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Modification of Aerial Microenvironment and Its Impact on Wheat (*Triticum Aetivum* L.) in Agroforestry Systems

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Abstract

The understory crop in an agroforestry system exoerience varied effect of trees besides the modified microenvironment. Under changing climatic scenarios and crunch of narural resources agroforestry is proved boon. The positive interactions at the tree-crop interface are reduction of heat load and proper nutrient balance. For wheat, ingeneral shading caused decrease in yield and yield components due to low photosynthetic leaf area. This paper discusses the Modification of aerial microenvironment in an agroforestry systems.

Keyworde: Wheat (*Triticum Aetivum* L.) ; Crop Growth; Modified Aerial Microenvironment; Agroforestry.

Introduction

Emission of greenhouse gases has now a days become a matter of great concern over the globe. The reduction in concentration of CO_2 in the atmosphere can be achieved by removal of the atmospheric CO_2 through carbon sequestration. agroforestry can increase the amount of carbon stored in lands for agriculture, while still allowing for growing of food crops .

Global circulation climate models predict an increase in mean ambient temperatures between 1.8 and 5.8^{0}C by the end of this century (IPCC, 2007).

Exposure to excessive temperatures during development reduces the yield of wheat. High global temperatures and frequent heat waves are likely to have similarly negative effects on natural systems. (yadav, 2010) Tree canopies can provide suitable microclimatic conditions for growth and development of wheat. Hot weather with dry wind is injurious to wheat plant at grain filling.

These decrease in photosynthetic rate and chlorophyll content in wheat plant. Grain filling is not greatly affected by short shading period but increasing the length of period of shading brought about an accelerating yield reduction.

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Wheat Performance under Modified Aerial Microenvironment

In poplar-wheat agroforestry system, growing condition of wheat are modified due to presence of tree and, thus, response of wheat differs than that of tree-less agricultural system. Age of poplar trees is recorded as most important factor influencing wheat grain (var. PBW 343) yield. On an average, reduction in grain yield was 20.10% under 1-year-old poplar plantation, which increased to 54% under 4-year-old plantation. Under irrigated poplar-based agro-ecosystem, light is the major limiting factor for reduction in grain yield (Chauhan *et. al*, 2009).

Denmead (1969) studied about comparative micrometeorology of a field of wheat and a forest of *Pinus radiata*. For a given short wave radiation intensity, quite large differences existed between communities in net radiation, evaporation, photosynthesis and soil heat flux. The first three were greater for forest and last was smaller. Wheat had higher foliage temperature than air but opposite for forest.

Dhillon *et al.* (1979) grew eucalyptus trees in N - S and E - W direction to study the effect of trees on adjoining crops. Reduction in grain / paddy yields of wheat and rice grown on the S aspect of E - W line of trees was greater than when grown on the N aspect. In general, reduction in yields of crops grown along the E - W tree line was relatively less than when they were grown along N - S line.

Sheikh and Haq (1978) showed yield reduction in wheat in quadrats at distances of 2 - 9 in 8 directions from 5 trees of *Acacia arabica* and 5 of *Dalbergia sissoo*. The yield was significantly reduced by shading. The effect was found decreased with distance from the tree. Yield was lowest in the sample taken from the north side of trees.

Dhillon *et al.* (1982) showed that the yield of wheat planted with eucalyptus trees was less reduced in N - S direction plantation than E - W direction plantation of trees. Intercropped potato showed more tolerance to shading effects as compared to paddy and wheat crops.

Sheikh *et al.* (1983) reported no significant difference in any measurement of wheat intercropped with 4 year old hybrid poplars . The total grain yield was also not effect significantly below trees.

Makasharipova *et al.* (1985) studied the effect of shading either through increased stand density or by using screens on wheat and found that ingeneral shading caused decrease in yield and yield components due to low photosynthetic leaf area.

Cole and Newton (1986) studied about folair and soil nutrient, canopy light penetration and predawn moisture stress in Douglasfir on Nelder plots. Canopy light penetration varied with competitor, density and height, above ground, the lowest value occuring under red alder canopy. It was concluded that grass competed primarily for moisture and that red alder reduced available light and moisture.

Hazra and Patil (1986) found that the infiltrated light below *Albizia lebbeck, Acacia procera, Lucaena leucocephala* and *Acacia tortilis* varied from 74-93 per cent of PAR than that of open sites. High R.H. below tree canopies (62-70 per cent) was another feature than open field (56 per cent).

Basu *et al.* (1987) studied the allelopathic effect of *Eucalyptus terelicornis* on the potato and wheat. Potato yield was greatly reduced in the plots near the eucalyptus. Field observation of wheat growth indicated marked reduction in plots near the eucalyptus.

