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

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Abstract
The experiment entitled "Effect of moisture regimes and integrated nitrogen management on the yield of potato (*Solanum tuberosum* L.) was conducted during 2017-18 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya (U.P.). The treatments included two irrigation methods ie M_1 (Regular furrow irrigation method) and M_2 (alternate furrow irrigation method), three moisture regimes ie I_1 0.8 IW/CPE,I_2 1.0 IW/CPE and $I_3$1.2 IW/CPE with 6cm water depth and three nitrogen management ie N_1(100% N through Urea), N_2 (75% N through Urea +25% N through compost) and N_3 (50% N through compost. Regular furrow irrigation M_1 with 1.0IW/CPE (I_2) and integrated nitrogen management 75% N through urea + 25% N through compost was found better for potato yield performance. Treatment combination $M_1I_2N_2$ given the highest net return of T 126255 ha^{-1} with B-C ratio of 1.92 during investigation.

Keywords: Potato, moisture regimes, integrated nitrogen management, irrigation methods

Introduction
Potato (*Solanum tuberosum* L.) is herbaceous annual plant and belongs to family Solanaceae. The edible part of potato is modified underground stem. It is originated in South America and brought to India in 16th century by the Portuguese.India is the second largest producer of potato contributing 11% of the world potato production after China with the production of 50.33 million tonners from and area of 1.843 million ha. The total area in world under potato cultivation is 19.33 mha and total production is 388.19 m tonnes with 20.11 tonnes productivity. Whereas in India, total area is 21.64 mha and production is 50.33m tonnes with 27.31 area is 1.843 mha and production is 5033 m tonnes with 27.31/ha productivity Anonymous, NHB (2018-18). Water is an another important input for potato production and its management problem varies from irrigation to irrigation. Optimum soil moisture needed to be maintained in root zone to meet crop requirement for higher yield. It can be achieved best through the use of drip and sprinkler irrigation system. However, its adoption is restricted mainly due to high investment for short duration crop like potato, which is most sensitive to soil moisture. Normally in potato furrow irrigation method is adopted for its growth and tuber formation. In every furrow irrigation, water is allowed into every furrow at each irrigation. Here water advanced both laterally and downwards as water moves along the irrigated furrow and eventually the lateral wetted fronts from the adjacent furrow meets. But when irrigation water is deficient, water has to be saved without much reduction in yield. 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. Water applied is reduced by 25 and 35 per cent compared to every furrow irrigated method and the crop yield may be reduced to the extent of 2 to 16 per cent. Nitrogen is the most limiting in potato production and has a great influence on crop growth, tuber yield and quality. A mature crop of potato yielding 30-40 tonnes tuber/ha consumes 120-145 kg N/ha. The Indian soils generally deficient in organic matter and are thus unable to release N at the desired rate, required to maintain adequate supply to the growing plant. Therefore, application of N in the form of fertilizer and manures becomes necessary to meet the crop needs. The deficiency of N leads to pale-green colouration of leaf margins at the initial stage; turning to pale-yellow foliage in case of acute deficiency. The symptoms first appear at lower leaves. However, excess of N delays tuber initiation and onset of linear phase of tuber growth, ultimately resulting in lower yield. Keeping all these facts in view the in present research work was carried out to find out evaluation of irrigation methods, moisture regimes and INM on potato production.

Materials and Methods

The experiment was laidout in split plot design with three replication at Agronomy Research Farm N.D. University of Agriculture and technology Kumarganj, Ayodhya (U.P.). The soil of the experimental field was silt loam in texture with medium fertility status. The treatments included two irrigation methods ie M_1 (Regular furrow irrigation method) and M_2 (alternate furrow irrigation method), three moisture regimes ie I_1 0.8 IW/CPE, I_2 1.0 IW/CPE and $I_3$1.2 IW/CPE with 6cm water depth and three nitrogen management ie N_1(100% N through Urea), N_2 (75% N through Urea +25% N through compost) and N_3 (50% N through compost. All the agronomic practices were fallowed according to treatment during study. All the data of yield and yield attributes were recorded and subjected to state statistical analysis with the help of method suggested by by Panse and Sukhatme (1967) [5].

Results and discussion

Plant height (60DAS), Number of haulums (60DAS), weight of tubers q/ha (50-75 gm), tuber yield q/ha and economics of different treatments have been given in Table-1.

