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Studies on interaction effect of different genotypes and nitrogen levels on vegetative growth and tuber yield of potato (*Solanum tuberosum* L.) in the plain region of Chhattisgarh

Yugalkishor Lodhi, Jitendra Trivedi and PK Sharma

Abstract
Potato (*Solanum tuberosum* L.) is an important crop among all vegetables for food and income generation as it produces a high yield per unit land and time. It is a balanced food containing less energy but nutritionally high-quality protein, essential vitamins and minerals including trace elements. A research trial was conducted at Research Farm of Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the year 2018-19 and 2019-20 to study the effect of interaction between genotypes and nitrogen levels on growth and yield of potato in the plain region of Chhattisgarh. The experiment was carried out in Factorial Randomized Block Design (FRBD) with 12 treatment combinations of 3 potato genotypes (AICRP-P-39, Kufri Garima and Kufri Pukhraj) and 4 nitrogen levels (0, 80, 160 and 240 kg N/ha) with three replications. Result regarding growth parameters revealed that AICRP-P-39 with 240 kg N/ha recorded maximum vegetative growth *i.e.*, Plant emergence (%), plant height (cm), number of shoots plant^{-1}, number of leaves plant^{-1}, while the minimum was recorded in Kufri Garima with 0 kg N/ha. Maximum tuber yield (kg plot^{-1} & t ha^{-1}) was recorded with AICRP-P-39 with 240 kg N/ha while the minimum was recorded in Kufri Garima with 0 kg N/ha.

Keywords: Genotypes, nitrogen levels, growth parameters, yield etc.

Introduction
Potato (*Solanum tuberosum* L.) is an important crop among all vegetables and has an important role in our daily diet. Potato is a tuber crop belongs to the Nightshade family having the rich amount of edible starch. It is very important for food and income generation as it produces a high yield per unit land and time.

Potato is not only a rich source of carbohydrates and calories but also furnishes high quality of amino acids, Vitamin B, Vitamin C and minerals. One hundred grams of potato tuber contains 80% moisture, 20% dry matter, 14% starch, 20% sugar, 2% protein, 1% mineral salts, 0.61% fiber and 0.1% fat (Anonymous, 2015) [3]. It is an important tuber crop rich in carbohydrates (22.6 g per 100 g of edible portion), minerals (Ca, Mg, Cu, Fe, P, K and Na), and vitamin C (17 mg) and contains 97 kilo calories energy per 100 g of edible matter.

There are various eatable foods made by the potato *i.e.*, chips, fingerchips, halwa, gulabjamun, rasgulla, murabba, kheer, guziya and barfi. Some alkaloid like solanine also found in potato. Potato has some medicinal properties also, like it has anti-scorbutic, aperients, diuretic, galacagoue, nervous sedative, stimulant to gout and antispasmodic (Rai and Yadav, 2005) [24].

In India, potato production is mainly confined to Uttar Pradesh, West Bengal, Bihar, Madhya Pradesh, Gujarat, Punjab, Assam and Haryana. The annual potato production in India was 434.17 lakh million ton from an area coverage of 21.17 lakh hectares with the productivity of 21.00 tons/ha (Anon., 2017) [4]. Presently, India ranks 2nd in area and production of potato in the world after China which contribute 11 per cent of world potato production (FAO, 2014). However, Chhattisgarh produces 644.83 thousand MT from the 41.95 thousand ha area occupies ninth rank in India in the year of 2015-16 MT/ha (Anon., 2017) [4].

The growth and yield of potato are mainly governed by availability of major nutrients required for its cultivation. Nitrogen is a key element in growth and development of crop plants. Nitrogen is the first limiting factor for potato crop which improves vegetative growth and invariably increases yield, tuber per plant, tuber size as well as tuber numbers (Anand & Krishnappa, 1988, Bhowmik & Dandapat, 1991) [2, 7]. Potato yield and yield components were affected by application of Nitrogen fertilizers (Zelalem *et al.*, 2009) [35].

Singh and Raghav (2000) [29] reported that increasing levels of nitrogen produced significantly higher tuber yield. Different variety of potato has different nitrogen use efficiency. Moreover, excessive nitrogen leads to poor tuber quality and delayed crop maturity, whereas, nitrogen deficiency usually results in poor vegetative growth and low yield. Therefore, achieving optimum applications for plant nutrient is a pre-requisite substitute strategy as it determines yield and varies with soil, crop and water available to the crop for optimum return and farm profit.

Genetic architecture has great influence on yield and quality parameters of potato. Various varieties of potato having different genotypes have been evolved. Different potato genotypes having wide variation in their yield potential and quality attributes can be involved in studies of their performances on growth and yield under different agro-climatic or nutritional conditions. The soil and climate conditions of our state are quite suited for cultivation of potato. Due to suitability and high returns, the area of potato in Chhattisgarh is increasing day by day. Hence, keeping above facts in view an experiment was conducted to study the performance of different varieties of potato under different nitrogen levels for growth and yield of potato under plain region of Chhattisgarh.

