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RESEARCH ARTICLE

Rate of photosynthesis as affected by irrigation levels in potato

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SUMMARY

During both the seasons (2009-2010 and 2010-2011) the field trial was conducted on PGI Farm without changing randomization. The experiment was laid out in *Rabi* season. IRGA instrument (LI-6400XT) was used for estimation different microclimatic parameters of the crop within the height of 2 mt. At higher levels of irrigation (1.2 and 1.0 IW/CPE) two peaks of net photosynthesis were evident at 11.00 to 12.30 and 14.00 to 14.30 hr. At lower levels of irrigation the second peak was absent. Increased stomatal conductance appeared to be the reason for the first peak whereas for the second peak non-stomatal characters may be responsible. Photosynthetic rates were highest when planting was carried out during the last week of October and mulch was applied during first earthing up. The results revealed that increase in irrigation levels from 0.8 to 1.2 IW/CPE ratio, planting within 44th MW with sugarcane trash mulch @ 5 t ha^{-1} exhibited higher values of all microclimatic parameter *viz.,* photosynthetic rate (34.40, 35.55 µ mol CO_2 m^{-2} s^{-1}), At harvest, the treatments combination $I_3D_2M_1$ was significantly superior, recording highest mean fresh weight of tubers $plant^{-1}$ (352.44 g) followed by $I_3D_1M_1$, $I_2D_2M_1$ and $I_3D_2M_2$ during first year. Significantly treatments combination $I_3D_2M_1$ recorded maximum mean fresh weight of tubers $plant^{-1}$ (498.96 g) followed by $I_3D_2M_2$, $I_2D_2M_1$ and $I_2D_2M_2$, while rests of the treatments were at par with each others during second year.

Key Words : Photosynthesis, Potato, Planting dates, Irrigation levels

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In India nearly 80 per cent of potatoes are grown in vast Indo-Gangetic plains of north India during short winter days from October to March. Uttar Pradesh, West Bengal, Bihar, Punjab, Madhya Pradesh, Gujarat, Assam, Karnataka and Uttarakhand are important potato growing states. About 25 million tones of potatoes are the requirement for consumption, seed purpose, processing industries and export. The estimated production of 24.51 million tonnes is quite less to meet the demand (Anonymous, 2011). The area under potato in Maharashtra is 18.8 thousand ha (2 % of India) with a production of 197.90 thousand MT and extremely low productivity of 10.52 t ha^{-1} (Anonymous, 2011). The part of North Satara and Pune districts are major potato growing areas of 80 per cent of area is under this crop in the state (Ahire, 1999). Due to increasing industrialization and job market created demand for processed and ready to eat convenience food, particularly in urban areas. A plant with adequate soil moisture transpires water profusely, keeping its leaves cooler than the surrounding air. When soil moisture is insufficient, plant is experiencing moisture stress, the leaves transpire less and become warmer. The plant leaves must remain turgid for leaf expansion, to keep stomata open for higher photosynthetic rate. In plant, leaves functions as an optical organs and spectral radiation properties are attuned to environment in which they live. The efficiency of absorption of PAR partly determines the efficiency of photosynthesis of plant. The PAR is absorbed more efficiently and centering around 400-700 nm, determines the plant development. Evapotranspiration from vegetative surface is influenced by many meteorological factors like temperature, radiation, humidity and physiological factor such as photosynthetic rate, leaf water potential and stomatal

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conductance of the plant. With this back ground in view, the present investigation was undertaken to know the rate of photosynthesis as influenced by Irrigation levels in potato.

