Forage Res., **47**(4) : pp. 494-498 (2022) **http://forageresearch.in**

SOIL MOISTURE DEPLETION PATTERN UNDER EUCALYPTS BASED AGROFORESTRY SYSTEM IN SEMI-ARID ECOSYSTEM OF NORTHERN INDIA

STANLEY KOMBRA[1], K. S. AHLAWAT[2], CHHAVI SIROHI[2], K. K. BHARDWAJ[3], CHARAN SINGH[3], SNEH YADAV[2] AND RITAMBHARA[3]

[1]Eastern highlands province, P. O. Box 112, Goroka 441, Papua New Guinea
[2]Department of Forestry, CCS Haryana Agricultural University, Hisar-125004 (Haryana), India
[3]Department of Soil Science, CCS Haryana Agricultural University, Hisar-125004 (Haryana), India
**(e-mail : stkombra@yahoo.com)*

(Received : 7 February 2022; Accepted : 19 March 2022)

SUMMARY

A field experiment was conducted to study the effect of eucalypts-based agroforestry system intercropped with berseem and oat on soil moisture status. In this study, the available soil moisture content increased substantially at different distances from tree line (1.5, 2.5 and 3.5 m). Minimum soil moisture content (5.4%) was recorded under berseem intercropped with eucalypts at 0-15 cm soil depth before 7th irrigation at 1.5 m distance from the tree line; however, maximum moisture content (24.8%) was found at 30-45 cm soil depth after 7 days of 1st irrigation in sole berseem (without tree). In an oat-eucalypts cropping system, minimum soil moisture content (6.5%) was observed at 0-15 cm soil depth before 3rd irrigation at 1.5 m distance from the tree line, while the maximum moisture content (26.2%) was recorded at 30-45 cm soil depth after 7 days of 1st irrigation. The moisture content also showed an increasing trend with the increase in soil depths.

Key words : Eucalypts, berseem, oat, soil moisture, irrigation, tree line distance

The major challenge for a large country like India is to ensure food security by increasing its production through sustainable development. After the green revolution, most of the irrigated areas are at their highest potential in output, while arid and semi-arid regions have the possible potential to produce more crops. In these areas, agroforestry as an innovative land management helps to get more food, fuel, and fiber which ultimately leading to higher farmer net returns (Prasad *et al.,* 2019). The critical benefit of agroforestry systems is increased biomass which helps to get higher total production without exhausting land resources (Singh, 2010). Eucalypts is famous under agroforestry in many country areas due to its fast-growing and salinity-tolerant nature (Sharma *et al.,* 2020). Eucalypts clones have revolutionized the world by becoming the most preferred agroforestry tree species with an assured market, highly lucrative returns, and supportive government policies (Dhillon *et al.,* 2018). However, trees and crops compete for nutrients and moisture (Das *et al.,* 2011). Berseem and oat are primary wintergreens and dry fodder-producing crops (Arora, 2007). In arid and semi-arid areas, soil moisture is a significant crop limiting factor because water is the sole source through which plants uptake nutrients (Bayala and Prieto, 2020). However, soil moisture depletes instantly during the active growth stages of trees due to the deep root system, which helps in extracting water from deeper soil horizons. Crops grown with trees increase such kind of competition. Soil moisture in conjugation with soil temperature influence physicochemical and biological properties of soil as well as plants (Özkan and Gökbulak, 2017). Root exudates of trees improve soil structure and increase infiltration rates, leading to lesser runoff and soil erosion (Kumar *et al.,* 2020). Water resources are better conserved under many trees, including eucalypts, than barren land or grass cover (Monalisa *et al.,* 2020). Since the soil moisture content of agroforestry ecosystems is influenced by numerous factors like light intensity, rainfall, soil moisture dynamics, biomass production, and microclimate of crops (Glatzle *et al.,* 2021). This is further complicated by combining different crops, trees, and animals in diverse environments and under variable management. The main objective of choosing leguminous and cereal intercrops is to predict the behavior of eucalypts for moisture conservation with different crop

combinations. Therefore, present investigation was carried out under eucalypts and fodder crops based agroforestry system to combat the problem of soil moisture management in semi-arid region of Haryana.

