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**Sonia Devi**
Department of Agricultural physics, I.A.R.I, New Delhi, India

**KK Bhardwaj**
Department of Soil Science, CCS HAU, Hisar, Haryana, India

**Garima Dahiya**
Department of Soil Science, CCS HAU, Hisar, Haryana, India

**Manoj Kumar Sharma**
Department of Soil Science, CCS HAU, Hisar, Haryana, India

**AK Verma**
Department of Soil Science, I.A.R.I, New Delhi, India

**Corresponding Author:**
**Sonia Devi**
Department of Agricultural physics, I.A.R.I, New Delhi, India

# Effect of agri-silvi-horticultural system on soil moisture content at different depths

**Sonia Devi, KK Bhardwaj, Garima Dahiya, Manoj Kumar Sharma and AK Verma**

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**Abstract**
The present study was conducted at Research Farm, Department of Forestry CCS HAU, Hisar to analyze the effect of agri-silvi-horticultural system (Kinnow +Eucalyptus+ Wheat, Kinnow+ Wheat and sole crop on soil moisture content at0-15, 15-30, 30-60 and 60-90 cm soil depths). Total five irrigations at an interval of one month were applied from sowing to harvesting stage. Soil moisture content was measured gravimetrically before each irrigation. Moisture content was increased significantly with increase in soil depth but it decreased under tree integrated system and maximum decrease was observed under Kinnow + Eucalyptus + wheat system. There was slight difference between first and second irrigation which shows more moisture content relative to succeeding 3 irrigations. During first irrigation, mean soil moisture content was significantly higher under control (12.6%) followed by Kinnow+Wheat (11.7%) and it was lowest under Kinnow+Eucalyptus+Wheat system (10.7%). Similarly at second irrigation, mean soil moisture content was significantly higher under control (11.7%) followed by Kinnow+Wheat (10.7%). Significantly lowest was under Kinnow+Eucalyptus+Wheat system (10.0%) as compared to control. In succeeding three irrigations, mean soil moisture content was statistically at par with each other in all the systems. Based on above study, results showed that there was more uptake of moisture under tree based system which is due to deep and proliferated root system of tree component as compared to sole crop.

**Keywords:** Agri-silvi-horticulture, moisture content, depths, eucalyptus, kinnow and wheat

## Introduction
The areas which lie in semi-arid region have less fertile and problematic soils. The State like Haryana is predominantly dependent on agriculture and particularly mono cropping of cereals have deteriorated the fertility of soil. Most of the soil of the southeastern districts of the state like Hisar, Bhiwani, and Rewari etc. are sandy to sandy loam, low in organic carbon and available nutrients and also suffering from increased salinity. On the other hand the ground water in these areas is deep and brackish. Productivity of the arid and semiarid region is about two times less ascompared to humid and sub humid region therefore, enhancing income in the lowrain fall region can be realized by cultivating different crops with fruit plants and forest trees in agri-silvi-horticultural system (Kumar *et al*., 2012) [4].Recent studies by Mugunga (2016) [7] suggest integration of Eucalyptus trees and crops is possible especially in spatially zoned agro forestry systems or as mixtures although the edge effect interactions between trees and crops seemed to affect crop yields.

There is robust evidence that agroforestry systems have the potential for improving water use efficiency by reducing the unproductive components of the water balance. A combination of crops and trees uses the soil water between the hedgerows more efficiently than the sole cropped trees or crops, as water uptake of the trees reached deeper and started earlier after flood irrigation than that of the sole crop, whereas the crop could better utilize top soil water (Lehmann *et al*. 1998) [5]. Significantly higher soil moisture in Gliricidia–Maize was found as compared to sole maize (Makumba *et al.*, 2006) [6]. Moisture content in different agroforestry systems in Northern and Southern region of Garhwal Himalaya, India was significantly higher under agroforestry system as compared to control (Arvind Bijalwan, 2010). Venkatesh *et al.* (2011) [11] revealed that there is no significant difference in the mean soil moisture content between the three land covers in Western Ghats, India.

