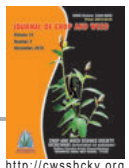
Journal of Crop and Weed, 19(1): 16-21 (2023) ISSN- O : 2349 9400 ; P : 0974 6315



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Study on effect of various levels of nitrogen on growth, yield and quality of sweet potato varieties [*Ipomoea batatas* (L) Lam.]

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Received : 07.07.2022 ; Revised : 01.09.2022 ; Accepted : 02.10.2022

DOI: https://doi.org/10.22271/09746315.2023.v19.i1.1653

ABSTRACT

Two field experiments were conducted at CTCRI (Central Tuber Crops Research Institute) Sreekariyam, Thiruvananthapuram, to study the effect of different levels of nitrogen on growth, yield and quality of sweet potato varieties during rabi 2020 and 2021. The experiment was laid out in Factorial Randomized Block Design with ten treatments and three replications. The experiment consisted of five levels of nitrogen (0, 25, 50, 100 and 125%) on two varieties of sweet potato (SreeArun and Sree Kanaka). The results revealed that application of super optimal (125% @ 62.5 kg ha^{-1}) level of nitrogen on two varieties of sweet potato had recorded significantly higher growth and quality parameters, and was at par with optimal dose of nitrogen (50 kg ha^{-1}). Application of nitrogen @ 62.5 kg ha^{-1} showed highest tuber yield (15.97 t ha^{-1}). Significantly higher quality parameters for crude protein (5.91%) and crude fibre (2.49%) were observed when super optimal level of nitrogen was given.

***Keywords*:** Nitrogen, Sree Arun, Sree Kanaka, Tuber yield, Quality

Sweet potato [*Ipomoea batatas* (L) Lam.] is an important vegetable crop and widely grown throughout warm temperature regions and tropical parts of the world between latitude of 40° N and 40° S of the equator, and upto 2300m altitude. This is a vegetatively propagated crop and rich in various essential nutrients. It is an excellent source of vitamins (A and C), complex carbohydrates, starch, high antioxidants, mineral and amino acids. Depending on cultivar the crop is rich in carotenoids and β-carotene (Kosambo *et al*., 1998). β- carotene is the precursor of vitamin A and it is very important in alleviating vitamin A deficiency. World annual production of sweet potato is 112.84 million tons and it is cultivated in the area of 9.20 million hectares (FAO, 2019).

Nitrogen being "The motor of plant growth" and an important factor in determining the yield and nutrient composition of root tubers, nitrogen application had linearly increased dry matter, carotenoid and protein content of sweet potato (Relente and Asio, 2020). Nitrogen is an essential element for maintaining better plant growth, increased tuber bulking rate, harvested tuber quality and more dry matter production (Roy and Jaiswal, 1998). N is an essential constituent of plant cell wall, cytoplasmic proteins, nucleic acids, chlorophyll and other parts of the cell and plays an important role in plant biochemistry (Hay and Walker, 1989). The response of this crop to N application depends highly on genotypic and environmental variations (Villagarcia, 1998). Nitrogen deficiency leads to poor crop growth and yield. Slow plant growth, poor yield, depressed protein levels, lower produce quality and inefficient water use are due to deficiency of available nitrogen. Quality of tubers particularly storage life is reduced due to excess application of nitrogen (FAO and IFA, 2000).

Sweet potato cultivation has been confined only to home gardens, because its commercial cultivation is not getting popularized in state like Kerala due to the unawareness among farmers of its health and nutritional benefits and its poor yields under Kerala climatic condition. Due to less production of this crop, very few research works were done in this line so far, hence an attempt has been made to evaluate the importance of nitrogen requirement and varietal influence on growth, yield and quality parameters of this crop in laterite soil of Kerala during *rabi* 2020 and 2021.