MATERIALS AND METHODS

The present study was carried out under eucalypts (*Eucalyptus tereticornis*) based agroforestry system in Research field of Department of Forestry, CCS Haryana Agricultural University, Hisar, located at 29° 09' N latitude and 75° 43' E longitude with 215.2 m above mean sea level in semi-arid region of south-western Haryana. This area has a subtropical climate with 350-400 mm average annual rainfall, which is received mainly during the monsoon (July to September). The minimum temperature reaches up to 0°C in December and January, while the maximum in May and June up to 45°C due to hot and sunny days. Berseem and oat were grown in the interspaces of 2.8 year old *Eucalyptus teriticornis* plantation at 7×3 m spacing. Berseem and oat (without trees) formed as control (sole crops). The soil moisture content was calculated as a per cent dry weight basis by the gravimetric method. The soil samples were drawn from pre and post irrigation, at three depths (0-15, 15-30, and 30-45 cm) and three distance from tree line (1.5, 2.5 and 3.5 m) under eucalypts based agroforestry as well as control. The collected soil samples were dried at 105°C in an oven for 24 hours. The following formula was used for moisture content (MC) calculation:

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

RESULTS AND DISCUSSION

The results show that the eucalypts tree line affected the moisture content in berseem at varying soil depths and distances. However, the moisture content was higher with increasing soil depth, but it

