

EFFECT OF MOISTURE REGIMES AND INTEGRATED NITROGEN MANAGEMENT ON GROWTH CHARACTERS OF POTATO (*SOLANUM TUBEROSUM* L.)

Pradeep Kumar¹, Anuj Pratap Singh³, Jitendra Kumar³, Rishabh Singh Chandel³, Sauhard Dubey^{2*} and Prashant Kumar⁴

¹Dept. of Soil & Water conservation, C.S. Azad University of Ag. & Tech, Kanpur

²Dept. of Agronomy, C.S. Azad University of Ag. & Tech., Kanpur

³Dept. of Agronomy, Narendra Dev University of Ag. & Tech., Kumarganj, Ayodhya

⁴Dept. of Ag. Economics, Narendra Dev University of Ag. & Tech., Kumarganj, Ayodhya

Email: sauhardsd29@gmail.com

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Abstract: A field experiment was conducted to study the effect of moisture regimes and integrated nitrogen management on the performance of potato crop (*Solanum tuberosum* L.) during Rabi season of 2016-17 at Agronomy Research Farm, Narendra Deva University of Agriculture & Technology (Narendra Nagar), Kumarganj, Faizabad (UP). The treatments included to irrigation methods viz. M₁ (Regular furrow irrigation method) and M₂ (alternate furrow irrigation method), moisture regime viz. 0.8 IW/CPE, 1.0 IW/CPE and 1.2 IW/CPE with 6 cm irrigation water depth and nitrogen management viz. N₁ (100% dose of N through urea), N₂ (75% dose of N through urea + 25% dose of N through compost) and N₃ (50% dose of N through urea + 50% dose of N through compost). The experiment was laid out in Split Plot Design with four replications. The soil of experimental field was silt loam in texture, poor in organic carbon and nitrogen, medium in available phosphorus and rich in potassium with pH 8.0. The planting was done by hand on ridges and nutrients and irrigations were applied as per treatment. Initial plant stand was non-significant under various irrigation methods, moisture regimes and nitrogen management. The growth characters viz. plant height, number of haulms at 30 DAP was also insignificant but at 60 and 90 DAP, there were significantly superior under M₁ (regular furrow irrigation method) with I₂ (1.0 IW/CPE) and N₂ (75% dose of N through urea + 25% dose of N through compost). Number of all grade of tubers was found to be significant due to effect of moisture regimes.

Keywords: Furrow irrigation, Split plot design, Moisture regimes, Irrigation water

INTRODUCTION

Potato (*Solanum tuberosum* L.) is herbaceous annual plant and belongs to the 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.

Potato is the 4th major food crop after rice, wheat and maize of the world and a rich source of energy and produces more food per unit area and time than all major food crops. It is one of the most efficient food crop which produce more dry matter, dietary fiber, quality protein, minerals and vitamin than wheat, maize and rice per unit area and time is considered as a balanced and nutritive food. Potato can be compared only with rice, wheat and maize for its contribution towards securing the food and nutrition and avoiding poverty and hunger especially in developing countries, where food is perpetually on demand to feed increasing population living with inherent social and political conflict. It is also utilized in preparation of readymade products like fried items (Dices, vanies, flakes, granules, starch, gravy thicker, potato custard etc.) and canned potato. Nitrogen is the most limiting in potato production and has a great influence on crop growth, tuber yield and quality. 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. The economic response of potato in alluvial soils of north-western and central Indo-Gangetic plains in India has been reported upto 180 kg N/ha. In potato crop, application of N at proper time is important for getting full benefit of applied N. In general, for plains where growth period is short (100-120 days), application of N in two split doses, i.e. half at planting and rest at the time of earthing up gives higher yields and results in higher N recovery than applying entire dose at planting. This reduces leaching and other losses and gives better utilization of applied N.

The application of organic manures particularly FYM or compost is recommended for potato crop. Organic manure not only supply nutrients to the crop but also improve physical conditions of soils, such as texture and its water holding capacity. Normally in potato furrow irrigation method is adopted for its

*Corresponding Author

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.

MATERIALS AND METHODS

The experiment was conducted during the winter season 2016-17 at Agronomy field. The experiment was laid out in Split Plot Design and replicated four times. There were 18 treatments, involving two irrigation methods three moisture regimes and three nitrogen management respectively.