MATERIALS AND METHODS

The field trial of potato (Variety) Kufri Pukhraj was conducted during both the seasons (2009-2010 and 2010-2011) on PGI Farm without changing randomization. The experiment was laid out in Split Plot Design in *Rabi* season with recommended dose of fertilizer . 120:60:120 NPK kg ha-1. There were eighteen treatments comprised of nine main plot treatments and two sub-plot treatments:

Treatment details : A. Main plot treatments (nine)	
Irrigation levels (I) X Planting dates (D)	
I_1D_1 - (0.8 IW/CPE) X (42 MW)	I_2D_1- (1.0 IW/CPE) X (42 MW)
I_1D_2 - (0.8 IW/CPE) X (44 MW)	I_2D_2 - (1.0 IW/CPE) X (44 MW)
I_1D_3 - (0.8 IW/CPE) X (46 MW)	I_2D_3 - (1.0 IW/CPE) X (46 MW)
I_3D_1 - (1.2 IW/CPE) X (42 MW)	
I_3D_2 - (1.2 IW/CPE) X (44 MW)	
I_3D_3 - (1.2 IW/CPE) X (46 MW)	
B. Sub-plot Treatments (Two) Mulching (M)	
M_1 - With mulch	M_2 - Without mulch

Treatment details :

IRGA instrument (LI-6400XT) was used for estimation different microclimatic parameters of the crop within the height of 2 mt. The LI-6400XT is the only photosynthesis measurement system to put the CO_2 and H_2O gas analyzers in the sensor head. These dual paths, non-dispersive infrared analyzers feature an open path design with the optical bench of the sample analyzer open directly to the leaf chamber mixing volume. Leaf dynamics are measured in real time, preventing confounding correlations between gas exchange and changes in environmental driving variables. The microclimate observations were recorded as:

Microclimatic observation				
Sr. No.	Particulars	Frequency	Period (DAP)	Sample size
1.	Photosynthetic rate	4	28,56, 84, and at harvest	One plant from each net plot
2.	Microclimate-yield relation in potato (Response analysis)	4	_"_	--do--

RESULTS AND DISCUSSION

The important findings of the experiment studies under different irrigation levels, planting dates and mulching are presented in this chapter under appropriate heads.

Effect of different treatments on photosynthetic rate :

The data pertaining to photosynthetic rate of potato as influenced by various treatments at different growth stages are housed in Table 1 and 2 (2009 and 2010). In general, during both seasons, there was a rapid increase in photosynthetic rate from early growth stage to 56 days and thereafter it gradually decreased towards maturity of the crop. Highest mean values of photosynthetic rate were recorded at 56 DAP interval as 19.74 and 20.22 µ mol CO_2 m^{-2} s^{-1} in 2009 and 2010, respectively.

Effect of irrigation levels and planting dates (IxD) :

During the first year at 28 DAP the mean photosynthetic rate was maximum with I_3D_2 (11.61 µ mol CO_2 m^{-2} s^{-1}) followed by I_2D_2, which was at par with I_1D_2, I_3D_1, I_2D_1 and I_1D_1. During second year I_3D_2 significantly recorded maximum photosynthetic rate (11.84 µ mol CO_2 m^{-2} s^{-1}) followed by I_2D_2 which was at par with I_1D_2 and I_3D_1, while remaining treatments were at par with each others. At 56 DAP during first year, the maximum and significantly higher mean photosynthetic rate was obtained with I_3D_2 (28.38 µ mol CO_2 m^{-2} s^{-1}) followed by I_2D_2, which was at par with I_1D_2, I_3D_1 and I_2D_1. During second year maximum photosynthetic rate was obtained by I_3D_2 (27.25 µ mol CO_2 m^{-2} s^{-1}) followed by I_1D_2 and I_3D_1, while remaining treatments were at par with each others.

At 84 DAP during first year, significantly maximum mean photosynthetic rate was registered under I_3D_2 (20.25 µ mol CO_2 m^{-2} s^{-1}) followed by I_2D_2, which was at par with I_1D_2, while rests of the treatments were at par with each others. During second year I_3D_2 recorded significantly maximum photosynthetic rate (29.04 µ mol CO_2 m^{-2} s^{-1}) followed by I_2D_2, which was at par with I_1D_2, I_3D_1 and I_2D_1.At harvest during first year, significantly maximum mean photosynthetic rate was registered under I_3D_2 (10.49 µ mol CO_2 m^{-2} s^{-1}) followed by I_2D_2, which was at par with I_1D_2, I_3D_1 and I_2D_1.During second year, maximum photosynthetic rate was obtained by I_3D_2 (11.04 µ mol CO_2 m^{-2} s^{-1}) which was at par with I_2D_2, and I_1D_2, while rest of the treatments were at par with each other. Significantly lowest mean photosynthetic rate was obtained in I_1D_3 at all the growth stages.