Methods and Materials

The research trial was carried out during the year 2018-19 and 2018-19 at Research Farm of Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The soil of experimental field was clay-loam having pH 7.7. The experiment was laid out in Factorial Randomized Block Design (FRBD) with 12 treatment combinations of 3 potato genotypes (AICRP-P-39, Kufri Garima and Kufri Pukhraj) and 4 nitrogen levels (0, 80, 160 and 240 kg N/ha) with three replications. Healthy sprouted potato tubers were treated with fungicide and planted on a well-prepared field at 60 cm x 20 cm distance in ridge with application of recommended dose of P and K fertilizers and uniformly maintained all the cultural practices adopted in potato cultivation.

All the experimental plants were provided same cultural practices *i.e.,* fertilizer application, irrigation, gap filling, earthing-up, weed management, haulm cutting and plant protection measures during whole period of investigation.

Under growth parameters, the observations *i.e.,* Plant emergence (%), plant height (cm), number of shoots plant^{-1}, number of leaves plant^{-1} and regarding yield parameters, total tuber yield of potato (kg plot^{-1} and t ha^{-1}) were recorded.

Results and Discussion

The results of the experiment pertaining to various aspects of growth parameters and yield are summarized as follows:

Plant emergence (%)

The data on plant emergence percentage ware recorded at 30 DAP and statistically analyzed (Table 1) showed that significantly influenced by genotypes. Among different potato genotypes the highest per cent emergence (92.20) was observed in AICRP-P-39 during both the years and over pooled mean data which was followed by Kufri Pukhraj (90.80). Least plant emergence per cent was observed in genotype Kufri Garima (89.41) during both the years and over pooled mean data.

In terms of nitrogen level's impact, the highest percent emergence (93.73) was observed in 240 kg N/ha, which was statistically equal to 160 kg N/ha (93.01) and 80 kg N/ha (89.40) during both the experimental years and over the pooled mean data. In 0 kg N/ha, the lowest percent emergence (86.21) was observed.

Similarly, Singh (1995) [28] recorded the highest germination percentage (100) in potato 30 days after planting with a high nitrogen dose of 200 kg/ha. Chopra *et al.* (2006) [9] found that raising nitrogen levels from 0-250 kg/ha increased the percentage of emergence in potato, and Banjare (2012) [5] found that increasing nitrogen levels up to 375 kg N/ha increased plant emergence.

Under the current study, interaction results were found to be non-significant in both the years and the pooled mean data. These findings matched those of Singh (1995) [28], Kanbi and Bhatnagar (2005) [17], and Patel (2013) [23], who found no substantial difference in plant emergence percentage when different amounts of fertilizer were applied to different potato cultivars.

Plant height (cm)

The data on plant height were recorded at 30, 45, 60 and 75 days after planting (Table 2). It is obvious from the data that significant difference in plant height was observed at different stages of growth (45, 60 and 75 DAP) due to different genotypes and varying levels of nitrogen in potato. At 30 DAP, plant height was found non-significantly differ during both the years and on the basis of pooled mean data. In general, there was slow growth of potato plants up to 30 DAP and thereafter, there was sharp increase in plant height up to 75 DAP.

The significantly taller plants were recorded in genotype AICRP-P-39 (39.29 cm) at all the plant growth stages, followed by Kufri Pukhraj (37.33 cm) at all growth stages during both the years and over pooled mean data. The lowest plant height was observed in Kufri Garima (35.44 cm) during both the years and over pooled mean data at all the stages of plant growth.

As regards nitrogen levels, it was observed that the plant height was progressively increased with increasing nitrogen levels. The maximum plant height (42.59 cm) was recorded with application of 240 kg N/ha which was significantly followed by application of 160 kg N/ha (41.50 cm) and 80 kg N/ha (37.17 cm) during both the years and over pooled mean data at all the stages of plant growth. The minimum plant height (28.14 cm) was recorded with application of 0 kg N/ha.

The interaction between potato genotypes and different N levels showed significant impact on plant height at 45, 60 and 75 DAP during both the years and in pooled mean data. Among mean interaction between potato genotypes and nitrogen levels, AICRP-P-39 with application of 240 kg N/ha (V_1N_4) produced tallest plants among all other interactions, however, it was at par with AICRP-P-39 with application of 160 kg N/ha (V_1N_3) followed by V_3N_4, V_3N_3, V_2N_4, V_2N_3 and V_1N_2. However, the minimum plant height was recorded in Kufri Garima with application of 0 kg N/ha (V_2 N_1) during both the years and over pooled mean data.