Geographically, the experimental site falls under humid, sub-tropical climate and is located at 26° 47' N latitude and 82° 12' E longitude on an elevation of about 113 meter above mean sea level in the indo-gangetic alluvial soil belt of Eastern Uttar Pradesh. Faizabad region receives a mean annual precipitation about 1200 mm. Maximum rainfall in this area is received from mid June to end of September. However, occasional showers are very common in the month of January and February. The winter months are cold whereas, summer months are extremely hot, the western hot winds locally known as Loo, starts from April and continued till the onset of monsoon in the month of June.

The different components of weather parameters *e.g.* rainfall, temperature (maximum and minimum), relative humidity, evaporation rate and sun shine hours recorded during the crop season. The representative soil samples were taken with the help of soil auger from five randomly selected places to a depth of 15 cm prior to laying out the field trials. The samples were worked thoroughly, oven heated. The pre-sowing irrigation was given after harvesting of previous crop. At first, ploughing was done by tractor drawn soil turning plough followed by subsequent ploughing and harrowing. The planking was done invariably after each ploughing till planting. Required quantities of nitrogen as per treatment through urea was applied in two split doses as top dressing and at the time of earthing and compost was incorporated one month before the planting of potato.

Scheduling of irrigation was based on climatological approach (IW/CPE ratio). The formula for ratio is as under:

$$\text{IW/CPE ratio} = \frac{\text{Depth of irrigation water (intensive water 60 mm)}}{\text{Cumulative pan evaporation (CPE)}}$$

The depth of irrigation water was measured as:

$$\text{Depth of water} = \frac{\text{Volume of water (m}^3\text{)}}{\text{Land area (m}^2\text{)}} \times 100$$

Different growth characters observed were accordingly taken like initial plant stand, plant

height, Number of haulms (m^{-1}), Number of leaves (m^{-1}) was counted at 30, 60 and 90 DAP from tagged plants and the average number of leaves m^{-1} was calculated by dividing total number.

RESULTS AND DISCUSSION

The results of the experiment are being discussed; elucidated and interpreted in the light of available literatures and evidences. The whole of the findings are being discussed under the following broad headlines. In general initial plant stand, plant height, number of haulms, numbers of leaves, fresh and dry matter were observed with regular furrow method of irrigation and alternate furrow irrigation method. Initial plant stand at 15 DAP did not influence significantly due to various moisture regimes. It may be because of the fact that the initially the soil get moist uniformly in the vicinity of tuber seed due to good quality of tilt one common irrigation after a week of planting under both the irrigation methods and maintain optimum moisture in the field and resulted in uniform plant stand.

Plant height and number of haulms m^{-1} were influenced significantly at all the growth stages except 30 DAP. Maximum values of these parameters were recorded with regular furrow irrigation method (M_1). It may be due to high and uniform moisture which leads the high nutrient uptake and there by better vegetative growth.

Number of leaves m^{-1} was influenced significantly at all the growth stages of crop *i.e.* 30, 60 and 90 DAP (Table 4.2). Maximum value of plant height cm was recorded with regular furrow irrigation method (M_1). It may be due to uniform distribution of moisture which produced taller plants and ultimately resulted more number of leaves. Similar findings have also been made by Halim (2013).

Fresh and dry weight of haulms was also significantly higher under regular furrow method of irrigation (M_1). This may be the fact that this irrigation method produced taller plants and more number of haulms and leaves which ultimately increase the fresh and dry weight of haulms. The initial plant stand at 15 DAP did not influence significantly due to various moisture regime. As other factors such as tuber size and post-cold storage period influencing emergence were common to all treatments. It may be due to the food material already stored in the seed tubers, which gave initial boost to the emerging plants. It might be because of the fact that the initial common irrigation after a week of planting provided in both the irrigation methods maintain the optimum moisture condition in the field and resulted in uniform plant stand.

