Indian Journal of Plant and Soil
Volume 4 Number 1, January - June 2017
DOI: http://dx.doi.org/10.21088/ijps.2348.9677.4117.4

Review Article

Soil Microenvironment and its Impact on Wheat (*Triticum Aetivum* L.) in Agroforestry Systems

Ravi Kiran

Author's Affiliation: Assistant Professor (Agrometeorology), Department of Agrometeorology, College of Agriculture, GBPUA & T, Pant Nagar, Distt- U.S. Nagar, Uttarakhand 263145, India.

Abstract

The understory crop in an agroforestry system is exposed to varied above and below ground environment subjected to different trees and crops interactions thereby varied response on each component. Under changing climatic scenarios and scarce natural resources agroforestry is proved to be a boon for forthcoming agricultural scenario. There is both positive and negative interactions at the tree-crop interface for below ground environment. This paper discusses the Modification of soil microenvironment in an agroforestry systems.

Keywords

Wheat (*Triticum Aetivum* L.); Crop Growth; Modified Soil Ground Environment; Agroforestry.

Introduction

The advantages of agroforestry systems are numerous under changing climatic conditions. Below-ground interactions are the most important aspects for optimizing yield for water as the availability of same is decreasing day by day. For this porpose the tree should have deep roots and the crop, shallow roots along with healthy interactions of the root systems of both components, however , not studied very deeply. The crop grown below trees gets modified microclimatic conditions, which effect the growth and yield of crop in many ways. The effect on wheat crop of trees have been evaluated by various workers as followed :

Effect of Water Table Depth

Powell (1980) showed that in 0.55 and 1.0 m water table depth wheat grew better with water table depth of 1.0 m but plant water potential differed little between treatments.

Nicastro (1981) reported that in controlled environment trials, dry matter yield of durum wheat cv. Creso increased with increase in temperature and soil moisture content.

Alvino et al. (1984) reported that ear formation was delayed by 5 days when water table was just below the surface but this difference disappeared by harvest. Lowest yield for each cv. were nearly always for those areas where the water table was nearest the surface but the optimum level for highest yields was more variable and was on average, 90 cm below the soil surface. The height of water table also affected plant density, 1000 grain weight, logging and grain protein content.

Cavazza and Pisa (1988) reported maximum yield of wheat at 125 cm average water table depth but, declined slightly at deeper level because of shortage of water. The yield was only 25 per cent of maximum, when the average water table depth throughout the growing season was 12 cm. It reached 82 per cent at an average depth of 25 cm.

Khera et al. (1989) showed that at soil moisture content 24 per cent (7-11 Dec.) and 22 per cent (25-30 Dec.), the grain yield of wheat was 1.49 and 1.00 t / ha, respectively. The higher moisture content increased spike length, number of grains / spike and 1000 grain weight.

Bac and Zyromski (1990) found that evapotranspiration was significantly positively correlated with soil water content in the 1st and 3rd 10 d of May the middle 10 d of June and last 20 d of

Corresponding Author: Ravi Kiran,
Assistant Professor (Agrometeorology), Department of Agrometeorology, College of Agriculture, GBPUA&T, Pant Nagar, Distt- U.S. Nagar, Uttarakhand 263145, India.
E-mail: ravikiransaxena@rediffmail.com
Received on 01.03.2017, **Accepted on** 17.03.2017

July. Field water consumption was positively correlated with soil water content for the first 20 d of May and was negatively correlated with significant correlation in late May and mid July.

Pinter et al. (1990) reported similar grain yield of six wheat cultivars under well watered conditions but varied considerably under water stress. Cultivars that were warmest when well watered, maintained the highest relative yields when exposed to deficit irrigation regimes.

Vielmeyer and Weissert (1990) reported in wheat, grown in pots, reduction of soil moisture from 60 -20 per cent of maximum saturation decreased the number of shoot / plant from 5.2 - 6.8 to 2.0 - 3.4. Reduction due to water stress were greater at high (0.5 g / pot) than at low (0.1 g / pot) N.

Singh et al. (1991) investigated the effect of number of post sowing irrigation on yield of wheat under shallow (loam) and deep water table (sandy loam) conditions and highest yield (4.14 and 3.83 t / ha on shallow and deep water table) were observed from 4 irrigation.

Varga - Huszonits (1992) reported that effect of photo period during ear formation to ripening was not considered important whereas soil water was increasingly important at this stage.

Modification of Soil Environment

Pathak et al. (1962) reported that porosity, water holding capacity and permeability of soil under forest cover was greatly improved as compared to soil under open cultivation. There was more infiltration, more soil aggregation and bigger aggregates under forest.

Dabral et al. (1965) studied the soil moisture distribution patterns under sal, teak and chirpine plantations and reported significantly lower depletion of soil moisture under teak as compared to sal species. The moisture depletion rates varied with the depth of soil differences in species, mechanical composition of soil, water holding capacity and organic matter content of soil.