This increase in plant height could be due to higher nitrogen concentrations stimulating carbohydrate and protein assimilation, which in turn increased cell division and tissue formation, resulting in increased plant vegetative growth (Meyer and Anderson, 1970) [21]. The conclusions of this inquiry for plant height are somewhat similar to the findings of the previous investigation of Pandey *et al.* (2007) [22],

Saeidi *et al.* (2009) [26], Zamil *et al.* (2010) [34], Yassen *et al.* (2011) [33], Israel *et al.* (2012) [14], Kumar *et al.* (2017) [18], Sriom *et al.* (2017) [30], Yadav (2017) [32] and Mechao *et al.* (2018) [20].

Number of shoots plant^{-1}

The data obtained on number of shoots per plant at different stages of crop growth *i.e.*, at 30, 45, 60 and 75 days after planting (DAP) during both the years and the pooled mean data. (Table 3) showed that the number of shoots per plant increased with the increase in age of the plant up to 75 DAP. At 30 DAP, number of shoots plant per plant was found non-significantly differ during both the years and in pooled mean data. Number of shoots per plant recorded at 45, 60 and 75 DAP were significantly influenced by different potato genotypes and nitrogen levels during both the years and in pooled mean data.

The significant difference was observed among three potato genotypes at all the stages of plant growth. Among different potato genotypes AICRP-P-39 recorded significantly greater number of shoots per plant (7.81) at all the stages of plant growth, which was found significantly superior among all the genotypes in this study followed by Kufri Pukhraj (7.31) during both the years and over pooled mean data. The lesser number of shoots per plant was recorded in Kufri Garima (6.88) during both the years and in pooled mean data at all the stages of plant growth.

Regarding the influence of different nitrogen levels, showed marked effect on number of shoots per plant of potato at all the stages of growth. Significantly maximum number of shoots per plant (8.61) was recorded with application of 240 kg N/ha which was significantly followed by application of 160 kg N/ha (8.23) and 80 kg N/ha (6.89) during both the years and over pooled mean data at all the stages of plant growth. The minimum number of shoots per plant (5.59) was recorded with application of 0 kg N/ha.

The interaction between potato genotypes and different nitrogen levels showed significant impact on number of shoots per plant at 45, 60 and 75 DAP during both the years and in pooled mean data. Among all mean interaction effects, AICRP-P-39 with application of 240 kg N/ha (V_1N_4) produced maximum number of shoots per plant as compared to other interactions, however, it was at par with AICRP-P-39 with application of 160 kg N/ha (V_1N_3) followed by V_3N_4, V_3N_3, V_2N_4, V_2N_3 and V_1N_2. However, the minimum number of shoots per plant was recorded in Kufri Garima with application of 0 kg N/ha (V_2N_1) during both the years and over pooled mean data.

The increase in the number of shoots per plant with increasing nitrogen levels in this study could be due to the higher dose of nitrogen stimulating carbohydrate and protein assimilation. Banjare (2012) [5] discovered a rise in the number of shoots per plant when the nitrogen level was increased to 370 kg N/ha. These results were in close agreement with the findings of Pandey *et al.* (2007) [22], Saeidi *et al.* (2009) [26], Yassen *et al.* (2011) [33], Regassa *et al.* (2016) [25], Sriom *et al.* (2017) [30], Kumar *et al.* (2017) [18], Dangi *et al.* (2018) [10] and Hamdi *et al.* (2018) [13]. They also reported that the number of shoots per plant influenced with increasing levels of nitrogen.

Number of leaves plant^{-1}

The data regarding the number of leaves per plant were recorded at 30, 45, 60 and 75 days after planting are presented in Table 4. It is revealed from the data recorded at different growth stages that the number of leaves per plant increased with the increase in age of the plant up to 75 DAP. At 30 DAP, number of leaves plant per plant was found non-significantly differ while, the number of leaves per plant recorded at 45, 60 and 75 DAP were significantly influenced by different potato genotypes and nitrogen levels during both the years and in pooled mean data.

The data showed that the maximum number of leaves per plant (69.36) was recorded in AICRP-P-39 than rest of the other potato genotypes followed by Kufri Pukhraj (67.12) which also recorded significantly higher number of leaves per plant than Kufri Garima (63.74) during both the years and over pooled mean data.

As regards the nitrogen levels, the increasing levels of nitrogen were found effective for making difference in the number of leaves per plant. An application of 240 kg N/ha was found best amongst all nitrogen levels for obtaining the maximum number of leaves per plant (76.42) which was significantly followed by application of 160 kg N/ha (73.36) and 80 kg N/ha (63.22) at 45, 60 and 75 DAP during both the years and over pooled mean data. However, at 30 DAP number of leaves plant per plant was found non-significantly differ among different nitrogen levels. The minimum number of leaves per plant (53.96) was recorded with application of 0 kg N/ha during both the years and over pooled mean data.

