control (sole crops). The gravimetric method was used to calculate the soil moisture content on a per cent dry weight basis. Soil samples were taken at three depths (0-15 cm, 15-30 cm and 30-45 cm) at three distances from tree line (1.5 m, 2.5 m and 3.5 m) before and after each irrigation under eucalypts based agroforestry and control. The soil samples were dried in an oven for 24 hours at 105°C. The following formula was used for moisture content (MC) calculation:

$$MC(\%) = \frac{\text{Weight of moist soil sample (g)} - \text{weight of oven dry soil sample (g)}}{\text{Weight of oven dry soil sample(g)}}$$

RESULTS AND DISCUSSION

During the study period, the maximum per cent reduction in moisture content (52.3, 48.2 and 43.0) was recorded at a distance of 1.5 m from tree line in all the soil depths before 2nd irrigation over control (sole barley). The moisture content increased with increasing soil depth and the increasing distance from eucalypts tree line during the crop growing season. Maximum loss in moisture content (5.2 %) was observed at 1.5m distance from tree line under eucalypts plantation before 2nd irrigation. Soil moisture content was also affected by the distance from the tree line. Before 1st irrigation, moisture content under barley based agroforestry system was 6.4, 7.1 and 7.9 % at 1.5, 2.5 and 3.5 m of distance from the tree line at a depth of 0-15 cm, respectively (Fig. 1).

The soil moisture content was affected by distance from the tree line at different soil depths when mustard intercropped with eucalypts planation. Maximum soil moisture content was observed under sole cropping after 7 days of 1st irrigation at 30-45 cm soil depth at a distance of 3.5 m and minimum soil moisture status was found under eucalypts based agroforestry at 0-15 cm of soil depth and 1.5 m away from tree line. At 0-15 cm of soil depth, moisture content decreased by 38.4, 33.9, 51.9 and 32.2% under eucalypts based agroforestry system as compared to sole cropping before1st and 2nd irrigation, after 7 days, respectively at a distance of 1.5 m from the tree line (Fig. 2). The lower soil moisture content in eucalypts based agroforestry system was due to increased rate of transpiration (Hakmanda *et al.*, 2020) which results from the inclusion of the eucalypts trees under agroforestry (Van Kanten and Vaast 2006). Deep-rooted plants consume more deep soil moisture than conventional cropland due to their well-developed and deeper root systems and higher evapotranspiration rates (Zhang *et al.*, 2018; Arora *et al.*, 2021). The maximum per cent reduction in moisture content was found higher in mustard intercropped with eucalypts plantation at a 1.5 m distance from tree line during the cropping season after both the irrigations. According to Bosi *et al.* (2020a), soil water availability is more dynamic in upper soil layer due to faster water uptake by plants and evaporation from the soil in the first days of a dry spell (Silva *et al.*, 2020). Roots are strongly concentrated in surface horizons (Bayala and Prieto, 2020); hence, greater competition for water occurs in the upper layers of the soil (Platis *et al.*, 2019).