Gupta et al. (1975) studied soil moisture distribution under some permanent vegetative covers and found that the moisture depletion rate was maximum for eucalyptus forest (0.14 cm/day) while the minimum depletion rate was in grass land (0.05 cm/day).

Jha and Rathor (1981) studied soil moisture distribution pattern under eucalyptus and pine stands and found that stand retained a higher amount of soil moisture in their middle layers as compared to upper and lower layer of the 1.8 m soil profile.

Lyles et al. (1984) determined wheat yield in an agroforestry system and measured soil water status adjacent to different tree species of single row wind breaks. Wheat yield was reduced due to root competition for soil water and the process of root pruning was helpful in reducing these adverse effects of wind breaks.

Sugiyama (1984) reported poor yield of wheat and rice grown in the valleys along rivers or wadis in 1963. In 1973 after establishment of eucalyptus trees plantation there, landsat monitoring showed that the plantation had changed the surface water level which in turn had converted the arid area into arable land. It was suggested that plantations can be a counter measure against desertification.

Huang (1985) found that interplanting with *Paulowonia* had no significant influence on seasonal variations in soil moisture and nutrients. However, spatial variations were present within 2-10 m bands from the trees and within the 80-140 cm. depth owing to litter and root system effect.

A field investigation was carried out at the Horticultural Research Center, Patharchatta, located in the campus of GB Pant University of Agriculture and Technology, Pantnagar, India (29° N, 79° 30 E, 243.83 m above mean sea level). *Eucalyptus tereticonis* was planted in a Nelder wheel design in March 1989 (Nelder, J.A. 1962). It consisted of fifteen tree rows each oriented at an angle of 24° from the adjacent tree row, having ten trees in each row at a distance of 2.0, 5.4, 13.5, 17.8, 21.5, 24.6, 27.4, 29.9, 32.2 and 34.4 m respectively, enclosing a total number of 15 plots between the tree rows. The plots were serially numbered from 1 to 15 anticlockwise starting from a tree row oriented to 0° in north direction and divided into three sub plots of area 26.62 m^2 each for the propose of the investigation . The first, second and the tenth trees were considered as buffer trees to avoid border effect. Therefore, a constant tree stand of 333 trees per hectare was provided in the area between the third and the ninth trees of each row resulted each tree in the experimental area occupying an average area of 30 m^2. Tree rows were given the treatment of pruning of 33% of tree height for proper radiation penetration below tree canopies. Diurnal changes in Net radiation (Rn) over wheat crop in the treatment 1, 6 and 11 and in control was recorded from 0730 to 1700 h. At tillering stage the total soil heat flux(s) in treatment 1, 6, and 11 were 42, 99 and 94% of the control, respectively. The values of s were 6, 9, 10 and 6% of the corresponding values of rn in treatment 1, 6, 11 and control, respectively. At flag leaf emergence stage the total soil heat flux(s) beneath the treatment 1, 6 and 11 was 42, 45 and 58% of control, respectively. The values of s were 5, 4, 6 and 4% of the corresponding rn in treatment 1, 6, 11 and control, respectively. At flowering stage the total soil heat flux(s) beneath the treatment 1, 6 and 11 was 144, 96 and 145% of the control, respectively. The values of s were7, 5, 5 and 3% of corresponding values of rn in treatment 1, 6, 11 and control, respectively. At maturing stage the total soil heat flux (s) beneath the treatment 1, 6 and 11 was 41, 76 and 59% of control, respectively. The values of s beneath the canopy was 2, 3, 2 and 2% of corresponding values of rn in treatment 1, 6, 11, and control, respectively (Ravi Kiran, 1997) (Figure 1).