The interaction between potato genotypes and different nitrogen levels showed significant impact on number of leaves per plant at 45, 60 and 75 DAP during both the years and in pooled mean data. Among all mean interaction effects, AICRP-P-39 with application of 240 kg N/ha (V_1N_4) produced maximum number of leaves per plant as compared to other interactions, however, it was at par with AICRP-P-39 with application of 160 kg N/ha (V_1N_3) followed by V_3N_4, V_3N_3, V_2N_4, V_2N_3 and V_1N_2. However, the minimum number of shoots per plant was recorded in Kufri Garima with application of 0 kg N/ha (V_2N_1) during both the years and over pooled mean data.

This rise may be attributed to improved nutrient uptake, which culminated in increased carbohydrate synthesis, which is used in the formation of new cells. These observations are consistent with those of Pandey *et al.* (2007) [22], Adhikari (2009) [1], Saeidi *et al.* (2009) [26], Yassen *et al.* (2011) [33], Jatav (2013) [16], Banjare *et al.* (2014) [6], Marzouk *et al.* (2016) [19], Kumar *et al.* (2017) [18], Sriom *et al.* (2017) [30], Dangi *et al.* (2018) [10], Hamdi *et al.* (2018) [13] and Mechao *et al.* (2018) [20].

Total tuber yield (kg plot^{-1})

The data obtained on total tuber yield (kg plot^{-1}) during both the years and over the pooled mean data (Table 5). Data shown in the table revealed that there was a significant influence of genotypes on total tuber yield (kg plot^{-1}). Among different potato genotypes the highest total tuber yield (31.06 kg plot^{-1}) was noticed under genotype AICRP-P-39 followed by Kufri Pukhraj (29.93 kg plot^{-1}) during both the years and over pooled mean data. However, the lowest total tuber yield (29.17 kg plot^{-1}) was obtained with Kufri Garima during both the years.

As regards the influence of nitrogen levels on total tuber yield, the highest total tuber yield (34.46 kg plot^{-1}) was recorded with application of 160 kg N/ha followed by nitrogen level 240 kg N/ha (33.92 kg plot^{-1}) followed by application of 80 kg N/ha (31.11 kg plot^{-1}) during both the years and over pooled mean data. The lowest total tuber yield (20.71 kg plot^{-1}) was noticed under 0 kg N/ha during both the years and over pooled mean data.

The combination effect between potato genotypes and nitrogen levels showed significant impact on total tuber yield

(kg plot^{-1}) recorded at harvest during both the years and in pooled mean data. Among all mean interaction effects, AICRP-P-39 with application of 160 kg N/ha (V_1N_3) obtained highest total tuber yield (35.18 kg plot^{-1}) followed by V_1N_4, V_3N_3, V_3N_4, V_2N_3, V_2N_4, V_1N_2, V_3N_2 and V_2N_2. However, the lowest total tuber yield (19.84 kg plot^{-1}) was recorded in Kufri Garima with application of 0 kg N/ha (V_2N_1) during both the years and over pooled mean data.

Under this study, the application of 160 kg N/ha resulted in the maximum overall tuber yield (kg plot^{-1}). It may be attributed to increased nutrient absorption, which would have increased photosynthetic activity as well as photosynthate translocation for tuber formation, resulting in increased tuber production. The results are in strong contrast to those of Sriom *et al.* (2017) [30], Shunka *et al.* (2017) [27], Kumar (2017) [18], Yadav (2017) [32], Chaudhari *et al.* (2018) [8], Dangi *et al.* (2018) [10], Hamdi *et al.* (2018) [13] and Mechao *et al.* (2018) [20] also reported increase in total tuber yield (kg plot^{-1}) with increase in nitrogen levels.

Total tuber yield (t ha^{-1})

The data recorded on total tuber yield (t ha^{-1}) during both the years and over the pooled mean data (Table 5). Among different potato genotypes the highest total tuber yield (35.21 t ha^{-1}) was noticed under genotype AICRP-P-39 followed by Kufri Pukhraj (33.92 t ha^{-1}) during both the years and over pooled mean data. However, the lowest total tuber yield (33.15 t ha^{-1}) was obtained with Kufri Garima during both the years.

As regards the influence of nitrogen levels on total tuber yield, the highest total tuber yield (38.72 t ha^{-1}) was recorded with application of 160 kg N/ha followed by nitrogen level 240 kg N/ha (38.13 t ha^{-1}) followed by application of 80 kg N/ha (35.43 t ha^{-1}) during both the years and over pooled mean data. The lowest total tuber yield (24.08 t ha^{-1}) was noticed under 0 kg N/ha during both the years and over pooled mean data.

