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Research Communication

Response of potato (*Solanum tuberosum* L.) to irrigation methods, moisture regimes and integrated nitrogen management

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ABSTRACT

A field experiment was conducted in split-plot design during the winter (*rabi*) season of 2015–16 at Agronomy Research Farm, Kumarganj, Ayodhya (Uttar Pradesh) to evaluate the response of potato (*Solanum tubersum* L.) to irrigation methods, moisture regimes and nitrogen management. Treatments effect was non-significant on initial plant stand [15 days after planting (DAP)]. The plant height, number of haulms, number of leaves at 90 DAP and dry weight of haulms were significantly superior under regular furrow irrigation method, 1.0 irrigation water: cumulative pan evaporation (IW : CPE) and 75% dose of urea through N + 25% dose of N through FYM over their counterparts. All the growth characters were found highest under nitrogen-management treatment 75% dose of urea through N + 25% dose of N through FYM, which was statistically superior to rest of the nitrogen-management treatments. Yield attributes, viz. number of tubers (grade-wise)/hill, weight of tubers (grade-wise) (kg/plot), and tuber yield (q/ha) were found highest under regular furrow method of irrigation (M_1) and moisture regime, 1.0 IW : CPE (I_2) over 0.8 IW : CPE (I_1) and 1.2 IW : CPE (I_3). Moisture regimes significantly influenced number of all grade of tubers. All the yield attributes were significantly higher under nitrogen management treatment N_2, and was statistically superior to rest of the nitrogen management treatments.

Key words : FYM, Irrigation methods, Moisture regimes, Nitrogen management, Potato, Tubers

Potato is most important and popular crop in the word. It is able to supply most dietary need of human body. India is the second largest producer of potato. Country produces 53 million tonnes from an area 2.16 million ha (NHB, 2018–19). The average yield of potato tuber is 25–30 t/ha and it consumes 120–140 kg N/ha. Excess application of N delays tuber initiation and onset of linear phase of tuber growth, resulting lower yield. Indian soils are deficient in organic matter and unable to release adequate N to maintain plant growth. Therefore, application of nitrogen in form of fertilizers and manures becomes indispensable to meet the needs of the crop (Trehan *et al.,* 2008). Organic manures (FYM or compost) application is recommended to potato crop because it helps in improving the physical conditions of soils, supplies macro-and micro-nutrients and integrates balanced nutrient management in potato. Water is another important input for potato production. The practice of alternate furrow irrigation results in application of water to one side of each crop row. The entire soil surface may still be thoroughly wetted after irrigation due to lateral movement and applied water is reduced by 25 to 35% compared to every furrow-irrigated method with a slight (2–16%) reduction in crop yield. Thus, one of the best methods of deficit irrigation is alternate furrow method of irrigation. This method promotes irrigation efficiency and prevents losses of water Kassaye *et al.* (2020). Thus, there is a great need of an appropriate irrigation scheduling to get higher production with better post-harvest characteristic.

A field experiment was conducted during the winter (*rabi*) season 2015–16 at Agronomy Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh. The field was well-drained and properly leveled. The soil of experi-

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mental field was silt loam with organic carbon 0.35%, available N 147.5 kg/ha, P_2O_5 14.50 kg/ha, K_2O 210.1 kg/ha and *p*H 8. The experiment was conducted in a split-plot design with 4 replications. The treatments comprised 2 methods of irrigation (M_1, regular furrow irrigation; M_2, alternate furrow irrigation), 3 moisture regimes [I_1, 6 cm irrigation at 0.8 irrigation water: cumulative pan evaporation (IW : CPE); I_2, 6 cm irrigation at 1.0 IW : CPE and I_3, 6 cm irrigation at 1.2 IW : CPE] in main plot and 3 nitrogen levels (N_1, recommended dose of N 150 kg/ha; N_2, 75% dose of N through urea + 25% N through FYM and N_3, 50% dose of N through urea + 50% N through FYM] in sub plots. Total treatment combinations were 18 combining irrigation methods, moisture regimes and N levels. Plot-wise FYM was incorporated 15 days before the planting of potato. Nitrogen was applied in 2 splits-as basal and time of earthing. Recommended dose of P_2O_5 and K_2O was applied uniformly as basal in all plots at planting time. Potato var. 'Kufri Badshah', was planted @ 25 q seed tuber/ha in furrows opened at a distance of 60 cm × 15 cm with the help of furrow opener. The crop was grown with recommended practices. Irrigations were applied by tubewell by measuring with the help of V-notch as per treatment. Earthing was done 35 days after planting with the help of *Kudal*. Indofil M-45 @ 2 kg/ha was sprayed against late blight disease. Observations in respect of initial plant stand 15 days after planting (DAP), plant height (cm), number of haulms/meter, number of leaves (90 DAP), dry weight of haulms before 15 days of harvesting of potato tuber, number of tubers (grade-wise hill), weight of tuber grades (kg/plot) and tuber yield (t/ha) were recorded. The data were analyzed following the standard methods of statistics.

