

Original Research Article

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Comparison of Irrigation Methods in Terms of Vegetative Growth of Potato (*Solanum tuberosum* L.) Cultivars

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ABSTRACT

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The studies were conducted at Research Farm of the Department of Vegetable Science during 2016-17 and 2017-18 to evaluate the effect of irrigation methods *viz.*, drip and furrow irrigation on growth parameters of four potato cultivars *viz.*, Kufri Pukhraj, Kufri Surya, Kufri Pushkar and Kufri Bahar. The experiment was laid out in randomized block design with four replications. The observations were recorded on plant emergence at 30 days, number of shoots per hill at 90 days and plant height at 30, 60 and 90 days after planting. Results revealed that the drip irrigation gave highest value for all the growth parameters as compared to furrow irrigation. The Kufri Pushkar had maximum growth, whereas, the minimum plant emergence and plant height was recorded with Kufri Surya but the number of shoots per hill was recorded minimum in Kufri Pukhraj. Based on the two years results, the potato cultivar Kufri Pushkar with drip irrigation proved best for the growth for potato plants.

Introduction

Potato (*Solanum tuberosum* L.), also known as Irish potato and the king of vegetables, belonging to the family Solanaceae is one of the most important vegetable crops in the world and in terms of human consumption, it ranks 4th after wheat, rice and corn (Hassan, 2003). The Andean tuber crop was originally domesticated in South America and its worldwide dissemination was started after Columbus's voyages brought it to Europe in 16th century. Potato is one of the main cash crops among vegetables, which is grown and consumed all round the world (Nyunza and Mwakaje, 2012). The countries like China, USA, Europe, Russian Federation, India and

Japan have the highest potato yield in the world. In world, India ranks 3rd in area, *i.e.*, 18.28 million hectare and 2nd in the production, *i.e.*, 364.87 million ton of potato (FAOSTAT, 2012). India is the second largest producer of potato in the world after China with the total area and production of 2.14 million hectares and of 48.60 million ton, respectively during 2016-17 (Anonymous, 2017). Potato is also one of the most important crops of Haryana, having area of 34.53 thousand ton with the production and productivity of 896.95 thousand MT and 25.98 t/ha, respectively (NHB, 2017). India stands at fourth place with respect to the production of potato in the world, but the productivity is very low as compared to other advanced

countries. The higher productivity could be achieved by selection of proper varieties specific to areas and other agronomical practices. India being a vast country with varied agro-climatic regions, a single variety or hybrid may not be suitable for all the agro-climatic conditions. Hence, varieties are needed to be evaluating for specific regions (Amarananjundeswara, 2018).

Water is the key input in potato production and the problem of water management varies from region to region. Potato plants are sensitive to changes in soil moisture due to their shallow root system and improper irrigation management practices not only waste the expensive and scare water resources but also reduce the tuber yield and quality (Khalel, 2015). Therefore, quantity, frequency and method of irrigation always decide growth, yield, quality and storability of potato tubers (Shahnazari *et al.*, 2007). The amount of water needed by the potato crop varies with soil type, temperature, humidity, air movement, plant and stem populations, varieties and cultural practices (Wiersema, 1987) but critical stages for irrigation are tuber initiation and tuber bulking (Abdallah, 1996). Further, the water resources are becoming scarce day by day and it has been predicted to get worsen globally due to extreme weather conditions like draught, flood, *etc.* The decline in water resources requires the development of new water saving strategies. Furrow and sprinkler methods of irrigation are widely used in potato because it is easy to do and requires low maintenance (Onder *et al.*, 2005). There is a need for economizing water uses by replacing conventional method of irrigation to more efficient irrigation system *i.e.*, drip irrigation, which saved approx. 45% water as compared to furrow irrigation system (Chongtham *et al.*, 2016). The drip irrigation system offers opportunity for the precise application of water-soluble fertilizers and other nutrients to soil at appropriate times in

desired concentrations than furrow irrigation. It can also reward farmers by giving them high crop yield if combined with good farming practices such as high yielding varieties, good soil management, proper fertilization, mechanization operations and improved seeds (Pair *et al.*, 1975). Moreover, it reduces manmade environmental effects that involve water wastage, land reclamation with sewage, water waste from the cities and factories, converting them into agricultural crop productivity. Drip irrigation system was not widely used in potato production because of high cost of installation but now the cost has relatively decreased due to improved technology. Therefore, the study was undertaken to find the effect of irrigation methods on growth of potato cultivars.