The combination effect between potato genotypes and nitrogen levels showed significant impact on total tuber yield (t ha^{-1}) recorded at harvest during both the years and in pooled mean data. Among all mean interaction effects, AICRP-P-39 with application of 160 kg N/ha (V_1N_3) obtained highest total tuber yield (39.80 t ha^{-1}) followed by V_1N_4, V_3N_3, V_3N_4, V_2N_3, V_2N_4, V_1N_2, V_3N_2 and V_2N_2. However, the lowest total tuber yield (23.05 t ha^{-1}) was recorded in Kufri Garima with application of 0 kg N/ha (V_2N_1) during both the years and over pooled mean data.

Under this study, the application of 160 kg N/ha resulted in the maximum overall tuber yield (t ha^{-1}). It may be attributed to increased nutrient absorption, which would have increased photosynthetic activity as well as photosynthate translocation for tuber formation, resulting in increased tuber production. Similar studies have been published by Firew *et al.* (2016) [12], Marzouk *et al.* (2016) [19], Regassa *et al.* (2016) [25], Wubengeda *et al.* (2016) [31], Sriom *et al.* (2017) [30], Shunka *et al.* (2017) [27], Kumar *et al.* (2017) [18], Yadav (2017) [32], Chaudhari *et al.* (2018) [8], Dangi *et al.* (2018) [10], Hamdi *et al.* (2018) [13] and Mechao *et al.* (2018) [20] also reported increase in total tuber yield (t ha^{-1}) with increase in nitrogen levels.

Table 1: Per cent emergence of potato at 30 days after planting as influenced by different genotypes and nitrogen levels

Treatments	Plant Emergence (%)		Pooled Mean
	2018-19	2019-20	
Varieties/Genotypes			
V_1: AICRP-P-39	93.92	91.02	92.20
V_2: Kufri Garima	90.74	88.09	89.41
V_3: Kufri Pukhraj	92.34	89.48	90.80
SEm ±	0.52	0.45	0.46
CD (P = 0.05)	1.57	1.36	1.38
CV	6.46	7.11	6.35
Nitrogen Levels			
N_1: 0 kg/ha	87.57	84.90	86.21
N_2: 80 kg/ha	90.47	87.82	89.40
N_3: 160 kg/ha	94.50	91.52	93.01
N_4: 240 kg/ha	95.05	92.40	93.73
SEm ±	1.06	1.04	1.05
CD (P = 0.05)	3.18	3.12	3.15
CV	7.39	7.24	7.21
Interaction (V x N)			
V_1N_1	88.4	85.7	87.1
V_1N_2	91.3	88.7	90.0
V_1N_3	95.8	92.1	93.9
V_1N_4	96.2	93.6	94.9
V_2N_1	86.5	83.8	85.2
V_2N_2	89.9	87.2	88.5
V_2N_3	92.9	90.2	91.6
V_2N_4	93.7	91.1	92.4
V_3N_1	87.8	85.1	86.5
V_3N_2	90.3	87.6	88.9
V_3N_3	94.9	92.2	93.5
V_3N_4	95.2	92.6	93.9
SEm ±	1.54	1.51	1.87
CD (P = 0.05)	NS	NS	NS
CV	6.41	7.18	6.24

*DAP – Days after planting

Table 2: Plant height (cm) of potato at various growth stages as influenced by different genotypes and nitrogen levels

