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VA Apotikar
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

AV Solanke
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

GS Laharia
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
VA Apotikar
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Correlation studies between different microclimate parameters with growth attributes in potato as influenced by different treatmentse

VA Apotikar, AV Solanke and GS Laharia

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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 microclimatic parameters *viz*. In correlation studies it was observed that the main microclimatic parameters *viz.*, photosynthetic rate was positively correlated with number of functional leaves, leaf area, plant spread. Similarly stomatal conductance also positively correlated with functional leaves, leaf area, plant spread, dry matter, number and fresh weight of tubers. PAR has positive correlation with number of functional leaves, leaf area, plant spread, dry matter, number and fresh weight of tubers. Stomatal resistance, air and leaf temperature were negatively correlated with number of functional leaves, leaf area, plant spread, dry matter, number and fresh weight of tubers, photosynthetic rate, CO_2 concentration, stomatal conductance, PAR, GDD and LUE.

Keywords: Correlation studies, microclimate parameters and growth attributes

Introduction
In the world more than billion people eat potatoes (Rajendra Prasad, 2002) [2]. The potato is a crop which always been the poor man's friend. For vegetable purpose, it has become one of the most popular crops in the country. Potatoes are economical food as they provide a source of low cost energy to human diet. Potato is one of the world leading vegetable crops and cheapest source of carbohydrate and furnishes appreciable amount of vitamin B_1 and C_1 as well as minerals (Thompson and Kelly 1972) [3]. Being a temperate crop, growth of potato and yield are adversely affected due to higher temperature, especially mean temperature of above 17 °C. Hence proper planting time must be framed to produce maximum yield by efficient utilization of natural resources. Exposure of crop to excellent growth period is only possible by proper planting dates and escaping the crop from many weather hazards.
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 correlation between different microclimate parameters with growth attributes as influenced by sowing windows in potato.

Materials 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

Results and Discussions

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

Correlation studies: At the 28 DAP, data on correlation coefficient between various biometric observation, growth functions, yield, yield attributes, microclimatic attributes in potato are presented in Table1, which shows that the number of branches, number of leaves, leaf area showed strong positive correlation with photosynthetic rate, stomatal conductance, PAR, GDD and LUE. There was also positive correlation of plant spread with photosynthetic rate and CO_2 concentration. Similarly dry matter accumulation has positive correlation with LAI, LAD and PAR. The number of tuber plant^{-1} and tuber weight plant^{-1} were positively correlated with photosynthetic rate, CO_2 concentration and stomatal conductance, PAR, and GDD.

However, all the biometric characters have negative correlation with the stomatal resistance. The numbers of leaves, leaf area plant^{-1} and dry matter accumulation has negative correlation with the air temperature and leaf temperature. Similarly there was negative correlation of plant spread with humidity and leaf temperature. In the same way number of tuber and fresh weight of tuber was negatively correlated with stomatal resistance.

At the 56 DAP, it had showed (Table 2) highly significant positive correlation between number of leaves with photosynthetic rate, stomatal conductance, PAR, GDD, LUE and humidity. There was also positive correlation between leaf area and photosynthetic rate, stomatal conductance, PAR, LUE and humidity.

It is seen from the data presented in Table 2, that there was strong positive correlation plant spread and photosynthetic rate, CO_2 concentration, stomatal conductance, PAR, LUE and humidity. Similarly dry matter had positive correlation with stomatal conductance, GDD and LUE. Significantly strong positive correlation of number and fresh weight of tubers was also found with stomatal conductance and PAR.

AT the 84 DAP, the data presented in Table 3 there was positive correlation of number of leaves with photosynthetic rate, stomatal conductance, PAR, LUE and humidity. There was positive correlation of leaf area with photosynthetic rate, stomatal conductance, PAR, LUE and humidity. The plant spread had strong positive correlation with photosynthetic rate, stomatal conductance, and PAR Similarly the dry matter had significantly positive correlation with photosynthetic rate, stomatal conductance, PAR, LUE and humidity. The number of tubers plant^{-1} and fresh weight of tubers plant^{-1} have shown positive correlation with photosynthetic rate, stomatal conductance, PAR. However, all the biometric and yield characters were negatively correlated with stomatal resistance, air temperature and leaf temperature.

