International Journal of Farm Sciences **4(2)**: 24-32, 2014

Microclimatic variations under different planting methods of rice, *Oryza sativa* L

AMANDEEP KAUR, LK DHALIWAL and SOMPAL SINGH

School of Climate Change and Agricultural Meteorology
Punjab Agricultural University, Ludhiana 141004 Punjab
Email for correspondence: sompal69@rediffmail.com

ABSTRACT

Field experiments were conducted at the research farm of School of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana, Punjab during Kharif season of 2012 and 2013 to study the microclimate particularly relative humidity and canopy temperature in rice crop canopy. The rice varieties PR-118 and PR-116 were transplanted on three dates viz 15 June, 30 June and 15 July by two planting methods (bed and conventional planting). Photosynthetically active radiation (PAR) and canopy temperature were measured at different growth stages. PAR interception was found to be highest in crop transplanted on 15 June (D_1) followed by 30 June (D_2) and 15 July (D_3). So far as the method of transplanting is concerned PAR interception was higher (up to 5%) in bed planting (M_1) as compared to conventional planting (M_2). Higher relative humidity was recorded within crop canopy at flowering stage than panicle initiation stage during both the crop seasons. During rice growing season 2013 higher relative humidity was recorded as compared to 2012. The canopy temperature was slightly higher in bed planted method as compared to conventional method.

Keywords: Rice; PAR; relative humidity; canopy temperature

INTRODUCTION

Agricultural productivity is influenced mainly by cultural practices followed and prevailing weather conditions. Rice is the predominant cereal crop in north-west India including the state of Punjab. In Punjab rice currently occupies an area of 28.18 lakh hectare with production of 105.42 lakh tons with an average yield of 37.41 qha^{-1} (Anon 2013). India contributes 26 per cent in world rice production (Anon 2011). Rice requires a mean temperature range of 17 to 33°C, growing season rainfall range of 0 to 5,100 mm and solar radiation range of 300 to 600 calories/cm^2/day in its growing areas and seasons. Rice is a water loving plant requiring a heavy rainfall of 125 cm during its vegetative period and an annual rainfall of 100-200 cm (Prasada Rao 2008). To improve production it is imperative to understand the weather both at macro- and micro-levels as weather directly influences the crop growth and development. For higher productivity rice requires higher light intensity. For enhancing crop productivity its exposure to sunlight and utilization efficiency are important so as to produce dry matter. Light of the optimum intensity, quality and duration is essential for normal photosynthesis, plant growth and development. It governs the distribution of photosynthates among different organs of plants. The rate of photosynthesis is dependent upon the availability of photosynthetically active radiation intercepted by the leaves. The ultimate capacity of a plant to produce dry mater depends on degree of exposure to sunlight and its radiation use efficiency. Temperature and relative humidity within crop canopy vary as the crop grows. Atmospheric humidity influences the internal water potential of plants and the rate at which plants transpire water into atmosphere (Hoffman 1973). There is a need to know the microclimate variations particularly relative humidity and temperature in rice crop for optimum crop production. Hence the present investigations were done to study the relative humidity and canopy temperature profiles in rice crop under different planting methods.

MATERIAL and METHODS

Field experiments were conducted during Kharif season of 2012 and 2013 at research farm of Punjab Agricultural University, Ludhiana, Punjab. It is situated at 30°54'N latitude and 75°48'E longitude and is 247 m amsl. The area experiences an average annual rainfall of 705 mm of which about 80 per cent is received during June to September. Two varieties of paddy viz PR-118 (V_1) and PR-116 (V_2) were transplanted by bed planting (M_1) and conventional (M_2) methods on three different dates viz 15 June (D_1), 30 June (D_2) and 15 July (D_3) during both the crop seasons. Seedlings were transplanted at a spacing of 20 cm x 15 cm in conventional and 30 cm x 10 cm in bed planting method. The experiment was laid out in the factorial split plot design. Each treatment was replicated four times. The diurnal cycles of photosynthetically active radiation interception were recorded with line quantum sensor (Model LI-190 SB) at 15 days interval after transplanting of rice crop. Par measurements were made usually four times a day (10.00, 12.00, 14.00 and 16.00 h) and average value was worked out. The per cent interception was calculated as under:

$$\text{PAR interception (\%)} = \frac{\text{PAR (I)} - \text{PAR (T)} - \text{PAR (R)}}{\text{PAR (I)}} \times 100$$

Where

PAR (I)= PAR incoming above the canopy

PAR (T)= PAR transmitted to the ground

PAR (R)= PAR reflected from the canopy

The relative humidity and canopy temperature were measured within crop canopy (ie at 10 cm height from ground level) and above crop canopy (ie at 10 cm height above crop canopy) using Assmann Psychrometer instrument. The canopy temperature was measured with Infrared thermometer. Diurnal mean relative humidity was measured at different phenological stages and calculated using Psychometric tables. Canopy temperature was measured at 1400 hours at 15 days interval with the help of Infrared Thermometer (FLUKE-574).