The study of agri-silvi-horticultural system on soil moisture content particularly in semiarid region of Haryana is very limited. Therefore, the study was conducted to work out soil moisture content under agri-silvi-horticultural system at different depths.

**Methods and material**

The present study was conducted at Research Farm, Department of Forestry CCS HAU, Hisar, which is located at 29º 09' N latitude and 75º 43' E longitudes at an elevation of 215 meters above mean sea level which comes under semi-arid region of North-West India. The average annual rainfall is 350-400 mm and climate is sub-tropical. Soil samples were taken from different depths (0-15, 15-30, 30-60 & 60-90 cm) in moisture boxes and dried, their weight before and after drying was noted down. Weights of empty boxes were also taken. Drying was done at constant weight with the help of hot air oven at $105^0$C for 24 hours. Amount of moisture present in the soil sample was the weight difference between wet and oven dried soil sample. There were five irrigations applied under *i.e.* Kinnow +Eucalyptus +wheat, Kinnow +wheat and control (devoid of trees) during sowing of wheat and then applied at the interval of one month. Design employed for the study was randomized block design. There were 4 replications of each treatment and data was analyzed using SPSS software.

**Results**

Soil moisture percentage was significantly differed when we compare it with system, soil depth and also with their interaction. Analyzed data of soil moisture percentage is depicted in the following tables (tables1-5 and figures 1-5) which clearly showed that there was significant increased soil moisture content with increase in soil depth.

Following order was recorded for mean percent soil moisture with respect to depth: 60-90 cm>30-60 cm>15-30 cm>0-15 cm having soil moisture content of 15% >12.9% >9.7% >9.1% respectively at first irrigation. There was more increase in soil moisture at 60-90 cm soil depth (64.8%) followed by 30-60 cm (41.7%) and 15-30 cm (6.6%) over 0-15 cm depth (Table & Figure 1).Mean soil moisture content was significantly higher under control (12.6%) followed by Kinnow+wheat (11.7%) and it was lowest under Kinnow+Eucalyptus+wheat system (10.7%).

**Table 1:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during first irrigation

| Systems | Moisture content at first irrigation (%) | | | | |
|---|---|---|---|---|---|
| | Depth (cm) | | | | |
| | 0-15 | 15-30 | 30-60 | 60-90 | Mean |
| Control | 9.8 | 10.1 | 14.3 | 16.3 | 12.6 |
| Kinnow +wheat | 9.0 | 9.8 | 12.6 | 15.4 | 11.7 |
| Kinnow +Eucalyptus +wheat | 8.5 | 9.2 | 11.7 | 13.3 | 10.7 |
| Mean | 9.1 | 9.7 | 12.9 | 15.0 | |
| LSD (P=0.05) | System | Depth | System × Depth | | |
| | 0.5 | 0.9 | 1.2 | | |