Plant Height (cm)												
	30 DAP			45 DAP			60 DAP			75 DAP		
Treatments	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**
Varieties/Genotypes												
V_1: AICRP-P-39	32.88	31.21	32.04	35.91	34.16	35.03	37.96	36.21	37.09	38.41	40.16	39.29
V_2: Kufri Garima	28.91	27.25	28.08	32.11	30.45	31.28	34.27	32.61	33.44	34.61	36.27	35.44
V_3: Kufri Pukhraj	30.65	28.98	29.81	33.99	32.32	33.16	35.76	34.09	34.93	36.49	38.16	37.33
SEm ±	0.75	0.91	0.84	0.06	0.09	0.08	0.08	0.10	0.09	0.05	0.08	0.07
CD (P = 0.05)	NS	NS	NS	0.18	0.27	0.24	0.24	0.31	0.28	0.16	0.24	0.21
CV	8.46	7.11	7.95	8.83	7.79	9.06	11.06	12.31	13.42	7.68	9.63	8.13
Nitrogen Levels												
N_1: 0 kg/ha	21.97	20.30	21.14	24.97	23.31	24.14	26.97	25.31	26.14	27.31	28.97	28.14
N_2: 80 kg/ha	31.00	29.34	30.17	33.98	32.31	33.15	35.99	34.32	35.16	36.34	38.00	37.17
N_3: 160 kg/ha	34.65	33.10	33.87	38.10	36.43	37.27	40.15	38.48	39.31	40.67	42.34	41.50
N_4: 240 kg/ha	35.63	33.84	34.73	38.96	37.18	38.07	40.88	39.10	39.99	41.70	43.48	42.59
SEm ±	1.16	1.24	1.22	0.24	0.18	0.21	0.12	0.19	0.17	0.16	0.15	0.15
CD (P = 0.05)	NS	NS	NS	0.72	0.54	0.64	0.36	0.57	0.51	0.48	0.46	0.47
CV	9.39	8.24	8.81	8.49	9.82	8.79	10.36	11.46	11.37	8.72	8.51	8.61
Interaction (V x N)												
V_1N_1	24.5	22.9	23.7	27.6	25.9	26.7	29.6	27.9	28.7	29.9	31.6	30.7
V_1N_2	31.7	30.1	30.9	34.7	33.1	33.9	36.7	35.1	35.9	37.1	38.7	37.9
V_1N_3	37.1	35.7	36.4	40.4	38.7	39.6	42.4	40.7	41.6	42.7	44.4	43.6
V_1N_4	38.2	36.2	37.2	41.0	39.0	40.0	43.2	41.2	42.2	44.0	46.0	45.0
V_2N_1	19.5	17.8	18.7	22.5	20.8	21.7	24.5	22.8	23.7	24.8	26.5	25.7
V_2N_2	30.1	28.4	29.3	33.0	31.4	32.2	35.0	33.4	34.2	35.4	37.0	36.2
V_2N_3	32.5	30.8	31.6	35.8	34.1	35.0	38.5	36.8	37.6	38.8	40.5	39.6
V_2N_4	33.6	31.9	32.7	37.1	35.4	36.3	39.1	37.4	38.2	39.4	41.1	40.2
V_3N_1	21.9	20.2	21.0	24.9	23.2	24.0	26.9	25.2	26.0	27.2	28.9	28.0
V_3N_2	31.2	29.5	30.3	34.2	32.5	33.3	36.2	34.5	35.4	36.6	38.2	37.4
V_3N_3	34.4	32.8	33.6	38.1	36.4	37.3	39.6	37.9	38.7	40.5	42.1	41.3
V_3N_4	35.1	33.4	34.3	38.8	37.1	38.0	40.4	38.7	39.6	41.7	43.4	42.6
SEm ±	1.49	1.81	1.67	0.31	0.28	0.29	0.21	0.30	0.25	0.22	0.24	0.23
CD (P = 0.05)	NS	NS	NS	0.93	0.84	0.88	0.63	0.90	0.76	0.67	0.72	0.69
CV	11.41	12.18	11.34	9.38	8.83	10.27	12.64	13.74	14.11	9.42	10.32	9.89

*DAP – Days after planting

Table 3: Number of shoots plant^{-1} at various growth stages of potato as influenced by different genotypes and nitrogen levels

Number of shoots plant^{-1}												
	30 DAP			45 DAP			60 DAP			75 DAP		
Treatments	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**
Varieties/Genotypes												
V_1: AICRP-P-39	5.17	4.34	4.75	6.09	5.25	5.67	7.03	6.19	6.61	8.23	7.39	7.81
V_2: Kufri Garima	4.81	3.98	4.39	5.58	4.75	5.16	6.35	5.52	5.93	7.29	6.46	6.88
V_3: Kufri Pukhraj	4.99	4.16	4.58	5.87	5.03	5.45	6.73	5.90	6.32	7.73	6.89	7.31
SEm ±	0.13	0.15	0.12	0.04	0.03	0.04	0.03	0.04	0.03	0.07	0.02	0.04
CD (P = 0.05)	NS	NS	NS	0.13	0.10	0.12	0.11	0.12	0.11	0.22	0.06	0.13
CV	9.24	11.10	10.36	11.83	11.83	9.06	10.86	12.81	11.42	8.92	9.96	8.13
Nitrogen Levels												
N_1: 0 kg/ha	4.52	3.69	4.11	5.26	4.42	4.84	5.61	4.78	5.19	6.01	5.18	5.59
N_2: 80 kg/ha	4.91	4.08	4.49	5.71	4.88	5.29	6.42	5.59	6.01	7.31	6.48	6.89
N_3: 160 kg/ha	5.20	4.37	4.78	6.13	5.30	5.71	7.29	6.46	6.87	8.64	7.81	8.23
N_4: 240 kg/ha	5.32	4.49	4.91	6.28	5.45	5.86	7.49	6.66	7.07	9.02	8.19	8.61
SEm ±	0.15	0.18	0.19	0.03	0.04	0.03	0.04	0.03	0.04	0.05	0.03	0.03
CD (P = 0.05)	NS	NS	NS	0.10	0.13	0.11	0.13	0.10	0.12	0.17	0.08	0.10
CV	11.32	10.39	11.72	11.58	10.58	8.79	11.06	11.63	10.37	9.29	10.51	9.61
Interaction (V x N)												
V_1N_1	4.37	3.83	4.30	5.50	4.60	5.08	6.00	5.13	5.53	6.37	5.53	5.95
V_1N_2	5.07	4.23	4.65	5.89	5.03	5.45	6.61	5.83	6.25	7.57	6.73	7.15
V_1N_3	5.37	4.53	4.95	6.50	5.67	5.98	7.70	6.87	7.28	9.40	8.57	8.98
V_1N_4	5.57	4.74	5.16	6.57	5.74	6.16	7.87	6.94	7.36	9.57	8.73	9.15
V_2N_1	4.33	3.50	3.92	4.93	4.10	4.52	5.23	4.40	4.82	5.63	4.80	5.22
V_2N_2	4.73	3.90	4.32	5.53	4.62	5.12	6.23	5.37	5.75	7.10	6.27	6.58
V_2N_3	5.07	4.23	4.65	5.90	5.05	5.47	6.81	6.03	6.47	7.87	7.03	7.45
V_2N_4	5.10	4.27	4.68	5.94	5.08	5.55	7.18	6.33	6.75	8.37	7.53	8.15
V_3N_1	4.57	3.73	4.15	5.33	4.40	4.92	5.63	4.80	5.22	6.03	5.20	5.62
V_3N_2	4.93	4.10	4.52	5.73	4.81	5.32	6.43	5.53	5.95	7.27	6.43	6.85