RESULTS and DISCUSSION

The microclimate of a crop stand is largely influenced by photosynthetically active radiations (PAR) interception, relative humidity and canopy temperature within and above crop canopy. Air temperature within canopy has direct effect on physiological process such as photosynthesis, transpiration and respiration. It also determines thermal environment within the crop stand.

Photosynthetically active radiation (PAR) interception

Solar radiation, its interception and transmission within the crop canopy are directly related with crop production. Diurnal variations in PAR interception indicate that it was minimum during morning hours, after that it increased and maximum interception was observed between 12 noon to 1 pm and after that it again decreased. The PAR interception was recorded at 15 days interval ie 45, 60, 75, 90 and 105 days after transplanting (DAT). During the entire growing period of the crop intercepted photosynthetically active radiation (IPAR) increased with crop growth with its peak value at 75 DAT in all the treatments and thereafter decreased at successive growth stages. The reason for this decline in IPAR (MJm^{-2}) might be due to decrease in leaf area index and the chlorophyll content in the mature leaves during both the years. PAR distribution at flowering stage of the crop under different planting methods in varieties PR-118 and PR-116 during both the years has been depicted in Table 1. The photosynthetically active radiation (PAR) was observed to be comparatively higher (up to 5%) in bed planting as compared to the conventional planting. Among all the dates of transplanting the radiation interception was more in the crop transplanted on 15 June (D_1) followed by 30 June (D_2) and 15 July (D_3) during 2012. PAR interception on 15 June transplanted crop ranged between 68.8-83.9 per cent followed by 30 June (54.2-83.4%) and 15 July (52.1-80.2%) during 2012. During 2013 the PAR interception ranged between 53.8-83.6 per cent under 15 June followed by 30 June (55.4-78.9%) and 15 July (51.3-77.2%). Similar results have been reported by Dhaliwal et al (2006) and Sastri et al (2000). Mean PAR interception was higher in D_1 under bed planting during 2012 due to higher dry matter and leaf area index (LAI) as compared to second crop season. Significant differences were found in the amount of PAR intercepted between treatments up to maturity (Ahmad et al 2008). Over the crop season similar values of interception in rice were reported by Jamil (1999).

Diurnal relative humidity profiles

The study revealed that day time relative humidity was low at noon hours within crop canopy. Roy and Triphati (2006) also observed similar results in wheat crop. Similar trend in relative humidity was also observed above crop canopy. Higher relative humidity (up to 6%) was recorded within crop canopy than above crop canopy during both the seasons. Higher relative humidity was recorded within crop canopy at flowering stage than panicle initiation stage (Table 1 & 2). This is in conformity with the findings of Reddy et al (2007). Within crop canopy higher relative humidity was found in 30 June transplanted rice followed by 15 June and 15 July. These results are also supported by the work done by Khichar and Niwas (2006). As compared to planting methods higher relative humidity was found in conventional planting than bed planting method during both the seasons. The diurnal relative humidity (10.00 h to 16.00 h) ranged between 57.0 to 93.3 per cent during 2012 (Table 2). The corresponding humidity range during second season was 64.3 to 98.7 per cent (Table 3). The diurnal variations were reported in the relative humidity and it was found that the relative humidity was higher in the morning hours that decreased with the advancement of the day towards noon and by the evening it increased during both the crop seasons.

Canopy temperature measurements

Canopy temperature measurements are made to estimate the plant water status and to schedule irrigation under modified climate. Canopy temperature is related to plant water stress because of the evaporative cooling evolved in the transpiration may cool leaves below ambient air temperature. The temperature in 15 June transplanted crop was comparatively higher (25.9-30.0°C) than 30 June (22.9-29.9°C) and 15 July (22.6-29.7°C) transplanted crop. The canopy temperatures differed with the planting methods. It was reported that the temperature values were higher in bed planted crop (24.0-29.9°C) as compared to conventional planting method (23.5-29.8°C) during 2012 crop growing season. Similar trends were found in 2013 crop season. This was because of the microclimate modified by the higher relative humidity in conventional method. Similarly Das et al (1984) reported that canopy air temperature was significantly correlated with LAI, total dry biomass and grain yield.

