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NITROGEN AND PLANT DENSITY EFFECTS ON SEED SIZED TUBER YIELD AND QUALITY OF POTATO

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ABSTRACT

The effect of nitrogen and plant spacing on seed sized tuber yield and seed quality of potato (cv. Asterisk) was studied at the Bangabandhu Sheikh Mujubur Rahman Agricultural University, Salna, Gazipur. Four rates of nitrogen (100, 130, 160 and 190 kg ha^{-1}) and four plant spacing (70 cm × 25 cm, 60 cm × 25 cm, 50 cm × 25 cm and 40 cm × 25 cm) constituted the treatment variables. In general, application of higher rate of nitrogen and higher plant spacing intensified canopy development, plant growth and increased total tuber development of seed potato. Application of 190 kg N ha^{-1} and 40 cm × 25 cm plant spacing contributed to the highest seed sized tuber yield (30.59 t ha^{-1}) which was identical to that produced with 130 kg N ha^{-1} at 40 cm × 25 cm plant spacing. Contrary, the treatment of 160 kg Nha^{-1} and 40 cm × 25 cm plant spacing produced the maximum tuber yield per plot (20.88 kg) and the highest tuber yield per hectare (34.81 t ha^{-1}). The N levels and spacing did not affect significantly the N and K content in tuber though the higher rates increased accumulation of the two elements. Similarly soluble sugar and starch content were also not affected significantly by the N levels and different plant spacing. Therefore, for getting maximum seed sized tuber yield 190 kg N ha^{-1} and for maximum tuber yield 160 kg N ha^{-1} at 40 cm × 25 cm spacing are suggested to apply.

Keywords: N and K content in tuber, plant spacing, *Solanum tuberosum*

Introduction

Potato *Solanum tuberosum* L. is mostly consumed as a vegetable in Bangladesh. Due to favorable climate and people acceptance potato production is increasing day by day. In 2019 Bangladesh became the seventh largest potato producing country in the world (Singha and Maezawa 2019). The production of potato has been increased noticeably and in 2021 the production was 9.88 t with per hectare yield of 21.1 t ha^{-1} (BBS 2021). Though the yield level has been increased remarkably, yet that is much lower than other potato growing countries, like the Netherlands, USA and Australia and UK (FAO 2021).

There are several reasons for low yield of potato in Bangladesh, such as the use of low quality seed, application of improper amount of manures and fertilizers, use of traditional cultivation techniques etc. However, the use of improper amount of manures and fertilizers is considered as the main reasons for poor seed quality and yield of potato. Nitrogen is the first limiting factor for potato yield and its deficiency is most severe in the alluvial soils where most of the potato crop of Bangladesh is grown. Nitrogen is so important in potato production that the value of the other inputs cannot be fully realized unless nitrogen is applied to the crop in an optimum amount (Grewal *et al*. 1992, Maltas *et al.* 2018). Though farmers of Bangladesh use fertilizers for potato cultivation, they hardly follow recommended doses based on soil nutrient status. Excess N can reduce tuber bulking rates while deficiency may limit canopy growth and reduced carbohydrate production in tuber (Thorton 2020).

Plant spacing is considered as another important yield contributing factor for potato production. Closer spacing stimulates faster growth and also shorten growth duration of a crop. In wider spacing, plants remained greener and the haulms senesced later than that in closer spacing (Bussan *et al.* 2007). However, in sparse planting the natural resources utilization by the crop remains under-exploited. The plant spacing has also a direct influence on seed rate vis-à-vis cost of production.

Since nitrogen enhances vegetative growth, it is necessary to determine its optimum level of application for a

particular plant spacing for yield maximization (Zebarth *et al.* 2006). The present study was therefore undertaken to optimize nitrogen requirement at a particular plant density for maximizing seed sized potato yield, and also to assess the effect of nitrogen and plant density on the quality of seed potato tubers.

Materials and Methods

The experiment was conducted at the field of the Department of Horticulture of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). The pH of the soil was 5.8, organic carbon 0.68%, total N was 0.07%, available P 16.9 (mg/kg), exchangeable K 0.55 (meq/100) and available S was 2.78 ppm.

