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- Short communication

EFFECTS OF DIFFERENT IRRIGATION REGIMES AND GENOTYPES ON YIELD CONTRIBUTING PARAMETERS OF POTATO (*SOLANUM TUBEROSUM* L.) UNDER CHHATTISGARH, INDIA

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Abstract

The field experiment was conducted at the Horticultural Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India during Rabi 2018-19 in Split plot Design with four level of irrigation regimes and four potato genotypes. The irrigation treatments were allotted in the main plot while, potato genotypes allotted in the sub-plots. At 75 days after planting (DAP) and 90 days after planting (DAP), the various yield contributing parameters were affected significantly by the different irrigation regimes except the plant emergence and number of shoots/plant. The number of shoots/plant, number of total leaves/plant, fresh weight of tubers/plant (g), total number of tuber/plant and harvest index (%) were significantly affected by the different irrigation regimes and potato genotypes. The plant with irrigation at 25 mm cumulative pan evaporation (CPE) produced the maximum plant height, number of shoots/plant, number of total leaves/plant, number of tubers/plant, fresh weight/plant and harvest index at 75 DAP and 90 DAP, respectively. The potato genotype AICRP-P-38 gave the highest fresh weight of tuber/ plant, number of tubers/plant and harvest index at 75 DAP and 90 DAP, respectively.

In our daily diet, the potato has very important place. It is a wholesome food. Other than the carbohydrate which is major constitute, potato provides essential substances like protein, vitamins and mineral. These all are works for body building. Being a richest source of energy, potato is needed to maintain day by day for the output of human energy (Das 2014).

The most important factors influencing the production of potato are the availability of nutrient (Haddad *et al*. 2016) and water (Alva 2008) and favourable climatic condition like temperature (Levy and Veilleux 2007). According to Levy *et al*. (2013) the shortage of water has strong effect on growth, yield and quality of potato whether it occurs for a short period of time or for entire growth cycle. The insufficient irrigation reduced the various yield and yield contributing parameters like number, weight and size of tuber plant (Alva *et al.* 2012). Under the water limitation condition, less water can be applied at the appropriate growth stage to fulfil the demand for evapo-transpiration.

Though many literatures are available on the effect of irrigation on potato (Alva, 2008; Levy *et al*. 2013), insufficient is found on the performance of potato genotypes under various levels of irrigation. With keeping this view, the present investigation was planned to evaluate the effects of different irrigation regimes and genotypes on yield performance of potato (*Solanum tuberosum* L.) in Chhattisgarh, India during rabi, 2018-19.

The experiment was conducted All India Coordinated Research Project on Potato at Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), India during the *rabi* 2018-19. The experiment consisted of eight treatments under split plot design. Irrigation levels were assigned in the main plot, while, the varieties were in the subplot. The

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amount of water for irrigation was calculated by taking weekly rainfall and cumulative pan evaporation data from Department of Agrometeorology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.). Cultural operation for the crop was similar for all the treatments *i.e.* amount of fertilizers (N: P: K) (150:100:100 Kg/ha) and other operations as earthing up, weeding operations and application of plant protection chemicals as and when required. On the basis of cumulative pan evaporation (CPE) the treatments were received following amount and number of irrigations.

Table 1. Number of irrigation and total water given at 75 DAP and 90 DAP during Crop Growth Period of 2018-19.

Irrigation levels (mm CPE) ↓	No. of irrigation		Water used (mm)	
Days to harvest →	75 DAP	90 DAP	75 DAP	90 DAP
I_1= 20 mm CPE	5	7	250	350
I_2= 25 mm CPE	4	5	200	250
I_3= 30 mm CPE	3	4	150	200
I_4= 30 + mulching with paddy straw	3	4	150	200

- One irrigation = water given up to 50 mm depth.