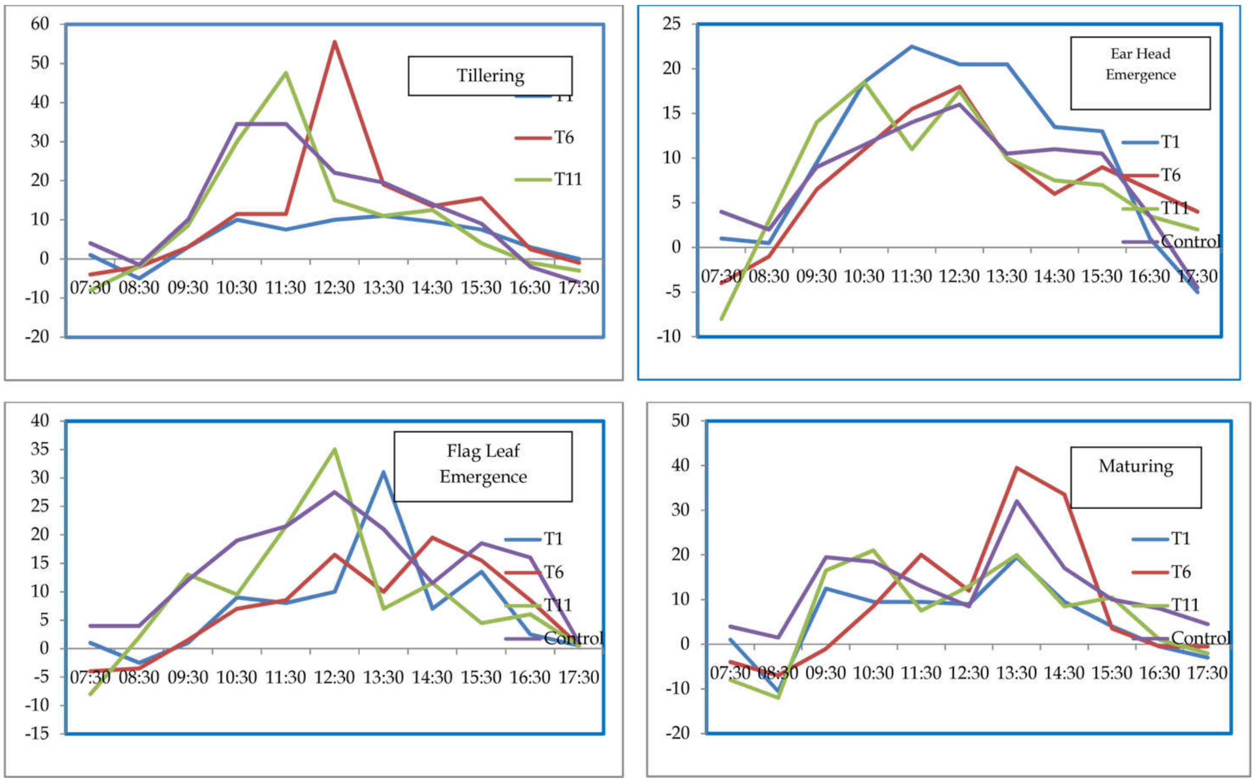

Fig. 1: Diurnal variation in soil heat flux (W/m^2) at different stages of wheat intercropped with Eucalyptus in a Nelder Wheel Design from 07:30 to 17:30 Hrs. Source : Ravi Kiran, 1997

Shrivastava and Mishra (1987) reported a selective behaviour of different tree species towards water uptake. The fast growing species like *Eucalyptus* 'hybird' consumed maximum amount of water where as *Pongamia pinnata* consumed the least.

Chakraborty and Chakraborty (1989) studied about the change in soil properties under *Acacia auriculiformis* plantation in Tripura and reported progressive increase with age of plantation in soil pH, E.C., water holding capacity, organic carbon, nitrogen and potassium in soil.

Malik and Sharma (1990) studied the effect of a single East - West tree line of 3.5 year old *Eucalyptus tereticornis* on the yield of adjacent mustard and wheat crops. It was found that eucalyptus absorbed 5 times more water than mustard from 0-150 cm. soil profile resulting in 47 per cent and 34 per cent reduction in mustared and wheat yields, respectively. *Eucalyptus tereticornis* was not found suitable for deep water table conditions.

Tomar et al. (1992) studied about the effect of perennial mulches on moisture conservation in an agroforestry condition. The distribution of soil profile did not differ at the time of sowing of wheat with depth (0-90 cm). Overtime the magnitude of moisture distribution changed and greatest amount was found in plots mulched by *Shorea robusta* followed by *Eucalyptus tereticornis.*

Pant (1993) studied soil moisture distribution in soil at 0-20, 20-40 and 40-60 cm soil depth. Under agrosilvicultural system composed of wheat intercropping with four tree species namely *Populus deltoides, Eucalyptus 'hybird', Trewia nudiflora, Syzygium cumini* and sole crop. The experimental field had a shallow water table ranging between 98 to 123 cm and variations in soil moisture distribution under different tree species was largely due to shallow watertable. Soil moisture showed an increasing trend with soil depths and a decreasing trend with season. Slightly higher moisture recorded under trees as compared to the sole crop (without trees) plot.

Kundu (1994) in an experiment on intercropping of wheat with five tree species *Dalbergia sissoo, Bombax ceiba, Tectona grandis, Albizia lebbeck* and *Trewia nudiflora* found that soil moisture content was highest in the month of February followed by March, December and April. Soil moisture content increased gradually with increasing depths and its range was about 20-30 percent. The trees helped in conserving soil moisture evapotranspiration losses due to shading effects.

Sahu (1995) reported that in agroforestry conditions in *tarai* conditions of U.P., the different tree species did not show any significant effect on water table as well as moisture distribution in the soil profile.

Acknowledgements

Knowledge is scarce about belowground interactions in agroforestry systems based on tree crops. Each system has its own interaction amd implications on the understory crop. A whole new set of concepts is necessary for a deeper analysis of belowground processes of agroforestry systems involving tree crops. Most of the times,crops are purposely grown under tree canopies to reduce heat load. Just because plants are grown under shade does not necessarily result into reduced yields than optimum, as efficiency of photosynthesis drops off with high light intensity but the rate of photosynthesis hardly increases once the light intensity is over threshold value, so the net photosynthesis is hardly get affected. This means that plants under trees can still grow optimally. However further research focussing changing climatic conditions is needed in future.

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