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Response of potato to different treatments on growth attributes

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Abstract
The field trial was conducted during both the seasons (2009-10 and 2010-11) on PGI Farm without changing randomization. The experiment was laid out in *Rabi* season. The various components of growth attributes viz. functional leaves and leaf area were calculated at an interval of 28 days. The number of functional leaves at 56 DAP in irrigation applied 1.2 IW/CPE ratio with sugarcane trash mulching (I3M1) or early planting on 44th MW with sugarcane trash mulching (D2M1) recorded maximum number of functional leaves than other treatment combination.
The application of mulching recorded significantly higher values of growth parameters viz., number of functional leaves, leaf area and plant height, number of branches, plant spread per plant than without mulching. Whereas, water stress condition impose due to without mulching at recorded significantly less values of these characters as compared to mulching.

Keywords: Potato, treatments, growth attributes

Introduction
Potato is one of the most important crops of the world, ranking next to rice and wheat. It assumes greater significance for its ability to provide food security to millions of people across the globe, as it provides more dry matter content, proteins and calories from per unit area of land and time. It is a wholesome food which is rich in carbohydrates, phosphorus, calcium, vitamin C and vitamin A, minerals and is high yielding short duration crop with high protein calorie ratio. Potato is one of the unique crop grown in our country having high productivity and supplementing food needs. (Gupta, 2006) [2]. The non-adoption of improved agro-techniques in a climate change scenario as irrigation scheduling, variable planting dates and use of mulch are the limiting factors for low productivity and poor in creation of favorable microclimatic conditions. Globally this climate change should also be addressed in eco-friendly manner.
With this back ground in view, the present investigation was undertaken to know the humidity and growth attributes as influenced by sowing windows in potato.

Material and Methods
The field trial of Potato (Variety) Kufri Pukhraj was conducted during both the seasons (2009-10 and 2010-11) on PGI Farm without changing randomization. The experiment was laid out 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)	
M1- With mulch	M2- Without mulch

Leaf area plant^{-1}
The plants uprooted for dry matter studies were utilized for measuring leaf area plant^{-1}. All these values were used combine to calculate the leaf area

plant^{-1} with the help of following formula as given below:

Leaf area = (L x W x factor) x n

where,

L= Maximum length of leaf (cm)
W= Maximum width of leaf at one third length from the base of leaf cm),
Factor= Leaf area constant for potato *i.e.* 0.8720
n = Number of leaves in respective group

Results and Discussion

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

Effect of irrigation level and planting dates on growth attributes

Among the quantitative growth and yield attributing characters, the height of main axis, number of primary branches, canopy components (number of functional leaves, its area and spread) and total number of tubers are reported to be associated with tuber yield. The yield of crop is a complex terminal outcome of plant growth to which there exists diverse and inter related phonological and physiological development tracks in its life cycle. This dynamic process is affected by continuous interactions occurring between environment and plant physiological process including the important components of yield.

At the end of this stage, mean plant height, number of branches and functional leaves, leaf area and total dry matter plant-1 were 32.15 cm, 8.20, 36.79, 2.42 dms-1 and 1.99g, respectively; during first year, while it were 33.00 cm, 10.14, 43.17, 2.96 and 3.24, respectively; during second year.

Later on, during both the years of experimentation, at 56 DAP, mean number of functional leaves, plant spread and leaf area expansion plant^{-1} reached to their maximum extent. Whereas, mean plant height as well as total dry matter plant^{-1} were maximum at maturity. Besides, 56 DAP onwards, the accumulation of total dry matter plant^{-1} was maximum towards the sink. Thus, the percent contributions of tuber dry matter to total dry matter accumulation plant^{-1} was enhanced from 56 DAP and reached to its maximum at harvest.

During the tuber development stage till maturity phase, the growth rate in terms of mean plant height, number of branches and functional leaves as well as leaf area plant^{-1} was slowed down. As well, during both the years, mean leaf area plant^{-1} decreased consistently from 84 DAP up to harvest owing to leaf senescence and shedding. While, the stem and leaves contributed relatively more only up to 56 DAP and less towards maturity phase due to diversion of photosynthates to tubers which being the economic component of potato crop.

The various growth attributes of potato *viz.*, mean plant height (cm), number of branches and functional leaves as well as leaf area (dm^2) plant^{-1} were influenced significantly due to different irrigation levels and planting date during both the years of investigation. The beneficial effect of irrigation on growth and development of potato crop is well established with reference to all the growth attributes.

