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Short communication

Response of different cultivars of potato to various soil moisture regimes under South Eastern Rajasthan

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ABSTRACT

A field experiment was conducted to assess the effect of water management practices and varieties on the growth, yield and water productivity of potato at Agricultural Research Station, Kota during the year 2017-18 and 2018-19 situated in the humid south eastern plain zone of Rajasthan. Five potato varieties (V_1- AICRP-P-21, V_2- AICRP-P-32, V_3- AICRP-P-37, V_4- AICRP-P-38 and V_5- Kufri Sindhuri) as main plot treatment and four levels of irrigation (subplot treatments) i.e I_1-Irrigation at 20 mm cumulative pan evaporation (CPE) , I_2-Irrigation at 25 mm CPE (5, sub-optimal irrigations), I_3-Irrigation at 30 mm CPE (4 irrigations at critical stages) and I_4- Irrigation at 30 mm CPE + paddy straw mulch @ 5 t/ha at the time of planting were arranged in split plot design with three replications. The results revealed that the emergence was significantly higher in variety AICRP- P-38, tuber yield and plant height was significantly higher in variety Kufri Sinduri and number of shoots per plant were significantly higher in the variety AICRP- P-32. Application of straw mulch @5 t/ha along with four irrigation gave crop yield at par with the treatment with five irrigation and resulted in saving of one irrigation as compared to I_3 treatment. Thus, paddy straw mulching @5t/ha alongwith four irrigation (I_3) may be recommended to achieve higher tuber yield, seed grade tubers under lower water availability in arid environment of Rajasthan.

Key words: *Solanum tuberosum*, Tuber yield, water productivity.

Potato (*Solanum tuberosum* L.) is one of the most important tuber crops, grown in more than 125 countries over an area of about 19.3 million hectare (FAOSTAT, 1) and consumed almost daily by more than a billion people. The potatoes on fresh weight basis contain about 16-20% carbohydrates, 2.5-3.2% crude protein, 0.8-1.2% minerals, 0.1-0.2% crude fats, 0.6% crude fibre and B_1, B_3 and B_6 vitamins. In Rajasthan, total area under potato cultivation is 15,000 ha, with production of 240,000 MT and productivity of 160 q/ha (Anonymous, 2). Potato crop has a shallow rooting system and is susceptible to many biotic and abiotic stresses and is especially more prone to water stress. The water deficiency may result in the severe reduction of potato quality and productivity. The maximum root length of about 85 % is concentrated in the upper 30-40 cm soil layer. Therefore, sufficient water availability is a critical issue for the targeted production of potato crop (Fabeiro *et al.,* 3). Potato water requirement varies from 350-550 mm depending upon the length of growing season, atmospheric conditions, soil type, and variety.

The various options to reduce water needs include improved irrigation management (scheduling) and equipment for uniform and efficient application, weather forecasting to improve effective rainfall, encouraging deeper rooting of crops, use of lower water requiring or drought tolerant crop varieties, modifying soil to improve soil moisture retention. The water is scarce and supplies are erratic or variable in the Rajasthan condition, thus timely irrigation and conservation of soil moisture reserves are the most important agronomic interventions to maintain yields during drought stress. Mulches have been known to reduce evaporative losses, especially during the early growth period of the crop. Jalota *et al.* (4) reported that the straw mulching help in conserving soil moisture, lowering soil temperature, and also improving growth and yield of crops under soil moisture limiting conditions. However, Shock *et al.,* (7) reported that potatoes can tolerate limited degree of moisture stress, before tuber set without significant potato yield losses. Jefferies and MacKerron (5) reported that the potato varieties differ in their tolerance against soil moisture stress. Thus, the present investigation was carried out to assess the impact of irrigation management under different potato cultivars on the growth, yield and water productivity of the potato.

The experiment was conducted at the Agricultural Research Station, Kota during the year 2017-18 and 2018-19. The experimental site is located in the arid zone of Rajasthan with dry climate. The soil of the experimental site had 7.4 pH, 0.42 % OC, 210 kg/ha

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available Nitrogen, 23.2 kg/ha available Phosphorus and 591 kg/ha available potassium.

The main plot treatments included five potato varieties (i.e. V_1- AICRP-P-21, V_2- AICRP-P-32, V_3- AICRP-P-37, V_4- AICRP-P-38 and V_5- Kufri Sindhuri), while four levels of irrigations i.e. I_1-Irrigation at 20 mm CPE (6, adequate irrigations), I_2-Irrigation at 25 mm CPE (5, sub-optimal irrigations), I_3-Irrigation at 30 mm CPE (4 irrigations at critical stages viz. SF, TI, ETES & LTES) and I_4- I_3 + paddy straw mulch @ 5 t/ha at the time of planting were arranged in sub plot replicated thrice in split plot design. The planting was done during 4th week of October and first week of November in the year 2017-18 and 2018-19, respectively. The planting was done using row spacing of 60 cm and plant to plant spacing of 20 cm. Full dose of P and K and 50% N of recommended dosage of 187.5 kg N, 125 kg P and 125 kg K per hectare was applied at the time of planting along and the remaining 50% N was applied after 30 days of planting at the time of earthing up of potato. Insect pests were controlled following recommended insect pest management practices. Potato plants were dehaulmed 20 days before the harvesting of the crop.