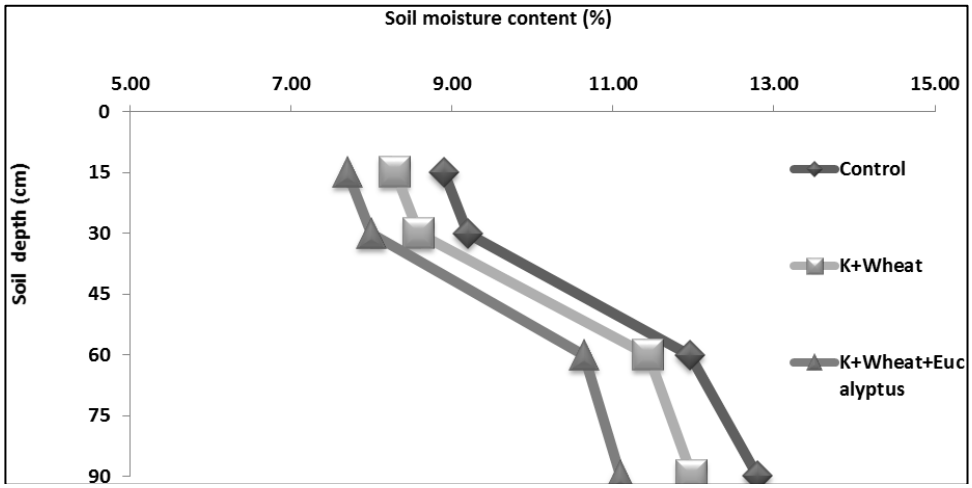


**Fig 1:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during first irrigation

At second irrigation, following order was recorded for soil moisture content with respect to depth: 60-90 cm>30-60 cm>15-30 cm>0-15 cm having soil moisture content of 13.6% >11.8% >9.1% >8.7% respectively. There was more increment in soil moisture content at 60-90 cm soil depth (56.3%) followed by 30-60 cm (35.6%) and 15-30 cm (4.6%) over 0-15cm depth. Mean soil moisture content was significantly higher under control (11.7%) followed by Kinnow +wheat (10.7%). Significantly lowest was under Kinnow +Eucalyptus +wheat system (10.0%) as compared to control. Agri-silvi-horti and agrihorti systems showed statistically at par soil moisture content (Table& Figure 2).

**Table 2:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during second irrigation

| Systems | Moisture content at second irrigation (%) | | | | |
|---|---|---|---|---|---|
| | Depth (cm) | | | | |
| | 0-15 | 15-30 | 30-60 | 60-90 | Mean |
| Control | 9.4 | 9.5 | 13.2 | 14.9 | 11.7 |
| Kinnow +Wheat | 8.7 | 9.1 | 11.5 | 13.4 | 10.7 |
| Kinnow +Eucalyptus +wheat | 8.0 | 8.7 | 10.8 | 12.5 | 10.0 |
| Mean | 8.7 | 9.1 | 11.8 | 13.6 | |
| LSD (P=0.05) | System | Depth | System × Depth | | |
| | 0.9 | 1.2 | 2.2 | | |

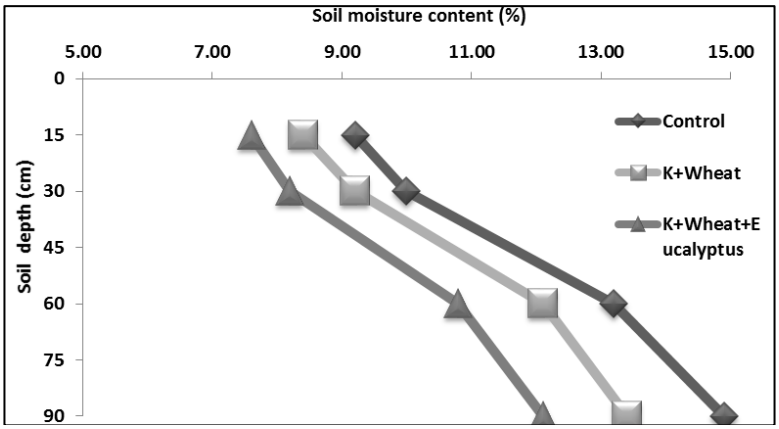


**Fig 2:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during second irrigation

Similarly, at third irrigation following order was recorded for soil moisture content with respect to depth: 60-90 cm>30-60 cm>15-30 cm>0-15 cm having soil moisture percentage of 12.2% >10.5% >7.9% >7.6% respectively. There is more percentage increment in soil moisture percentage at 60-90 cm soil depth (60.5%) followed by 30-60cm (38.1%) and 15-30cm (3.9%) over 0-15 cm depth. Mean soil moisture content was statistically at par with each other in all the systems (Table & Figure 3).

**Table 3:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during third irrigation

| Systems | Moisture content at third irrigation (%) | | | | |
|---|---|---|---|---|---|
| | Depth (cm) | | | | |
| | 0-15 | 15-30 | 30-60 | 60-90 | Mean |
| Control | 7.5 | 7.6 | 10.8 | 12.4 | 9.6 |
| Kinnow +Wheat | 7.7 | 8.0 | 10.3 | 12.2 | 9.6 |
| Kinnow+ Eucalyptus +wheat | 7.6 | 8.0 | 10.4 | 12 | 9.5 |
| Mean | 7.6 | 7.9 | 10.5 | 12.2 | |
| LSD (P=0.05) | System | Depth | System × Depth | | |
| | 1.0 | 1.2 | 2.1 | | |

