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Original Article

Variation in Soil Heat Flux in Different Stages of Wheat (*Triticum Aestivum* L.) below *Eucalyptus Tereticonis* Planted in Nelder Fan Design under Shallow Water Table Conditions

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Abstract

An experiment was conducted to study the effect of modified radiation climatic conditions on soil heat flux in wheat cv PBW-226sown on 21st November 1996 below 8 years old *Eucalyptus tereticonis* planted in a Nelder wheel design for providing different microclimatic conditions to the intercropped wheat. The angle between the two adjacent rows was 24^0. The area per tree was $30m^2$. Total number of trees was 105. Net plot size of one treatment was $248m^2$. Diurnal soil heat was measured in T_1 (0^0-24^0), T_2 (120^0-144^0), T_3 (240^0-264^0) and control plot simultaneously at tillering, flag leaf emergence, ear head emergence and maturity. Soil heat flux varied diurnally and was highest in control at all stages of crop except noon in some cases. Fluctuating soil heat flux was observed below trees.

Keywords

Soil Heat Flux; *Eucalyptus Tereticonis*; Wheat; Shallow Water Table.

Introduction

Tree canopies can provide suitable microclimatic conditions for growth and development of wheat. Wheat is most sensitive to shading at the time of rapid ear growth (Fischer, 1975). High temperature during post-anthesis period decrease grain number per spike and 1000 grain weight (Mehra *et al.*, 1991). High yield is also correlated with low soil temperature, from the beginning of shoot elongation to the beginning of heading (Tichy *et al.*, 1987). The increased carbon dioxide concentration is helpful in simulating the developement of tillerbuds (Nicolas *et al.,* 1993). Carbon dioxide enriched wheat produced about twice the dry matter of control plants. Tillers and earhead numbers increase by carbon dioxide enrichment irrespective of N supply (Hocking and Meyer, 1991).

Growing wheat under tree canopies, heat load, can be changed during the different stages of crop for beneficial purpose. Carbon dioxide concentration is also increased in the agro-forestry conditions and results into the early and better growth of wheat plants. Excess shade may reduce the wheat yield; however, fluctuating light may be beneficial for crop. In this way, agro-forestry system can be used for changing the microclimatic conditions for the intercrops for beneficial purpose. Very few researches have been conducted on agro-forestry using Nelder wheel.

The present investigation attempts to study the effect of modified soil thermal environment of wheat as an understory crop below *Eucalyptus tereticonis* planted in a Nelder wheel design.

Materials and Methods

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). The climate of the region is humid subtropical, characterized by dry hot summers and cold winters having dry season from early October to mid June and a wet season from mid June to early October. Average annual total rainfall is 1434.4 mm (90% in mid June to end of September). The diunet radiational

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maximum air temperatures are highest in May–June and the diunet radiational minimum air temperatures are lowest in January (range 41.0- 3.0 °C) while relative humidity is highest in July–August and lowest in December–January; (range 80-35%) in April–May.

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.

Field was harrowed four times with disc harrow, properly levelled for better germination and growth, before the sowing of experimental crop. Nitrogen, phosphorus and potassium were applied at the rate of 120kg, 80kg, and 60kg per hectare. Half of nitorgen and full doses of phosphorus and potassium were broadcasted during land preparation and mixed thoroughly by cross harrowing. The remaining half dose of nitrogen was top dressed at 25 DAS i.e. just after first irrigation.

The wheat variety PBW-226 was sown below the tree canopies with the help of seed drill on 21st. November, 1996. The rate of seed was 100 kg / ha. The seed was sown in rows 23cm apart and at the depth of 5cm. The area not covered by seed drill was sown manually by hand hoe. Two hand weeding were given at 45 and 80 days after sowing. Only one irrigation was given at 20-25 days after sowing at crown root initiation (C.R.I.) stage.

Soil heat flux (S) were measured with the help of Soil heat flux plate (Middleton Instruments) respectively in T_1 (0^0-24^0), T_2 (120^0-144^0), T_3 (240^0-264^0) and control at three points plot simultaneously at tillering, flag leaf emergence, ear head stage and maturing stage at half hour interval starting from monet radiationing to evening. Soil heat flux was recorded at the midpoint of one metre marked row. Observations from all these instruments were measured with portable battery operated digital micro-voltmeters (Century Instruments, Chandigarh, India).

Results

The state of weather parameters is depicted in Fig 1.