MATERIALS AND METHODS

Two field experiments were conducted at ICAR - Central Tuber Crops Research Institute (CTCRI), Sreekariyam, Thiruvananthapuram during *rabi*, 2020-2021 and 2021-2022. Initial soil physical and chemical properties were mentioned in Table 1. The land was ploughed and cross harrowed to bring the soil to a fine tilth prior to planting. Clods were crushed with clod crusher to make the soil loose and friable. Dried and decomposed manure was applied @ 5 t ha^{-1} and mixed thoroughly in the soil. After attaining proper field conditions, ridges and furrows were made. The experimental design used was Factorial Randomized Block Design (FRBD) with ten treatments and three replications. The five nitrogen levels were 0, 25, 50, 100 and 125%of CTCRI recommendation and the two contrast varieties of sweet potato were chosen: Sree Arun

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How to cite : Suresh Kumar, J., Niwas, N., Jose, S. and Sunitha, S. 2023. Study on effect of various levels of nitrogen on growth, yield and quality of sweet potato varieties [*Ipomoea batatas* (L) Lam. *J. Crop and Weed*, 19 (1): 16-21.

(long duration variety- 110 days) and Sree Kanaka (short duration variety - 90 days). For sweet potato, CTCRI recommends a nitrogen dose of 50 kg ha^{-1} in addition to 25 kg P and 50 kg K. Nitrogen, phosphorus and potassium were applied to each plot in the form of Urea, Single super phosphate and MOP (muriate of potash) as per the treatments. Entire quantity of phosphorus, 50% of nitrogen and potassium were applied at sprouting of the vines. Remaining 50% of nitrogen and potassium were top dressed at four weeks after first dose. The average monthly temperature of the experimental period ranged between 23-29 ^{o}C and average monthly rain fall was 30 mm. The vine cuttings of 20-25 cm length were taken and planted on ridges taken 60 cm apart with plant to plant spacing of 20 cm. The basal portion up to 10 - 15 cm was buried in soil horizontally. Intercultural operations like irrigation, gap filling and weeding were carried out timely, weeding was done manually. Plants were harvested after three months. Bulked tubers were harvested by digging when leaves turn yellow. The growth parameters were recorded at harvest from the selected plant samples. These samples were harvested separately for taking post-harvest observation. The length of vines from base to tip was measured before harvest. Total number of leaves and branches in each plant was counted and recorded separately. Leaf area index was calculated before senescence of the crop. The yield characters such as length of the tuber and diameter of the tuber was measured in centimetres (cm) after the harvest. Tuber yields were recorded in kilogram (kg) per plot and tonnes (t) per hectare. The data collected over two seasons was analysed using the SAS (2010) / STAT statistical analysis package (version 6.12, SAS Institute, Cary, NC, USA). Means were tested by least significant difference at P (0.05).

RESULTS AND DISCUSSION

Growth parameters

Effect of nitrogen: The results (Table 2) indicate that each successive increase in the level of nitrogen significantly improved the growth parameters. Significantly higher vine length (257.5 cm) and number of branches per vine (8.17) were observed under super optimal (125% @ 62.5 kg ha^{-1}) level of nitrogen application. The number of leaves per vine (108.5) and leaf area index (5.46) were significantly higher at 62.5 kg ha^{-1}over 25 kg ha^{-1} and control. However differences in these parameters were not significant with 50 kg ha^{-1} nitrogen application.

The increase in plant and tuber dry matter production was due to more availability of nitrogen. It improved the vigour of the plant growth, stimulating meristematic activity, synthesis of amino acids, cell division and elongation, as well as some plant physiological processes which contributed to increased vegetative growth. Results of similar trend were reported in sweet potato by Sebastiani *et al*. (2006), Okpara *et al*. (2009), Chandrahar (2016), Pushpalatha *et al*. (2017), Jamaati-e-Somarin *et al*. (2009) and Sharma *et al*. (2014) in potato.