V_3N_3	5.17	4.33	4.75	6.10	5.27	5.68	7.39	6.57	6.98	8.67	7.83	8.35
V_3N_4	5.30	4.47	4.88	6.30	5.47	5.88	7.50	6.70	7.06	8.93	8.10	8.52
SEm ±	0.26	0.31	0.29	0.05	0.06	0.05	0.06	0.05	0.06	0.10	0.04	0.05
CD (P = 0.05)	NS	NS	NS	0.15	0.18	0.16	0.19	0.15	0.18	0.30	0.13	0.15
CV	12.13	11.41	12.38	11.69	11.69	10.27	12.45	11.45	11.81	8.72	10.39	11.69

*DAP – Days after planting

Table 4: Number of leaves plant^{-1} at various growth stages of potato as influenced by different genotypes and nitrogen levels

Number of Leaves plant^{-1}												
	30 DAP			45 DAP			60 DAP			75 DAP		
Treatments	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**
Varieties/Genotypes												
V_1: AICRP-P-39	37.91	36.08	36.99	45.23	43.39	44.31	59.27	57.44	58.36	70.27	68.44	69.36
V_2: Kufri Garima	35.53	33.69	34.61	41.84	40.01	40.92	54.41	52.58	53.49	64.66	62.83	63.74
V_3: Kufri Pukhraj	36.81	34.98	35.90	43.73	41.90	42.81	57.12	55.29	56.20	68.04	66.20	67.12
SEm ±	0.71	0.76	0.74	0.13	0.10	0.12	0.31	0.38	0.36	0.31	0.38	0.33
CD (P = 0.05)	NS	NS	NS	0.40	0.31	0.36	0.94	1.15	1.08	0.93	1.15	0.99
CV	9.46	10.11	9.95	11.07	11.79	11.31	11.06	13.18	11.42	14.87	12.63	13.13
Nitrogen Levels												
N_1: 0 kg/ha	29.97	28.14	29.06	35.45	33.61	34.53	44.66	42.82	43.74	54.88	53.05	53.96
N_2: 80 kg/ha	35.63	33.80	34.72	42.32	40.48	41.40	53.13	51.30	52.22	64.13	62.30	63.22
N_3: 160 kg/ha	40.26	38.42	39.34	47.95	46.11	47.03	63.61	61.78	62.69	74.28	72.44	73.36
N_4: 240 kg/ha	41.13	39.30	40.22	48.69	46.88	47.77	66.34	64.50	65.42	77.34	75.50	76.42
SEm ±	1.08	1.10	1.12	0.20	0.22	0.21	0.41	0.34	0.35	0.34	0.35	0.35
CD (P = 0.05)	NS	NS	NS	0.61	0.76	0.64	1.24	1.03	1.05	1.33	1.06	1.05
CV	11.39	9.24	10.81	11.49	9.82	10.79	10.36	12.29	11.37	12.72	11.51	12.68
Interaction (V x N)												
V_1N_1	30.4	28.5	29.5	37.4	34.6	35.5	47.1	45.2	46.2	56.5	55.6	55.6
V_1N_2	36.9	35.1	36.0	43.3	41.4	42.4	55.2	53.4	54.3	65.4	63.4	64.3
V_1N_3	41.7	39.9	40.8	50.2	48.4	49.3	66.9	65.6	66.1	78.7	77.0	77.9
V_1N_4	42.6	40.8	41.7	51.0	49.2	50.1	68.9	68.3	68.5	81.3	80.1	80.2
V_2N_1	27.4	27.6	27.5	32.6	31.8	31.9	42.4	40.6	41.5	51.3	50.6	50.8
V_2N_2	34.1	32.3	33.2	39.3	37.4	40.3	49.5	47.6	48.6	59.5	58.5	58.6
V_2N_3	38.7	36.8	37.8	45.6	43.7	44.7	57.8	56.9	56.6	68.8	66.9	67.9
V_2N_4	39.9	38.1	39.0	45.9	44.1	45.0	60.0	59.2	59.3	71.0	69.2	70.3
V_3N_1	28.1	28.3	29.2	35.3	33.5	34.4	44.6	42.7	43.6	53.9	53.3	53.2
V_3N_2	35.9	34.1	35.0	41.4	39.6	41.5	52.7	50.9	51.8	62.7	60.9	61.8
V_3N_3	40.4	38.5	39.5	47.0	46.2	47.1	62.2	61.4	61.7	73.6	72.4	73.3
V_3N_4	40.9	39.0	40.0	48.2	47.3	48.3	64.4	63.2	63.9	76.1	74.8	75.7
SEm ±	1.51	1.64	1.57	0.33	0.31	0.32	0.70	0.67	0.69	0.65	0.71	0.69
CD (P = 0.05)	NS	NS	NS	1.00	0.93	0.96	2.10	1.92	2.07	1.94	2.13	2.07
CV	12.94	11.38	12.34	12.81	10.83	11.42	12.64	13.74	12.19	13.82	12.32	12.78