Effect of mulching :

The data presented in Table 3 and 4 implies that the mean photosynthetic rate was significantly influenced due to mulching. The maximum and significantly higher mean photosynthetic rate was recorded in mulching compared to without mulching at all the days of observations during both the years of experimentation.

Interactions effect :

Treatments combination of irrigation levels with mulching (IxM) and planting dates with mulching (DxM) were

Table 3: Interaction effect of irrigation levels and planting dates with mulching on photosynthetic rate at 56 DAP

Irrigation levels	M_1 (With mulch)	M_2 (Without mulch)	Mean	Planting dates	M_1 (With mulch)	M_2 (Without mulch)	Mean
Photosynthetic rate (μ mol co_2 m^{-2} s^{-1}) 2009-2010							
I_1 (0.8 IW/CPE)	18.93	15.89	17.41	D_1 (42 MW)	21.67	18.27	19.97
I_2 (1.0 IW/CPE)	21.95	17.36	19.65	D_2 (44 MW)	29.56	20.56	25.06
I_3 (1.2 IW/CPE)	25.19	19.11	22.15	D_3 (46 MW)	14.83	13.53	14.18
Mean	22.02	17.45	19.74	Mean	22.02	17.45	19.74
S.E.±	0.86			S.E.±	0.86		
C.D. (P=0.05)	2.55			C.D. (P=0.05)	2.55		
Photosynthetic rate (μ mol co_2 m^{-2} s^{-1}) 2010-11							
I_1 (0.8 IW/CPE)	22.44	14.50	18.47	D_1 (42 MW)	24.56	15.61	20.08
I_2 (1.0 IW/CPE)	24.22	15.89	20.06	D_2 (44 MW)	28.67	20.17	24.42
I_3 (1.2 IW/CPE)	26.00	18.28	22.14	D_3 (46 MW)	19.44	12.89	16.17
Mean	24.22	16.22	20.22	Mean	24.22	16.22	20.22
S.E.±	0.75			S.E.±	0.75		
C.D. (P=0.05)	2.23			C.D. (P=0.05)	2.23		

Table 4 : Interaction effect of irrigation levels and planting dates with mulching on photosynthetic rate at 84 DAP

Irrigation levels	M_1 (With mulch)	M_2 (Without mulch)	Mean	Planting dates	M_1 (With mulch)	M_2 (Without mulch)	Mean
2009-2010							
I_1 (0.8 IW/CPE)	12.78	9.72	11.25	D_1 (42 MW)	14.78	10.83	12.81
I_2 (1.0 IW/CPE)	15.22	11.06	13.14	D_2 (44 MW)	19.22	15.17	17.19
I_3 (1.2 IW/CPE)	16.44	13.50	14.97	D_3 (46 MW)	10.44	8.28	9.36
Mean	14.81	11.43	13.12	Mean	14.81	11.43	13.12
S.E.±	0.47			S.E.±	0.47		
C.D. (P=0.05)	1.40			C.D. (P=0.05)	1.40		
2010-11							
I_1 (0.8 IW/CPE)	18.49	16.37	17.43	D_1 (42 MW)	21.56	19.14	20.35
I_2 (1.0 IW/CPE)	20.92	17.93	19.43	D_2 (44 MW)	28.54	21.05	24.80
I_3 (1.2 IW/CPE)	26.21	19.87	23.04	D_3 (46 MW)	15.51	13.98	14.75
Mean	21.87	18.06	19.96	Mean	21.87	18.06	19.96
S.E.±	0.88			S.E.±	0.88		
C.D. (P=0.05)	2.62			C.D. (P=0.05)	2.62		

found non significant except 56 DAP and 84 DAP during the both years. The interaction combination of irrigation levels and planting dates with mulching (IxDxM) were found significant during both the years.