Materials and Methods

The experiment was carried out at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar, Haryana during 2016-17 and 2017-18. Hisar is situated at latitude of 29° 10' N, longitude of 75° 46' E and at the height of 215.2 meters above mean sea level and falls in semi-arid and sub-tropical region with hot and dry summer and severe cold in winter. The maximum temperature was ranged between 17.2 to 30.8 °C and 17.3 to 30.8°C, while the minimum was ranged between 6.0 to 12.8 °C and 2.5 to 14.8°C during both the years, respectively. The soil of experimental field was sandy loam. The treatments consisted of two irrigation methods, *i.e.*, drip and furrow irrigation and four potato cultivars, *i.e.*, Kufri Pukhraj, Kufri Surya, Kufri Pushkar and Kufri Bahar. The treatments were laid out in randomized block design with four replications. The planting was done manually by placing each tuber at 20 cm spacing in row and spacing between rows was at 60 cm. The potato plants were irrigated at 40 mm depth in furrow irrigation, while the drip irrigation was

applied at 10 mm depth during both the years. The fertilizers were applied as per the recommendations for potato crop in Haryana conditions (NPK @ 150:50:100 kg/ha). The recommended plant protection measures were also adopted when required for raising healthy potato crop. The haulm killing was done chemically with Gramoxone @ 7 ml/lit at 90 days of planting after taking necessary data. The data were recorded on percent plant emergence at 30 days, plant height at monthly interval and number of shoots per hill at the time of harvest.

Statistical analysis

The statistical software OPSTAT (<http://14.139.232.166/opstat/index.asp>), developed by CCS, Haryana Agricultural University, Hisar (Haryana), India was used for statistical analysis of data (Sheoran, 2010).

Results and Discussion

The drip irrigation and potato cultivars had significant effect on all the growth parameters during both the years. The mean plant emergence (86.20 and 90.52%) was recorded maximum with drip irrigation, while the minimum mean plant emergence (83.19 and 84.47%) was observed with treatment where furrow irrigation was applied during 2016-17 and 2017-18, respectively (Table 1). The results obtained during both the years were in good accordance with those of Chawla and Narda (2000) and Shiwani *et al.*, (2017) who stated that the adequate amount and frequency of irrigation stimulates crop growth and development of most of the vegetable crops. Further, the uneven distribution and insufficient use of irrigation water leads to deep percolation and leaching losses of nutrients that might be the reason for lower percent emergence (Sankar *et al.*, 2008). Different potato cultivars showed variable percent emergence. The maximum mean plant

emergence (88.67 and 92.88%) was found with potato cultivar Kufri Pushkar, whereas, the minimum mean plant emergence (80.41 and 82.65%) was recorded with Kufri Surya during 2016-17 and 2017-18, respectively. These results confirm the findings of Yadav *et al.*, (2017) and Chongtham *et al.*, (2016). The interaction effect was found non-significant which ranged between 79.96 to 90.77% and 80.51 to 95.83% during 2016-17 and 2017-18, respectively (Table 1).

The results of various levels of irrigation methods and potato cultivars with their interaction in relation to plant height at monthly intervals are shown below (Table 2, Table 3 and Table 4). The irrigation methods, potato cultivars and their interaction differed significantly with regard to plant height at monthly intervals. In 2016-17, the maximum plant height at 30, 60 and 90 days (40.04, 50.10 and 60.25 cm) was found under drip irrigation, whereas, the minimum (36.07, 47.30 and 56.21 cm) was recorded under furrow irrigation. During 2017-18, the highest value for plant height at 30, 60 and 90 days (42.37, 52.02 and 64.11 cm) was found under drip irrigation, while the lowest value (37.06, 48.88 and 58.88 cm) was noted under furrow irrigation.

