



E-ISSN: 2709-9385
 P-ISSN: 2709-9377
 JCRFS 2022; 3(1): 68-71
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www.foodresearchjournal.com
 Received: 02-10-2021
 Accepted: 09-12-2021

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Effect of different treatments on fresh weight of tuber and soil moisture extraction pattern

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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 yield and yield contributing characters were calculated. The growth and yield contributing characters, fresh weight of tubers were higher in 1.2 IW/CPE ratio (5 irrigations at 18 to 20 days interval) and planting on 44th MW (Oct 29-Nov 04) with sugarcane trash mulch as compared to other treatments. Further, application of irrigation at 1.0 IW/CPE ratio with sugarcane trash mulching (I₂M₁) or early planting on 42nd MW with sugarcane trash mulching (D₁M₁) was followed the next in order of significant. The maximum water extraction values were 48.42 and 49.53 percent, suggesting that crop should be irrigated at 1.2 IW/CPE ratio (5 irrigations at 18 to 20 days interval) and planting to be carried during 44th MW (Oct 29-Nov 04) with sugarcane trash mulch. The soil moisture extraction was more in mulching. The mulching creates maximum available soil moisture at all the growth stages. The without mulching (26.58 and 21.91%) recorded maximum water extraction from lower soil layer (30-45 cm) resulting in less available soil moisture.

Keywords: Sowing window, fresh weight of tuber, soil moisture extraction pattern

Introduction

In India nearly 80% of potatoes are grown in vast Indo-Gangetic plains of north India during short winter days from October to March. Potato is grown over the states under very diverse conditions. Among various factors responsible for low productivity of potato, improper scheduling of irrigation is major one. The criterion of soil water availability for scheduling irrigation could not be considered in isolation and this led to the development of climatological approach which takes into account the integrated effect of all-weather parameters that determine water use by the crop. 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 fresh weight of tuber along with soil moisture extraction pattern 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 ₁ D ₁ - (0.8 IW/CPE) X (42 MW)	I ₂ D ₁ - (1.0 IW/CPE) X (42 MW)
I ₁ D ₂ - (0.8 IW/CPE) X (44 MW)	I ₂ D ₂ - (1.0 IW/CPE) X (44 MW)
I ₁ D ₃ - (0.8 IW/CPE) X (46 MW)	I ₂ D ₃ - (1.0 IW/CPE) X (46 MW)
I ₃ D ₁ - (1.2 IW/CPE) X (42 MW)	
I ₃ D ₂ - (1.2 IW/CPE) X (44 MW)	
I ₃ D ₃ - (1.2 IW/CPE) X (46 MW)	
B. Sub-plot Treatments (Two) Mulching (M)	
M1 - With mulch	M2 - Without mulch

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Post-harvest studies

The sample plants which selected earlier for pre harvest studies of potato crop were used later for post-harvest studies too.

Harvesting of tubers

Before harvesting of tubers dehauling was done and haulms were put on the ridges for drying and tubers were kept in soil for five days for hardening of tuber skin. Harvesting of potato tubers was done manually according to the planting dates. The ring lines were first harvested and then tubers from net area were harvested and weighed separately gradewise from each net plot.

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.

Fresh weight of tubers

The data regarding gradewise yield of tubers ($q\ ha^{-1}$) as influenced by various treatments during 2009-10, 2010-11 and total are presented in Table 1, 2 and 3

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 1 and 2 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 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.

Interaction effect between (IxM)

Data presented in Table 51 and 52 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 to rest of the treatments, while rests of the treatments were at par with each other's 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 to 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 to rest of the treatments, while rests of the treatments were at par with each other's.

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 to 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 the 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 51 and 52 implies that the mean fresh weight of tubers $plant^{-1}$ was significantly influenced due to mulching. The maximum as significantly higher mean 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 ($I \times M$) and planting dates with mulching ($D \times M$) and ($I \times D \times M$) were found significant except at 28 DAP during the second year only.

Interaction effect between (IxM)

At 56 Table 53 revealed that I_3M_1 (180.78 g) recorded significantly maximum mean fresh weight of tubers $plant^{-1}$ which was at par with I_2M_1 and found significantly superior to rest of the treatments combination during second year.

At 84 DAP and harvest Table 53 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 to rest of the treatments combination during second year.

Interaction effect between (DxM)

At 56 DAP during second year, the interaction combination of different treatments, D_2M_1 was recorded significantly the 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 53).

