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Effect of differential irrigation regimes on potato (*Solanum tuberosum*) yield and post-harvest attributes*

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Potato (*Solanum tuberosum* L.) is a temperate crop that grows and yields well in cool and humid climate or seasons yet it is grown in climatic region from the tropics to sub-polar and comprises a major food crop in many countries (Shalhevet *el al.* 1983). In India its area has increased from 0.6 million ha in 1980 to 1.3 million ha in 2000 and production has increased from 11.88 to 26.0 million tonnes (Kashyap and Panda 2002). The yield in our country is, however, below than average worldproduction. Hence water application is critical to make the most efficient use of drip irrigation system for irrigation water management.

The yield, quality and disease resistance is greatly influenced by timing and frequency of irrigation applied (Carr 1989, Murtani and Guz 1989). The farmers on the other hand apply water to the crop without regard to whether the plant actually needs water at that stage. The reasons behind improper use of irrigation is that sufficient information is not available on the scheduling of irrigation in general and using drip irrigation in particular in relation to higher yield with better produce quality. Thus there is a great need of an appropriate irrigation scheduling to get higher production with better post-harvest characteristic. Hence a comprehensive field investigation was undertaken to study the effects of various irrigation regime on the growth, crop yield and post-harvest attributes of potato tuber.

This study was conducted during the winter seasons of 2002–2003 and 2003–2004 (October-January) at research farm of the Institute, Abohar, Punjab. The soil moisture content at field capacity (– 1/3 Mpa) and wilting point (–15 Mpa) was 11.49 and 3.94% on dry weight basis (w/w) respectively. The plant available water was 117 mm/m. The depth of water at the time of irrigation was equal, ie the readily available water (RAW).

The experiment was laid out in a randomized block design with 4 replications. Farmyard manure @ 50 tonnes/ha was applied prior to field preparation. Water soluble fertilizers @ 187 kg N/ha, 63 kg P_2O_5/ha and 125 kg K_2O/ha (recommended dose) were applied through fertigation which started two weeks after planting. 'Kufri Chandramukhi' potato crop was planted at 60 cm × 10 cm in plots measuring 6 cm × 6 m. Immediately after planting, irrigation was given through furrow. Four irrigation regimes (0.60, 0.80 1.00 and 1.20 fraction of open pan evaporation) were taken for drip irrigation treatment. The depth of water in each irrigation was 10.50 mm approximately (equal to RAW). Irrigation for 0.60, 0.80 1.00 and 1.20 of Ep was applied when cumulative pan evaporation (CPE) reached to 17.50, 13.10, 10.50 and 8.75 mm respectively after accounting the effective rainfall.

Plant height was measured at the tallest point of the shoot. Before vine kill, each vine was taken to determine total above ground biomass. However many of the vines had already senesced. Tubers were classified as A (> 45 mm), B(28–45 mm) and C (< 28 mm) grade. Specific gravity was determined as ratio of weight of potatoes in air and water. Starch in tuber was estimated using the procedure given in AOAC (2000).

The height and branches/plant of potato increased with increase in irrigation regime from 0.60 Ep to 1.20 Ep (Table 1). Plant height and branches/plant were statistically at par . When crop was subjected to 1.0 and 1.20 EP of irrigation but irrigation at 0.60 and 0.80 Ep recorded significant reduction. The difference in plant growth parameters with irrigation levels was mainly due to the variation in available soil moisture. Kashyap and Panda (2002) have also reported that water stress decrease plant growth.

At harvest biomass was significantly lower with 0.60 and 0.80 Ep of irrigation than the other treatments (Table 1). Higher biomass at 1.00 and 1.20 Ep of irrigation was recorded due to better vegetative growth as higher plant height and branches/plant was observed under 1.00 and 1.20 Ep of irrigation.

Table 1 shows that at irrigation scheduled of 1.00 and 1.20 Ep, tuber yield did not differ significantly . One Ep of irrigation might not have allowed the soil moisture to get depleted sufficient enough to retard the extraction of water by the roots. On the other hand when irrigation was scheduled

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Table 1 Plant growth parameters, tuber yield and water use efficiency at different irrigation treatments

Treatment	Plant height (cm)	Branches/ plant	Above ground biomass (g/plant)	Tuber yield (tonnes/ ha)	Dry matter yield (tonnes/ ha)	Irrigation water use efficiency (tonnes/ ha-cm)
Irrigation (EP)						
0.60	40.58	3.25	27.63	18.68	3.82	1.17
0.80	49.00	4.00	30.25	24.62	5.17	1.31
1.00	55.55	4.56	34.53	27.34	5.78	1.30
1.10	56.85	5.00	36.15	29.33	6.14	1.19
LSD (*P*=0.05)	6.38	0.55	3.04	2.01	–0.36	0.10