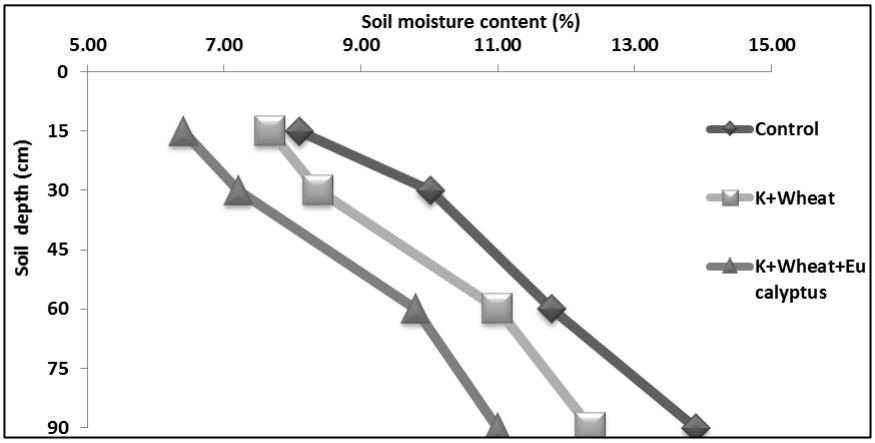


**Fig 3:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during third irrigation

Following order was recorded for soil moisture content with respect to depth: 60-90 cm>30-60 cm>15-30 cm>0-15 cm having soil moisture content of 11.6% >10.2% >7.8% >6.8% respectively at fourth irrigation. The increment in soil moisture content was more at 60-90 cm soil depth (70.5%) followed by 30-60cm (50%) and 15-30 cm (14.7%) over 0-15 cm depth.Mean soil moisture content was statistically at par with each other in all the systems (Table & Figure 4).

**Table 4:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during fourth irrigation

| Systems | Moisture content at fourth irrigation (%) | | | | |
|---|---|---|---|---|---|
| | Depth (cm) | | | | |
| | 0-15 | 15-30 | 30-60 | 60-90 | Mean |
| Control | 6.6 | 7.7 | 10.8 | 12.2 | 9.3 |
| Kinnow +Wheat | 7.0 | 7.8 | 10.1 | 11.9 | 9.2 |
| Kinnow +Eucalyptus +wheat | 6.9 | 7.8 | 9.6 | 10.8 | 8.8 |
| Mean | 6.8 | 7.8 | 10.2 | 11.6 | |
| LSD (P=0.05) | System | Depth | System × Depth | | |
| | 1.0 | 1.2 | 2.1 | | |

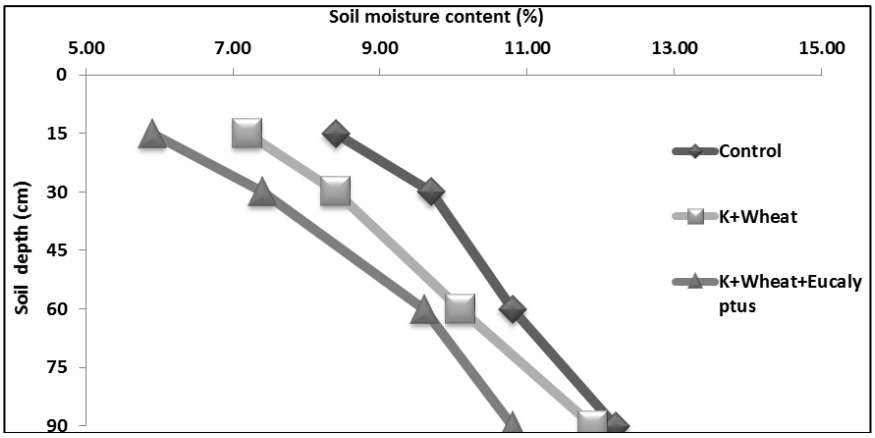


**Fig 4:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during fourth irrigation

Following order was recorded for soil moisture content with respect to depth: 60-90 cm>30-60 cm>15-30 cm>0-15 cm having soil moisture content of 10.2% >9% >6.8% >5.8% respectively at fifth irrigation. There was more content increment in soil moisture content at 60-90 cm soil depth (75.8%) followed by 30-60 cm (55.1%) and 15-30 cm (17.2%) over 0-15 cm depth. Mean soil moisture content was statistically at par with each other in all the systems (Table & Figure 5)

