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Water management in potato (*Solanum tuberosum*)

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ABSTRACT

A field experiment was conducted during 1986–87 and 1987–88 on silty-loam soil at Faizabad to study the effect of water management on yield of potato (*Solanum tuberosum* L.). Irrigation of 60 mm depth applied at 33 mm cumulative pan evaporation in every furrow gave the maximum tuber yield (279.9 and 313.7 q/ha) of potato and recorded highest water-use efficiency (93 and 115 kg/ha-mm) and consumptive use of water (273 and 246 mm). Of the total profile water use, 65.7–72.7% was utilized from the upper 0–30 cm layer, indicating its effective rooting zone. Irrigation in every furrow gave better performance than alternate furrow system. Both the planting techniques showed similar effect on tuber yield, water use and its efficiency.

Potato (*Solanum tuberosum* L.) gives higher yield at a relatively higher soil-moisture level. Of late, irrigation on the basis of evaporation has come out to be most reliable device. Bhan and Dhama (1982) suggested irrigations at 25 mm cumulative pan evaporation (40 mm water in each irrigation) for potato in central tract of Uttar Pradesh. However, irrigation requirements differ with locations, soil types and cultural practices. Under the condition of limited water supply higher benefits may be achieved by adopting suitable irrigation and planting techniques. Hence the present study was conducted to assess the effect of different irrigation schedules, planting and irrigation techniques on yield of potato under silty loam soils of Faizabad.

MATERIALS AND METHODS

A field experiment was conducted during 1986–87 and 1987–88 at Faizabad. Sixteen treatment combinations comprising 4 irrigation schedules [irrigation at 33, 40, 50 and 66 mm cumulative pan evaporation (CPE)], 2 irrigation methods (irrigation to every furrow and alternate furrow) and 2 planting methods (ridge and flat) were laid out in split-plot design with 3 replications. The irrigation schedules were kept in main plot. The combination of 2 irrigation techniques and 2 planting techniques were allotted to subplots. The soil of the experimental field was silty loam, slightly alkaline (pH 8.1 and 7.8) with low available nitrogen (180 and 188 kg/ha), medium phosphorus (18.2 and 18.6 kg/ha) and medium potash (260 and 280 k/ha) in respective years. The mean values of field capacity, permanent wilting point and bulk density of the field (0–60 cm) were 22.07%, 6.54% and 1.41 g/cc respectively. The available water in the soil profile of 0–60 cm was 131 mm.

Table 1. Tuber yield, consumptive use and water-use efficiency as influenced by various treatments

Treatment	Tuber yield (q/ha)			Consumptive use of water (mm)			Water-use efficiency (kg/ha-mm)		
	1986–87	1987–88	Mean	1986–87	1987–88	Mean	1986–87	1987–88	Mean
Irrigation schedule									
33 mm CPE	252.4	283.2	267.8	273	246	259	93	115	104
40 mm CPE	229.7	235.3	232.5	246	212	229	93	111	102
50 mm CPE	201.3	208.8	205.0	235	199	217	86	105	95
66 mm CPE	159.0	172.4	165.7	214	181	197	74	95	84
CD (P = 0.05)	17.8	21.9	14.1						
Irrigation method									
Every furrow	228.1	246.5	237.3	251	222	236	91	111	101
Alternate furrow	193.0	203.1	198.0	233	196	214	83	104	93
CD (P = 0.05)	7.6	7.9	5.5						
Planting method									
Ridge	209.6	222.4	216.0	242	211	226	87	106	96
Flat	211.5	227.2	219.3	343	208	225	87	109	98
CD (P = 0.05)	NS	NS	NS						

The cultivar 'Kufri Lalima' was planted in the first week of November. Half of N (75 kg/ha) and full dose of P_2O_5 (80 kg/ha) and K_2O (80 kg/ha) were applied at planting and remaining half (75 kg N/ha) was top-dressed at the time of earthing up. Scheduling of irrigations based on cumulative pan evaporation was followed after the first common irrigation. An application of 6 hectare-centimeter water (1,080 litres/plot) was made in every furrow system, whereas half of it was given under alternate furrow in each irrigation. The total number of irrigation was 4, 3, 3 and 2 in the first season and 5, 4, 4 and 3 in the second season under 33, 40, 50 and 66 mm CPE irrigations respectively. The corresponding figures for total quantity of irrigation water were 18.0, 13.5, 13.5 and 9.0 ha-cm during 1986–87 and 22.5, 18.0, 18.0 and 13.5 ha-cm in 1987–88. The total winter rains received during respective crop season were 83.4 and 9.7 mm, which were found to be effective and used in calculation of consumptive use. Soil-moisture study was made by adopting the procedure suggested by Singh *et al.* (1960). Water-use efficiency was calculated from fresh-tuber yield and water consumed by the crop.

RESULTS AND DISCUSSION

Tuber yield

Irrigation of 60 mm depth applied at 33 mm CPE gave the maximum tuber yield which was 9.9, 25.4 and 58.7% higher in the first season and 20.4, 35.6 and 64.3% higher in the second season over that of irrigations scheduled at 40, 50 and 66 mm CPE respectively (Table 1). This may be attributed to increased uptake of nutrients (N, P, K) which was favoured by adequate moisture available throughout the crop-growth period due to 33 mm CPE. Bhan and Dhama (1982) and Sood and Sharma (1986) also reported similar results. Irrigations scheduled at 40 mm CPE gave significantly higher tuber yield than 50 mm CPE irrigation. Though the number of irrigations were equal in both the treatments, but mild stress at critical stages under 50 mm CPE resulted in low tuber yield.