At 84 DAP and harvest, during second year, the interaction combination of different treatments, D_2M_1 was recorded significantly the 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 between (IxMxM)

At 56 DAP, the treatments combination $I_3D_2M_1$ was significantly superior, recording the 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 other's during both years.

At 84 DAP, the treatments combination $I_3D_2M_1$ was significantly superior, recording the 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 other's during second year.

At harvest, the treatments combination $I_3D_2M_1$ was significantly superior, recording the 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 other's during second year.

These results are corroborated with the findings of Shiri-e-Janagard *et al.* (2009) [3] reported that moisture-stress will reduce the leaf area which results in reducing the photosynthesizing surface which will ultimately reduce the fresh tuber weight and dry matter accumulation in potato crop under stressed treatments. The early planting recorded maximum fresh tuber weight and dry matter than late once. The similar results were recorded by Gronowicz *et al.* (1992) [1]. This might be due to the favourable climatic condition available during crop growth period.

Effect of different treatments on soil moisture extraction pattern: The soil moisture extraction pattern in potato, it was revealed that irrespective of various irrigation levels and planting dates; the proportion of moisture extraction decreased progressively (parabolic) with the increase in soil layer depths, respectively.

In potato, the obtained pattern was: 0-15 cm (Av. 46.73 percent), 15-30 cm (Av. 32.52 percent) and 30-45 cm (Av. 20.75 percent). Thus, it clearly indicate that potato availed higher proportion of available soil moisture from the upper soil layers (0-15 cm) which is normally the active root zone of the crop from soil moisture point of view.

While, with respect to various irrigation levels and planting dates applied to potato, it was noticed that more frequent levels of irrigation (I₃ (1.2 IW/CPE) and I₂ (1.0 IW/CPE) ratios) extracted higher percentages of moisture from the upper soil layers than the less frequent levels of irrigation (I₁ (0.8 IW/CPE) ratio).

On pooled basis, potato showed the pattern as 0-15 and 15-30 cm = Av. 46.44 Vs 31.70 per cent, respectively. On the

other hand, stressed levels of irrigation extracted higher percentages of moisture from lower successive layers than the non-stressed levels of irrigation where in mulching exhibited the pattern as: 0-15, 15-30 and 30-45 cm = Av. 47.60, 32.94 and 19.57 per cent, respectively, while in without mulching the pattern was: 0-15, 15-30 and 30-45 cm = Av. 45.28, 30.47 and 24.25 percent, respectively.

In all, an appraisal of both years comparative study revealed that irrespective of various irrigation levels applied, potato availed higher proportion of soil moisture from the surface layers (i.e. 0-15 cm). In treatment, with mulching extracted higher percentages of moisture from the upper soil layer than lower layers (i.e. 0-15 and 15-30 cm) and vis-a-vis in lower successive soil layer exactly the reverse trend was noticed in potato. Similarly without mulching extracted higher percentages of moisture from the lower soil layer (i.e. 30-45 cm) and vis-a-vis in upper successive soil layers exactly the reverse trend was noticed.

Table 1: Mean fresh weight of tubers plant⁻¹ as influenced periodically by various treatments 2009-10

Treatments	Mean fresh weight of tubers (g) 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 ₁ D ₁ (0.8 IW/CPE x 42 MW)	21.54	19.03	20.28	134.67	119.33	127.00	236.00	219.39	227.70	293.90	277.39	285.65
I ₁ D ₂ (0.8 IW/CPE x 44 MW)	26.05	21.54	23.79	142.33	104.00	123.17	254.28	249.89	252.09	312.72	307.04	309.88
I ₁ D ₃ (0.8 IW/CPE x 46 MW)	14.50	12.00	13.25	127.00	117.00	122.00	235.10	223.00	229.05	292.66	280.87	286.76
I ₂ D ₁ (1.0 IW/CPE x 42 MW)	26.03	18.53	22.28	134.67	127.00	130.83	257.85	247.23	252.54	319.15	304.32	311.74
I ₂ D ₂ (1.0 IW/CPE x 44 MW)	24.54	21.54	23.04	157.67	142.33	150.00	284.18	254.13	269.15	340.79	322.38	331.58
I ₂ D ₃ (1.0 IW/CPE x 46 MW)	20.03	15.52	17.78	134.67	111.67	123.17	256.35	233.33	244.84	314.69	301.81	308.25
I ₃ D ₁ (1.2 IW/CPE x 42 MW)	26.05	21.54	23.79	173.00	134.67	153.83	285.35	268.43	276.89	341.67	326.43	334.05
I ₃ D ₂ (1.2 IW/CPE x 44 MW)	27.06	22.55	24.81	188.33	173.00	180.67	294.44	272.86	283.65	352.44	331.95	342.20
I ₃ D ₃ (1.2 IW/CPE x 46 MW)	22.52	19.51	21.01	96.33	77.17	86.75	271.56	257.72	264.64	329.56	315.72	322.64
Mean	23.15	19.08	21.12	143.19	122.91	133.05	263.90	247.33	255.62	321.95	307.55	314.75
	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)	1.50		NS	11.21		33.60	2.70		8.10	1.36		4.09
Sub plot (M)	0.33		0.97	1.97		5.87	1.14		3.38	0.61		1.81
Interactions												
I X M	0.56		NS	3.42		NS	1.97		NS	1.05		NS
D X M	0.56		NS	3.42		NS	1.97		NS	1.05		NS
(I X D) X M	0.98		NS	5.92		17.60	3.41		10.13	1.83		5.43