Before seed sowing 5 t/ha cow dung, 30 kg/ha P in the form of TSP, 160 kg/ ha K in the form of MP, 15 kg/ha S as gypsum, 3 kg/ha Zn as ZnO, 6 kg/ha Mg as magnesium sulphate and 1 kg/ha B as boric acid were applied as basal during final land preparation. The treatments were composed of four N levels, namely N1 =100; N2 =130; N3 =160; N4 =190 Kg N ha^{-1} (Urea, 46% N_2), and four plant spacing, i.e. S1= 70cm × 25cm; S2 = 60cm × 25cm; S3= 50cm × 25cm; S4 = 40cm × 25cm. Thus, the number of seed tubers planted was in S1 = 57143 $hectare^{-1}$, S2 = 66666 $hectare^{-1}$, S3 = 80000 $hectare^{-1}$ and S4 = 100000 $hectare^{-1}$. Half of the urea and muriate of potash (MP) and total amount of triple super phosphate (TSP) were mixed together and then applied into the soil. Fertilizers were placed in row which was deeper than the tuber row. Rest of the urea and MP were applied as top dress at 30 days after planting (DAP).

The foundation potato seed tubers of variety Asteric collected from BADC cold storage at Sherpur were planted. Irrigation was provided after emergence, 30, 40 and 50 DAP, while hand weeding was done at the time of earthing up the crop. Dursban 20 EC was used at the rate of 2ml per liter under the plant on ridge at 35 DAP before irrigation. Dithane M-45 at the rate of 2 kg ha^{-1} was sprayed at 10 days interval. Ridomil Gold was sprayed at the rate of 2 kg ha^{-1} once after rainfall to prevent the late blight disease of potato. The experimental design was two-factor RCBD with three replications. The plot was 2m × 3m in size. Data on different agronomic and physiological parameters recorded.

Preparation of plant samples for N and K analysis: The representative potato tuber samples from each plot were dried in an oven at 60°C for about 48 hours. The tuber then ground separately and pass through a 20 mesh sieve. The prepared samples were then put into the paper bags and kept into the desiccators till being used. The ground samples were weighed and used for digestion.

Total nitrogen content was estimated by Micro Kjeldahl method (Black, 1965) using Selenium powder, $CuSO_4$, H_2O and K_2SO_4 mixture (1: 10: 1000) as catalyst, following Salicylic-H_2SO_4 digestion. K contents were determined by nitric perchloric acid digestion method (Yamakawa, 1992). Dried plant materials were digested with concentrated HNO3 and HClO4 mixture as described by Piper (1950) for the determination of total K content. Total K content was determined by atomic absorption spectrophotometer.

Soluble sugar and starch estimation: The samples dried in an oven at 70°C for 72 hrs and then the samples were ground finely. The ground samples were covered with aluminium foil and put into oven. Twenty mg glucose powder (chemical grade) was added into 20 ml water and shaken well to make the solution homogenous. Five ml solution was transferred into a 100 ml volumetric flask and made up the volume. Then 0, 1, 2, 3, 4 and 5ml diluted glucose solutions were added to six test tubes. After that 5, 4, 3, 2, 1, and 0 ml distilled water was added respectively to make the volume 5ml each. These are the soluble sugar standards.

For starch analysis twenty mg glucose powder (chemical grade) was added into 20 ml water and shaken well to make the solution homogenous. Five ml solution was transferred to a 100 ml volumetric flask and made the volume. 0.0, 0.4, 1.4, 2.4, 3.4 and 4.4 ml diluted glucose solutions were added in six Pyrex test tubes. Afterward, 0.6 ml 0.46N $HclO_4$ was added to each test tube. Then 4.4, 4.0, 3.0, 2.0, 1.0 and 0.0ml distilled water was added respectively to each test tube to make the volume 5 ml. These were the starch standards.

Preparation of anthrone reagent: Fresh, pure and concentrated sulfuric acid was taken in a beaker. The beaker was surrounded by ice. Anthrone powder was added to acid maintaining the ratio acid : anthrone = 1 litre : 2 gm. The mixture was stirred until the anthrone powder

completely dissolved into acid. After adding anthrone to acid the temperature rose significantly. The reagent was stored (covered with aluminium foil) into a refrigerator.