Plant height (60DAS), Number of haulums (60DAS), weight of tubers q/ha (50-75 gm), tuber yield q/ha were observed under both irrigation methods. The regular furrow method of irrigation exhibth its superiority in growth and yield of potato then alternate method may be due to fact that under regular furrow method irrigated plant got better soil environment for its root growth, and nutrients uptake, consequently better growth and yield of potato tuber while in case of alternate furrow irrigation method plant got relatively compact soil environment which may causes poor growth and uptake of nutrients. There by ultimately lower growth and yield of potato tuber. Similar result was also found by Kumar *et al*. (2013) [3].

Growth and yield of potato tuber per unit of water applied were recorded maximum under moisture resume I_2(1.0IW/CPE) over I_1(0.8IW/CPE) and I_3(1.2 IW/CPE) Table-1.Higher growth and yield of potato tuber under high moisture regime may be possible due to sufficient moisture availability and higher nutrients uptake but in case of I_3 moisture regime excess availability of moisture which may causes nutrients losses due leaching Chandra *et al*. (2001) [2].

Maximum growth and yield of potato tuber were obtained under N_2 treatment (75%N through urea and 25%N through compost) and significantly superior over rest of the treatments. Maximum growth and yield of potato tuber was obtained may be due to integrated nitrogen managements in the organic and inorganic form of N, which also help in cell elongation of eastern due to development of cell and rapid cell division and cell elongation in meristematic region of the plant Pandey *et al*. (2007) [4].

Table 1: Effect of different treatments on growth and tuber yield of potato.

Treatment	Plant height 60days	No. of haulms (m-1) 60days	Weight of tubers grades hill-1(g)C(50-75g)	Total weight of tubers per plot(kg)	Tuber yield (qha-1)
Irrigation methods					
M_1	51.35	39.71	86.73	22.90	289.2
M_2	47.65	36.85	80.84	21.28	268.8
Sem+	0.708	0.490	1.072	0.01	4.060
CD at 5%	2.13	1.478	3.231	0.05	12.237
Moisture regimes					
l_1	49.31	38.13	83.28	21.97	277.5
l_2	51.69	39.97	87.30	23.08	291.46
l_3	47.51	36.74	80.24	21.22	267.96
Sem+	0.868	0.601	1.412	0.495	4.973
CD at 5%	2.615	1.91	4.35	1.490	14.987
Nitrogen Management					
N_1	48.2	37.31	81.48	21.53	271.86
N_2	52.55	4.64	88.75	23.51	296.08
N_3	47.71	36.90	80.58	21.30	268.95
Sem+	0.724	0.594	1.33	0.488	4.023
CD at 5%	2.077	1.705	3.806	1.399	11.538

Table 2: Effect of different treatments on economics of potato.

Treatments	Net return (Rs. Ha-1	Benefit: Cost ratio
$M_1I_1N_1$	110982	1.79
$M_1I_1N_2$	122135	1.89
$M_1I_1N_3$	104193	1.55
$M_2I_1N_1$	89912	1.45
$M_2I_1N_2$	100105	1.56
$M_2I_1N_3$	82943	1.24
$M_1I_2N_1$	109862	1.74
$M_1I_2N_2$	126235	1.92
$M_1I_2N_3$	103493	1.52
$M_2I_2N_1$	105052	1.67
$M_2I_2N_2$	119165	1.82
$M_2I_2N_3$	98117	1.45
$M_1I_3N_1$	97762	1.52
$M_1I_3N_2$	108495	1.63
$M_1I_3N_3$	90673	1.31
$M_2I_3N_1$	88542	1.39
$M_2I_3N_2$	99545	1.50
$M_2I_3N_3$	81933	1.18

Table-2 Indicate that highest net return was obtained under regular furrow method of irrigation 1.0 IW/CPW and 75% N through urea + 25 % N though compost ($M_1I_2N_2$) with highest benefit cost ratio of 1.92 were also recorded under the same treatment combination.

On the basis of results may be conducted that Regular furrow irrigation M_1 with 1.0IW/CPE (I_2) and integrated nitrogen management 75% N through urea + 25% N through compost was found better for potato yield performance. Treatment combination $M_1I_2N_2$ given the highest net return of Rs.126235 ha^{-1} with B-C ratio of 1.92 during investigation.

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