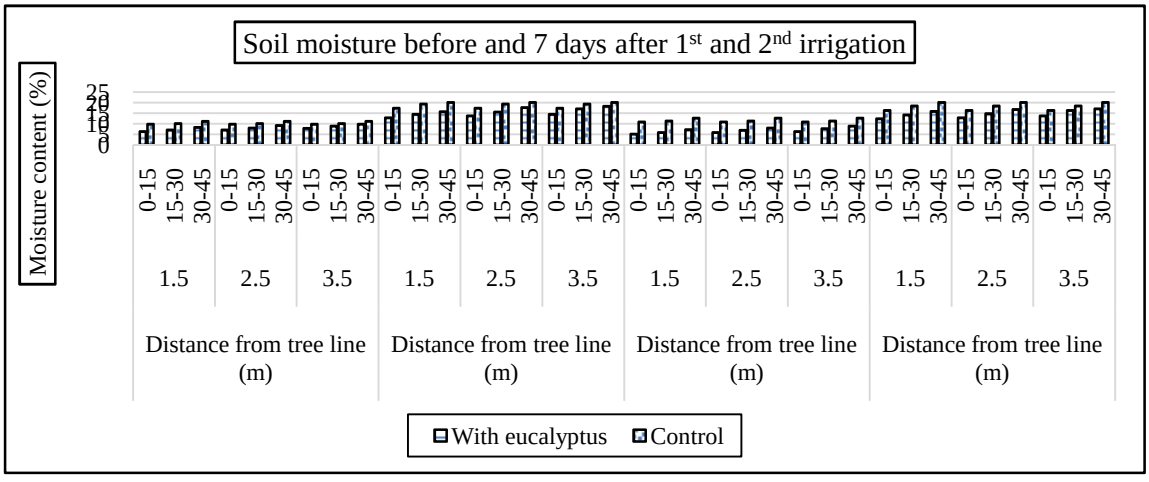

Fig. 1. Moisture content (%) at different distances from tree line at various soil depths in barley under eucalypts plantation and control.

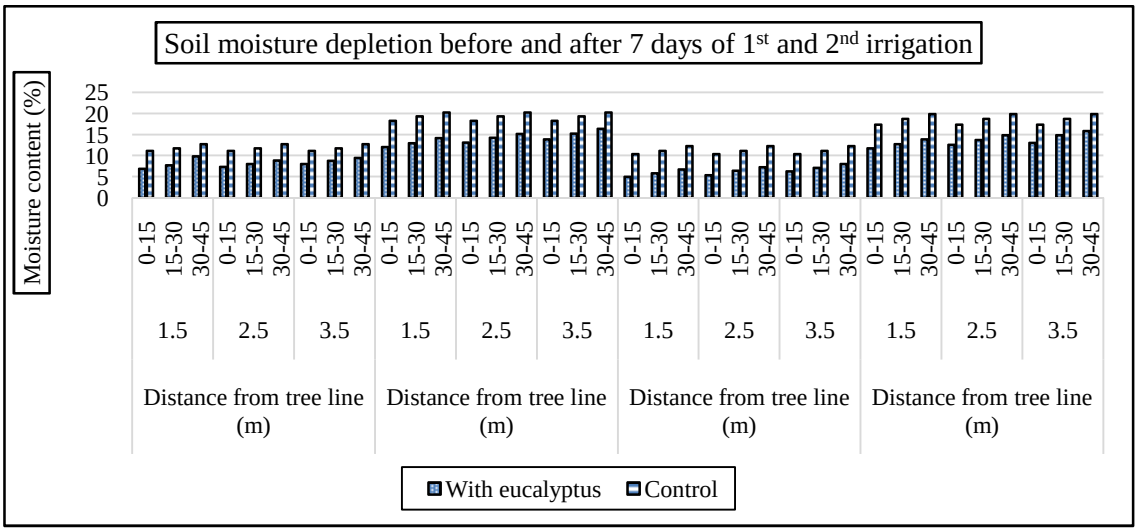

Fig. 2. Variation in soil moisture content (%) in different soil depths and from tree line distances in mustard intercropped with eucalypts and sole mustard (control).

The high water use of eucalypts has led to concerns about the environmental impacts of its cultivation (Tomé *et al.,* 2021). However, some improved eucalypts hybrids have efficient water use characteristics and are more suitable for semi-arid regions of the tropics (Shem *et al.,* 2009).

CONCLUSION

The present investigation concludes that mustard intercropped with eucalypts based agroforestry system exhibited maximum percent reduction (51.9 %) at 0-15 cm depth at1.5 m distance from tree line, before 2nd irrigation. However, distance 3.5 m from eucalypts tree line and soil depth 30-45 cm exhibited minimum per cent reduction (9.4 %) after 7 days of 1st irrigation when barley grown in the interspaces of eucalypts plantation and control. During this study, the moisture content was lower under eucalypts based agroforestry system due to more competition between crop and tree for moisture.

FUTURE SCOPE

There is a need of long term study to know more about moisture availabity under agroforestry based systems. Intergrated approaches of crop production like use of microorganisms may be tested to enance moisture availability in rhizosphere of tree.

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Conflict of Interest. None.

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