The results of present investigation were in line with the findings of Chawla and Narda (2001), Ferreira and Carr (2002), Yuan *et al.*, (2003) and Badr *et al.*, (2012). According to Kashyap and Panda (2003), the growth of potato plant responds positively to frequent irrigation. The higher frequency and better uniformity of irrigation water in drip system could be attributed to maximum plant height under drip irrigation as compared to furrow irrigation (Chongtham *et al.*, 2016). The reduction in plant height in potato varieties under furrow irrigation might be due to stomata closure and reduced CO₂ in soil moisture stress, which hindered the

photosynthesis and other biochemical processes and ultimately nutrient uptake of plants hampered (Fitsum *et al.*, 2016).

The potato cultivars also had significant effect on plant height at monthly interval as shown in Table 2, 3 and 4. During 2016-17, the

maximum plant height at 30, 60 and 90 days (41.10, 53.26 and 62.37 cm) of planting was recorded in Kufri Pushkar followed by Kufri Bahar (39.01, 50.32 and 59.29 cm), whereas, the minimum plant height at 30, 60 and 90 days (34.87, 44.01 and 54.08 cm) after planting was found in Kufri Surya.

Table.1 Effect of irrigation methods on plant emergence (%) at 30 days of potato cultivars

Irrigation methods Cultivars	2016-17					2017-18				
	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean
I₁: Drip	84.79	80.85	90.77	88.38	86.20	89.32	84.80	95.83	92.11	90.52
I₂: Furrow	82.76	79.96	86.58	83.46	83.19	82.26	80.51	89.93	85.19	84.47
Mean	83.78	80.41	88.67	85.92		85.79	82.65	92.88	88.65	
Factors	Irrigation	Variety	Irrigation x Variety			Irrigation	Variety	Irrigation x Variety		
SE (m)±	0.49	0.69	0.97			0.34	0.48	0.68		
C.D.	1.44	2.04	N.S.			1.01	1.42	N.S.		

Table.2 Effect of irrigation methods on plant height (cm) at 30 days of potato cultivars

Irrigation methods Cultivars	2016-17					2017-18				
	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean
I₁: Drip	38.86	37.65	42.90	40.74	40.04	41.85	40.55	44.72	42.36	42.37
I₂: Furrow	35.65	32.09	39.29	37.28	36.07	36.36	34.94	39.01	37.91	37.06
Mean	37.25	34.87	41.10	39.01		39.10	37.75	41.87	40.13	
Factors	Irrigation	Variety	Irrigation x Variety			Irrigation	Variety	Irrigation x Variety		
SE (m)±	0.17	0.24	0.34			0.08	0.11	0.16		
C.D.	0.50	0.70	0.99			0.24	0.33	0.47		

Table.3 Effect of irrigation methods on plant height (cm) at 60 days of potato cultivars

Irrigation methods Cultivars	2016-17					2017-18				
	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean
I₁: Drip	49.34	45.95	53.77	51.35	50.10	51.56	48.43	54.65	53.45	52.02
I₂: Furrow	45.10	42.06	52.76	49.30	47.30	47.84	46.33	51.64	49.73	48.88
Mean	47.22	44.01	53.26	50.32		49.7	47.38	53.14	51.59	
Factors	Irrigation	Variety	Irrigation x Variety			Irrigation	Variety	Irrigation x Variety		
SE (m)±	0.16	0.22	0.31			0.10	0.14	0.19		
C.D.	0.46	0.65	0.92			0.29	0.41	0.57		

Table.4 Effect of irrigation methods on plant height (cm) at 90 days of potato cultivars

Irrigation methods Cultivars	2016-17					2017-18				
	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean
I₁: Drip	59.04	56.84	64.67	60.45	60.25	61.91	59.03	68.59	66.90	64.11
I₂: Furrow	55.31	51.31	60.08	58.13	56.21	59.10	53.74	62.65	60.01	58.88
Mean	57.18	54.08	62.37	59.29		60.51	56.39	65.62	63.45	
Factors	Irrigation	Variety	Irrigation x Variety			Irrigation	Variety	Irrigation x Variety		
SE (m)±	0.26	0.37	0.53			0.30	0.43	0.60		
C.D.	0.78	1.10	1.56			0.90	1.27	1.79		

Table.5 Effect of irrigation methods on number of shoots per hill at 90 days of potato cultivars

