

Increasing yield potential of potato (*Solanum tuberosum*) by using irrigation methods and fertilizer levels

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ABSTRACT

The experiment was conducted during 1998–99 and 1999–2000 to study the yield potential of potato (*Solanum tuberosum* L.) by adopting different irrigation methods and fertilizer levels. Eighteen treatments comprising 3 irrigation methods, viz. sprinkler, drip and furrow, and 6 fertilizer levels, viz. 80 : 40 : 40, 120 : 60 : 60, 160 : 80 : 80, 80 : 40 : 80, 120 : 60 : 120 and 160 : 80 : 160 (N : P₂O₅ : K₂O kg/ha), were undertaken in split-plot design with 6 replications. The crop was planted in November during both the years on ridges, spaced at 60 cm keeping 20 cm space between plants. The pooled results indicated that sprinkler and drip irrigation systems resulted in significantly higher potato tuber yield to extent of 43.5 and 21.2%, respectively, compared with the furrow-irrigation method. The fertilizer dose of 120 : 60 : 120 N : P₂O₅ : K₂O kg/ha resulted in significant higher yield than rest of fertilizer levels and found optimum for potato. Sprinkler irrigation gave the maximum returns (Rs 42,850/ha) and benefit : cost ratio with 120 : 60 : 120 N : P₂O₅ : K₂O kg/ha and benefit : cost ratio and hence found less economical for potato.

Key words : Potato, Irrigation methods, Fertilizer, Economics

Water is the key input in potato production and its management problem varies from region to region. The optimum soil moisture is needed to be maintained in the root zone, to meet the crop requirements for higher yields. It can be achieved best through the use of improved irrigation system, such as drip and sprinkler, which save water up to 30–50%. However, its adoption is restricted mainly due to huge investment for short-duration crop like potato. Potato is the underground tuber crop and nutrients removed by crop are quite high (Sharma *et al.*, 1978; Singh and Grewal, 1979). Nutrient management is an important factor responsible for increased yields and quality of tuber. In view of this, the present investigation was conducted to study effect of irrigation methods and fertilizer levels on growth and yield of potato.

MATERIALS AND METHODS

Eighteen treatments comprising 3 irrigation methods, viz. sprinkler, drip and furrow, and 6 fertilizer levels, viz. 80 : 40 : 40, 120 : 60 : 60, 160 : 80 : 80, 80 : 40 : 80, 120 : 60 : 120 and 160 : 80 : 160 (N : P₂O₅ : K₂O kg/ha), were undertaken in split-plot design with 6 replications. The soil was clay loam with 22.5% sand, 30.5% silt and 47% clay content, with pH 8.4, electrical conductivity 0.54 dS/m, bulk density 1.31 g/cm³, field capacity 39.3% and per-

manent wilting point 20.3%. The crop was planted on ridges spaced at 60 cm keeping 20 cm spacing between plants. The planting was done in November during both the years. All the P₂O₅ and K₂O and 50% nitrogen fertilizer were applied at the time of planting and remaining N was applied 30 days after planting. In sprinkler method, 3 cm depth of irrigation water was applied at 25 mm CPE, in furrow method the irrigation were applied at 50 mm CPE with 6 cm depth at each irrigation. The water through drip was applied at alternate day and the quantity of water was applied on cumulative pan evaporation for 2 days considering various crop factors at different growth stages. The root zone soil moisture was monitored with help on neutron moisture meter. The soil was low in available N (190 kg/ha), medium in available P (12 kg/ha) and high in available K (261 kg/ha). The details regarding installation of irrigation system and irrigation scheduling are given in Table 1.

RESULTS AND DISCUSSION

Potato yield

The advanced irrigation methods, viz. sprinkler and drip, resulting in 16.02 and 13.08 tonnes/ha potato tuber yield, respectively, were significantly superior to the yield obtained from furrow method of irrigation (10.79 tonnes/

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ha). The results confirm the findings of Grewal and Singh (1978). The yield obtained owing to sprinkler and drip methods were 49 and 21% higher than furrow method of irrigation respectively. The application of fertilizer dose @ 120 : 60 : 60 N : P₂O₅ : K₂O kg/ha resulted in the maximum potato tuber yield during both the years and pooled over the 2 seasons (14.01 tonnes/ha) which was significantly higher than the yields obtained due to rest of the fertilizer levels. The higher fertilizer dose of 160 : 80 : 160 kg/ha resulted in decreased yield (11.98 tonnes/ha). Hence a fertilizer dose of 120 : 60 : 120 N : P₂O₅ : K₂O kg/ha proved to be optimum for potato crop under Deccan canal tract of Maharashtra.