Interaction effect of (IxM) :

At 56 DAP during first year, the interaction combination of different treatments, I_3M_1 recorded significantly highest mean photosynthetic rate (25.19 μ mol CO_2 m^{-2} s^{-1}) followed by I_2M_1 and I_3M_2, which were at par with rests of the treatments except I_1M_2 (Table 7). During second year the treatment combination of I_3M_1 registered maximum photosynthetic rate (26.00 μ mol CO_2 m^{-2} s^{-1}) which was at par with I_2M_1 and I_1M_1.

At 84 DAP during first year, the interaction combination of different treatment, I_3M_1 recorded significantly highest mean photosynthetic rate (16.44 μ mol CO_2 m^{-2} s^{-1}) which was

at par with I_2M_1 (Table 6). During second year, I_3M_1 obtained maximum photosynthetic rate (26.21µ mol CO_2 m^{-2} s^{-1}) followed by I_2M_1, which was at par with I_3M_2 and I_1M_1.

Interaction effect of (DxM) :

At 56 DAP during first year, the interaction combination of different treatments, D_2M_1 recorded significantly highest photosynthetic rate (29.56 µ mol CO_2 m^{-2} s^{-1}) followed by D_1M_1, which was at par with D_2M_2 (Table 5). During second year, D_2M_1 registered maximum photosynthetic rate (28.67 µ mol CO_2 m^{-2} s^{-1}) followed by D_1M_1 and D_2M_2, which were at par with D_3M_1.

At 84 DAP during first year, the interaction combination of different treatments, D_2M_1 recorded significantly highest photosynthetic rate (19.22 µ mol CO_2 m^{-2} s^{-1}) followed by D_2M_2, which was at par with D_1M_1 (Table 4). During second year, D_2M_1 obtained maximum photosynthetic rate (28.54 µ mol CO_2 m^{-2} s^{-1}) followed by D_1M_1 which was at par with D_1M_2.

Interaction effect of (IxDxM) :

At 28 DAP, during first year, the treatment combination $I_3D_2M_1$ was significantly superior, recording highest mean photosynthetic rate (11.63 µ mol CO_2 m^{-2} s^{-1}) which was at par with $I_3D_2M_2$, $I_2D_2M_1$ and $I_1D_2M_1$ (Table 3). During second year the treatment combination $I_3D_2M_1$ recorded maximum photosynthetic rate (13.86 µ mol CO_2 m^{-2} s^{-1}) followed by $I_3D_2M_2$, which was at par with $I_2D_2M_1$, $I_2D_2M_2$, $I_1D_2M_1$, $I_3D_1M_1$, $I_2D_1M_1$, $I_1D_1M_1$, $I_3D_3M_1$ and $I_1D_2M_2$ again at par with $I_2D_2M_1$ and $I_2D_2M_2$, while rests of the treatments were at par with each other (Table 4). At 56 DAP, during first year, the treatments combination $I_3D_2M_1$ was significantly superior, recording highest mean photosynthetic rate (34.40 µ mol CO_2 m^{-2} s^{-1}) followed by $I_2D_2M_1$ which was at par with $I_1D_2M_1$, $I_3D_1M_1$ and $I_2D_1M_1$. During second year the treatment combination $I_3D_2M_1$ recorded maximum photosynthetic rate (30.00 µ mol CO_2 m^{-2} s^{-1}) which was at par with $I_2D_2M_1$, $I_1D_2M_1$, $I_3D_1M_1$, while rests of the treatments were at par with each others.