Data presented in Table 1 and 45 and Table 4 and 48 revealed that during both the years of experimentation, at all the stages of crop growth, 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 exhibited significantly higher values for the mean number of functional leaves and leaf area plant^{-1} than the remaining treatments. Whereas, during the same period, irrigation scheduled at 0.8 IW/CPE and planting on 46th MW (I_1D_3) treatment recorded significantly lowest mean total number of functional leaves and leaf area plant^{-1} over rest of the treatments. The mean number of functional leaves per plant at 28, 56, 84 DAP and at harvest was 39.30, 81.38, 79.74 and 36.79 respectively (Same trend for second year also). The number of functional leaves per plant increased with the advancement of crop age upto 56 DAP. The 44th MW recorded significantly more number of leaves than other planting date at all days after planting. This might be due to the favourable climatic conditions during early planting of potato. These results are in consonance with Nair and Nair (1995) [3], the mean leaf area per plant at 28, 56, 84 DAP and at harvest was 7.13, 11.23, 4.05 and 2.42 dm^2 respectively. The mean leaf area plant^{-1} increased with advancement of crop age upto 56 DAP.

Effect of mulching on growth attributes

The various growths attributes of potato *viz.*, mean plant height, number of branches and functional leaves as well as leaf area plant^{-1} were influenced significantly due to mulching during both the years of investigation. The beneficial effect of mulching on growth and development of potato crop is well established with reference to all the growth attributes. Same trend was reported by Chen Go Ling (1997) [2]

Data presented in Table 1 and 2 and Table 4 and 5 revealed that during both the years of experimentation, at all the stages of crop growth with sugarcane trash mulching exhibited significantly higher values for the mean number of functional leaves and leaf area plant^{-1} than without mulching. Whereas, during the same period, without mulching recorded significantly lowest mean total number of functional leaves and leaf area plant^{-1} over with sugarcane trash mulching. The mean number of functional leaves per plant at 28, 56, 84 DAP and at harvest were 43.01, 87.94, 86.44 and 41.92 respectively. The number of functional leaves per plant increased with the advancement of crop age up to 56 DAP (81.38 and 83.35 respectively). The mulching recorded significantly more number of leaves plant^{-1} than without mulching at all days after planting. This might be due to availability of soil moisture condition with the favourable climatic conditions in mulching. These results are in consonance with Zhang Yun Qi *et al.* (2004) [4]. The maximum mean leaf area per plant was recorded at 56 DAP were 12.25 and 11.60 (dm^2 plant^{-1}) respectively.

Table 1: Mean number of functional leaves plant^{-1} as influenced by various treatments 2009-10

Treatments	Mean number of functional leaves plant^{-1}											
	28 DAP			56 DAP			84 DAP			AT harvest		
	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean
I_1D_1 (0.8 IW/CPE x 42 MW)	34.30	32.55	33.43	71.14	69.12	70.13	78.00	69.33	73.67	29.70	26.60	28.15
I_1D_2 (0.8 IW/CPE x 44 MW)	47.60	38.50	43.05	99.96	80.85	90.41	96.67	74.00	85.33	49.53	35.67	42.60
I_1D_3 (0.8 IW/CPE x 46 MW)	31.85	25.90	28.88	67.62	54.39	61.01	66.67	55.33	61.00	26.07	16.47	21.27
I_2D_1 (1.0 IW/CPE x 42 MW)	38.85	34.65	36.75	81.59	72.77	77.18	80.00	71.33	75.67	36.20	29.80	33.00
I_2D_2 (1.0 IW/CPE x 44 MW)	63.70	42.70	53.20	111.77	89.67	100.72	117.33	87.33	102.33	65.07	43.07	54.07
I_2D_3 (1.0 IW/CPE x 46 MW)	32.20	26.95	29.58	68.36	56.60	62.48	67.33	57.33	62.33	26.53	19.07	22.80
I_3D_1 (1.2 IW/CPE x 42 MW)	40.95	35.70	38.33	86.00	74.97	80.48	84.00	72.00	78.00	40.40	32.40	36.40
I_3D_2 (1.2 IW/CPE x 44 MW)	65.10	51.80	58.45	136.71	108.78	122.75	120.00	104.67	112.33	77.20	55.93	66.57
I_3D_3 (1.2 IW/CPE x 46 MW)	32.55	31.50	32.03	68.36	66.15	67.25	68.00	66.00	67.00	26.60	26.00	26.30
Mean	43.01	35.58	39.30	87.94	74.81	81.38	86.44	73.04	79.74	41.92	31.67	36.79
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
Main plot (I X D)	2.11		6.31	4.42		13.26	4.01		12.02	3.21		9.62
Sub plot (M)	0.83		2.48	1.75		5.21	1.59		4.73	1.27		3.78
Interactions												
I X M	1.45		NS	3.04		8.96	2.75		NS	2.20		NS
D X M	1.45		NS	3.04		8.96	2.75		NS	2.20		NS
(I X D) X M	2.50		7.44	5.26		15.63	4.77		14.18	3.82		11.34

Table 2: Mean number of functional leaves plant^{-1} as influenced by various treatments 2010-11