**Table 5:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during fifth irrigation

| Systems | Moisture content at fifth irrigation (%) | | | | |
|---|---|---|---|---|---|
| | Depth (cm) | | | | |
| | 0-15 | 15-30 | 30-60 | 60-90 | Mean |
| Control | 5.4 | 6.0 | 8.7 | 9.7 | 7.5 |
| Kinnow +wheat | 6.1 | 7.2 | 9.3 | 11.0 | 8.4 |
| Kinnow +Eucalyptus +wheat | 6.0 | 7.2 | 9.1 | 10.0 | 8.1 |
| Mean | 5.8 | 6.8 | 9.0 | 10.2 | |
| LSD (P=0.05) | System | Depth | System × Depth | | |
| | 1.0 | 1.2 | 2.1 | | |

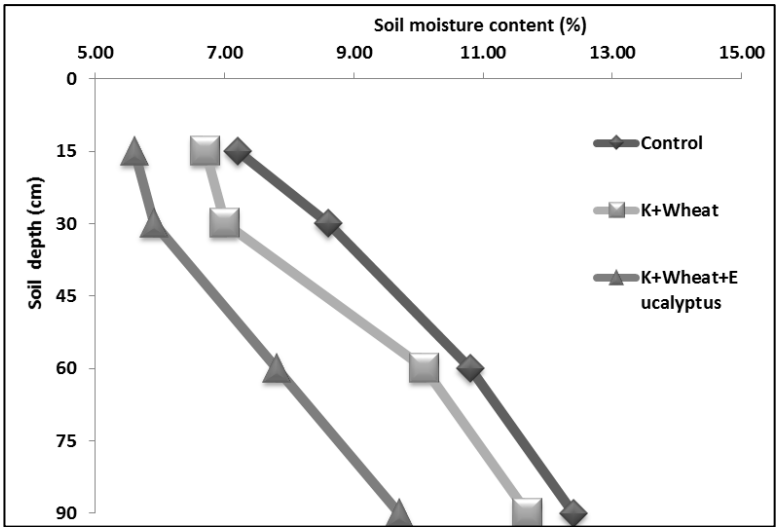


**Fig 5:** Effect of different agri-silvi-horticulture system on soil moisture content (%) at different depth during fifth irrigation

## Discussion

Gravimetric moisture content increased significantly with increase in soil depth and it decreased in tree integrated system. Significantly higher moisture was observed under sole cropping system followed by Kinnow +wheat system and lowest was under Kinnow +Eucalyptus +wheat system. The reason behind the low moisture content under tree based system was due to deep root system of tree species which absorb more water as compared to sole cropping system. Soil moisture at surface was less as compared to deeper layers due to more evaporation rate. There was slight difference between first and second irrigation which shows more moisture content relative to succeeding 3 irrigations. Mean soil moisture percentage with respect to depth followed the order: 60-90>30-60>15-30>0-15 cm and this was significantly higher under control (12.6%) followed by Kinnow +wheat (11.7%) and lowest under Kinnow +Eucalyptus +wheat system (10.7%). These results are in agreement with the findings of Tererai *et al*. (2014) [10] who reported that invaded sites of Eucalyptus showed significantly reduced soil moisture levels than their counterpart of un-invaded sites in winter and spring seasons of riparian soils of South Africa. Similarly, Alemie (2009) [1] also reported soil moisture reduction under Eucalyptus plantations with the reductions being highest at distances nearer to the tree.

## Conclusion

Gravimetric moisture content increased significantly with increase in soil depth and it decreased in tree integrated system. Significantly higher moisture was observed under sole cropping system followed by Kinnow +wheat system and lowest was under Kinnow +Eucalyptus +wheat system.

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