AT harvest the data on correlation coefficient between various biometrics characters yield and yield attributes are presented in Table 4, which showed significantly positive correlation of number of leaves with photosynthetic rate, stomatal conductance, GDD, LUE and humidity. There was strong positive correlation between leaf area with photosynthetic rate, stomatal conductance, PAR, GDD, LUE and humidity. There was also positive correlation between plant spread with CO_2, stomatal conductance, PAR, GDD, LUE and humidity. It had also showed significantly positive correlation of dry matter with photosynthetic rate, CO_2, stomatal conductance, PAR, GDD and LUE.

It is evident from the data that there was strong positive correlation of number of tubers plant^{-1} with stomatal conductance and PAR. There was also positive correlation of fresh weight of tuber plant^{-1} with photosynthetic rate, stomatal conductance, PAR and LUE. Tuber yield ha^{-1} had positive correlation with photosynthetic rate, stomatal conductance, GDD and LUE.

Table 1: Correlation coefficients between different microclimate, biometric observations, yield and yield attributes at 28 DAP

Sr. No	Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	No. of functional leaves plant^{-1}	1**															
2	Leaf area plant^{-1} (dm^2)	0.652**	1**														
3	Plant spread (cm)	0.311	0.489*	1**													
4	Dry matter plant^{-1} (g)	0.506*	0.393	-0.027	1**												
5	No of tubers plant^{-1}	0.666**	0.736**	0.561*	0.365	1**											
6	Fresh weight of tubers (g plant^{-1})	0.666**	0.736**	0.561*	0.365	0.952**	1**										
7	Photosynthetic rate (µ mol CO_2 m^{-2} s^{-1})	0.488*	0.726**	0.494*	0.308	0.766**	0.766**	1**									
8	CO_2 conc. (µ mol CO_2 m^{-2} s^{-1})	0.403	0.505*	0.782**	0.025	0.694**	0.694**	0.567*	1**								
9	Stomatal conductance (mol. m^{-2} s^{-1})	0.566*	0.814**	0.265	0.286	0.608**	0.608**	0.649**	0.431	1**							
10	PAR (µ mol CO_2 m^{-2} s^{-1})	0.618**	0.58*	0.341	0.619**	0.618**	0.618**	0.307	0.378	0.522*	1**						
11	GDD	0.547*	0.434	0.388	0.395	0.525*	0.525*	0.566*	0.383	0.44	0.597**	1**					
12	LUE (g MJ^{-1})	0.621**	0.763**	0.195	0.298	0.453	0.453	0.569*	0.344	0.856**	0.371	0.446	1**				
13	Stomatal resistance (mol. m^{-2} s^{-1})	-0.4	-0.391	-0.081	-0.427	-0.229	-0.229	-0.118	-0.154	-0.444	-0.392	-0.333	-0.308	1**			
14	Air temp.(°C)	-0.156	-0.07	0.058	-0.097	0.113	0.113	-0.173	0.196	-0.282	-0.105	-0.28	-0.349	-0.07	1**		
15	Humidity (%)	0.034	0.142	-0.139	0.059	0.329	0.329	0.162	0.101	-0.072	-0.028	-0.071	-0.057	0.028	0.726**	1**	
16	Leaf temp.(°C)	-0.785	-0.56	-0.374	-0.261	-0.667	-0.667	-0.581	-0.391	-0.545	-0.545	-0.53	-0.53	0.026	0.458	0.073	1**

*=Significant at 5% level, **=Significant at 1% level

Table 2: Correlation coefficients between different microclimate, biometric observations, yield and yield attributes at 56 DAP.