At 84 DAP, during first year, the treatments combination $I_3D_2M_1$ was significantly superior, recording highest mean photosynthetic rate (21.00 µ mol CO_2 m^{-2} s^{-1}) which was at par with $I_3D_2M_2$. The treatment combination $I_3D_2M_2$ was again at par with $I_2D_2M_1$ and $I_1D_2M_1$, while rests of the treatments were at par with each others. During second year the treatment combination $I_3D_2M_1$ recorded significantly highest mean photosynthetic rate (35.55 µ mol CO_2 m^{-2} s^{-1}) followed by $I_2D_2M_1$, which was at par with $I_1D_2M_1$, $I_3D_1M_1$, $I_3D_2M_2$ and $I_2D_1M_1$. At harvest, during first year, the treatment combination $I_3D_2M_1$ was significantly superior, recording highest mean photosynthetic rate (12.80 µ mol CO_2 m^{-2} s^{-1}) followed by $I_2D_2M_1$, which was at par with $I_3D_2M_2$ and $I_1D_2M_1$. During second year $I_3D_2M_1$ obtained highest mean photosynthetic rate (12.76 µ mol CO_2 m^{-2} s^{-1}) which was at par with $I_2D_2M_1$ followed by $I_1D_2M_1$, $I_3D_2M_2$ and $I_2D_2M_2$ in descending orders.

Effect of different treatments on mean fresh weight of tubers plant^{-1} :

Data referring to mean fresh weight of tubers plant^{-1} as influenced by various treatments at different growth stages are presented in Table 5 and 6 for the corresponding *Rabi* seasons of 2009 and 2010.In general, mean fresh weight of tubers plant^{-1} by potato was increased gradually at every phase of crop growth till harvest during both the years of investigation. The rate of increase was initially slow up to 56 DAP, rapid during 56 DAP to 84 DAP and attain maximum mean fresh tuber weight of 314.75 and 417.92 g at harvest during 2009 and 2010, respectively due to marked improvement in partitioning in dry matter towards tuber production.

Irrigation levels and planting dates (I x D) :

Data presented in Table 5 and 6 revealed that mean fresh weight of tubers plant^{-1} was influenced significantly. At 56 DAP the maximum and significantly higher mean fresh weight of tubers plant^{-1} was obtained with I_3D_2 (180.67 and 211.33 g) which was at par with I_3D_1, I_3D_1 and I_2D_2 and superior over rest of the treatments, while rests of the treatments were at par with each others during both years.

At 84 DAP significantly maximum mean fresh weight of tubers plant^{-1} was registered under I_3D_2 (283.65 g) and was at par with I_3D_1 and was superior over rest of the treatments. During second year, I_3D_2 (366.81g) recorded maximum mean fresh weight of tubers plant^{-1} followed by I_2D_2, significantly superior over rest of the treatments, while rests of the treatments were at par with each others. At harvest statistically maximum mean fresh weight of tubers plant^{-1} was obtained in I_3D_2 (342.20 g) followed by I_3D_1 and was superior over rest of the treatments during first year. Significantly maximum mean fresh weight of tubers plant^{-1} was recorded in I_3D_2 (481.81 g) followed by I_2D_2, I_3D_3, I_3D_1 and I_1D_2. Significantly lowest mean fresh weight of tubers plant^{-1} was observed in I_1D_1 at all the growth stages.

Effect of mulching :

The data presented in Table 5 and 6 implies that the mean fresh weight of tubers plant^{-1} was significantly influenced due to mulching. The maximum as significantly higher mean was fresh weight of tubers plant^{-1} was recorded in mulching compared to without mulching at all the days of observations during both the years of experimentation.

Interactions effect :

Treatments combination of irrigation levels with mulching (I_xM) and planting dates with mulching (D_xM) and (I_xD_xM) were found significant except at 28 DAP during the second year only.

Interaction effect of (IxM) :

At 56 DAP Table 7 revealed that I_3M_1 (180.78 g) recorded significantly maximum mean fresh weight of tubers plant^{-1}

Table 6 : Mean fresh weight of tubers plant^{-1} as influenced periodically by various treatments 2010-2011