The plot size prepared was 4.2 m X 3.4 m. The well sprouted seed tubers of potato genotypes were planted on ridges at 60 X 20 cm spacing on 18 November, 2018. The first pre-emergence irrigation was given just after seven days of planting, thereafter irrigation were scheduled as per treatment. For, each and every irrigation 50 mm irrigation depth was applied. The total 250, 200, 150 and 150 mm for 75 day and 350, 250, 200 and 200 mm for 90 DAP irrigation water (excluding one pre-planting irrigation and two post planting irrigation) was applied to the crop for I_1 (20 mm CPE), I_2 (25 mm CPE), I_3 (30 mm CPE) and I_4(30 mm CPE+ mulching with paddy straw) irrigation treatment, respectively as shown in the Table - 1.The potato crops requires ample amount of water for its proper growth and tuber yield. Under the stress condition some hybrids can survive better and produce good yield. Above treatments were based on the cumulative pan evaporation. Irrigation at 30 CPE decrease the number of irrigation, which might be create the stress condition and become too serious. The paddy mulch was included in the treatment I_4 (30 mm CPE+ mulching with paddy straw) keeping the view that if there will be water stress condition up to 30 CPE, can paddy mulch increase the yield better than the treatment I_3. All the recommended package and practice for potato for Raipur region were adopted to fetch high yield.

The duration of crops was 75 and 90 days. Haulm cuttings of potato crop were scheduled at 75 and 90 DAP. The haulm cutting was done at 2ndFebruary and 18th February for 75 Days and 90 Days crop, respectively. Total rainfall received during crop season (planting to haulm cutting) was 70.8 mm.

The various observation which were taken are the final emergence count (at 30 DAP) while observations on plant height (cm), number of shoots per plant, number of total leaves per plant were recorded at full growth stage (50days after planting). Data on fresh weight of tuber plant^{-1}(kg), number of tuber plant^{-1}, dry weight of tuber plant^{-1} (kg) and harvest index (%) were recorded at the time of harvesting.

Pre–planting irrigation was given to create uniform moisture condition in field soil and two post-planting irrigations were also applied evenly to all the treatments to ensure uniform germination. Irrigation was applied through furrow irrigation In each and every irrigation, 50 mm water was applied. Open pan evaporation was measured in mm per day from USWB class ‘A’

open pan evaporimeter. The amount of water that evaporated from the cropped field was replenish by applying same amount of irrigation water. The schedule of Irrigation was done on the basis of different CPE given as treatments.

The maximum plant emergence (90.91 % and 90.57 %) was reported in treatment I_1: irrigation at 20 mm CPE followed by 89.72 % and 89.38 % in I_2:when irrigation applied at 25 mm CPE for the maturity of 75 DAP and 90 DAP. However, the plant emergence was non-significant for the 75 DAP. In case of effects of potato genotypes**,** plant emergence was found non-significant. Kumar *et al*, (2007) stated that as the plant emergence found non-significant for irrigation treatment, variety treatment and interaction. The plant stand was medium for all the irrigation levels and cultivars as one pre-planting and two post-planting irrigation were applied to all the treatment to have uniform crop emergence. This result is also supported by the Bisht *et al*, (2012)

The effect different irrigation regimes and potato genotypes have the significant effects on plant height at 75 DAP and 90 DAP. The maximum height of plant (50.9 cm and 56.1 cm) was recorded, when the plot was irrigated at 20 mm CPE followed by (46.6 cm and 51.7 cm) when irrigation applied at 30 mm CPE + paddy straw mulch @5 t ha^{-1} planting. However, the lowest value for plant height was recorded under too much stress condition *i.e*. irrigation at 30 mm CPE. Alenazi *et al*. (2016) supported this result and stated that the plant height was affected by water stress; it reached its maximum value under full irrigation earlier than under water stress treatments. As after I_1, I_4 gave maximum plant height which was probably due to mulching of rice straw. The mulch increased the plant height over the no mulching plot (Sadawarti *et al*. 2013). In concern with the performance of potato genotype the tallest plant was reported in AICRP-P-32 (54.5 cm and 60.4) which was statistically *at par* with Kufri Sindhuri (54.4 cm and 60.4 cm) and the minimum plant height was reported in AICRP-P-38 (35.6 cm and 39.1 cm) for 75 DAP and 90 DAP. Deblonde and Ledent (2001) reported that the plant height reduced by drought treatments.
The number of stem $plant^{-1}$ was affected significantly by the irrigation regimes at 75 DAP but it was not different significantly at 90 DAP. It was also affected by potato genotypes significantly. The maximum (3.6 and 4.4) number of stem/plant was reported with I_1 : irrigation applied at 20 mm CPE followed by $I_{2:}$ irrigation at 25 mm CPE at both 75 DAP and 90 DAP, respectively. The number of shoots/plant decreased with the decrease in irrigation water. This result is supported by Patel and Patel (2001) and Bisht *et al*. (2012). However, in case of genotypes the number of stem/plant differed significantly, which is supported by results. The stem number/plant significantly higher (4.0 and 5.0) for the genotype AICRP-P-21 followed by AICRP-P-38 (3.5 and 4.3) for 75 DAP and 90 DAP, respectively. The minimum number of shoots/plant was recorded in AICRP-P- 32 for 75 DAP and 90 DAP (2.5 and 3.2, respectively).This finding is supported by the findings of Islam *et al*, (1990) who reported significant effect of irrigation water quantities on the number of stems of potato plant. Lynch and Tai (1979) showed that the number of stem plant -1 was mainly determined by size of the seed tuber and the soil type.