Tillering Stage

The total soil heat flux (S) in treatment 1, 2, and 3 were 42, 99 and 94% of the control, respectively (Fig 2). The values of S were 6, 9, 10 and 6% of the corresponding values of Net radiation in treatment 1, 2, 3 and control, respectively.

Flag Leaf Emergence Stage

The total soil heat flux (S) beneath the treatment 1, 2 and 3 was 42, 45 and 58% of control, respectively (Fig 3). The values of S were 5, 4, 6 and 4% of the corresponding Net radiation in treatment 1, 2, 3 and control, respectively.

Earhead Emergence Stage

The total soil heat flux(S) beneath the treatment 1, 2 and 3 was 144, 96 and 145% of the control, respectively (Fig 4). The values of S were 7, 5, 5 and 3% of corresponding values of Net radiation in treatment 1, 2, 3 and control, respectively.

Maturing Stage

The total soil heat flux (S) beneath the treatment 1, 2 and 3 was 41, 76 and 59% of control, respectively (Fig 5). The values of S beneath the canopy was 2, 3, 2 and 2% of corresponding values of Net radiation in treatment 1, 2, 3 and control, respectively.

The value of Soil heat flux varies with surface cover, soil moisture content, and solar irradiance. The amount of thermal energy that moves through an area of soil in a unit of time is the soil heat flux or heat flux density and varies during a day or between seasons. Kundu (1994) also found similar results under agro-forestry conditions. The daily average values of soil heat flux (S) the values were highest in control except at ear head emergence stage in T_1. This may be due to poor growth in T_1 of wheat due to poor solar radiation penetration and more soil moisture in north side of the Nelder Wheel (Fig 6). It may be concluded that soil heat flux was highly varied on diurnal basis in wheat intercropped with *Eucalyptus tereticonis* in nelder wheel due to varied microclimatic conditions created by plantation of trees. Further research is needed on the microclimatic aspects for wheat sown with *Eucalyptus tereticonis* planted in a Nelder wheel providing different microclimatic conditions to the intercropped wheat.

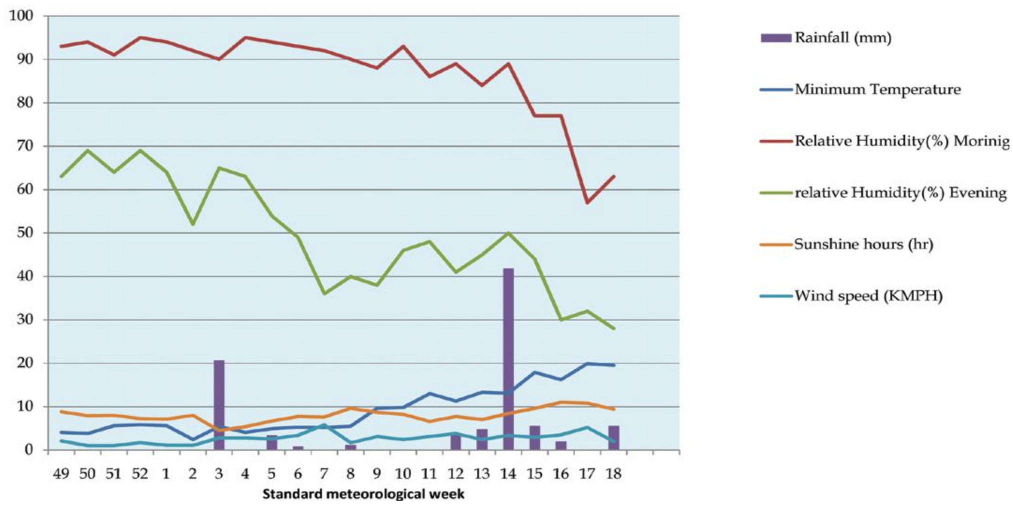

Fig. 1: Weekly Average Weather Data for Experimental Period (From November, 1996 to April, 1997)