The data on number of shoot and plant height was recorded before the dehulming of the potato foliage. The number of tubers under three categories on the basis of tuber weight (≤25 g, 25-75 g and >75 g) were counted and weighted. The water productivity (WP_{I+R}) as a ratio of total tuber yield to amount of water applied through irrigation and rainfall was calculated.

Two years data was pooled and subjected to statistical analysis using the split plot design. Statistical analysis was done using PROC GLM using SAS (SAS Institute, USA). The means were compared for test of significance using Duncan Multiple Range Test (DMRT). The Pearson's correlation analysis between growth, yield and yield attributes and water productivity were analysed using PROC CORR using SAS.

Pooled analysis of two-year data revealed that the emergence rate and plant height did not affect significantly by the level of irrigation (Table 1). However, the remaining parameters i.e., number of shoots/plant, yield of different grade tubers (0 – 25g, 25 – 75g and >75g) and total tuber yield varied significantly due to various irrigation management practices. It was observed that the irrigation at 20mm CPE (I_1) gave the highest number of shoots/plant, yield of different grade tubers and total yield of tubers. However the I_4 treatment i.e. I_3 + application of mulching being at par with I_1 and I_2 produced the highest number of seed sized (25-75 g) tubers. Thus, application of straw mulch may be helpful in producing quality seeds tuber of potato (Table 2). Wien et al. (9) also reported higher crop growth with mulching due to enhanced root growth and nutrient uptake. The I_2 and I_4 remained statistically at par with respect to almost all the parameters of yield attributes. The data revealed that the application of straw mulch@5 t/ha resulted in saving of one irrigation without any significant yield reduction as

Table 1. Effect of irrigation levels and verities on growth parameters and yield attributes.

Treatment	Emergence (%)	Plant height (cm)	No. of shoots/ plant	Yield of tubers 0-25 g (t/ha)	Yield of tubers 25-75 g (t/ha)	Yield of tubers >75 g (t/ha)	Total tuber yield (t/ ha)
			Irrigation				
Irrigation at 20 mm CPE (I_1)	91.85	46.33	3.15a	3.72a	13.44a	17.46a	34.70a
Irrigation at 25 mm CPE (I_2)	91.43	46.59	3.01a	3.61a	13.26ab	16.96ab	33.87ab
Irrigation at 30 mm CPE (I_3)	93.48	45.99	3.07a	2.76c	11.22c	14.37c	28.30c
I_3 + paddy straw mulch(I_4)	92.77	47.6	2.81b	3.29b	13.00b	16.71b	33.02b
p-value	0.07	0.09	<0.01	<0.01	<0.01	<0.01	<0.01
			Varieties				
AICRP-P-21 (V_1)	92.88b	43.44c	2.91b	3.13b	11.72c	14.49d	29.43c
AICRP-P-32 (V_2)	90.47cd	43.68c	3.29a	3.33a	12.59b	15.98c	31.95b
AICRP-P-37 (V_3)	92.05bc	46.09b	2.98b	3.41a	12.74b	16.71b	32.79b
AICRP-P-38 (V_4)	96.55a	46.78b	2.95b	3.49a	13.29a	17.15ab	33.93a
K.Sindhuri(V_5)	89.97d	53.15a	2.94b	3.39a	13.31a	17.55a	34.26a
p-value (Varieties)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 2. Effect of irrigation levels and varieties on number of tubers

Treatment	No. of tubers 0-25 g (000'/ ha)	No. of tubers 25-75 g (000'/ ha)	No. of tubers >75 g (000'/ ha)
Irrigation			
Irrigation at 20 mm CPE (I_1)	233.33a	219.77a	146.47a
Irrigation at 25 mm CPE (I_2)	237.07a	213.63a	142.80a
Irrigation at 30 mm CPE (I_3)	169.80b	180.3b	113.67b
I_3 + paddy straw mulch (I_4)	253.80a	228.5a	138.67a
p-value	<0.01	<0.01	<0.01
Varieties			
AICRP-P-21 (V_1)	236.33	176.17c	145.50a
AICRP-P-32 (V_2)	205.75	196.58b	137.83a
AICRP-P-37 (V_3)	227.75	219.17a	137.0a
AICRP-P-38 (V_4)	225.42	226.33a	136.58a
K.Sindhuri(V_5)	222.25	233.50a	119.92b
p-value (Varieties)	0.72	<0.01	<0.01