Extraction of soluble sugar: The dried composite samples were ground finely in a mortar and pastel. 50 mg of finely ground sample was placed into a 15 ml centrifuge tube and 10 ml of 80% ethanol was added. The tubes were covered with aluminum foil and were kept in a water bath at 80-85°C for 30 minutes. Then the samples were centrifuged and decanted into a 50 ml beaker. This extraction was repeated three more times. The alcohol extract was evaporated on a water bath at 80-85°C until most of the alcohol was removed (e.g. the volume was reduced to about 3 ml). The volume was made up to 25 ml with distilled water. Five ml of sugar extract was transferred to a 100 ml volumetric flask and made up to volume with distilled water. 5 ml of this diluted sugar extract was taken into a Pyrex test tube and then these tubes and the tubes containing the glucose standards (0, 1, 2, 3, 4, and 5 ml standard glucose solution) were put into an ice bath. To each tube 10 ml of anthrone reagent was added slowly, allowing the reagent to run down the side of the test tube. The solution was stirred slowly with a glass rod. The tubes were put into boiling water bath for exactly 7.5 minutes and were cooled immediately in ice. Then the absorbance was measured at 630 nm and sugar content as mg/g dry weight was estimated using standard curve.

Starch estimation: The residue left in the centrifuge tube after collecting sugar extract was dried in an oven at 80°C and 2 ml of distilled water was added to each centrifuge tube. The tubes were put in a boiling water bath for 15 minutes and stirred occasionally. The tubes were allowed to cool and 2ml of 9.2 N $HclO_4$ was added to each tube while stirring constantly. Then the solution was stirred occasionally for 15 minutes. The suspension was then made up to about 10 ml and centrifuged. The supernatant was collected and 2 ml of 4.6 N $HclO_4$ was added to the residue. This suspension was stirred for 15 minutes and made up to 10 ml with distilled water. Then the suspension was centrifuged and the supernatant were combined. The combined supernatants were made up to 50 ml with distilled water. Five ml of starch extract was transferred to a 50 ml volumetric flask and made up to volume with distilled water. Five ml of this diluted starch extract was taken into a Pyrex test tube. Then these tubes and the tubes containing glucose standards (0, 1, 2, 3, 4 and 5 mg/5ml including 0.6 ml of 0.46 N $HclO_4$ solution for each tube) were put into ice bath. To each tube 10 ml of the anthrone reagent was added slowly allowing the reagent to run down the side of the test tube. The solution was stirred slowly with a glass rod. Then tubes were put in a boiling water bath for exactly 7.5 minutes and were cooled immediately in ice. The absorbance was measured at 630 nm and starch content was estimated as mg/g dry weight using standard curve.

Estimation of nutrient uptake: Nutrient uptake from the soil was calculated using the following formula:

$$\text{Nutrient uptake} = \frac{\%\ A \times Y}{100}\ \text{Kg ha}^{-1}$$

Where, % A = Nutrient (N and K) content of potato tuber; and Y = Total dry matter production of potato tuber (Kg ha^{-1})

The data collected on different parameters were subjected to analysis of variance (ANOVA). Microsoft EXCEL and MSTAT software programs were used wherever appropriate and the means were compared by least significant difference (LSD) test.

Results and Discussion

Different agronomic characters were influenced significantly by the N levels and spacing. Since the interaction effect of most of the characters were significant the combined effects of N and spacing on potato are presented and discussed.

As shown in Table 1 there was significant interaction between nitrogen and plant spacing on number of tubers/ hill. The highest number of tubers per hill (11.81) was found from the treatment combination of 160 kg N/ ha with 40cm × 25cm spacing, which was statistically similar to several treatment combinations. The minimum tubers per hill (9.16) was observed from 100 kg N/ha with 50cm × 25cm spacing. Similar to the findings the influence of N and plant density on potato tuber production was also reported by Mohammed *et al*. (1993) and Zebart *et al.* (2007) that tuber number/ plant increased with the increase in plant spacing and nitrogen levels. The increase in number of tubers per hill might be due to increased photosynthetic

activity and translocation of photosynthates to the sink which might have helped in the initiation of more stolons (Anand and Krishnappa 1988, Bussan *et al.* 2007). The increase in number of tubers per hill with the increasing levels of nitrogen was also reported by Bhowmik and Dandapat (1991), Muleta and Aga (2019).

The combined effect of different levels of nitrogen and plant spacing had significant effect on the weight of tubers hill^{-1} (Table 1). The maximum weight of tubers hill^{-1} (484.73 g) was observed in the treatment combination of 190 kg ha^{-1} nitrogen with 70 cm × 25 cm plant spacing. The minimum (309.08 g) was found in case of 100 kg ha^{-1} nitrogen with 40 cm × 25 cm plant spacing.