*DAP – Days after planting

Table 5: Total tuber yield (kg plot^{-1} and t ha^{-1}) of potato as influenced by different genotypes and nitrogen levels

Total tuber yield (kg plot^{-1} and t ha^{-1}) of potato						
	Total tuber yield (kg plot^{-1})			Total tuber yield (t ha^{-1})		
Treatments	**2018-19**	**2019-20**	**Pooled Mean**	**2018-19**	**2019-20**	**Pooled Mean**
Varieties/Genotypes						
V_1: AICRP-P-39	32.48	29.65	31.06	37.52	32.91	35.21
V_2: Kufri Garima	30.69	27.64	29.17	35.28	31.02	33.15
V_3: Kufri Pukhraj	31.30	28.55	29.93	36.21	31.62	33.92
SEm ±	0.04	0.02	0.03	0.04	0.01	0.02
CD (P = 0.05)	0.13	0.06	0.10	0.13	0.03	0.05
CV	6.76	6.31	6.42	6.76	7.31	7.23
Nitrogen Levels						
N_1: 0 kg/ha	22.08	19.35	20.71	25.49	22.67	24.08
N_2: 80 kg/ha	32.55	29.66	31.11	37.48	33.39	35.43
N_3: 160 kg/ha	35.90	33.02	34.46	41.47	35.98	38.72
N_4: 240 kg/ha	35.42	32.42	33.92	40.91	35.35	38.13
SEm ±	0.04	0.03	0.04	0.04	0.01	0.03
CD (P = 0.05)	0.12	0.08	0.11	0.12	0.03	0.09
CV	6.36	7.46	7.37	7.36	8.46	8.37
Interaction (V x N)						
V_1N_1	23.17	20.54	21.86	26.81	24.04	25.43
V_1N_2	33.70	30.83	32.27	38.99	34.26	36.63

V_1N_3	36.58	33.77	35.18	42.32	37.28	39.80
V_1N_4	36.45	33.45	34.95	41.95	36.03	38.99
V_2N_1	21.34	18.34	19.84	24.53	21.57	23.05
V_2N_2	31.53	28.53	30.03	35.93	32.60	34.26
V_2N_3	35.24	32.24	33.74	40.59	35.10	37.85
V_2N_4	34.63	31.47	33.05	40.06	34.82	37.44
V_3N_1	21.73	19.16	20.44	25.14	22.40	23.77
V_3N_2	32.42	29.63	31.03	37.51	33.33	35.42
V_3N_3	35.87	33.05	34.46	41.50	35.55	38.52
V_3N_4	35.19	32.36	33.78	40.71	35.19	37.95
SEm ±	0.07	0.05	0.06	0.07	0.02	0.04
CD (P = 0.05)	0.21	0.14	0.19	0.21	0.06	0.12
CV	6.92	7.21	7.17	6.94	7.74	7.71

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