Treatments	28 DAP M_1 (With mulch)	28 DAP M_2 (Without mulch)	28 DAP Mean	56 DAP M_1 (With mulch)	56 DAP M_2 (Without mulch)	56 DAP Mean	84 DAP M_1 (With mulch)	84 DAP M_2 (Without mulch)	84 DAP Mean	At harvest M_1 (With mulch)	At harvest M_2 (Without mulch)	At harvest Mean
	Mean fresh weight of tubers (g) plant^{-1}											
I_1D_1 (0.8 IW/CPE x 42 MW)	19.54	18.54	19.04	161.33	144.67	153.00	232.79	222.34	227.56	353.68	339.34	346.51
I_1D_2 (0.8 IW/CPE x 44 MW)	25.56	21.05	23.30	169.67	144.67	157.17	288.00	265.13	276.57	405.00	382.13	393.57
I_1D_3 (0.8 IW/CPE x 46 MW)	18.04	8.50	13.27	163.00	78.00	120.50	241.80	217.00	229.40	358.80	334.36	346.58
I_2D_1 (1.0 IW/CPE x 42 MW)	19.54	18.04	18.79	161.33	153.00	157.17	282.33	261.36	271.84	399.33	378.36	388.84
I_2D_2 (1.0 IW/CPE x 44 MW)	24.05	21.05	22.55	186.33	169.67	178.00	344.35	314.60	329.48	461.35	431.60	446.48
I_2D_3 (1.0 IW/CPE x 46 MW)	19.54	15.03	17.29	161.33	136.33	148.83	279.60	230.36	254.98	395.60	347.36	371.48
I_3D_1 (1.2 IW/CPE x 42 MW)	27.06	19.54	23.30	203.00	161.33	182.17	306.39	275.00	290.69	421.39	397.33	409.36
I_3D_2 (1.2 IW/CPE x 44 MW)	26.57	22.06	24.32	219.67	203.00	211.33	385.96	347.67	366.81	498.96	464.67	481.81
I_3D_3 (1.2 IW/CPE x 46 MW)	22.03	18.27	20.15	119.67	98.83	109.25	312.49	289.35	300.92	429.49	406.35	417.92
Mean	22.44	18.01	20.22	171.70	143.28	157.49	297.08	269.20	283.14	413.73	386.83	400.28
	S.E.	C.D. (P=0.05)		S.E.	C.D. (P=0.05)		S.E.	C.D. (P=0.05)		S.E.	C.D. (P=0.05)	
Main plot (I X D)	1.36	NS		11.42	34.23		2.33	6.98		1.96	5.89	
Sub plot (M)	0.45	1.35		2.60	7.72		1.31	3.89		1.14	3.39	
Interactions												
I X M	0.79	NS		4.50	13.37		2.27	6.74		1.98	5.88	
D X M	0.79	NS		4.50	13.37		2.27	6.74		1.98	5.88	
(I X D) X M	1.36	NS		7.80	23.16		3.93	11.68		3.43	10.18	

NS=Non- significant

which was at par with I_2M_1 and found significantly superior over rest of the treatments combinations during second year. At 84 DAP and harvest Table 7 revealed that I_3M_1 (334.95 and 449.95 g) followed by I_3M_2 and recorded significantly maximum mean fresh weight of tubers plant^{-1}, which was at par with I_2M_1 and found significantly superior over rest of the treatments combinations during second year.

Interaction effect of (DxM) :

At 56 DAP during second year, the interaction combination of different treatments, D_2M_1 recorded significantly highest mean fresh weight of tubers plant^{-1} (191.89 g) followed by D_1M_1, which was at par with D_2M_2 (Table 7). At 84 DAP and harvest, during second year, the interaction combination of different treatments, D_2M_1 recorded significantly highest mean fresh weight of tubers plant^{-1} (339.44 and 455.10 g) followed by D_2M_2, and D_3M_1.

Interaction effect of (IxDxM) :

At 56 DAP, the treatments combination $I_3D_2M_1$ was significantly superior, recording highest mean fresh weight of tubers plant^{-1} (188.33 and 219.67 g) which was at par with $I_3D_2M_2$, while rests of the treatments were at par with each others during both years. At 84 DAP, the treatments combination $I_3D_2M_1$ was significantly superior, recording highest mean fresh weight of tubers plant^{-1} (294.44 g) which was at par with $I_3D_1M_1$ followed by $I_2D_2M_1$ and $I_3D_2M_2$ during first year. Significantly treatments combination $I_3D_2M_1$ recorded maximum mean fresh weight of tubers plant^{-1} (385.96 g) followed by $I_3D_2M_2$, $I_2D_2M_1$ and $I_2D_2M_2$, while rests of the treatments were at par with each others during second year.