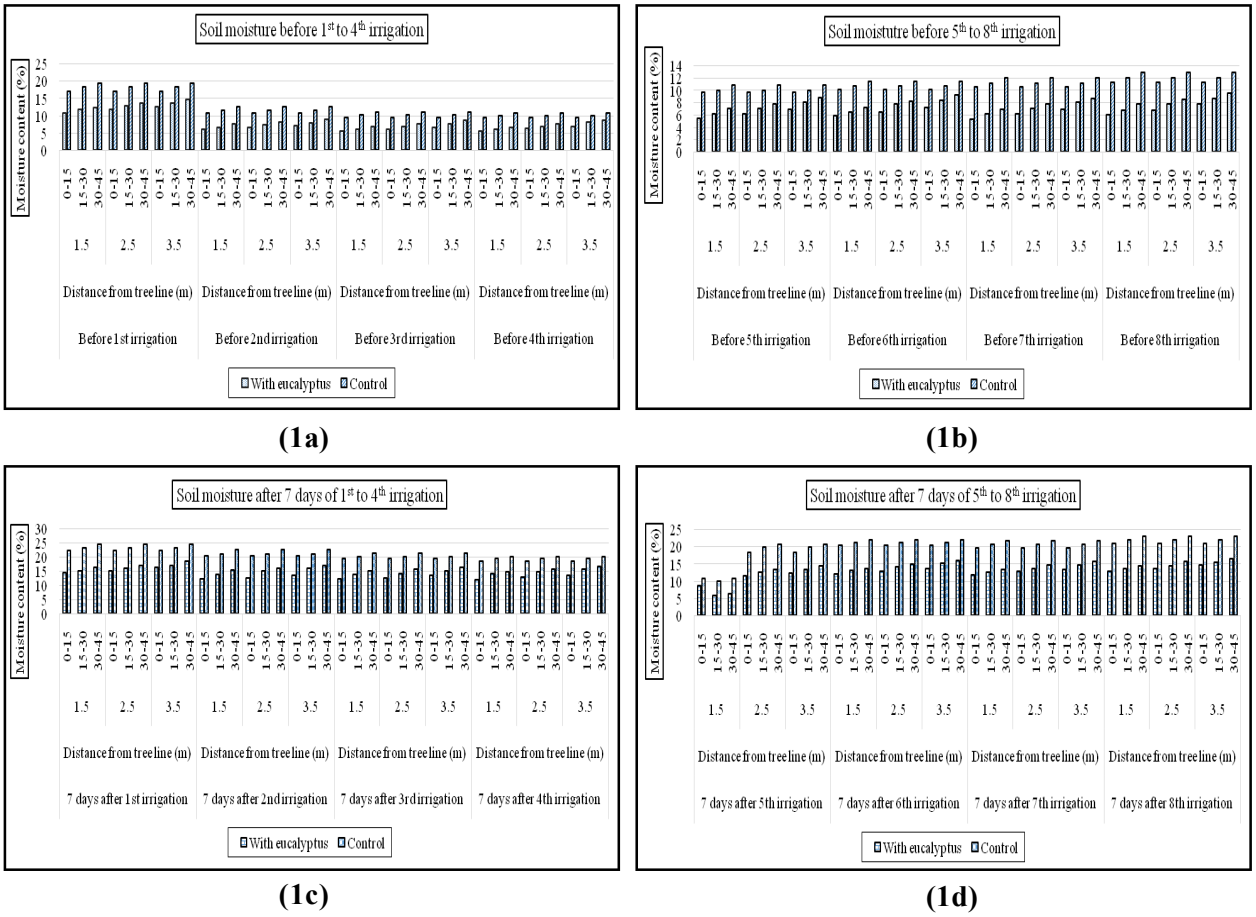
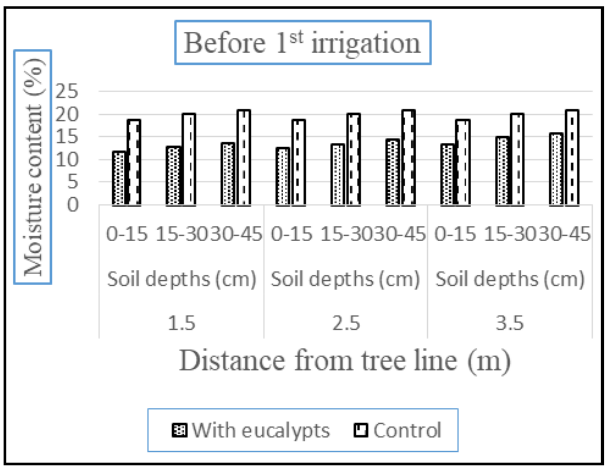
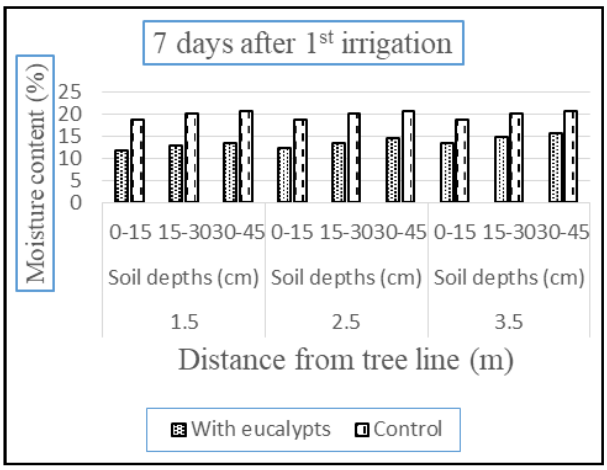


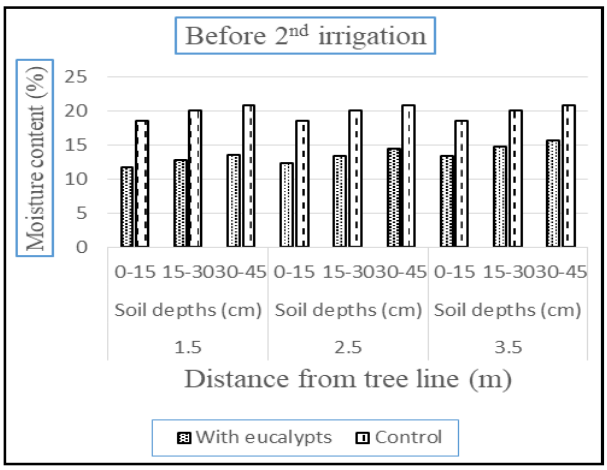
Fig. 1. (1a, 1b, 1c and 1d): Soil moisture status before and after irrigation under eucalypts based agroforestry system and sole berseem at different tree line distances (1.5, 2.5 and 3.5 m) and soil depths (0-15, 15-30 and 30-45 cm).