Water economy

Minimum water was applied through drip system (22 cm) compared to other irrigation method (Table 3). In sprinkler 31 cm of water was applied, while in furrow irrigation maximum quantity of water (36 cm) was applied. Thus, water saving of 14% only, being more frequent with fairly uniform distribution in sprinkler system resulted in almost no stress conditions through crop season in addi-

tion to maintenance of favourably microclimate condition which helped in sizable increase in yield as compared to furrow method (Hooda *et al.*, 1979). Therefore, in sprinkler method the potato tuber yield was higher (16.02 tonnes/ha) being 43.5% higher than furrow method of irrigation. The drip method of irrigation resulted in 39% water saving but slightly less increase in yield (21%) over

Table 3. Economics analysis of plantation of potato under different irrigation methods

Particulars of economics	Sprinkler system	Drip system	Surface method
1. Fixed cost of drip system (Rs/ha/season)	5,000	15,931	1,900
2. Operational cost of potato cultivation (Rs/ha)	14,130	13,650	14,130
3. Seasonal cost (Rs/ha)	19,130	29,581	16,030
4. Water applied (cm/ha)	31	22	36
5. Yield (tonnes/ha)	16.02	13.08	10.79
6. Market rate (Rs/tonne)	3,500	3,500	3,500
7. Gross income (Rs/ha)	56,070	45,780	37,765
8. Net income (7-3) (Rs/ha)	36,940	16,199	21,735
9. Benefit of drip			
a. Water saving (%)	32.32	34.18	33.23
b. Area increased (ha)	0.16	0.64	
c. Additional gross income (Rs)	8,971	29,299	57,719
d. Additional cost of area (Rs)	3,061	18,932	
10. Total cost Rs (3 + 9d)	22,199	48,513	16,030
11. Total gross income (Rs) (7+9c)	65,049	75,079	37,765
12. Total net income (Rs) (11-10)	42,850	26,566	21,735
13. Benefit : cost ratio (11/10)	2.93	1.55	2.35
14. Net income over surface (Rs)	21,115	4,831	
15. Net profit/cm of water Rs (8/4)	1,191.60	736.40	603.75
16. WUE (q/ha-cm)	5.17	5.95	3.00

Table 1. Details regarding irrigation methods used for potato

Aspect	Sprinkler	Drip	Furrow
Lateral spacing (m)	12	1.2	
Spacing (m) of dripper/nozzle	12	0.6	
Discharge of dripper/nozzle	1 cm/h	3.80 lph	
Distribution efficiency (%)	86	91	65
Irrigation scheduling	25 mm	Alternate	50 mm
CPE	day	CPE	
Depth of irrigation (cm)	2.5 cm	As per CPE	6 cm

Table 2. Potato yield (tonnes/ha) as affected by irrigation and fertilizer treatments

Treatment	Yield tonnes/ha			Depth of irrigation (cm)	Water-use efficiency (q/ha-mm)
	1998-99	1999-2000	Pooled		
Irrigation method					
Sprinkler	10.76	21.28	16.02	31	5.16
Drip	11.82	14.33	13.08	22	5.95
Ridges/furrow	9.66	11.91	10.79	36	3.00
CD (P=0.05)	1.62	1.62	0.51		
Fertilizer levels (N:P:K kg/ha)					
80 : 40 : 40	9.71	15.16	11.41	30	4.29
120 : 60 : 40	10.44	15.22	11.93	30	4.57
160 : 80 : 80	10.97	16.11	12.58	30	4.82
80 : 40 : 40	10.18	16.35	12.11	30	4.62
120 : 60 : 120	12.29	17.79	14.01	30	5.26
160 : 80 : 160	10.87	14.43	11.98	30	4.62
CD (P=0.05)	1.62	1.62	0.63		

furrow method of irrigation. The potato tuber yield was lower under drip irrigation compared to sprinkler system, though water saving was more. The daily moisture status in each of irrigation treatments indicated that, in drip method of irrigation, the soil moisture was nearly at field capacity throughout growth period. In sprinkler the water was applied more frequently (at 25 mm CPE) and distributed more uniformly than furrow method. The moisture availability might be the prime factor responsible for enhancement of production potential of potato in advanced irrigation methods like sprinkler and drip.

Cost economics

The economics analysis (Table 3) indicated that, the sprinkler method of irrigation was economically beneficial for potato in terms of total net income (Rs 42,850), benefit : cost ratio (2.93), additional income over surface method (Rs 21,115/ha) and net income per unit of water (Rs 1,191.60/cm). In spite of 39% water saving in drip system,

it was found less economical for potato crop due to very high initial investment and lower yield compared to sprinkler method under scarcity condition.

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