At harvest, the treatments combination $I_3D_2M_1$ was significantly superior, recording highest mean fresh weight of tubers plant^{-1} (352.44 g) followed by $I_3D_1M_1$, $I_2D_2M_1$ and $I_3D_2M_2$ during first year. Significantly treatments combination $I_3D_2M_1$ recorded maximum mean fresh weight of tubers plant^{-1} (498.96 g) followed by $I_3D_2M_2$, $I_2D_2M_1$ and $I_2D_2M_2$, while rests of the treatments were at par with each others during second year. Similar findings were reported by Sarma and Dutta (1999), Zhang *et al.* (2004), Singh and Ahmad (2008) and Costa *et al*. (1997).

At higher levels of irrigation (1.2 and 1.0 IW/CPE) two peaks of net photosynthesis (Table 1 and 2) were evident at 11.00 to 12.30 and 14.00 to 14.30 hr. At lower levels of irrigation the second peak was absent. Increased stomatal conductance appeared to be the reason for the first peak whereas for the second peak non-stomatal characters may be responsible. Photosynthetic rates were highest when planting was carried out during the last week of October and mulch was applied during first earthing up. Similar findings were reported by Kar (2003), Ku *et al.* (1977), Kimball *et al.* (1983) and Stuttle *et al.*

Table 7: Interaction effect of irrigation levels and planting dates with mulching on fresh weight of tubers plant^{-1}

Irrigation levels	M_1 (With mulch)	M_2 (Without mulch)	Mean	Planting dates	M_1 (With mulch)	M_2 (Without mulch)	Mean
56 DAP							
I_1 (0.8 IW/CPE)	164.67	122.44	143.56	D_1 (42 MW)	175.22	153.00	164.11
I_2 (1.0 IW/CPE)	169.67	153.00	161.33	D_2 (44 MW)	191.89	172.44	182.17
I_3 (1.2 IW/CPE)	180.78	154.39	167.58	D_3 (46 MW)	148.00	104.39	126.19
Mean	171.70	143.28	157.49	Mean	171.70	143.28	157.49
S.E.±		0.50		S.E.±		0.50	
C.D. (P=0.05)		13.37		C.D. (P=0.05)		13.37	
84 DAP							
I_1 (0.8 IW/CPE)	254.20	234.82	244.51	D_1 (42 MW)	273.84	252.90	263.37
I_2 (1.0 IW/CPE)	302.10	268.77	285.43	D_2 (44 MW)	339.44	309.13	324.29
I_3 (1.2 IW/CPE)	334.95	304.01	319.48	D_3 (46 MW)	277.97	245.57	261.77
Mean	297.08	269.20	283.14	Mean	297.08	269.20	283.14
S.E.±		2.37		S.E.±		2.37	
C.D. (P=0.05)		6.74		C.D. (P=0.05)		6.74	
At harvest							
I_1 (0.8 IW/CPE)	372.49	351.94	362.22	D_1 (42 MW)	391.47	371.68	381.57
I_2 (1.0 IW/CPE)	418.76	385.77	402.27	D_2 (44 MW)	455.10	426.13	440.62
I_3 (1.2 IW/CPE)	449.95	422.78	436.37	D_3 (46 MW)	394.63	362.69	378.66
Mean	413.73	386.83	400.28	Mean	413.73	386.83	400.28
S.E.±		1.98		S.E.±		1.98	
C.D. (P=0.05)		5.88		C.D. (P=0.05)		5.88	

(1996).