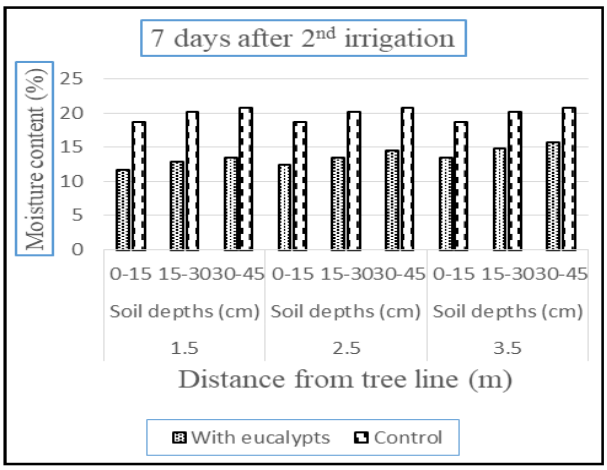
(2a)



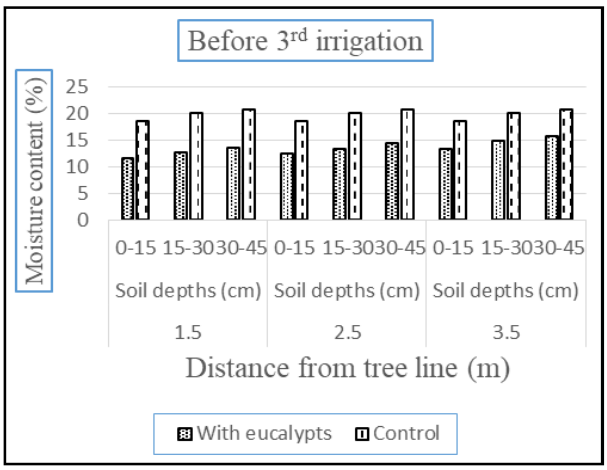
(2b)



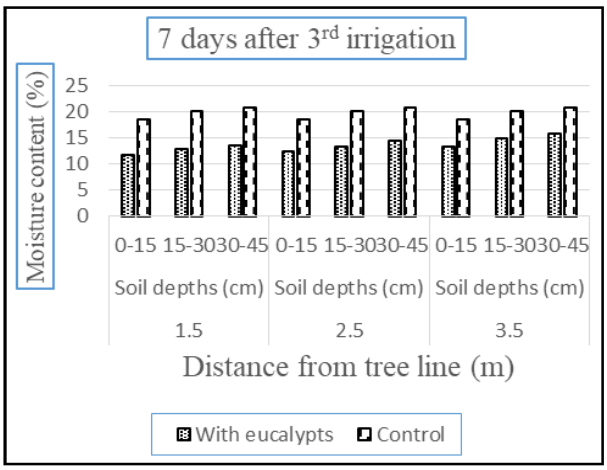
(2c)



(2d)



(2e)



(2f)

Fig. 2. (2a, 2b, 2c, 2d, 2e and 2f): Soil moisture status before and after irrigation under eucalypts based agroforestry system and sole oat at different tree line distances (1.5, 2.5 and 3.5 m) and soil depths (0-15, 15-30 and 30-45 cm)

