E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(8): 171-173
Received: 02-05-2024
Accepted: 06-06-2024

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Effect of levels of potassium and irrigation on Crop growth rate of potato

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i8c.1208

Abstract
Experiment was conducted at water management field of RAU, Pusa (Samastipur), Bihar on calcareous sandy loam soil, alkaline in nature having pH 8.5, low nitrogen, phosphorus and potassium in split plot (4.2 x 2.4 m^2) design, replicated thrice to evaluate the performance of potato on four levels of irrigation on the basis of IW/CPE ratio (I_1, I_2, I_3 and I_4 i.e., 0.6, 0.8, 1.0 and 1.2, respectively) in main plots and five levels of potassium (K_0, K_1, K_2, K_3 and K_4 i.e., K_2O @ 0, 50, 100, 150 and 200 kg ha^{-1}) in sub plots during 2005-06 and 2006-07. It was observed that the value of C.G.R. and L.A.I. increased with increasing levels of both irrigation and potassium application, at all the period of crop growth during both the years. It was also apparent that I_3 and I_4 levels were statistically at par and significantly superior to I_1 level of irrigation. Whereas, K_3 and K_4 levels were observed at par and significantly superior to both K_0 and K_1 levels of K-application. The values for both the parameters increased upto 60 DAP and then declined up to harvest stages of crop growth.

Keywords: Potato, nitrogen, phosphorus, potassium and crop growth

Introduction

Potatoes are grown throughout the world as a major staple food crop in 18.95 million ha with productivity of 16.8 t/ha. India ranks 4^{th} in area and 3^{rd} in production occupying 1.37 m ha of land and producing 23.9 m.t. potato with average productivity of 18.2 t/ha. In Bihar, potato is grown in 0.12 m ha with productivity of 11 t/ha. India has to support 16% of the world population with 4% of the total water resources on the earth (Charyulu *et al*., 2007) [2]. By 2020 India will have a population of 1.3 billion bringing about a substantial pressure on land to produce more food. Moreover, with the improvement in living standards of people, there will be shift in dietary pattern from cereals to vegetables. This will require the country to produce around 49 million tones of potato and most of it has to come through increased productivity. Adoption of modern technologies would be imperative to achieve the desired productivity levels. Potato being short duration crop, highly responsive to inputs, high in nutrition and capable of being grown under wide range of soils and climatic conditions is a crop for providing food security to the ever increasing Indian population. Potatoes are used as subsidiary food as part of vegetables in Terai region, whereas as staple food in Hill and Mountain regions (Subedi *et al*., 2019) [11]. Potato contributes to improve the livelihood in the rural areas because it is a source of food and income Gildemacher (2012). In Nepal, potato is cultivated since 200 years (Ojha *et al*., 2001) [8].

Introduction of high yielding potato varieties has emphasized the improvement in its important inputs like fertilizer, irrigation etc. The aspects gaining importance are the use of fertilizer and its interaction with irrigation. In plains of India potato is grown during dry season and irrigation water plays the most important role in sustaining growth of the plant and development of tuber. We receive approximately 1150 milimetre average rainfall annually, that too irregularly and only during limited period of two to three months. According to an estimate of the Central Groundwater Board, if we continue to exploit our ground water sources indiscriminately, then in the next 20 years, 15 states of the country may face acute shortage of underground water

(Charyulu *et al*., 2007) [2]. Thus, managing water supply is one of the critical issues facing humanity and a real challenge of this century.

Methods and Materials

Experiments were conducted at the Water Management Field, R.A.U., Pusa (Samastipur) district of North Bihar during Rabi seasons of the year 2005-06 and 2006-07. Pusa is situated on the bank of river Burhi Gandak. It lies at 25.98ºN latitude, 85.67ºE longitude and at an altitude of about 52 meter above the mean sea level.

The field experiments were laid out in split-plot design with three replications. Twenty treatments combinations comprising of four levels of irrigation and five levels of potash were made. The climate of the area concerned is humid subtropical. It receives fairly good amount of south-west monsoon with an average annual rainfall of 1270 mm out of that nearly 1025 mm (80.75%) occurs in the monsoon months. The maximum temperature recorded was 45ºC during the peak period of summer months of May-June and the minimum about 6ºC during winter months of December-January. The maximum relative humidity falls in the range of 85-90% during rainy month of July-September and the minimum in the range of 40-60% during summer month of March-April.