Number of total leaves $plant^{-1}$ was affected significantly by the various levels of irrigation regimes and different potato genotypes. It is clear from the Table 1 that under the higher level of irrigation regimes, number of total leaves per plant was decreased linearly. The maximum number of total leaves/plant (395.4 and 411.9) was counted under I_1: irrigation at 20 mm CPE followed by (371.9 and 383.0) I_2 : irrigation at 25 mm CPE for both harvesting time *i.e*. 75 DAP and 90 DAP, respectively. Dash *et al.* (2018) reported the highest number of leaves at 30 mm CPE irrigation frequency which found *at par* with 35 mm CPE. The mean number of leaves per plant increased with advancement in the age of crop till harvest of crop. Nimbalkar *et al*. (2010) found the maximum number of leaves were at 50 mm CPE than 75 mm CPE. Under the varietal performance, it has been seen that Kufri Sindhuri had the maximum (377.9 and 395.5) number of total leaves $plant^{-1}$ followed by AICRP-P-32 (368.6 and 377.7) at 75 DAP and 90 DAP,

Table 2. Effects of different irrigation regimes and potato genotypes on yield and yield contributing parameters of potato.

Parameters	Plant Emergence (%)		Plant Height (cm)		No. of shoots/plant		No. of total leaves/plant		Fresh weight of tubers/plant (kg)		Number of tubers/plant		Harvest index (%)	
Main Plot level of Irrigation Regimes (I)														
	75 DAP	90 DAP	75 DAP	90 DAP	75 DAP	90 DAP	75 DAP	90 DAP	75 DAP	90 DAP	75 DAP	90 DAP	75 DAP	90 DAP
I_1	90.91	90.57	50.9	56.1	3.6	4.4	395.4	411.9	0.387	0.357	10.16	8.60	66.33	62.75
I_2	89.72	89.38	45.9	51.0	3.3	4.1	371.9	383.0	0.496	0.464	9.65	8.89	76.93	73.58
I_3	89.32	88.57	40.8	45.3	3.0	3.8	344.6	355.8	0.487	0.421	9.53	8.67	70.28	64.68
I_4	89.57	86.93	46.6	51.7	3.1	3.8	346.6	352.4	0.428	0.421	9.49	9.44	68.18	65.38
SE (m)	1.60	0.56	1.0	0.6	0.1	0.2	4.2	9.6	0.007	0.009	0.10	0.60	1.30	0.92
CD	NS	1.40	2.4	1.4	0.3	NS	10.5	24.0	0.018	0.023	0.25	NS	3.25	2.29
Subplot levels of potato genotypes (V)														
V_1	89.70	88.33	39.8	44.2	4.0	5.0	353.8	365.3	0.410	0.408	9.67	8.81	74.73	72.70
V_2	89.52	89.18	54.5	60.4	2.5	3.2	368.6	377.7	0.442	0.391	9.08	9.00	61.02	55.62
V_3	89.64	89.17	35.6	39.1	3.5	4.3	358.3	364.6	0.511	0.440	12.01	9.47	77.03	72.41
V_4	90.67	88.76	54.4	60.4	3.0	3.7	377.9	395.5	0.436	0.424	8.08	8.32	68.93	65.67
SE (m)	1.59	0.44	0.8	0.7	0.1	0.2	5.2	9.0	0.006	0.006	0.26	0.41	1.46	1.37
CD	NS	NS	1.6	1.4	0.2	0.3	10.8	18.6	0.012	0.012	0.54	NS	3.03	2.85