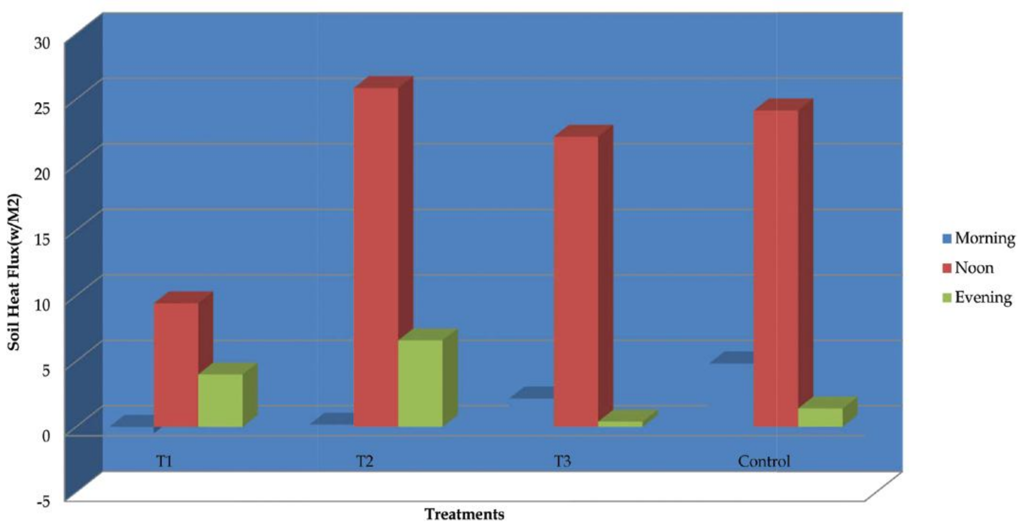

Fig. 2: Soil Heat Flux (S) Variations During Tillering Stage in Treatment 1,2 and 3 and Control

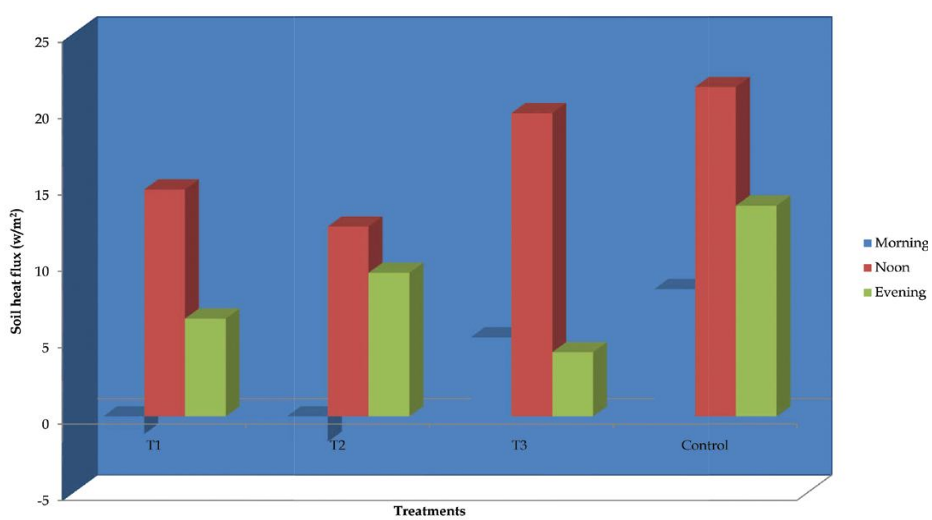

Fig. 3: Soil Heat Flux (S) Variations During Flag Leaf Emergence Stage in Treatment 1,2 and 3 and Control