It is observed from the data presented in Table 5 to 6 that during both the years of experimentation, of crop growth in respect of total dry matter accumulation plant^{-1}, while at all the days of observation regarding fresh tuber weight plant^{-1}, planting on 44th MW, the irrigation scheduled at 1.2 IW/CPE (I_3D_2) was comparable with 1.0 IW/CPE (I_2D_2) and produced significantly higher mean values of these attributes than rest of the treatments. The results are in the line of those reported by Sharma *et al.* (1999), Gadysiak *et al*. (2001), Kimball *et al.* (1983) and Khan *et al.* (2002).

Conclusion :

The application of irrigation at 1.2 IW/CPE ratio and planting on 44th MW with mulching of sugarcane trash @ 5 t ha^{-1} recorded higher values of crucial microclimatic parameters beneficial for potato growth *viz.,* photosynthesis rate (34.40, 35.55 µ mol CO^2 m^{-2} s^{-1}), CO_2 concentration (409.29, 414.26 µ mol CO_2 m^{-2} s^{-1}), at tuber formation stage (56 DAP) obtaining maximum fresh weight of tuber yield (328.98 q ha^{-1}) and haulm yield (12.64 q ha^{-1}) on pooled basis. Mulching of sugarcane trash @ 5 t ha^{-1} significantly reduced the consumptive use and increased the water use efficiency (19.62 %) by obtaining the higher tuber yield (244.60 q ha^{-1}) over without mulching (231.00 q ha^{-1}) on pooled basis. Irrigation applied at 1.2 IW/CPE ratio and planting on 44th MW with mulching of sugarcane trash @ 5 t ha^{-1} significantly obtained the higher tuber yield of 328.98 q ha^{-1} .

REFERENCES

Costa, L.D., Vedove Delle, G., Gianquinto, G., Giovanardi, R. and Peressotti, A. (1997). Yield, water use efficiency and nitrogen uptake in potato: influence of drought stress. *Potato Res.,* **40**:19–34.

Gadysiak, S., Rymaszewski, J., Czajka, M. and Grzes, S. (2001). Influence of irrigation on yields of three potato cultivars in the West Wielkopolski region. *Prace Zakresu Nauk Rolniczych*, **91**: 51-57.

Kar, Gouranga (2003). Tuber yield of potato as influenced by planting dates and mulches. *J. Agromet*., **5**(1): 60-67.

Khan, I.A., Deadman, M.L. and Al. Habsi, K. (2002). Screening potato varieties for tuber production in arid regions: effect of planting date on yield potential. *Sultan Qaboos Univ. J. Scientific Res. Agric. Sci.,* **7**(1):53-57.

Kimball, B.A. (1983). Carbon dioxide and agriculture yield: An assemblage and analysis of prior observations. *Agron. J.* , **75**:779-788.

Ku, S.B., Edwards, G.E. and Tanner, C.B. (1977). Effects of light, carbon dioxide and temperature on photosynthesis, oxygen inhibition of photosynthesis, and transpiration in *Solanum tuberosum. Plant Physiol.,* **59**:868–872.

Sarma, Abhijit and Dutta, T.C. (1999). Effect of mulching technique with black plastic film (25 micro) on potato crop under rainfed condition. *Crop Res. Hissar,* **18**(3):383-386.

Sharma, Ramnik Dubey, Y.P. and Kaistha, B.P. (1999). Influence of irrigation and nitrogen on yield, total water expense and water expense efficiency of potato in Lahaul valley of Himalayas. *J. Indian Soc. Soil Sci.,* **47**(1): 19-22.

Singh, Narendra and Ahmad, Zakwan (2008). Effect of mulching on potato production in high altitude cold arid zone of Ladakh. *Potato J.,* **35** (3-4):118-121.

Stuttle, G.W., Yorio, N.C. and Wheeler, R.M. (1996). Interacting effects of photoperiod and photosynthetic photon flux on net carbon assimilation and starch accumulation in potato leaves. *J. American. Soc. Hort. Sci.*, **121**:264-268.

Zhang., YunQi., Cui., ZhiFeng. and Zhang., ZhenXian. (2004). Effect of different plastic film mulching patterns on yield of spring potato. *China Vegetables.,* **2**:36-37.

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