decreased with the decrease in distance from eucalypts tree line during the period of experimentation. The maximum soil moisture content (24.8% and 26.2%) was found under sole cropping after 7 days of 1st irrigation at 30-45 cm soil depth (Fig. 1c and Fig. 2b); however, minimum soil moisture status (5.4 and 6.5%) was found under berseem and oat-based agroforestry system at 0-15 cm soil depth 1.5 m away from the tree line, respectively before 7th irrigation and before 3rd irrigation (Fig. 1b and Fig. 2e). In berseem based agroforestry, maximum moisture was 14.8 %, 9.2 %, 8.7 %, 8.9 %, 8.9 %, 9.3 %, 8.8 % and 9.6 % before 1st, 2nd,3rd, 4th, 5th, 6th, 7th and 8th irrigation which showed further increment to 18.7 %, 17.2 %, 16.5 %, 16.9 %, 15.7 %, 16.2 %, 15.8 % and 16.7 % after 7 days of 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th irrigation, respectively at 30-45 cm depth (Fig. 1a, 1b, 1c and 1d). However, oat-based agroforestry system exhibited maximum moisture content (13.8 %, 9.6 %, and 10.8 %) before 1st, 2nd, and 3rd irrigation, which was further increased to 19.7 %, 18.2 %, and 17.6 % after 7 days of 1st, 2nd and 3rd irrigation, respectively at 30-45 cm depth (Fig. 2a, 2b, 2c, 2d, 2e and 2f). The minimum moisture (5.4 % and 6.5 %) was recorded before 7th and 3rd irrigation at 0-15 cm soil depth at a distance of 1.5 m away from tree line (Fig. 1b and 2e), however the maximum moisture content (18.7 % and 19.7 %) was observed 7 days after 1st irrigation at 30-45 cm soil depth at 3.5 m distance from tree line in berseem and oat-based intercropping system (Fig. 1c and 2b), respectively. The per cent decrease in moisture content was higher before 7th irrigation (49.1, 43.8 and 42.1%) (Fig. 1b) and before 2nd irrigation (53.8, 53.8, 50.0%) (Fig. 2c) than control which was closely followed by before 8th irrigation (46.0, 43.0, 40.0%) (Fig. 1b) and before 3rd irrigation (46.7%, 46.6%, 45.5%) (Fig. 2e) at 1.5 m distance from eucalypts tree line at 0-15, 15-30 and 30-45 cm soil depth under berseem and oat-based intercropping system, respectively. The maximum loss in moisture content was observed at 1.5 m distance from the tree line. However, minimum per cent reduction in moisture content was found at 3.5 m away from eucalypts tree line than other distances intercropped with berseem and oat. Sole cropping exhibited a lower per cent decrease in moisture content in all the levels of irrigations as compared to berseem and oat intercropped with eucalypts. Moisture content was found lesser under berseem and oat intercropped with eucalypts plantation as compared to control at different soil depths. The lower soil moisture availability near tree line might be due to the more moisture uptake by eucalypts plantation than sole crops (Ceccon, 2007; Kidanu *et al.,* 2005). For a successful agroforestry system, the main challenge is to manage soil moisture content for crop and tree in arid and semi-arid regions (Ong and Kho, 2015). The relation of soil moisture availability and evapotranspiration revealed that it depends on moisture availability and crop behavior (Bosi *et al.,* 2020). Low moisture due to higher water pumping near the trees under agroforestry systems was reported by several researchers for different species, e.g., *Eucalyptus urograndis* (Bosi *et al.,* 2020), *Brachiaria decumbens* (Pezzopane *et al.,* 2015) and in loblolly pine and switch pine intercropping (Tian *et al.,*2017).

CONCLUSION

During this study, the maximum moisture reduction was found near the tree line. However, maximum moisture content was observed in the lowermost depth (30-45 cm) under eucalypts based agroforestry system. The per cent reduction in moisture was higher under oat-based agroforestry than berseem intercropped with eucalypts based agroforestry system. Therefore, the present study concludes that berseem grown with the interspaces of eucalypts may be the potential agroforestry system to conserve the soil moisture status in arid and semi-arid ecosystem.

REFERENCES

Arora, S., 2007 : Response of berseem to different soils of Punjab. *Advances in Plant Sciences*, **20**: 483-86.