The yield of tubers was also influenced significantly by the combined effect of different nitrogen levels and plant spacing (Table 1). The highest yield per hectare (34.8 1t ha^{-1}) was obtained from the treatment combination of 160 kg /ha nitrogen with 40 cm × 25 cm plant spacing and the lowest yield (22.1 t ha^{-1}) was obtained from the treatment combination of 130 kg ha^{-1} nitrogen with 70 cm ×25 cm which was statistically identical to the treatment combination of 100 kg ha^{-1} nitrogen with 70 cm × 25 cm plant spacing.

Yield of seed tubers were significantly influenced by the combined effect of different levels of nitrogen and plant spacing (Table 1). The variation in non-seed yield per hectare due to the combined effect of different nitrogen levels and plant spacing was found to be non-significant. The highest seed tuber yield ha^{-1} (30.59 t ha^{-1}) was obtained from the treatment combination of 190 kg ha^{-1} nitrogen with 40 cm × 25 cm plant spacing, which was statistically identical with the treatment combination of 130 kg/ha nitrogen with 40 cm × 25 cm plant spacing. The lowest seed yield (19.53 t ha^{-1}) per hectare was obtained from the treatment combination of 130 kg ha^{-1} nitrogen with 70 cm × 25 cm plant spacing. In case of non-seed

Table 1. Interaction effect of different levels of nitrogen and plant spacing on the yield of seed and non-seed potato tubers

Treatment Combinations	No. of tubers per hill (nos)	Wt. of tubers per hill (g)	Yield of tubers (t/ha)	Yield of seed tubers per hectare (t)	Yield of A grade seed tuber per hectare(t)	Yield of B grade tubers Per hectare(t)	Yield of under grade tubers per hectare (t)	Ratio (seed tuber:under grade tuber)
N1S1	10.68abc	423.83d	22.57i	21.40g	9.46fgh	11.93de	1.17	18.77
N1S2	11.40ab	403.33e	26.89f	24.76f	16.48a	8.26f	2.15	11.77
N1S3	9.16d	359.91h	28.79e	26.92e	15.94ab	10.97e	1.87	18.83
N1S4	10.20bcd	309.08i	28.85e	25.39f	14.23abcd	11.16de	3.46	7.51
N2S1	11.20ab	415.36d	22.15i	19.53h	8.19h	11.33de	2.62	8.96
N2S2	10.47abcd	413.96d	27.60f	25.24f	11.82def	13.42bcde	2.36	11.28
N2S3	11.52ab	393.24ef	31.46c	28.61bcd	12.36cde	16.24a	2.85	10.25
N2S4	10.72abc	359.30h	33.53b	30.35a	15.47ab	14.89abc	3.18	9.61
N3S1	9.77 cd	440.44c	23.49h	22.30g	9.45fgh	12.84cde	1.20	20.22
N3S2	10.80abc	436.74c	29.12e	26.94e	11.58efg	15.36abc	2.17	12.53
N3S3	10.88abc	386.24f	30.90cd	27.68de	13.91bcde	13.76abcd	3.22	8.61
N3S4	11.81a	372.92g	34.81a	29.95ab	13.67bcde	16.27a	4.86	6.37
N4S1	9.75cd	484.73a	25.85g	24.25f	9.24gh	15.01abc	1.60	17.50
N4S2	10.73abc	456.41b	30.43d	28.46cd	12.84cde	15.61ab	2.25	14.46
N4S3	11.47ab	395.66ef	31.65c	29.40abc	14.47abc	14.92abc	2.25	13.86
N4S4	9.82cd	361.02h	33.69b	30.59a	15.68ab	14.92abc	3.11	10.08
LSD (0.05%)	1.349	10.63	.823	1.36	2.50	2.68	NS	NS
CV%	7.6	1.6	1.7	3.1	11.7	11.8	26.4	40.6

Means separated in columns followed by the same letter(s) are not significantly different at 5% level by DMRT.