The observations taken during potato crop growth and at harvesting are presented in Table 1. Data showed that the plant emergence/m was not influenced significantly due to treatments. The maximum initial plant stand (5.89/m) at 15 DAP was recorded with M_1 followed by M_2 (5.88/m) treatment (Halim, 2013). Initial plant stand at 15 DAP was 5.98 plants/m under moisture regime I_2 (1.0 IW : CPE) and 5.93 plants/m with moisture regime I_1 (0.8 IW : CPE). Uniform plant stand might be due to the uniform soil moisture in the vicinity of tuber seed with 1 common irrigation a week after planting under both the irrigation methods and maintain optimum moisture in the field. The nitrogen-management practices did not influence the initial plant stand and the maximum initial plant stand (5.98/m) was recorded with N_2 treatment and minimum (5.57/m) with N_3 treatment.

The plant height (cm), number of haulms/m and number of leaves/m at 90 DAP and dry-weight of haulms (g/m) were significantly influenced by the irrigation methods, moisture regimes and nitrogen management practices (Table 1). The maximum plant height (48.8 cm), number of haulms (36.7/m), number of leaves (430.5/m) and dry-weight of haulms (27.9 g/m) were recorded in M_1 and were significantly higher than M_2, treatment, while lowest plant height (45.2 cm), number of haulms (34.1/m), number of leaves (399.5/m) and dry weight of haulms (25.8 g/m) were recorded in M_2. Under different moisture regimes, the maximum plant height (49.1 cm), number of haulms (36.9/m) and number of leaves (433.3/m) at 90 DAP and dry weight of haulms (28.4g/m) was recorded in moisture regime I_2 which was significantly higher than I_1 and I_3, while the lowest plant height (45.1 cm), number of haulms (33.9/m), number of leaves (398.3/m) and dry weight of haulms (25.8 g/m) were recorded with I_3 (Patel and Patel, 2001). The data revealed that the maximum plant height (49.8 cm), number of haulms (37.6/m) and number of leaves (440.6/m) at 90 DAS and dry weight of haulms (28.6/gm) were recorded in N_2 treatment, being significantly higher than N_1 and N_3 treatment. The lowest plant height (43.6 cm), number of haulms (33.1/m), number of leaves (387.8/m) and dry weight of haulms (25.3 g/m) were recorded at N_3 treatment (Kumar *et al.,* 2020).

Difference in number of tubers/hill and weight of tubers (kg/plot) of 'A', 'B', 'C', 'D' grades was significantly influenced by various irrigation methods, moisture regimes and nitrogen- management practices. The maximum number of tubers/hill and weight of tubers (kg/plot) of 'A', 'B', 'C' and 'D' grade were 1.40 and 12.71, 1.48 and 9.54, 1.82 and 7.95, and 1.23 and 1.59, respectively (M_1), and was significantly superior to M_2 treatment. The lowest number of tubers/hill and weight of tubers (kg/plot) of 'A', 'B', 'C' and 'D' grade were 1.28 and 11.80, 1.38 and 7.37, 1.74 and 7.37 and 1.16 and 1.47, respectively, M_2. It might be due to the ridges under alternate furrow irrigation were relatively dried at one of the sides and becomes compact which may not allow the proper development of tubers.

Under different moisture regimes, the maximum number of tubers/hill and weight of tubers (kg/plot) grade were 1.40 and 12.80, 1.49 and 9.60, 1.85 and 8.00, and 1.25 and 1.65, under grade ' A', 'B', 'C' and 'D' grade, respectively, moisture regime I_2 and was significantly higher than I_1 and I_3 moisture regime. while the lowest number of tubers/hill and weight of tubers (kg/plot) of 'A' 'B', 'C' and 'D' grades were 1.28 and 11.76, 1.35 and 8.82, 1.76 and 7.35, and 1.16 and 1.44, respectively, under I_3. Taller plants and higher number of leaves under higher moisture regime manufactures larger quantity of photosynthates, which converted and translocated in the tubers during metabolic processes of plants, resulting in larger number of tubers/plant and heavier weight/tuber. The results are in corroboration with the findings of Patel and Patel (2001).

The number of tubers/hill and weight of tubers (kg/plot)

Table 1. Initial plant stand, plant height, number of haulms, number of leaves and dry weight of haulms, number of tubers (grade-wise)/hill, weight of tuber grades (kg/plot), and tuber yield of potato as influenced by irrigation methods, moisture regimes and nitrogen management.