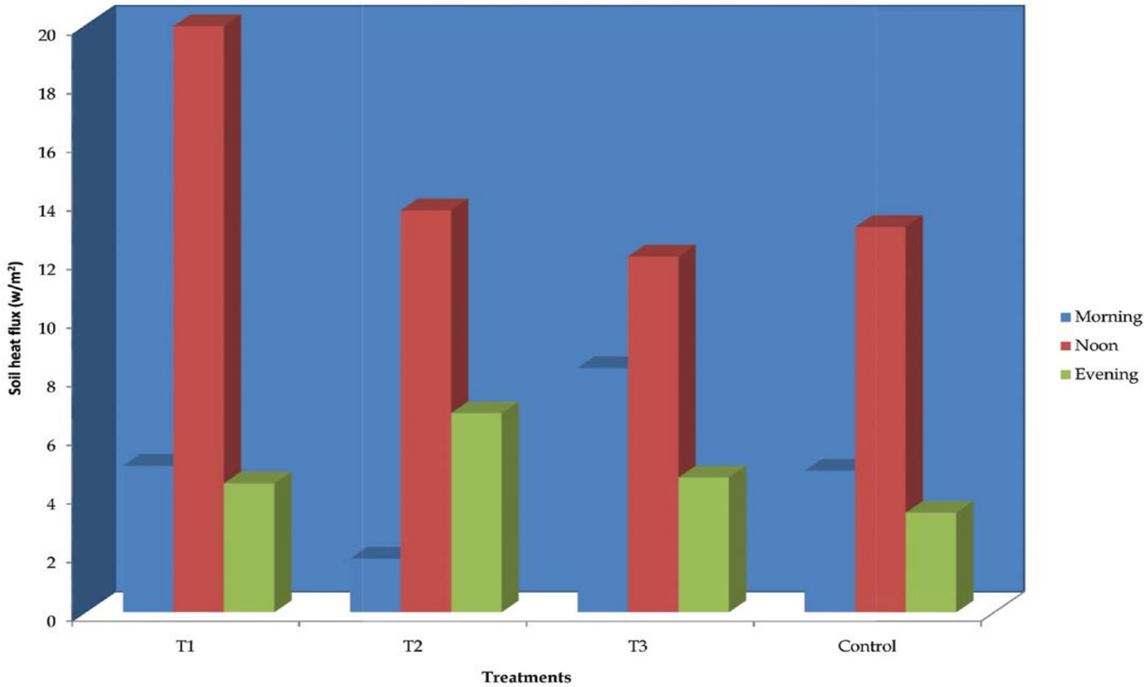

Fig. 4: Soil Heat Flux (S) Variations During Earhead Emergence Stage in Treatment 1,2 and 3 and Control

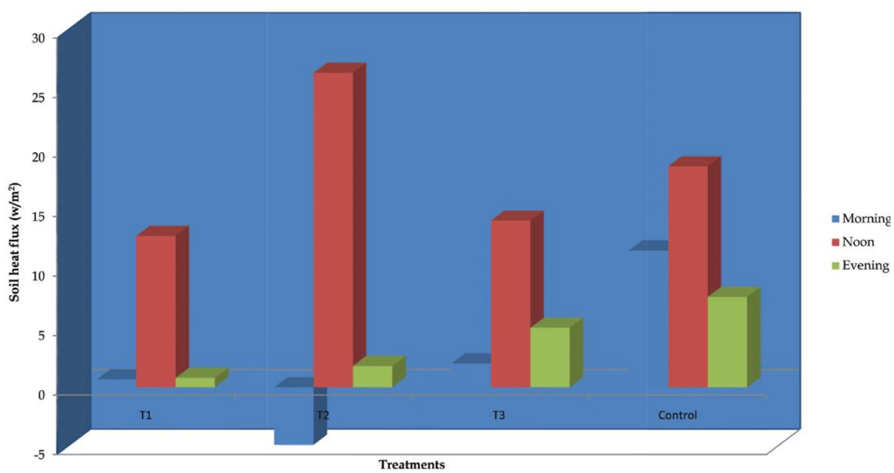

Fig. 5: Soil Heat Flux (s) Variations During Maturing Stage in Treatment 1,2 and 3 and Control

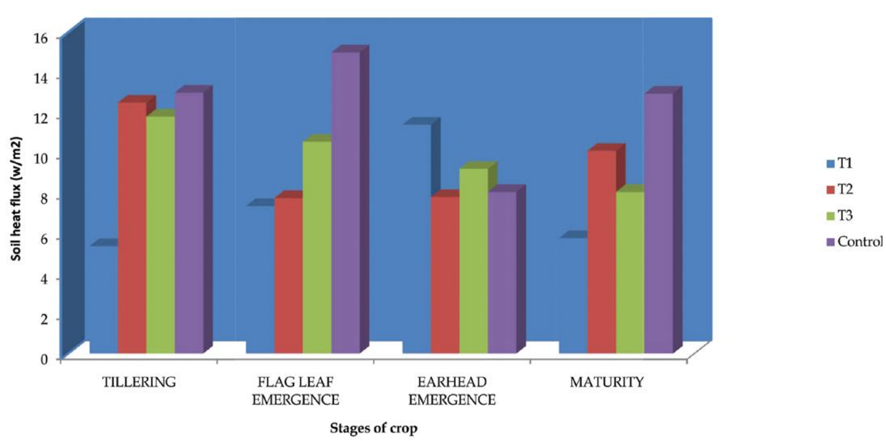

Fig. 6: Soil Heat Flux (s) Variations in Different Stages of Crop

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