Treatments	Mean number of functional leaves plant-1											
	28 DAP			56 DAP			84 DAP			AT harvest		
	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean
I_1D_1 (0.8 IW/CPE x 42 MW)	34.30	32.55	33.43	71.14	69.12	70.13	78.00	69.33	73.67	29.70	26.60	28.15
I_1D_2 (0.8 IW/CPE x 44 MW)	47.60	38.50	43.05	99.96	80.85	90.41	96.67	74.00	85.33	49.53	35.67	42.60
I_1D_3 (0.8 IW/CPE x 46 MW)	31.85	25.90	28.88	67.62	54.39	61.01	66.67	55.33	61.00	26.07	16.47	21.27
I_2D_1 (1.0 IW/CPE x 42 MW)	38.85	34.65	36.75	81.59	72.77	77.18	80.00	71.33	75.67	36.20	29.80	33.00
I_2D_2 (1.0 IW/CPE x 44 MW)	63.70	42.70	53.20	111.77	89.67	100.72	117.33	87.33	102.33	65.07	43.07	54.07
I_2D_3 (1.0 IW/CPE x 46 MW)	32.20	26.95	29.58	68.36	56.60	62.48	67.33	57.33	62.33	26.53	19.07	22.80
I_3D_1 (1.2 IW/CPE x 42 MW)	40.95	35.70	38.33	86.00	74.97	80.48	84.00	72.00	78.00	40.40	32.40	36.40
I_3D_2 (1.2 IW/CPE x 44 MW)	65.10	51.80	58.45	136.71	108.78	122.75	120.00	104.67	112.33	77.20	55.93	66.57
I_3D_3 (1.2 IW/CPE x 46 MW)	32.55	31.50	32.03	68.36	66.15	67.25	68.00	66.00	67.00	26.60	26.00	26.30
Mean	43.01	35.58	39.30	87.94	74.81	81.38	86.44	73.04	79.74	41.92	31.67	36.79
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
Main plot (I X D)	2.11		6.31	4.42		13.26	4.01		12.02	3.21		9.62
Sub plot (M)	0.83		2.48	1.75		5.21	1.59		4.73	1.27		3.78
Interactions												
I X M	1.45		NS	3.04		8.96	2.75		NS	2.20		NS
D X M	1.45		NS	3.04		8.96	2.75		NS	2.20		NS
(I X D) X M	2.50		7.44	5.26		15.63	4.77		14.18	3.82		11.34

Table 3: Interaction effect of irrigation levels and planting dates with mulching on functional leaves plant^{-1} at 56 DAP

Functional leaves plant^{-1} 2009-10							
Irrigation levels	**M_1 (With mulch)**	**M_2 (Without mulch)**	**Mean**	**Planting dates**	**M_1 (With mulch)**	**M_2 (Without mulch)**	**Mean**
I_1 (0.8 IW/CPE)	79.57	68.12	73.85	D_1 (42 MW)	79.57	72.29	75.93
I_2 (1.0 IW/CPE)	87.24	73.01	80.12	D_2 (44 MW)	116.15	93.10	104.62
I_3 (1.2 IW/CPE)	97.02	83.30	90.16	D_3 (46 MW)	68.11	59.05	63.58
Mean	87.94	74.81	81.38	Mean	87.94	74.81	81.38
S.Em±	3.04			S.Em±	3.04		
CD at 5%	8.96			CD at 5%	8.96		
Functional leaves plant^{-1} 2010-11							
Irrigation levels	M_1 (With mulch)	M_2 (Without mulch)	Mean	Planting dates	M_1 (With mulch)	M_2 (Without mulch)	Mean
I_1 (0.8 IW/CPE)	83.65	71.01	77.33	D_1 (42 MW)	83.23	74.84	79.04
I_2 (1.0 IW/CPE)	89.17	76.82	82.99	D_2 (44 MW)	113.59	95.39	104.49
I_3 (1.2 IW/CPE)	94.21	85.23	89.72	D_3 (46 MW)	70.20	62.83	66.51
Mean	89.01	77.69	83.35	Mean	89.01	77.69	83.35
S.Em±	2.85			S.Em±	2.85		
CD at 5%	9.11			CD at 5%	9.11		