Table 1. Per cent photosynthetically active radiation (PAR) in rice under different treatments during 2012 and 2013

Treatment	2012					2013				
	Days after transplanting					Days after transplanting				
	45	60	75	90	105	45	60	75	90	105
15 June (D_1)	68.8	82.9	83.9	83.7	78.2	53.8	76.7	83.6	79.9	77.9
30 June (D_2)	54.2	80.5	83.4	82.8	78.1	55.4	69.5	78.9	77.8	75.8
15 July (D_3)	52.1	80.2	81.9	80.8	76.0	51.3	67.5	77.2	74.3	74.4
PR-118 (V_1)	66.8	76.1	81.6	80.0	74.9	58.5	72.5	82.8	81.6	79.6
PR-116 (V_2)	66.0	75.5	80.4	79.1	74.5	56.2	72.2	82.8	80.4	78.1
Bed planting (M_1)	65	82.1	83.7	83.0	78.1	62.1	76.9	80.0	79.2	77.4
Conventional planting (M_2)	53.01	74.6	77.7	77.5	77.0	52.5	67.8	75.9	75.4	73.7

Table 2. Day time variation in relative humidity in rice crop during Kharif 2012

Treatment	Panicle initiation stage at				Flowering stage at			
	10.00 AM	12.00 Noon	2.00 AN	4.00 AN	10.00 AM	12.00 Noon	2.00 AN	4.00 AN
Relative Humidity (%) within crop canopy (10 cm high from ground level)								
15 June (D_1)	80.0	73.0	65.5	69.5	87.3	83.8	74.0	80.8
30 June (D_2)	86.7	76.5	72.7	78.7	88.0	85.8	79.5	82.5
15 July (D_3)	92.2	79.2	74.7	81.5	93.3	87.8	79.8	83.5
PR-118 (V_1)	85.7	76.5	69.5	78.0	86.8	84.2	77.2	83.2
PR-116 (V_2)	85.9	77.0	70.5	78.2	87.2	84.3	78.3	84.3
Bed planting (M_1)	84.5	74.5	67.2	74.0	86.2	84.2	76.3	81.0
Conventional planting (M_2)	87.8	78.0	74.8	79.2	92.8	87.3	79.2	83.5
Relative Humidity (%) above crop canopy (10 cm high above crop canopy)								
15 June (D_1)	79.5	70.0	54.0	61.0	85.0	70.5	64.0	67.2
30 June (D_2)	82.5	67.5	59.25	64.2	84.5	82.5	71.2	78.7
15 July (D_3)	88.0	70.0	65	67.2	90.25	83.5	75.5	77.2
PR-118 (V_1)	82.0	67.3	61.1	63.5	85.3	78.1	70.0	74.1
PR-116 (V_2)	82.4	68.0	61.6	64.8	85.8	79.5	70.5	74.6
Bed planting (M_1)	81.1	66.0	57.0	61.3	83.6	77.1	69.1	72.8
Conventional planting (M_2)	85.8	72.3	61.8	67.0	89.5	80.5	71.3	76.0

Table 3. Day time variation in relative humidity in rice crop during Kharif 2013

Treatment	Panicle initiation stage at				Flowering stage at			
	10.00 AM	12.00 Noon	2.00 AN	4.00 AN	10.00 AM	12.00 Noon	2.00 AN	4.00 AN
Relative Humidity (%) within crop canopy (10 cm high from ground level)								
15 June (D_1)	84.4	75.5	71.3	77.6	86.4	77.1	71.8	79.0
30 June (D_2)	87.0	76.6	75.4	82.0	88.3	80.3	77.1	85.8
15 July (D_3)	94.6	80.6	77.8	82.3	98.7	80.8	79.1	87.7
PR-118 (V_1)	86.3	76.8	74.4	79.9	87.3	78.3	75.1	83.4
PR-116 (V_2)	86.4	77.4	75.2	81.3	88.9	79.4	76.9	84.9
Bed planting (M_1)	85.4	76.2	73.8	79.1	87.6	77.4	74.3	82.8
Conventional planting (M_2)	87.3	79.0	75.8	82.2	88.7	81.3	77.7	85.6
Relative humidity (%) above crop canopy (10 cm high above crop canopy)								
15 June (D_1)	78.8	71.0	64.3	74.0	78.3	72.9	69.1	76.3
30 June (D_2)	80.6	74.9	74.0	76.8	81.9	75.6	74.9	77.8
15 July (D_3)	82.6	78.3	76.8	80.3	84.1	80.1	78.3	82.1
PR-118 (V_1)	80.0	73.6	73.1	76.4	80.9	76.1	73.6	77.8
PR-116 (V_2)	81.3	73.8	73.3	77.6	81.9	77.3	74.6	78.6
Bed planting (M_1)	79.4	73.5	69.3	75.8	80.5	74.3	72.7	77.6
Conventional planting (M_2)	81.9	75.9	74.1	78.3	82.3	78.2	75.6	79.8