compared to the I_2 treatment (Table 1). Parmar and Sharma (6) also reported that the modification in the hydrothermal regime with mulching improved the nutrient uptake and yield of wheat. Tian et al. (8) found that the mulching creates favourable microclimate which not only help in soil moisture conservation but also improved yield. Variety AICRP-P-38 showed the significantly higher emergence in potato, while plant height and number of shoots/ plant were significantly higher in variety Kufri Sindhuri and AICRP- P-32, respectively (Table 1). Among the varieties, Kufri Sindhuri (V_5) being at par with AICRP-38 gave significantly maximum total tuber yield and total number of seed sized tubers as compared to other varieties, however variety V_4 (AICRP-P-38) and V_3 (AICRP-P-37) remained statistically at par.

The data on the water productivity revealed that the highest water productivity was under the treatment I_4 as compared to other treatments (Fig. 1). Application of straw mulch @5 t/ha did not only save water but also produced yield at par with the I_2 treatment that was significantly higher than the treatment I_3 applying similar depth of irrigation as that of I_4 treatment. The water productivity of potato progressively decreased with an increase in irrigation water input. The results corroborate with the findings of Xie *et al.* (10). Among different varieties, Kufri Sindhuri (V_5) had comparatively higher

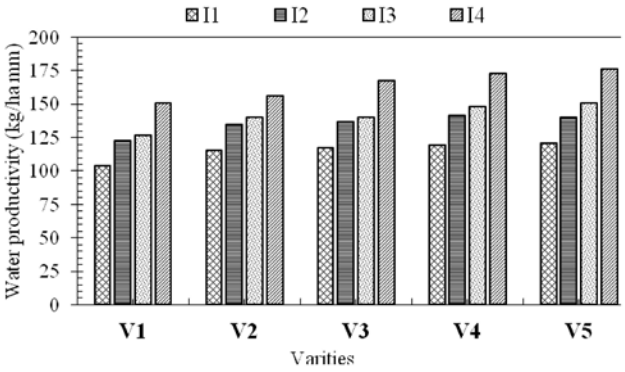

Fig. 1. Effect of irrigation and varieties on the water productivity of the Potato

water productivity as compared to other varieties and it was followed by V_4, V_3, V_2 and V_1 varieties, respectively.

The correlation between parameters has been presented in Table 3. The results showed that the plant height had negative correlation with emergence count. The number of shoots per plant was negatively correlated with the emergence and plant height. The tuber yield of < 25g, 25-50g yield and >75 g tuber was positively correlated with the plant height and number of shoots per plant. The total number of tubers and water productivity were positively correlated with all the parameters except number of shoots per plant.

Irrigation at 20 mm CPE (I_1) gave higher number and yield of tubers of almost all grade size i.e. 0-25 g, 25-75 g;> 75 g and total yield than the other treatments of irrigation. The application of straw mulch @5 t/ha along with four irrigation (I_4) gave crop yield at par with the treatment with five irrigation. Thus, straw mulching along with four irrigation is recommended to obtain higher tuber yield and seed grade tubers under lower water availability and to conserve water in potato cultivation in arid environment of Rajasthan.

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Table 3. Pearson Correlation Matrix for plant growth, water productivity and yield in potato (*significant at 5% and **significant at 1% level of significance)

	Emergencecount	Plant height	No. of shoots per plant	25g tuber yield	25-50g tuber yield	>75 g tuber yield	Total tuber yield	No. of tuber 25 g	No. of tuber 25-50 g	No. of tuber >75 g	Total no. of tuber	Water productivity
Emergence count	1											
Plant height	-0.048	1										
No. of shoots per plant	-0.062	-0.194*	1									
25g tuber yield	0.078	0.094	0.056	1								
25-50g yield	0.037	0.215**	0.039	0.873**	1							
>75 g tuber yield	0.048	0.313**	0.015	0.825**	0.949**	1						
Total tuber yield	0.050	0.253**	0.030	0.893**	0.983**	0.984**	1					
No. of tuber 25 g	0.161	0.115	-0.332**	0.303**	0.212*	0.203*	0.229*	1				
No. of tuber 25-50 g	0.036	0.313**	-0.171	0.365**	0.443**	0.428**	0.441**	0.277**	1			
No. of tuber >75 g	-0.109	0.360**	-0.024	0.409**	0.488**	0.591**	0.548**	0.287**	0.450**	1		
Total No. of tuber	0.105	0.274**	-0.306**	0.440**	0.420**	0.429**	0.444**	0.879**	0.664**	0.586**	1	
Water productivity	0.166	0.271**	-0.183*	0.451**	0.602**	0.612**	0.598**	0.094	0.143	0.154	0.152	1

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