I_1- Irrigation at 20 mm CPE; I_2- Irrigation at 25 mm CPE; I_3- Irrigation at 30 mm CPE; I_4- Irrigation at 30 mm CPE + paddy straw mulching @ 5 t/ha ; V_1- AICRP-P-21; V_2 - AICRP-P-32; V_3 - AICRP-P-38; V_4 - Kufri Sindhuri

respectively. Kumar *et al,* 2007 reported that total leaves plant^{-1} were not affected by different irrigation levels but it shows significantly difference among the potato genotypes in which KCH-2 shows significantly higher in KCH-1.

The fresh weight of tuber plant^{-1} reported significantly affected by the potato genotypes and the different irrigation regimes. Fresh weight of tuber plant^{-1} was found significantly higher (0.496 kg and 0.464 kg) with irrigation at 25 mm CPE 75 DAP and 90 DAP, respectively. Similar results also reported by others scientist (Kumar *et al.* 2004 and Sharma *et al.* 2019). Concerning to the potato genotypes the fresh weight of tuber plant^{-1} found maximum in AICRP-P-38 (0.511 kg and 0.440 kg) for 75 DAP and 90 DAP, respectively. Kumar *et al.* (2007) reported that reduction in average tuber size is due to water stress and yield reduction due to irrigation treatment was largely because of reduced tuber size rather than number of tubers hectare^{-1}. But in the present investigation the yield reduce due to lower number of tuber hectare^{-1} due to water stress. This results is also supported by the findings of Kumar *et al,* (2004); Farrag *et al*. (2016) and Ayas (2013).

Another yield contributing parameter is number of tubers plant^{-1} which was found significant for 75 DAP but not differ significantly for 90 DAP. Perusal of the data in Table3 revealed that maximum (10.16 and 8.60) number of tuber plant^{-1} counted when water applied at 20 mm CPE followed by at 25 mm CPE (9.65 and 8.89) for 75 DAP and 90 DAP, respectively. The minimum number of tuber plant^{-1}(9.49 and 9.44) was recorded at irrigation regimes 30 mm CPE for 75 DAP and 90 DAP, respectively. Similarly, in case of performance of potato genotypes, it was found that genotypes AICRP-P-38 recorded for the maximum number of tubers plant^{-1} (12.01 and 9.47) followed by AICRP-P-21 (9.67 and 8.81) 75 DAP and 90 DAP, respectively. The tuber number plant^{-1} found non-significant for 90 DAP. This result is supported by the Nimbalkar *et al.*, (2010) who stated that number of tuber plant^{-1} could be attributed to the cultivars differences and also by the climatic condition like temperature and soil type.

The maximum (76.93 % and 73.58 %) harvest index was reported in I_2: irrigation applied at 25 mm CPE at 75 and 90 DAP followed by when the crop was irrigated with I_3: 30 mm CPE at 75 DAP and I_4: irrigation at 30 mm CPE + paddy straw mulching for 90 DAP. However, genotype AICRP-P-38 gave the maximum harvest index % (77.03) for 75 DAP and AICRP-P-21 (72.70 %) for 90 DAP. Dey and Ray (2017) reported that the harvest index in irrigation treatment and variety was non-significant. These results may be due to the late un-seasonal rainfall at the later stage of plant growth which encourages the vegetative growth in all treatments. Top-growth could be stimulated vigorously in plants that are re-watered after a period of drought and high temperature in potato as reported by Van Loon (1981).

The growth and yield parameters decreased with increase in stress condition through irrigation. Hybrid AICRP-P-38 produced higher total and marketable tuber yield with large grade tuber when irrigated at 25 mm CPE. Though the tuber yield was maximum when irrigations were planned at 20 mm CPE in all potato hybrids, the differences between 20 and 25 mm CPE were not found much higher as compare to other water stress condition imposed by the different irrigation regimes. Therefore, irrigation at 25 mm CPE is suggested for getting maximum yield, keeping in view the importance of water which is becoming inadequate. The comparative performance of hybrid AICRP-P-38 for various yield and yield attributing traits was found to be superior among the four hybrids.

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