Irrigations given to every furrow increased tuber yield by 18.2 and 21.4% than alternate furrow in respective seasons (Table 1). Higher soil moisture available under every furrow irrigation increased the foliage growth, fresh weight of tubers/plant, bulking rate and finally tuber yield. Both the planting methods were equally effective in giving tuber yield. This was mainly due to almost similar conditions prevailed under both the methods of planting. Results are in partial agreement with those of Nankar and Dhond (1980).

The interaction effects between irrigation schedules × methods of irrigation had a significant effect on tuber yield (Table 2). The maximum tuber yield of 279.9 and 313.7 q was obtained with irrigations applied in every furrow at 33 mm CPE during the first and second years respectively. The magnitude of increase was higher in every furrow irrigation than that in alternate furrow system when irrigation level was increased from 66 mm CPE to 33 mm CPE.

Effect of planting × irrigation methods on yield of tuber was also significant (Table 2). The maximum increase of 44.0 and 53.5 q/ha in tuber yield was obtained in ridge planting × every furrow irrigation compared with ridge planting × every furrow irrigation compared with ridge planting × alternate furrow in 2 consecutive years. However the combination of flat planting and every furrow irrigation outyielded 26.3 and 33.3

Table 2. Interaction effect of different treatments on tuber yield of potato (q/ha)

Treatment	Irrigation method			
	1986–87		1987–88	
	Every furrow	Alternate furrow	Every furrow	Alternate furrow
Irrigation schedule				
33 mm CPE	279.9	224.8	313.7	253.1
40 mm CPE	250.0	209.3	260.0	210.4
50 mm CPE	214.5	187.9	224.2	193.8
66 mm CPE	168.2	149.9	189.0	156.3
Planting method				
Ridge	231.6	187.6	249.4	195.9
Flat	224.7	198.4	244.1	210.8
CD (P = 0.05) for			1986–87	1987–88
2 subplots in the same main plot			21.44	22.50
2 main plots in the same subplot			27.80	30.30
Combination of subplot treatments			10.7	11.2

CPE, Cumulative pan evaporation

q/ha tuber only than flat planting × alternate furrow irrigation.

Consumptive use of water

Amongst the different irrigation schedules, the highest consumptive use of 273 and 246 mm was recorded during first and second years respectively when irrigations were applied at 33 mm CPE. This was due to high frequency of irrigation, thereby more water was made available for evapotranspiration. Every furrow irrigation showed higher consumptive use of water than alternate furrow system. Though in every furrow system 60 and 90 mm more water was applied than alternate furrow, but the differences in consumptive use of every and alternative furrow systems were only 18 and 26 mm. Planting methods did not influence the consumptive use of water because it is mainly controlled by climatic parameters.

Water-use efficiency

The higher water-use efficiency (93 and 115 kg/ha-mm) was recorded with irrigation scheduled at 33 mm CPE. This was due to the fact that increase in tuber yield of potato was more than increase in consumptive use of water under higher irrigation levels. Higher water-use efficiency was also recorded in every furrow irrigation. Lower water-use efficiency under alternative furrow irrigation may be attributed to larger reduction in yield. Planting methods did not show variation in water-use efficiency.

Table 3. Soil-moisture-depletion pattern under various treatments

Treatment	Soil depth (cm) 1986–87				Soil depth (cm) 1987–88			
	0–15	15–30	30–45	45–60	0–15	15–30	30–45	45–60
Irrigation schedule								
33 mm CPE	81 (48.5)	41 (24.6)	28 (16.2)	17 (10.2)	98 (48.5)	48 (23.8)	35 (17.3)	21 (10.4)
40 mm CPE	68 (45.6)	38 (25.5)	27 (18.1)	16 (10.7)	79 (46.2)	41 (24.0)	31 (18.1)	20 (11.7)
50 mm CPE	60 (42.6)	38 (27.0)	27 (19.2)	15 (11.3)	71 (44.4)	41 (25.6)	30 (18.7)	18 (11.3)
66 mm CPE	50 (41.0)	32 (26.2)	25 (20.5)	15 (12.3)	60 (39.7)	37 (24.5)	34 (22.5)	20 (13.2)
Irrigation method								
Every furrow	70 (45.5)	40 (26.0)	28 (18.2)	16 (10.4)	86 (26.7)	44 (23.9)	34 (18.5)	20 (10.9)
Alternate furrow	59 (43.7)	34 (25.2)	26 (19.3)	16 (11.8)	68 (43.0)	40 (25.?)	31 (19.6)	19 (12.0)
Planting method								
Ridge	65 (45.1)	37 (25.7)	27 (18.8)	15 (10.4)	80 (46.2)	42 (24.3)	32 (18.5)	19 (11.0)
Flat	64 (44.1)	37 (25.5)	27 (18.6)	17 (11.7)	74 (43.8)	42 (24.9)	33 (19.5)	20 (11.8)

Figures in parentheses indicate per cent utilization from different soil depths
CPE, Cumulative pan evaporation

Moisture-depletion pattern

Contribution of soil moisture from different layers varied with different irrigation treatments. The contribution from top 0–30 cm soil layer was reduced with successive decrease in the irrigation level. To the extent of 48.5% of the total water used by the crop was from the uppermost layer (0–15 cm) and deeper soil layers contributed less water for crop use under treatment having frequent irrigation (33 mm CPE). Contrary to this, the contribution from lower layers (30–45 and 45–60 cm) was higher under 66 mm CPE than irrigation scheduled at 33 mm CPE. There was no remarkable difference in moisture-depletion pattern between techniques of planting.

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