Table 4. Canopy temperature of rice under different treatments during 2012 and 2013

Treatment	2012 Canopy temperature (ÚC) (days after transplanting)							2013 Canopy temperature (ÚC) (days after transplanting)						
	30	45	60	75	90	105	120	30	45	60	75	90	105	120
15 June (D_1)	25.9	26.7	27.5	28.8	30.0	28.5	26.9	25.8	27.5	28.1	31.2	32.2	28.8	26.8
30 June (D_2)	22.9	25.7	27.4	28.6	29.9	26.9	25.2	24.8	27.0	27.9	29.5	31.2	26.7	25.8
15 July (D_3)	22.5	24.8	27.2	28.5	29.7	26.7	24.5	24.4	25.7	27.8	29.1	31.0	26.5	25.4
PR-118 (V_1)	23.9	26.4	28.0	28.9	30.2	27.7	25.9	26.2	27.4	28.4	31.4	33.6	28.0	25.2
PR-116 (V_2)	23.7	25.1	27.7	28.3	29.5	27.1	24.7	25.4	26.4	27.7	29.0	33.0	27.9	24.4
Bed planting (M_1)	24.0	26.0	27.3	28.6	29.9	27.4	25.0	25.6	27.0	28.1	30.8	32.9	27.7	25.5
Conventional planting (M_2)	23.5	25.4	26.4	27.6	29.8	27.4	22.5	23.8	26.0	27.4	28.4	29.3	26.7	22.8

REFERENCES

Ahmad S, Zia-ul-haq M, Ali H, Shad SA, Ahmad A, Maqsood M, Khan MB, Mehmood S and Hussain A 2008. Water and radiation use efficiencies of transplanted rice (*Oryza sativa* L) at different plant densities and irrigation regimes under semi-arid environment. Pakistan Journal of Botany, **40(1)**: 199-209.

Anonymous 2011. Climatic conditions for rice crop in India. http://www.rice-trade.com (>rice in India>Rice cultivation in India).

Anonymous 2013. Area, production and average yield of rice in Punjab. http://www.indiastat.com

Das DK, Singh G, Kalra N and Sutradhar AK 1984. Remotely sensed canopy temperature of rice crop grown under different moisture regimes and nitrogen supply. Proceedings ICAR-ISRO Seminar on Crop Growth and Remote Sensing, IARI, New Delhi, 22-23 June 1984, pp 1-8.

Dhaliwal LK, Hundal SS, Chalal SK and Aneja A 2006. Effect of conventional and furrow planting methods on radiation interception, growth and yield of rice paddy. Proceedings of the International Workshop on Water Saving Practices in Rice Paddy Cultivation, 14-15 September 2006, Kuala Lumpur, Malaysia, pp 41-48.

Hoffman GJ 1973. Humidity effects on yield and water relations in nine crops. Transactions of the American society of Agricultural Engineers **16:**164-167.

Jamil M 1999. Effect of different planting methods and nitrogen levels on growth and yield of rice Basmati-385. MSc (Agric) thesis, Department of Agronomy, University of Agriculture, Faisalabad, Pakistan.

Khicher ML and Niwas R 2006. Microclimate profiles under different sowing environments in wheat. Journal of Agrometeorology **8(2):** 201-209.

Prasada Rao GSLHV 2008. Agricultural meteorology. Prentice Hall of India Pvt Ltd, New Delhi, pp185-188.

Reddy DR, Mahadevappa SG, Rao SBSN, Sreenivas G, Lata AM and Varma NRG 2007. Variation of relative humidity and air temperature in rice (*Oryza sativa* L) canopy. Journal of Agrometeorology **9(2):** 272-278.

Roy S and Triphati RP 2006. Variation of relative humidity and vapour pressure within wheat canopy. Journal of Agrometeorology **8(1):**117-120.

Sastri CVS, Rao TR and Mukherjee J 2000. PAR distribution in mustard (*Brassica juncea* L var Pusa Bold) crop canopy. Journal of Agrometeorology **2(1):** 15-20.

Received: 25.03.14 ***Accepted: 19.05.14***