Bayala, J. and I. Prieto, 2020 : Water acquisition, sharing and redistribution by roots: applications to agroforestry systems. *Plant and Soil*, **453**(1): 17-28.

Bosi, C., J. R. M. Pezzopane and P. C. Sentelhas, 2020 : Soil water availability in a full sun pasture and in a silvopastoral system with Eucalyptus. *Agroforestry Systems*, **94**(2): 429-440.

Ceccon, E., 2007 : Production of bioenergy on small farms: a two-year agroforestry experiment using *Eucalyptus urophylla* intercropped with rice and beans in Minas Gerais, Brazil. *New Forests*, **35**(3): 285-298.

Das, D. K., Chaturvedi, O. P., Jha, R. K. and Kumar, R. 2011 : Yield, soil health and economics of aonla

(*Emblica officinalis Gaertn.*)-based agri-horticultural systems in eastern India. *Current Science*, 786-790.

Dhillon, R. S., Chavan, S. B., Bangarwa, K. S., Bharadwaj, K., Kumari, S. and Sirohi, C. 2018 : Eucalyptus-based agroforestry system under semi-arid condition in north-western India: An economic Analysis. *Indian Journal of Ecology*, **45**(3): 470-474.

Glatzle, S., Stuerz, S., Giese, M., Pereira, M., de Almeida, R. G., Bungenstab, D. J., Macedo, M.C.M. and Asch, F. 2021 : Seasonal dynamics of soil moisture in an integrated-crop-livestock-forestry system in central-west Brazil. *Agriculture*, **11**(3): 245.

Kidanu, S., Mamo, T. and Stoosnijder, L. 2005 : Biomass production of Eucalyptus boundary and their effect on crop productivity on Ethiopian highland Vertisols. *Agroforestry Systems*, **63**: 281-290.

Kumar, T., K. K. Bhardwaj and P. Kaushik, 2020 : Effect of soil properties and nutrient status on *Eucalyptus tereticornis* based agroforestry system in India. *Agri.Xiv*, **9**(12): 1-5.

Monalisa, P., N. K. Panda, and R. S. P. Mishra, 2020 : Role of agroforestry in biomass production and soil moisture conservation in fruit based agrisilvihorticultural systems with legume intercrops in Odisha. *J. Pharmacognosy and Phytochemistry*, **9**(4): 1307-1310.

Ong, C. K. and R. M. Kho, 2015 : A framework for quantifying the various effects of tree-crop interactions. Tree-Crop Interactions: *Agroforestry in a Changing Climate*, CABI, 1-23.

Özkan, U. and Gökbulak, F. 2017 : Effect of vegetation change from forest to herbaceous vegetation cover on soil moisture and temperature regimes and soil water chemistry. *Catena*, **149**: 158-166.

Pezzopane, J. R. M., C. Bosi, M. L. F. Nicodemo, P. M. Santos, P. G. D. Cruz, and R. S. Parmejiani, 2015 : Microclimate and soil moisture in a silvopastoral system in southeastern Brazil. *Bragantia*, **74**: 110-119.

Prasad, R., Shukla, A., Saroj, N. K., Tripathi, V. D. and Kumar, D. 2019 : Long-term effect of in-situ soil moisture conservation (SMC) measures on soil properties in *Emblica officinalis* based agroforestry system. *J. Soil and Water Conservation*, **18**(3): 246-253.

Sharma, A. and V. K. Sah, 2020 : Comparative growth, yield and yield attributes of wheat under poplar and Eucalyptus based agroforestry system. *Plant archives,* **20**: 47-52.

Singh, G., 2010 : Rainfall dependent competition effected productivity of *V. radiata* in *Hardwickia binata* agroforestry in Indian Desert. *Indian Forester*, **136** : 301-315.

Tian, S., J. F. Cacho, M. A. Youssef, G. M. Chescheir, M. Fischer, J. E. Nettles, and J. S. King, 2017 : Switchgrass growth and pine–switchgrass interactions in established intercropping systems. *GCB Bioenergy*, **9**(5): 845-857.