Green (1987) reported that in wheat, fertilizer nitrogen accelerated the rate of canopy expansion giving greater canopy size and improving fraction and quantity of radiation absorbed by the foliage. The rate of crop growth from stem elongation to near maturity was constant while the quantity of irrigation increased.

Balsky *et al.* (1989) reported the reduction of 45-65 per cent in solar radiation, in soil temperature 5-11^{o}C and in rain fall by 50 per cent under the tree conopies of *Acacia tortilis* and *Adansonia digitata.*

Cameron *et al.* (1989) conducted an experiment in which *Eucalyptus grandis* was planted in a Nelder fan design into a setaria dominated pasture and reported that pasture growth was little affected by trees at the tree age of 0.5 years, but substantially reduced after 1.5 years under more than 1000 stems per hectare. By age 3.5 years, pasture production were reduced significantly under the tree canopies.

Ong *et al.* (1991) investigated about the above and below ground interaction such as change in light, temperature, humidity and soil moisture and found the effect of these on understorey crops. Atmospheric interaction was found positive in alley cropping in semi-arid tropics but a minor importance compared with the below ground interactions. The competition for soil moisture between two components was reponsible for negative interactions in semi-arid tropics.

Messing and Noureddine (1991) studied the effect of wind break on wind velocity, potential evapotranspiration, temperature, crop growth and water use efficiency on wheat. Both artificial and biological wind breaks were used. Wind velocity behind the artificial wind breaks varied between 30 to 60 per cent depending on the distance from wind break. A 60 per cent reduction in wind velocity was found at 4H (H was the height of wind break) with Acacia and Casuarina. The presence of wind breaks also decreased potential evapotranspiration, increased wheat growth and increased water use efficiency.

Corlette *et al.* (1992) reported that alley cropping of millet and *Leucaena leucocephala* changed the microclimatic conditions. *L. leucocephala* reduced the wind speed and incident light substantially. Leaf and soil temperatures within the alleys found warmer during night and cooler during the day than pure millet.

Wang and Shogren (1992) showed that paulownia intercropping with winter wheat, resulted in more efficient use of water and other limited resources and paulownia trees on crop land enhanced the microclimate and, therefore, increased the wheat yield and quality.

Pant (1993) measured the light available under tree canopy of different tree species and sole crop using a protable lux meter during morning (8.30-10.30), noon (11.30-1.30) and evening (3.00-4.30) hrs. at fifteen days intervals, right from July 1989 to June 1990. The reduction in average light availability, both under poplar and guthel during winters was only about 31 percent while during summer and rainy season it was as high as 56 percent. Light reduction was more pronounced during morning and evening hours as compared to noon hours under all the tree species.

Nazir *et al.* (1993) studied the effect on crop of wheat under *Dalbergia sissoo* and found that increasing duration of shading decreased plant height, number of fertile tillers/unit area, number of grains/spike, 1000-grain weight, grain protein concentration, percentage DM and grain yield.