Crop growth rate-

It represents dry matter accumulation per plant per unit area. Calculation given by Watson (1952) [12]. Crop growth rate was calculated by using the following formula:

$$\frac{W_2 - W_1}{t_2 - t_1}\ g/m^2/day$$

Where, W_2 and W_1 were dry weights of plants in a sample at two different time's t_2 and t_1, respectively.

Results and Discussion: Crop growth rates (CGR) between 0-30, 30-60 and 60-90 DAP were calculated from the dry weight of plant samples. The data have been presented in Table 1(a) & 2(b) for 2005-06 and 2006-07, respectively. During the periods of 30-60 and 60-90 DAP, the crop growth rates increased significantly with increase in levels of irrigation. Crop growth rate enhanced significantly with the increase in potassium application at 0-30, 30-60 and 60-90 DAP. The effect of interaction between irrigation and potassium on the crop growth rate during both the years at 0-30, 30-60 and 60-90 DAP was not significant. Higher CGR was recorded during the period 30-60 DAP in both years.

During the period of 0-30 DAP crop growth rate ranged between 1.10 to 1.20 g/m^2/day. Effect of levels of irrigation was found non-significant, but the potassium imparted marked influence on the crop growth rate during the period 0-30 DAP. Crop growth rate accelerated with the increase of potassium upto K_4 (K_2O @ 200 kg/ha). Highest CGR value (1.19) was obtained with 200 kg/ha which was significantly superior to K_0 and was at par with K_3, K_2 and K_1.

During the period of 30-60 DAP CGR. Increased with the increase in irrigation levels. Highest CGR value (8.55 g/m^2/day) was recorded with I_4 which was at par with I_3. Highest CGR value (8.77 g/m^2/day) was recorded with 200 kg K_2O/ha, which was significantly higher than other levels of potassium, except with K_3 (150 kg K_2O/ha) where the difference was not significant.

During the period of 60-90 DAP CGR was ranged between 5.01 to 7.26 in 2005-06. Highest CGR (6.60 g/m^2/day) was obtained with irrigation at I_4 (IW/CPE ratio = 1.20) which was significantly different from I_2 and I_1. But the CGR values between I_3 & I_4, and I_1 & I_2 did not differ significantly. At 60-90 DAP, maximum CGR (6.71 g/m^2/day) was observed at K_4 (200 kg/ha) level, which recorded significantly higher CGR than those of K_0, K_1 and K_2. There was no significant difference between K_3 and K_4 levels.

Similar trends in CGR were observed during 0-30 DAP in second year (2006-07). Highest CGR value (1.23 g/m^2/day) was recorded with K_4 (K_2O @ 200 kg/ha) which was significantly superior to K_0 and K_1 but was at par with K_3 and K_2. These results support the findings of Noor *et al*. (2011) [7].

During 30-60 DAP, C.G.R. was improved significantly with I_3 and I_4 levels of irrigation over I_1 level of irrigation. On the other hand increasing levels of K_2O from 0 to 200 kg/ha increased CGR from 6.94 to 8.94 g/m^2/day however, significant improvement was recorded only upto 100 kg/ha application of K_2O level. Saikia *et al*. (1987) [10] reported that potassium fertilization at increasing levels favourably influenced leaf area, LAD, leaf efficiency and tuber dry matter production.

During 60-90 DAP highest CGR was recorded (6.75 g/m^2/day) and (6.95 g/m^2/day) with application of I_4 and K_4, respectively. I_3 and I_4 levels of irrigation were found statistically at par with each other and significantly superior over I_1. Further, CGR increased significantly with increasing levels of K_2O application upto K_3 (K_2O @ 150 kg/ha) which was at par with K_4. As optimum soil moisture conditions favour K^+ diffusion in soil medium and thus beneficial to the supply of K^+ to plant roots (Mengel and Braunschweig, 1972) [5]. Also, that inadequate K^+ supply retards the vegetative development of the plants which may not only affect the production of vegetative plant material but also the development of reproductive organ and the filling of storage tissues with photosynthetes (Mengel and Forster, 1968) [6]. Thus, the results obtained during investigation may be attributed to the fact that irrigation and K-application improved K availability and inturn better crop growth. The results are in agreement with those of Chakrabarty *et al*. (1993) [1], Chowdhury and Verma (1997) [3] and Lalitha *et al*. (1997) [4]. Interaction was non-significant in both seasons i.e. 2005-06 and 2006-07. Similarly, the present results are in good accordance with those obtained by Noor *et al*. (2011) [7].