N1 =100; N2 =130; N3 =160; N4 =190 Kg N ha^{-1} ; S1= 70cm × 25cm; S2 = 60cm × 25cm; S3= 50cm × 25cm; S4 = 40cm × 25cm.

tubers, the maximum yield/ hectare (4.86 t ha^{-1}) was found in the treatment combination of 160 kg ha^{-1} nitrogen with 40 cm × 25 cm plant spacing and the minimum (1.17 t ha^{-1}) was found in the treatment combination of 100 kg ha^{-1} nitrogen with 70 cm × 25 cm plant spacing. Nitrogen and spacing affect plant growth, yield and even quality of potato tubers as reported by Zebarth *et al.* (2006). Too high and low level of N have negative effect on potato yield and yield attributes as reported by Zebarth *et al.* (2004) as because excessive level of N exert negative effect on nitrogen metabolism, while low level of nitrogen becomes scarce element for physiological and biochemical processes. Optimum spacing on the other hand is a determining factor for potential harvest of potato tubers (Caliskan *et al.* 2009, Dimantel and Gaile 2015) as both low and high plant density hinder the natural resource exploitation greatly.

Interaction of N and spacing affected the size grade distribution of tubers (Table 2). The highest percentage of A grade tuber number (54.12%) was harvested from the treatment combination S1N2 and the lowest percentage value (33.68%) was seen with the treatment combination of S2N1 (Table 2). The highest percentage of tuber number (36.12%) was seen in the treatment combination with S4N1 and the lowest (13.16%) was with the treatment combination of S1N2.

The combined effect of different levels of nitrogen and plant spacing was significant in all cases of tubers for A, B and under grade and seed sized tubers (Table 2). The highest amount (46.94%) under grade tuber was found with the treatment combination of S3N4, while the lowest (22.67%) was found with the treatment combination of S4N1. The highest (78.35%) of total seed sized was found

Table 2. Interaction effect of different levels of nitrogen and plant spacing on size grade distribution of tubers (% by number, % by weight) of potato

Treatment	Grade of tuber (%) by number				Grade of tuber (%) by weight			
	A grade (28-40 mm)	B grade (41-55 mm)	Under grade (<28 mm)	Total seed sized tuber (A + b)	A grade (28-40 mm)	B grade (41-55 mm)	Under grade (<28 mm)	Total seed sized tuber (A + b)
S1N1	50.73ab	27.62b	21.65g	78.35a	41.95cdef	52.87abc	5.18e	94.82a
S1N2	54.12a	13.16h	32.73de	67.27cd	61.27a	30.76f	7.97bcde	92.03abcd
S1N3	49.08abc	17.50fgh	33.42de	66.58cd	55.31ab	38.14ef	6.54cde	93.46abc
S1N4	41.18cde	14.37gh	44.45ab	55.55fg	49.36bc	38.68def	11.96ab	88.04de
S2N1	33.68e	23.75bcde	42.57abc	57.43efg	36.95ef	51.24abc	11.81ab	88.19de
S2N2	45.28bc	23.31bcdef	31.40def	68.60bcd	42.83cdef	48.64abcd	8.54bcde	91.46abcd
S2N3	42.36bcd	20.53cdefg	37.11bcd	62.89def	39.27def	51.67abc	9.06bcde	90.94abcd
S2N4	45.11bc	20.70cdef	34.19cde	65.81cde	46.06cd	44.44cde	9.50bcd	90.50bcd
S3N1	44.69bc	29.36b	25.95efg	74.05abc	40.26def	54.66ab	5.08e	94.92a
S3N2	44.34bc	25.61bcd	30.05defg	69.95abcd	39.82def	52.73abc	7.46cde	92.54abc
S3N3	44.39bc	19.31efgh	36.31bcd	63.69def	45.01cde	44.57cde	10.42abc	89.58cde
S3N4	35.00de	18.06efgh	46.94a	53.06g	39.26def	46.77bcde	13.96a	86.04e
S4N1	41.21cde	36.12a	22.67fg	77.33ab	35.74f	58.03a	6.23cde	93.77ab
S4N2	43.62bc	26.04bc	30.33defg	69.67abcd	42.25cdef	51.28abc	6.47cde	93.53abc
S4N3	43.57bc	19.78defg	36.65bcd	63.35def	45.72cd	47.13bcde	7.14cde	92.86abc
S4N4	44.82bc	19.20efgh	35.97bcd	64.03def	46.50cd	44.30cde	9.20bcde	90.80abcd
LSD (0.05)	8.487	6.239	8.884	8.884	8.75	10.01	4.128	4.128
CV%	11.6	16.9	15.7	8.1	11.9	12.7	29.0	2.7

Means separated in columns followed by the same letter(s) are not significantly different at 5% level by DMRT

N1 =100; N2 =130; N3 =160; N4 =190 Kg N ha^{-1} ; S1= 70cm × 25cm; S2 = 60cm × 25cm; S3= 50cm × 25cm; S4 = 40cm × 25cm.