Irrigation methods Cultivars	2016-17					2017-18				
	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean	Kufri Pukhraj	Kufri Surya	Kufri Pushkar	Kufri Bahar	Mean
I₁: Drip	5.63	6.39	6.70	6.55	6.32	5.97	6.48	6.84	6.77	6.51
I₂: Furrow	5.32	5.46	6.39	5.58	5.68	5.52	5.81	6.60	5.92	5.96
Mean	5.48	5.92	6.54	6.07		5.75	6.15	6.72	6.35	
Factors	Irrigation	Variety	Irrigation x Variety			Irrigation	Variety	Irrigation x Variety		
SE (m)±	0.04	0.05	0.07			0.05	0.07	0.09		
C.D.	0.11	0.16	0.22			0.14	0.19	0.27		

During 2017-18, the maximum plant height at 30, 60 and 90 days (41.87, 53.14 and 65.62 cm) of planting was registered with Kufri Pushkar followed by Kufri Bahar (40.13, 51.59 and 63.45), while the minimum plant height (37.75, 47.38 and 56.39 cm) was found with Kufri Surya. The results are in close confirmatory with the findings of Chongtham *et al.*, (2016), Yadav *et al.*, (2017) and Luthra *et al.*, (2017). The different behaviour of potato varieties with reference to growth parameters might be due to their genetic factors (Patel *et al.*, 2006).

The interaction effect of both the treatments was observed significant regarding plant height at 30, 60 and 90 days after planting. During 2016-17, the maximum plant height at 30, 60 and 90 days (42.90, 53.77 and 64.67 cm) was noted with Kufri Pushkar under drip irrigation, whereas, the minimum (32.09,

42.06 and 51.31 cm) was found in Kufri Surya under furrow irrigation. During 2017-18, the potato cultivar Kufri Pushkar with drip irrigation (44.72, 54.65 and 68.59 cm) gave maximum plant height, while the minimum (34.94, 46.33 and 53.74 cm) was recorded with Kufri Surya under furrow irrigation.

The data regarding number of shoots per hill at 90 days have been presented in Table 5. The data indicate that the both irrigation methods and cultivars had significant effect on number of shoots per hill at 90 days after planting during both the years. The highest number of shoots per hill (6.32 and 6.51) was recorded with treatment where drip irrigation was applied, while the lowest value for number of shoots per hill (5.68 and 5.96) was observed with furrow irrigation system during 2016-17 and 2017-18, respectively. These findings are in good accordance with the

results of Chawla and Narda (2000), Ferreira and Carr (2002), Yuan *et al.*, (2003) and Badr *et al.*, (2012). The increment in growth parameters under drip irrigation could be due to direct availability of water at root zone that increased photosynthetic ability of the plants and very important for transpiration and tissue formation that might increase number of shoots per hill also (Ahmed *et al.*, 2007).

Among the potato cultivars, Kufri Pushkar showed significantly higher number of shoots per hill (6.54 and 6.72), whereas, the minimum value for number of shoots per hill (5.48 and 5.75) was observed with potato cultivar Kufri Pukhraj during 2016-17 and 2017-18, respectively. These results confirm the findings of Yadav *et al.*, (2017), Chongtham *et al.*, (2016), Luthra *et al.*, (2017) and Amarananjundeswara *et al.*, (2018). During both the years, the interaction effect of different irrigation methods and potato cultivars was found significant regarding number of shoots per hill at 30, 60 and 90 days after planting (Table 5). The uppermost value for number of shoots per hill (6.70 and 6.84) at 30, 60 and 90 days was registered with cultivar Kufri Pushkar under drip irrigation followed by Kufri Bahar (6.55 and 6.77) under same irrigation method, while Kufri Pukhraj showed minimum value (5.32 and 5.52) for number of shoots per hill at 30, 60 and 90 days with furrow irrigation during 2016-17 and 2017-18, respectively.

In conclusion, the drip irrigation gave better growth of potato plants when compared with furrow irrigation. In addition, Kufri Pushkar followed by Kufri Bahar had highest value for all the growth parameters during 2016-17 and 2017-18. Based on investigation of two years, it may be concluded that the drip irrigation with Kufri Pushkar proved best for the growth of potato plants that could ultimately leads to higher yield.

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