Plant height at 60 and 90 DAP was influenced significantly due to various moisture regimes except 30 DAP. Maximum value for plant height was recorded with I_2 (1.0 IW/CPE) moisture regime in comparison to I_1 (0.8 IW/CPE) and I_3 (1.2 IW/CPE)

moisture regimes. It may be due to high moisture along with high nutrients which has boosted the vegetative growth. Higher moisture regime has also produced taller plants, which ultimately resulted in the production of more number of leaves. Similar findings have also been reported by Grewal and Singh (1978), Vanloon (1981) Sood and Sharma (1986) Patel and Patel (2001).

Number of haulms m^{-1} were significantly influenced by moisture regimes at 60th and 90th DAP stages except 30th DAP stages. This variation is due to fact that stolons which develop first and moves deeper in the soil become tubers, while later developed stolons being phototrophic becomes haulms above the soil surface. The higher moisture regime has encouraged the vegetative growth (stolonization) even during all stage of crop growth particularly at 60 and 90 DAP. These stolons being unable to go deep in the soil in order to develop a tuber have become the haulms. This is the possible reason for the high number of haulms in the higher moisture regimes during later stage of crop growth. The result in close conformity with the finding of Tripathi and Mishra (1984).

Number of leaves were also significantly influenced by moisture regimes at all stage of plant growth. Maximum value for number of leaves was recorded with I₂ (1.0 IW/CPE) moisture regime as compared to I₁ (0.8 IW/CPE) and I₃ (1.2 IW/CPE) (Table 4.2). It may be due to high supply of moisture along with nutrients which has boosted the vegetative growth. Higher moisture regime has also produced taller plants, which ultimately resulted in the production of more number of leaves. Similar findings have also been made by Grewal and Singh (1978), Vanloon (1981) Sood and Sharma (1986) Patel and Patel (2001).

Fresh and dry weight of haulms was significantly higher under moisture regime I₂ which was significantly higher over I₁ and I₃ (Table 4.3). This may be probably due to production of more number of haulms, leaves and taller plants ultimately increase plant weight Patel *et al.* (2000), Yadav *et al.* (2003). Initial plant stand was not influenced significantly due to effect of nitrogen management. This may be due to fact that only half of nitrogen was applied at

the time of planting which may not be injurious to the planted tubers and also it's obvious that well sprouted healthy tubers were planted which provided favorable condition for emergence and more over initial growth of potato depends on storage of food inside the tubers. Krishnappa and Shivashankara (1981) had also failed on to observe any significant effect of increasing levels of nutrients on emergence. Application of nitrogen 75% dose of N through urea + 25% of N through compost (N₂) produced maximum number of haulms m^{-1} which was significantly superior over rest of the nitrogen management treatments. Though, the number of haulms m^{-1} depends on the number of buds present on the seed tubers but their survival with plant growth depends on the nutrients available in the soil. The availability of nitrogen through urea as well as through compost at suitable doses, therefore, seems the main cause of increased number of haulms m^{-1} . The positive and significant effect of nutrients on number of haulms m^{-1} has also reported by Veer Kumar *et al.* (2002), Hassanpanah *et al.* (2009), Shiri-e-Janagrad *et al.* (2009), Dubey *et al.* (2020) and Suman *et al.* (2011).

The plant height and number of leaves m^{-1} at 30, 60 and 90 DAP were influenced significantly due to various nitrogen management practices. Maximum values of both parameters were recorded with the application of nitrogen 75% N through urea + 25% N through compost and significantly superior over rest of the other nitrogen management treatments. Minimum height and leaves were recorded with the application of nitrogen 50% N through urea + 50% N through compost. Similar findings have also been reported by Patel and Patel (2001), Prasad *et al.* (2004), Singh and Gupta (2005), Nasir Mahmood *et al.* (2006), Dubey *et al.* (2020), Roy *et al.* (2007), Kumar *et al.* (2002) and Pandey *et al.* (2007)

The increase in growth parameters might be because of better photosynthetic activities in large photosynthetic area. Since nitrogen is basic minerals associated with synthesis of protoplasm and in primary synthesis of amino acid. It is also an established fact that plant supplied with abundant nitrogen would assimilate more pH.

Table 1. Initial plant stand and plant height of potato as influenced by effect of irrigation methods, moisture regimes and integrated nitrogen management.