Table 3. Combined effect of nitrogen and spacing on the chemical composition of potato

Treatment	% K in potato tuber	% N in potato tuber	Soluble sugar content (%)	Starch content (%)
N1S1	1.74	2.04	4.11	13.21
N1S2	1.75	1.8	3.31	11.19
N1S3	1.69	1.95	3.95	13.88
N1S4	1.68	2.15	2.85	10.51
N2S1	1.83	1.95	3.34	10.93
N2S2	1.72	1.7	3.55	13.00
N2S3	1.56	1.87	2.79	11.26
N2S4	1.71	2.04	3.25	12.26
N3S1	1.64	2.02	2.93	15.25
N3S2	1.65	1.8	2.91	14.86
N3S3	1.62	1.89	3.60	11.32
N3S4	1.57	1.97	3.17	12.16
N4S1	1.71	1.93	4.03	10.47
N4S2	1.74	1.9	3.28	10.80
N4S3	1.71	2.05	3.51	10.38
N4S4	1.74	1.92	2.84	15.16
LSD	NS	NS	NS	NS
CV%	8.1	10.3	351.4	38.9

Means separated in columns followed by the same letter(s) are not significantly different at 5% level by DMRT

N1 =100; N2 =130; N3 =160; N4 =190 Kg N ha^{-1} ; S1= 70cm × 25cm; S2 = 60cm × 25cm; S3= 50cm × 25cm; S4 = 40cm × 25cm.

with the treatment combination of S1N1 and the lowest (53.06%) with the treatment combination S3N4. The under grade tuber and total seed sized tubers were varied significantly with the combined effect of different levels of nitrogen and plant spacing. In case of under grade tubers, the highest percentage (13.96%) was observed in the treatment combination of S3N4 and the lowest (5.08%) was in S3N1. In case of total seed sized tubers, the highest percentage (94.92%) was found in S3N1 and the lowest (84.04%) was with the treatment combination of S3N4. Thus, the increased amount of application of nitrogen increased the percentage of large tubers as found in this study is supportive with the report of Arsenault *et al.* (2001), Negero (2017). Contrary closer spacing resulted in higher number of small tubers as also reported by Caliskan *et al.* (2009), Ahmad *et al.* (1976) that an increasing trend in the production of large tubers with the increase in plant spacing.

Though the percentage of potassium in potato tuber was not significantly affected by the different levels of nitrogen, the highest concentration (1.72%) was observed with nitrogen level N1, N2 and N4, while the lowest (1.62%) with N3 (Table 3). Similarly, the percentage of potassium was not significantly affected by the plant spacing, though the highest value (1.73%) was observed in S1 treatment, while the lowest value (1.63%) in S3.

Soluble sugar concentration was not significantly affected by the different levels of nitrogen and different plant spacing. However, the highest (3.56%) and the lowest (3.13%) amounts were observed in N1 and N4 treatments, respectively. The highest soluble sugar concentration (3.60%) was measured in S1 while the lowest concentration (3.03%) was observed in S4. Similar to sugar the starch concentration was also not significantly affected by nitrogen application and plant spacing (Table 3). The highest and lowest contents of starch (13.40%) and lowest (11.70%) were observed in N3 and N4 treatments, respectively. Concerning the effect of spacing, the highest starch content (12.52%) was noticed in S4, while the lowest (11.71%) was observed in S3 treatment.

In this study the N levels and spacing did not affect significantly different physiological parameters though Gomez *et al.* (2017) reported that under optimal fertilization significant differences between factor interactions of cultivar × phenology × location for accumulation of N and P were detected, however, the nutritional extraction was largely depended on the genetic potential determined by the interaction with the environmental and edaphic supply. The contrasting results suggest for further intensive study on the N effect on physiological processes in potato.

Conclusion

The results of the study suggest that application of 190 kg N ha^{-1} at 40 cm × 25 cm plant spacing produced the highest seed sized tuber yield (30.59 t ha^{-1}) though 160 kg Nha^{-1} at 40 cm × 25 cm plant spacing produced the maximum tuber yield (34.81 t ha^{-1}).

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