Lalitha *et al*. (1997) [4] reported that potato at three levels of potassium 100, 125 and 150 kg/ha and reported that potassium (125 kg/ha) application significantly increased the yield, leaf area index, leaf area duration, crop growth rate, total dry matter per plant, bulking rate and harvest index over 100 kg K_2O/ha. However, 125 and 150 kg K_2O/ha were at par. These results concur with earlier reports of Adhikari1 and M.K. Rana (2017) [9] the various levels of irrigation and potash improved the growth and yield of potatoes. Irrigation level 35 mm CPE with potash @ 150 kg/ha was superior for best growth and yield of potato.

Table 1(a): Effect of levels of potassium and irrigation on crop growth rate (g/m^2/day) of potato during 2005-06

Treatment	0-30 DAP						30-60 DAP						60-90 DAP					
	K_0	K_1	K_2	K_3	K_4	Mean	K_0	K_1	K_2	K_3	K_4	Mean	K_0	K_1	K_2	K_3	K_4	Mean
I_1	1.10	1.14	1.16	1.18	1.18	1.15	6.54	7.02	7.48	7.80	7.96	7.36	5.01	5.42	5.82	6.11	6.29	5.73
I_2	1.11	1.14	1.17	1.18	1.18	1.16	6.90	7.42	7.84	8.25	8.72	7.82	5.04	5.44	6.02	6.14	6.32	5.79
I_3	1.12	1.15	1.18	1.19	1.12	1.17	7.22	7.87	8.32	8.74	9.06	8.24	5.53	6.01	6.39	6.77	6.96	6.33
I_4	1.12	1.16	1.18	1.20	1.20	1.17	7.50	8.10	8.65	9.17	9.35	8.55	5.72	6.23	6.69	7.10	7.26	6.60
Mean	1.11	1.15	1.17	1.18	1.19		7.03	7.60	8.07	8.50	8.77		5.32	5.77	6.23	6.53	6.71	

Source	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Irrigation	0.02	NS	0.13	0.46	0.09	0.30
Potassium	0.03	0.07	0.15	0.42	0.12	0.34
Irrigation x Potassium	0.04	NS	0.30	NS	0.24	NS

Table 1(b): Effect of levels of potassium and irrigation on crop growth rate (g/m^2/day) of potato during 2006-07

Treatment	0-30 DAP						30-60 DAP						60-90 DAP					
	K_0	K_1	K_2	K_3	K_4	Mean	K_0	K_1	K_2	K_3	K_4	Mean	K_0	K_1	K_2	K_3	K_4	Mean
I_1	1.07	1.15	1.18	1.21	1.22	1.17	6.39	7.05	7.60	8.04	8.22	7.46	4.87	5.44	5.92	6.34	6.49	5.82
I_2	1.06	1.14	1.17	1.22	1.22	1.17	6.87	7.34	8.09	8.58	9.08	7.99	5.02	5.53	6.00	6.42	6.61	5.92
I_3	1.10	1.14	1.19	1.23	1.24	1.18	7.11	7.52	8.40	8.92	9.17	8.22	5.37	5.97	6.45	6.96	7.09	6.36
I_4	1.11	1.17	1.21	1.23	1.25	1.19	7.40	8.17	8.76	9.27	9.29	8.58	5.66	6.28	6.84	7.35	7.62	6.75
Mean	1.08	1.15	1.18	1.22	1.23	1.17	6.94	7.52	8.21	8.70	8.94	8.06	5.23	5.80	6.30	6.77	6.95	6.21

Source	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Irrigation	0.02	NS	0.19	0.67	0.14	0.49
Potassium	0.03	0.08	0.20	0.58	0.16	0.47
Irrigation x Potassium	0.06	NS	0.40	NS	0.32	NS

Conclusion

It was observed that the value of C.G.R. increased with increasing levels of both irrigation and potassium application, at all the period of crop growth during both the years. It was also apparent that I_3 and I_4 levels were statistically at par and significantly superior to I_1 level of irrigation. Whereas, K_3 and K_4 levels were observed at par and significantly superior to both K_0 and K_1 levels of K-application. The values for both the parameters increased upto 60 DAP and then declined up to harvest stages of crop growth.

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