Treatments	Initial plant stand 15 DAP (m^{-1})	Plant height (cm)		
		30 DAP	60 DAP	90 DAP
Irrigation methods				
M ₁	5.88	22.51	51.35	53.63
M ₂	5.89	21.41	47.65	49.77
SEm±	0.072	0.40	0.708	0.60
CD at 5%	NS	NS	2.13	1.81
Moisture regimes				
I ₁	5.83	22.04	49.31	51.50
I ₂	5.92	22.65	51.69	53.99

I₃	5.90	21.19	47.51	49.62
SEm±	0.088	0.52	0.868	0.73
CD at 5%	NS	NS	2.615	2.52
Nitrogen management				
N₁	5.90	21.64	48.24	50.39
N₂	5.85	22.79	52.55	54.88
N₃	5.90	21.46	47.71	49.83
SEm±	0.094	0.330	0.724	0.83
CD at 5%	NS	0.948	2.077	2.406

Table 2. Number of haulms and number of leaves of potato as influenced by irrigation methods, moisture regimes and integrated nitrogen management.

Treatments	Number of haulms (m ⁻¹)			Number of leaves (m ⁻¹)		
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
Irrigation methods						
M₁	8.41	39.71	40.40	75.28	366.82	447.74
M₂	8.42	36.85	37.48	71.60	340.38	415.46
SEm±	0.13	0.490	0.622	0.954	4.258	6.307
CD at 5%	NS	1.478	1.873	2.874	12.83	19.008
Moisture regimes						
I₁	8.48	38.13	38.79	73.71	352.21	429.90
I₂	8.46	39.97	40.66	75.73	369.23	450.68
I₃	8.29	36.74	37.37	70.87	339.36	414.22
SEm±	0.18	0.601	0.761	1.161	5.705	7.725
CD at 5%	NS	1.91	2.294	3.519	17.11	23.280
Nitrogen management						
N₁	8.37	37.31	37.95	72.37	344.61	420.63
N₂	8.51	40.64	41.34	76.20	375.37	458.17
N₃	8.37	36.90	37.53	71.75	340.82	416.00
SEm±	0.10	0.594	0.529	1.062	5.56	6.054
CD at 5%	NS	1.705	1.518	3.047	15.956	17.362

Table 3. Fresh and dry weight of haulms at dehauling stage as influenced by effect of irrigation methods, moisture regimes and integrated nitrogen management.

Treatments	Weight of haulms /hill (g)	
	Fresh weight	Dry weight
Irrigation methods		
M₁	399.19	29.02
M₂	370.41	26.93
SEm±	4.324	0.461
CD at 5%	13.030	1.390
Moisture regimes		
I₁	383.29	27.87
I₂	401.81	29.21
I₃	369.30	26.85
SEm±	6.316	0.565
CD at 5%	18.95	1.702
Nitrogen management		
N₁	375.02	27.26
N₂	408.49	29.70
N₃	370.89	26.96
SEm±	5.740	0.325
CD at 5%	16.461	0.932

CONCLUSION

The response of potato to various treatments was measured in terms of quantitative expression *i.e.*

plant emergence, number of haulms, plant height, number of leaves hill⁻¹, fresh and dry weight of haulms gm⁻¹, number and weight of A, B, C and D grade tubers hill⁻¹, water use efficiency and tuber

yield ($q\ ha^{-1}$). Quality parameters *i.e.* dry matter and starch content and economics of various treatment combinations were also worked out. The salient feature of results have been summarized in brief as under:

Initial plant stand did not influence significantly due to irrigation methods, moisture regimes and nitrogen management. Plant height and number of haulms m^{-1} at 60 and 90 DAP varied significantly with regular furrow irrigation, moisture regimes except 30 DAP and I_2 (1.0 IW/CPE) and the same trend was followed in fresh and dry weight of haulms (gm^{-1}).

In general the water use efficiency decreased with the increase in total water applied

Initial plant stand did not differ significantly due to effect of nitrogen management. However, plant height (cm), number of haulms and leaves m^{-1} at 30, 60 and 90 DAP and fresh and dry weight of haulms gm^{-1} varied significantly under nitrogen management practices N_2 (75% N through urea + 25% N through compost) and recorded the highest values which were significantly superior over rest of the nitrogen management practices.

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