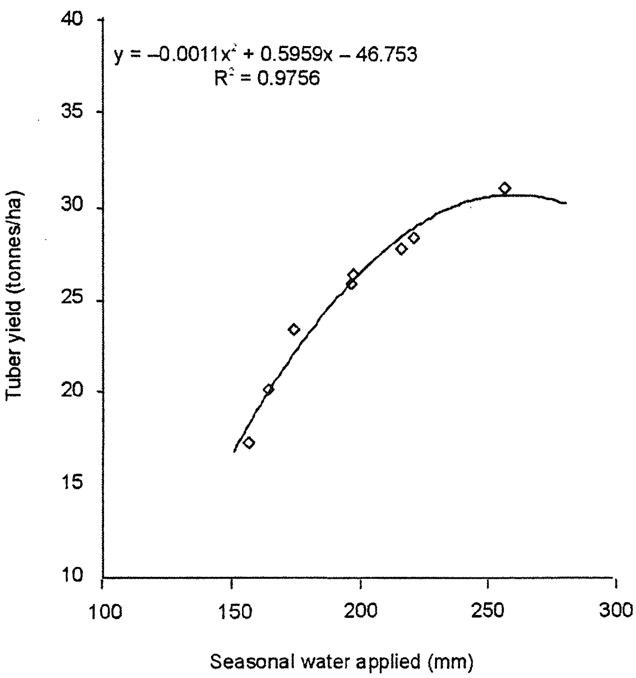

Fig 1 Relationship between tuber yield and seasonal water applied

Table 2 Post-harvest attributes as influenced by irrigation treatments

Treatment	Grade of tubers (%)			100-tubers weight (kg)	Starch (%)	Specific gravity
	A(>45) mm)	B (28–45mm)	C(<28 mm)			
Irrigation (EP)						
0.60	4	69	27	3.63	11.95	1.070
0.80	20	64	16	4.42	12.52	1.085
1.00	35	56	9	5.06	12.88	1.106
1.20	45	51	6	5.36	13.28	1.115
LSD (*P*=0.05)				0.51	0.61	0.031

at 0.80 and 0.60 Ep, tuber yield reduced significantly because of smaller number and size of tubers under moisture stress. Yaun *et al.* (2003) reported increase in tuber weight with increased irrigation water. Dry matter yield followed the same trend as that of the tuber yield.

Water-use efficiency (WUE) in both years was highest at 0.80 Ep (Table 1). Further increase in irrigation levels decreased the WUE. The least WUE was recorded in 0.60 Ep because of decrease in tuber yield. Islam *et al.* (1990) also reported similar findings. Hence water was used most effectively in 0.80 Ep. A considerable increase in percent of A (>45mm) and B (28.45mm) grade tubers was recorded when irrigation level increased from 0.60 to 1.20 Ep (Table 2). Higher percentage to smaller size tubers (C grade) in 0.60 Ep was obtained where less water was applied to the crop.

Irrigation levels had a significant effect on 100-tubers weight which increased with increasing irrigation from 0.60 to 1.20 Ep. However it was non-significant at 1.00 and 1.20 Ep. The results obtained are in line with reported earlier by Onder *et al.* (2005). Irrigation at 0.60 to 0.80 Ep reduced the 100-tuber yield significantly.

Specific gravity is one of the important quality parameters associated with the processing of tubers. Data (Table 2) showed increase in specific gravity with the increase in irrigation level from 0.60 to 1.20 Ep. Higher specific gravity observed at 1.00 and 1.20 Ep was probably due to the ensured optimum soil moisture for better nutrient utilization and thus leads to higher dry matter production. Waddel *et al.* (1999) illustrated the specific gravity of tuber to be significantly lower than that obtained under sprinkler irrigation.

Starch accumulation in tuber increased with increase in irrigation level. The highest starch (13.28%) was found at 1.20 Ep of irrigation, whereas lowest starch accumulation was at 0.60 Ep. Higher levels of irrigation (1.00–1.20 Ep) resulted in optimum soil moisture for growth thereby accelerating photosynthesis process and ultimately translocation of photosynthate into the tuber.

For the determination of water production function of potato, tuber yield was presented as function of seasonal water applied (Fig 1). Through non-linear regression analysis a mathematical relationship was obtained that showed a highly determination factor ($R^2 = 0.97$). Water stress during the growth stages had significantly affected the tuber production. The production function showed that seasonal water applied in 1.20 Ep (267 mm) was close to the theoretical water application (280 mm) for maximum tuber yield that was calculated based on the regression equation. In this experiment irrigation was stopped 15 days before harvesting for better post-harvest shelf-life of tuber.

SUMMARY

A study was conducted during 2002–03 and 2003–04 to evaluate the role of differential irrigation regime on growth, yield and post-harvest attributes of potato (*Solanum tuberosum* L.) Plant height, biomass and tuber yield increased with

increase in irrigation. The highest tuber yield was obtained in the irrigation regime of 1.20 Ep while the highest irrigation water-use efficiency was found in 0.80 Ep. Preferable grade of tuber (> 28 mm size) decreased with decrease in irrigation level from 1.20 to 0.60 Ep. Specific gravity and starch percentage in tuber increased with increase in irrigation. Therefore potatoes should be irrigated at 1.20 Ep for higher yield and better quality. However if water availability is limited 0.80 Ep would be most appropriate for scheduling irrigation.

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