Sr. No	Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	No. of functional leaves plant^{-1}	1**															
2	Leaf area plant^{-1} (dm^2)	0.718**	1**														
3	Plant spread (cm)	0.642**	0.691**	1**													
4	Dry matter plant^{-1} (g)	0.507*	0.555*	0.571*	1**												
5	No of tubers plant^{-1}	0.726**	0.686**	0.418	0.399	1**											
6	Fresh weight of tubers (g plant^{-1})	0.726**	0.686**	0.418	0.399	1**	1**										
7	Photosynthetic rate (µ mol CO_2 m^{-2} s^{-1})	0.668**	0.562*	0.559*	0.321	0.461	0.461	1**									
8	CO_2 conc. (µ mol CO_2 m^{-2} s^{-1})	0.297	0.361	0.676**	0.301	0.113	0.113	0.535*	1**								
9	Stomatal conductance (mol. m^{-2} s^{-1})	0.626**	0.887**	0.655**	0.561*	0.597**	0.597**	0.603**	0.485*	1**							
10	PAR (µ mol CO_2 m^{-2} s^{-1})	0.728**	0.785**	0.54*	0.398	0.682**	0.682**	0.535*	0.392	0.791**	1**						
11	GDD	0.474*	0.292	0.309	0.482*	0.336	0.336	0.588*	0.13	0.21	0.1	1**					
12	LUE (g MJ^{-1})	0.477*	0.647**	0.576*	0.566*	0.29	0.29	0.293	0.28	0.671**	0.411	0.059	1**				
13	Stomatal resistance (mol. m^{-2} s^{-1})	-0.269	-0.52	-0.547	-0.231	-0.453	-0.453	-0.496	-0.73	-0.569	-0.517	-0.225	-0.24	1**			
14	Air temp.(°C)	-0.088	-0.545	-0.414	-0.293	-0.041	-0.041	-0.343	-0.219	-0.512	-0.272	-0.214	-0.214	0.326	1**		
15	Humidity (%)	0.568*	0.616**	0.545*	0.411	0.466	0.466	0.445	0.368	0.38	0.487*	0.538*	-0.004	-0.466	-0.481	1**	
16	Leaf temp.(°C)	-0.495	-0.808	-0.583	-0.593	-0.487	-0.487	-0.573	-0.501	-0.821	-0.694	-0.213	-0.553	0.557*	0.672**	-0.488	1**

*=Significant at 5% level, **=Significant at 1% level

Table 3: Correlation coefficients between different microclimate, biometric observations, yield and yield attributes at 84 DAP.

Sr. No	Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	No. of functional leaves plant^{-1}	1**															
2	Leaf area plant^{-1} (dm^2)	0.621**	1**														
3	Plant spread (cm)	0.517*	0.589*	1**													
4	Dry matter plant^{-1} (g)	0.487*	0.773**	0.457	1**												
5	No of tubers plant^{-1}	0.668**	0.552*	0.504*	0.516*	1**											
6	Fresh weight of tubers (g plant^{-1})	0.658**	0.593**	0.484*	0.548*	0.974**	1**										
7	Photosynthetic rate (µ mol CO_2 m^{-2} s^{-1})	0.697**	0.591**	0.593**	0.568*	0.541*	0.487*	1**									
8	CO_2 conc. (µ mol CO_2 m^{-2} s^{-1})	0.316	0.445	0.262	0.335	0.062	0.175	0.119	1**								
9	Stomatal conductance (mol. m^{-2} s^{-1})	0.678**	0.887**	0.601**	0.784**	0.62**	0.642**	0.704**	0.479*	1**							
10	PAR (µ mol CO_2 m^{-2} s^{-1})	0.737**	0.719**	0.588*	0.559*	0.66**	0.639**	0.611**	0.413	0.861**	1**						
11	GDD	0.411	0.225	0.433	0.324	0.29	0.326	0.4	0.068	0.259	0.145	1**					
12	LUE (g MJ^{-1})	0.47*	0.83**	0.442	0.819**	0.361	0.454	0.441	0.57*	0.859**	0.644**	0.227	1**				
13	Stomatal resistance (mol. m^{-2} s^{-1})	-0.382	-0.441	-0.346	-0.441	-0.244	-0.368	-0.255	-0.727	-0.523	-0.415	-0.379	-0.658	1**			
14	Air temp. (°C)	-0.099	-0.624	-0.35	-0.53	-0.121	-0.111	-0.276	-0.247	-0.635	-0.362	-0.206	-0.645	0.343	1**		
15	Humidity (%)	0.618**	0.561*	0.406	0.477*	0.433	0.451	0.2	0.349	0.538*	0.521*	0.538*	0.529*	-0.49	-0.496	1**	
16	Leaf temp.(°C)	-0.487	-0.778	-0.415	-0.734	-0.303	-0.28	-0.503	-0.431	-0.837	-0.659	-0.025	-0.744	0.283	0.74**	-0.455	1**