Treatment	Initial plant stand 15 DAP/(m)	Plant height (cm)	Number of haulms/ (m)	Number of leaves/ (m)	Dry weight/ (g/m) of haulms (dehaulming stage)	Number of tubers (grade-wise)/hill				Weight of tuber grades (kg/plot)				Tuber yield (t/ha)
		90 DAS				A (0–25g)	B (25–50g)	C (50–75g)	D (>75g)	A (0–25g)	B (25–50g)	C (50–75g)	D (>75g)	
Irrigation methods														
M_1	5.89	48.8	36.7	430.5	27.9	1.40	1.48	1.82	1.23	12.7	9.54	7.95	1.59	27.6
M_2	5.88	45.2	34.1	399.5	25.9	1.28	1.38	1.74	1.16	11.8	8.85	7.37	1.47	25.6
SEm±	0.07	0.5	0.6	6.1	0.4	0.01	0.02	0.02	0.01	0.16	0.12	0.08	0.02	4.5
CD (P=0.05)	NS	1.6	1.7	18.3	1.3	0.04	0.06	0.06	0.04	0.48	0.38	0.26	0.07	12.2
Moisture regimes														
I_1	5.93	46.8	35.7	413.4	27.5	1.33	1.43	1.79	1.18	12.2	9.13	7.63	1.53	26.5
I_2	5.98	49.1	36.9	433.3	28.4	1.40	1.49	1.85	1.23	12.8	9.60	8.00	1.65	27.8
I_3	5.95	45.1	33.9	398.3	25.8	1.28	1.35	1.76	1.16	11.8	8.82	7.35	1.44	25.5
SEm±	0.08	0.7	0.7	7.4	0.5	0.01	0.02	0.02	0.01	0.19	0.15	0.10	0.03	5.0
CD (P=0.05)	NS	2.0	2.1	22.4	1.6	0.057	0.07	0.06	0.05	0.59	0.47	0.32	0.09	15.0
Nitrogen management														
N_1	5.93	47.9	35.5	416.7	26.8	1.35	1.42	1.84	1.18	12.2	9.26	7.73	1.53	26.4
N_2	5.98	49.9	37.6	440.6	28.6	1.42	1.52	1.88	1.29	13.0	9.76	8.13	1.63	28.2
N_3	5.57	43.6	33.1	387.8	25.3	1.24	1.35	1.73	1.10	11.4	8.56	7.11	1.44	25.2
SEm±	0.09	0.8	0.5	5.8	0.3	0.02	0.02	0.02	0.01	0.18	0.14	0.12	0.01	3.7
CD(P=0.05)	NS	2.2	1.4	16.7	0.9	0.06	0.05	0.07	0.05	0.52	0.40	0.35	0.05	10.7

DAP, Days after pla tibng; DAS, days after sowing

were significantly influenced by the nitrogen-management practices. The maximum number of tubers/hill and weight of tubers (kg/plot) were 1.42 and 13.01, 1.52 and 9.76, 1.88 and 8.13 kg and 1.29 and 1.63 in grade A, B, C and D, respectively, at N_2 treatment and lowest were 1.24 and 11.42 , 1.35 and 8.56, 1.73 and 7.11, and 1.10 and 1.44, in A, B, C, and D grade tuber respectively, at N_3 treatment. It might be owing to the increased photosynthetic activity of plant resulting enhanced supply and availability of nutrients, leading to increased the plant height, number of leaves and number of tubers/plant and weight of tubers/hill/plot (Sarkar *et al.,* 2011; Yaseen *et al.* 2011).

A significant increase in the tuber yield was observed in regular furrow method (M_1) over alternate furrow method (M_2), although the pace of increment was 7.81%. Sarkera *et al*. (2019) also mentioned that alternate furrow-irrigation method resulted in the highest potato yield in Bangladesh. Among the different moisture regimes, significantly maximum tuber yield was observed in I_2, treatment, being 4.91 and 9.02% higher than I_1 and I_3 treatments respectively. Nitrogen-management practices revealed that, an incorporation of 25% N through FYM (N_2) resulted significantly higher tuber yield over N_1 and N_3 treatments. This treatment out yielded N_1 and N_3 treatments by 6.87 and 11.9% respectively.

Therefore, it can be concluded that irrigation applied at 1.0 IW : CPE ratio under regular furrow method and integration of nitrogen (75% N through urea + 25% N through FYM) seems to be best for getting the higher tuber yield of potato in the silt loam soils of Uttar Pradesh. Although, at least 1 more year research will be needed to draw a valid conclusion.

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