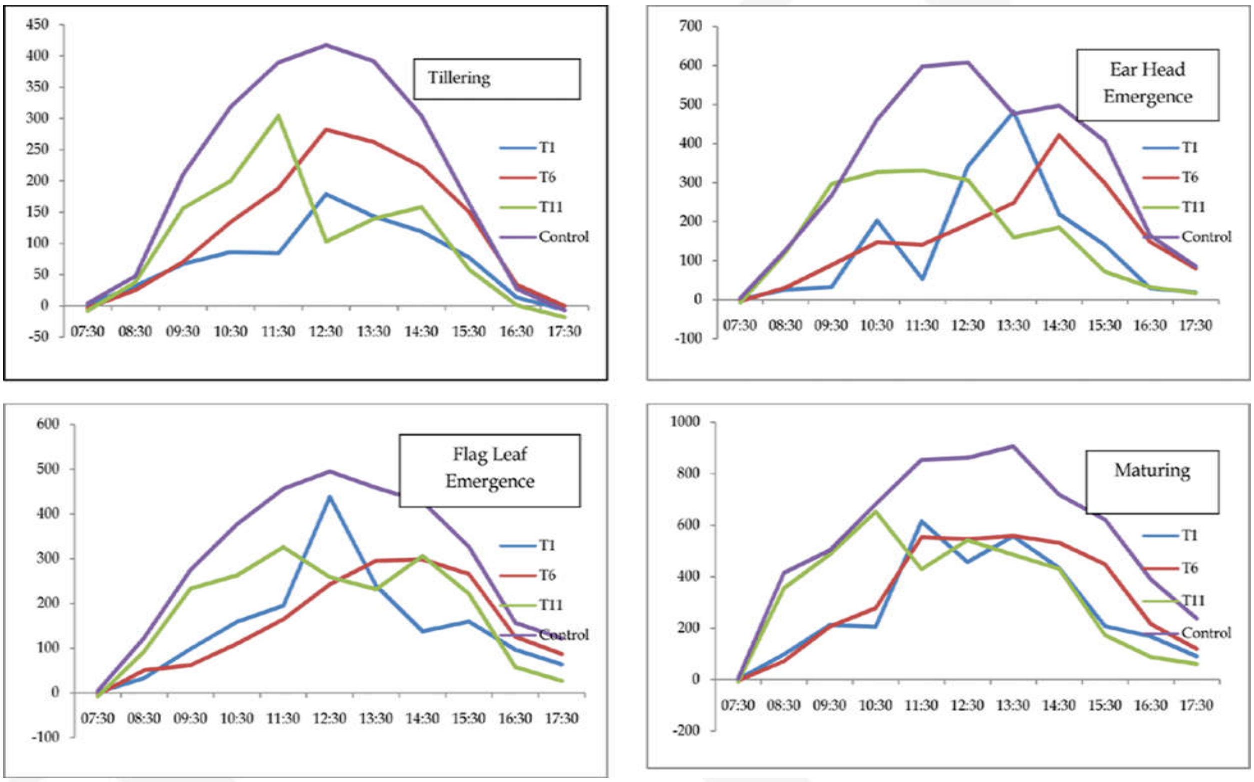

Fig. 1: Diurnal variation in net radiation (W/m^2) at different stages of wheat intercropped with Eucalyptus in a Nelder Wheel Design from 07:30 to 17:30 Hrs
Source: Ravi Kiran, 1997

Jiang *et al.* (1994) analysed the paulownia intercropping types and their benefits and found that paulownia trees could improve the micorclimate by reducing wind speed (21-50 per cent) in May and by increasing relative humidity in summer which favoured the wheat yield.

The present 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 resulting 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. The data show that wheat crop received 37, 60 and 50% Rn of the control in treatment 1, 6 and 11, respectively and the maximum values of Rn were 234, 341, 314 and 426 W/m^2 in treatment 1, 6, 11 and control, respectively at tillering stage. Diurnal changes in Rn over the wheat crop in treatment 1, 6, 11 and in control show that wheat crop received 43, 49 and 50% Rn of the control, respectively and the maximum values of Rn were 546, 436, 475 and 663 W/m^2 in treatment 1, 6, 11 and control, respectively at Flag leaf emergence stage. Diurnal changes in Rn over wheat in treatment 1, 6 and 11 show that wheat crop received 50, 52 and 64% Rn of control during flowering stage of wheat crop and the maximum values of Rn were 509, 350, 380 and 504 W/m^2 in treatment 1, 6, 11 and control, respectively at Flowering stage. Diurnal changes in Rn over wheat in treatment 1, 6 and 11 show that crop received 48, 58 and 62% Rn of the control and the maximum values of Rn were 573, 622, 735 and 923 W/m^2 in treatment 1, 6, 11 and control, respectively at Maturing stage (Ravi Kiran, 1997) (Figure 1).

Jiang *et al.* (1994) showed that the effect of crown shading on photosynthetically active radiation (PAR) was not significant on the number of effective spikes and grain of wheat, but it affected total grain yield and 1000 grain weight, with size of the effect depending on the distances from the trees.

A study was conducted to explore the carbon sequestration potential of agroforestry systems specifically poplar-wheat-based system. Total CO2 assimilation by the biomass in the poplar-wheat-based agroforestry system and monocropping of poplar and wheat was estimated at 28.6, 17.2 and 17.8 t/ha/year, respectively. It is established that agroforestry in irrigated agroecosystems, such as the poplar-wheat integrated cropping system, store more carbon in above- and below-ground biomass than sole crop cultivation. (Chauhan and Chauhan, 2009)

Conclusion

In agroforestry excess shade may reduce the wheat yield mostly ; however, flactuating light may be beneficial for crop. In this way, agroforestry system can be used for changing the microclimatic conditions for the intercrops for beneficial purpose.

There is a decreased potential evapo-transpiration, increased wheat growth and increased water use efficiency in agroforestry. Trees intercropping with winter wheat, resulted in more efficient use of water and other limited resources and paulownia trees on crop land enhanced the microclimate and, therefore, increased the wheat yield and quality. Further research is needed on the exploitation of this aspect.

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