*=Significant at 5% level, **=Significant at 1% level

Table 4: Correlation coefficients between different microclimate, biometric observations, yield and yield attributes at harvest.

Sr. No	Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	No. of functional leaves plant^{-1}	1**															
2	Leaf area plant^{-1} (dm^2)	0.666**	1**														
3	Plant spread (cm)	0.528*	0.773**	1**													
4	Dry matter plant^{-1} (g)	0.514*	0.833**	0.708**	1**												
5	No of tubers plant^{-1}	0.489*	0.604**	0.515*	0.498*	1**											
6	Fresh weight of tubers (g plant^{-1})	0.668**	0.719**	0.524*	0.569*	0.871**	1**										
7	Photosynthetic rate (µ mol CO_2 m^{-2} s^{-1})	0.838**	0.657**	0.527*	0.541*	0.342	0.494*	1**									
8	CO_2 conc. (µ mol CO_2 m^{-2} s^{-1})	0.599**	0.712**	0.732**	0.681**	0.757**	0.789**	0.324	1**								
9	Stomatal conductance (mol. m^{-2} s^{-1})	0.807**	0.63**	0.448	0.573*	0.355	0.634**	0.772**	0.418	1**							
10	PAR (µ mol CO_2 m^{-2} s^{-1})	0.303	0.356	0.533*	0.498*	0.173	0.27	0.123	0.557*	0.218	1**						
11	GDD	0.418	0.785**	0.742**	0.686**	0.748**	0.726**	0.316	0.859**	0.303	0.345	1**					
12	LUE (g MJ^{-1})	0.405	0.21	0.444	0.257	0.115	0.176	0.181	0.406	0.155	0.6**	0.323	1**				
13	Stomatal resistance (mol. m^{-2} s^{-1})	0.615**	0.594**	0.751**	0.683**	0.433	0.369	0.623**	0.622**	0.364	0.464	0.6**	0.58*	1**			
14	Air temp.(°C)	0.68**	0.843**	0.592**	0.723**	0.46	0.544*	0.737**	0.385	0.668**	0.225	0.471*	0.255	0.564*	1**		
15	Humidity (%)	-0.582	-0.57	-0.619	-0.568	-0.738	-0.741	-0.483	-0.805	-0.54	-0.257	-0.722	-0.185	-0.597	-0.281	1**	
16	Leaf temp.(°C)	-0.138	-0.676	-0.549	-0.581	-0.421	-0.44	-0.128	-0.562	-0.054	-0.256	-0.804	-0.365	-0.481	-0.452	0.353	1**

*=Significant at 5% level, **=Significant at 1% level

Conclusion

The main microclimatic parameters *viz.*, photosynthetic rate was positively correlated with number of functional leaves, leaf area, plant spread. Similarly stomatal conductance also positively correlated with functional leaves, leaf area, plant spread, dry matter, number and fresh weight of tubers. PAR has positive correlation with number of functional leaves, leaf area, plant spread, dry matter, number and fresh weight of tubers. Mulching of sugarcane trash @ 5 t ha^{-1} significantly reduced the consumptive use and daily water use by obtaining the higher dry matter accumulation yield over without mulching 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 dry matter accumulation yield.

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