Table 2: Mean fresh weight of tubers plant⁻¹ as influenced periodically by various treatments 2010-11

Treatments	Mean fresh weight of tubers (g) 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 ₁ D 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 ₁ D 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 ₁ D 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 ₂ D 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 ₂ D 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 ₂ D 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 ₃ D 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 ₃ D 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 ₃ D 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.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
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

Table 3: The soil moisture extraction pattern from different soil layers of potato as influenced by different treatments on pooled

Treatments	Soil moisture extraction pattern (%) on pooled								
	M ₁ (With mulch)			M ₂ (Without mulch)			Mean		
	Soil layer (cm)			Soil layer (cm)			Soil layer (cm)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
I ₁ D ₁ (0.8 IW/CPE x 42 MW)	47.23	32.98	19.83	45.22	30.71	24.08	46.23	31.85	21.96
I ₁ D ₂ (0.8 IW/CPE x 44 MW)	48.41	33.75	18.17	46.13	31.63	22.25	47.27	32.69	20.21
I ₁ D ₃ (0.8 IW/CPE x 46 MW)	46.06	31.04	23.04	43.82	27.97	28.22	44.94	29.51	25.64
I ₂ D ₁ (1.0 IW/CPE x 42 MW)	47.73	33.05	19.38	45.52	30.75	23.74	46.63	31.90	21.56
I ₂ D ₂ (1.0 IW/CPE x 44 MW)	48.66	34.19	17.20	46.33	31.90	21.78	47.49	33.05	19.50
I ₂ D ₃ (1.0 IW/CPE x 46 MW)	46.42	31.72	21.86	43.95	28.84	27.21	45.19	30.28	24.54
I ₃ D ₁ (1.2 IW/CPE x 42 MW)	48.01	33.27	18.72	45.61	30.90	23.49	46.81	32.09	21.11
I ₃ D ₂ (1.2 IW/CPE x 44 MW)	48.98	34.46	16.77	46.57	32.24	21.20	47.78	33.35	18.99
I ₃ D ₃ (1.2 IW/CPE x 46 MW)	46.88	31.96	21.16	44.43	29.31	26.27	45.65	30.64	23.72
Mean	47.60	32.94	19.57	45.28	30.47	24.25	46.44	31.70	21.91

Conclusion

The interaction effect between main plot treatment (Irrigation levels or planting dates) and sub plot treatment (Mulching) were non-significant for all the yield contributing characters and fresh tuber and haulm yield during first year but it was significant for large sized tuber yield and total tuber yield and haulm yield during second year and on pooled analysis also. With the application of irrigation at 1.2 IW/CPE ratio with sugarcane trash mulching (I₃M₁) or early planting on 44th MW with mulching (D₂M₁). Further, application of irrigation at 1.0 IW/CPE ratio with sugarcane trash mulching (I₂M₁) or early planting on 42nd MW with sugarcane trash mulching (D₁M₁) was followed the next in order of significant.

An appraisal of both the years of comparative study referring to soil moisture extraction pattern revealed that irrespective to application of various irrigation levels, potato crop extracted higher percentage of soil moisture from the upper soil layers (0-15 cm) than lower layers.

Application of irrigation at (1.2 and 1.0 IW/CPE ratios) extracted higher percentages of moisture from the upper soil layers than the irrigation at (0.8 IW/CPE ratio). Whereas, under stressed condition of potato extracted higher percentages of soil moisture from lower successive soil layers (15-30 and 30-45 cm) than the non-stressed condition during both the years of investigation.

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