Table 4: Mean leaf area plant^{-1} as influenced by various treatments 2009-10

Treatments	Mean leaf area plant^{-1} (dm^{-2})											
	28 DAP			56 DAP			84 DAP			AT harvest		
	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean
I_1D_1 (0.8 IW/CPE x 42 MW)	6.54	6.53	6.54	10.50	10.11	10.30	3.89	3.80	3.85	2.19	2.18	2.18
I_1D_2 (0.8 IW/CPE x 44 MW)	7.05	6.86	6.96	11.46	10.75	11.10	4.22	4.10	4.16	2.73	2.46	2.59
I_1D_3 (0.8 IW/CPE x 46 MW)	6.16	4.58	5.37	10.17	8.08	9.13	2.86	2.53	2.70	1.94	1.61	1.78
I_2D_1 (1.0 IW/CPE x 42 MW)	6.66	6.59	6.63	10.58	10.17	10.38	3.97	3.93	3.95	2.25	2.19	2.22
I_2D_2 (1.0 IW/CPE x 44 MW)	7.43	7.35	7.39	13.72	11.36	12.54	4.45	4.40	4.42	3.36	2.68	3.02
I_2D_3 (1.0 IW/CPE x 46 MW)	6.39	6.39	6.39	10.25	8.27	9.26	3.80	2.88	3.34	2.08	1.89	1.99
I_3D_1 (1.2 IW/CPE x 42 MW)	6.83	6.79	6.81	10.99	10.67	10.83	4.08	4.05	4.07	2.49	2.33	2.41
I_3D_2 (1.2 IW/CPE x 44 MW)	14.89	8.35	11.62	22.28	12.62	17.45	7.35	5.03	6.19	3.67	3.31	3.49
I_3D_3 (1.2 IW/CPE x 46 MW)	6.49	6.41	6.45	10.33	9.88	10.10	3.86	3.66	3.76	2.16	2.10	2.13
Mean	7.60	6.65	7.13	12.25	10.21	11.23	4.28	3.82	4.05	2.54	2.30	2.42
	S.Em±	CD at 5%		S.Em±	CD at 5%		S.Em±	CD at 5%		S.Em±	CD at 5%	
Main plot (I X D)	0.40	1.20		0.62	1.86		0.33	1.00		0.12	0.37	
Sub plot (M)	0.18	0.53		0.24	0.71		0.09	0.26		0.05	0.14	
Interactions												
I X M	0.31	NS		0.41	NS		0.15	NS		0.08	NS	
D X M	0.31	NS		0.41	NS		0.15	NS		0.08	NS	
(I X D) X M	0.53	1.58		0.71	2.12		0.26	0.78		0.14	0.43	

Table 5: Mean leaf area plant^{-1} as influenced by various treatments 2010-11

Treatments	Mean leaf area plant^{-1} (dm^{-2})											
	28 DAP			56 DAP			84 DAP			AT harvest		
	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean	M_1 (With mulch)	M_2 (Without mulch)	Mean
I_1D_1 (0.8 IW/CPE x 42 MW)	4.25	4.10	4.17	10.39	10.22	10.31	7.31	7.14	7.23	2.68	2.67	2.68
I_1D_2 (0.8 IW/CPE x 44 MW)	4.50	4.38	4.44	11.59	11.37	11.48	7.59	7.35	7.47	3.15	2.96	3.05
I_1D_3 (0.8 IW/CPE x 46 MW)	3.77	3.14	3.45	8.88	7.99	8.44	6.82	5.00	5.91	2.44	1.93	2.19
I_2D_1 (1.0 IW/CPE x 42 MW)	4.29	4.21	4.25	11.06	10.42	10.74	7.31	7.24	7.28	2.75	2.69	2.72
I_2D_2 (1.0 IW/CPE x 44 MW)	4.73	4.68	4.70	12.03	11.91	11.97	7.91	7.79	7.85	3.89	3.18	3.53
I_2D_3 (1.0 IW/CPE x 46 MW)	4.08	3.93	4.01	9.87	9.84	9.85	7.01	6.83	6.92	2.51	2.45	2.48
I_3D_1 (1.2 IW/CPE x 42 MW)	4.36	4.33	4.35	11.32	11.03	11.18	7.53	7.32	7.43	3.00	2.88	2.94
I_3D_2 (1.2 IW/CPE x 44 MW)	7.64	5.31	6.48	19.06	12.57	15.82	15.51	8.90	12.20	5.17	3.81	4.49
I_3D_3 (1.2 IW/CPE x 46 MW)	4.17	4.08	4.13	10.18	10.10	10.14	7.11	6.98	7.05	2.60	2.58	2.59
Mean	4.64	4.24	4.44	11.60	10.60	11.10	8.24	7.17	7.70	3.13	2.79	2.96
	S.Em±	CD at 5%		S.Em±	CD at 5%		S.Em±	CD at 5%		S.Em±	CD at 5%	
Main plot (I X D)	0.21	0.62		0.57	1.72		0.44	1.32		0.16	0.49	
Sub plot (M)	0.09	0.25		0.24	0.73		0.20	0.58		0.06	0.19	
Interactions												
I X M	0.15	NS		0.42	NS		0.34	NS		0.11	NS	
D X M	0.15	NS		0.42	NS		0.34	NS		0.11	NS	
(I X D) X M	0.26	0.76		0.73	2.18		0.59	1.75		0.19	0.57	

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