Effect of variety: Main vine length (190.26 cm), number of leaves per vine (89.33) were significantly higher in variety Sree Arun due to its genetic nature, being a long duration variety; it has an extensive root system which contributes to the better uptake of nutrients which improved the growth characters. Sree Kanaka variety recorded significantly higher number of branches per vine (8.27) and leaf area index (6.05) due to its profuse branching capacity and more wider leaves (Sunitha *et al*., 2018).

Interaction effect of N x variety: Interaction between varieties and various levels of nitrogen application had positively influenced the growth parameters of sweet potato. Significantly higher vine length (278.11) was recorded when super optimal (125 Kg ha^{-1}) level of nitrogen was applied in Sree Arun variety. Application of super optimal (125 Kg ha^{-1}) level of nitrogen on Sree Kanaka showed significantly higher leaf area index.

Yield and yield attributes

Effect of nitrogen: Each consecutive levels of nitrogen had significantly improved the yield of sweet potato (Table 5). Application of nitrogen @ 62.5 kg ha^{-1} recorded significantly higher number of tubers per vine (6.83), length of the tuber (15.38 cm) and tuber yield per hectare (15.97 t ha^{-1}) over 25 kg $ha^{-1}$and control. However, these parameters were on par with 50 kg ha^{-1} nitrogen application. This may be due to more availability of nitrogen promoted luxurious growth, improved physiological activities and accumulation of more carbohydrates and their translocation, accumulation in tubers resulted in larger size of tubers and increased number of tubers with higher yields in sweet potato. Results of similar type were reported by Alfred *et al*. (2000), Philips *et al*. (2005), Okon (2006), Ukom *et al*. (2009), Chandrahar (2016) in sweet potato.

Effect of variety: Significantly higher number of tubers per vine (5.28), length of the tuber (15.29 cm) and tuber yield per hectare (13.56 t ha^{-1}) were observed in variety Sree Arun due to its long duration and high yielding capacity compared to the short duration variety Sree Kanaka. Long duration varieties have more vegetative period and much carbohydrates were accumulated before senescence (Sunitha *et al*. 2018).

Effect of N x variety: Yield parameters were not significantly influenced with nitrogen and variety interaction.

Quality parameters

In case of quality parameter of sweet potato, genetic nature of the specific variety had contributed significantly (Table 6). Sree Kanaka recorded

Table 1: Initial soil properties of the experimental plot

S.No	Parameters	unit	value
1	Soil pH	-	5.98
2	Organic Carbon	%	0.64
3	Nitrogen	kg ha^{-1}	151.57
4	Phosphorous	kg ha^{-1}	54.96
5	Potassium	kg ha^{-1}	272.46
6	Bulk density	Mg m^{-3}	1.19
7	Particle density	Mg m^{-3}	2.16
8	Maximum water holding capacity	%	40.64
9	Porosity	%	48.15
10	Acid Phosphate	ìg p-nitro phenol g^{-1} soilhr^{-1}	272.08
11	Dehydrogenase	ìg TTC g^{-1} soil24 hr^{-1}	750.02
12	Urease	ìgg^{-1} soil hr^{-1}	65.70

Table 2: Growth characteristics as influenced by various levels of nitrogen on two contrast varieties of sweet potato at two months after planting (mean of two seasons)

Treatment	Length of main vine (cm)	No. of branches $vine^{-1}$	No. of leaves $vine^{-1}$	Leaf area index (LAI)
Varieties				
V_1	190.26	5.70	89.33	2.28
V_2	168.15	8.27	78.14	6.05
SEm	**3.43**	**0.10**	**2.22**	**0.15**
LSD (0.05)	**10.29**	**0.30**	**6.66**	**0.45**
Nitrogen (kg ha^{-1})				
N_0	89.33	5.83	56.22	2.82
N_1	134.27	6.41	69.36	3.35
N_2	187.66	6.88	84.11	4.17
N_3	227.27	7.64	100.5	5.03
N_4	257.5	8.17	108.5	5.46
SEm	**5.43**	**0.16**	**3.52**	**0.23**
LSD (0.05)	**16.28**	**0.48**	**10.53**	**0.71**
Interaction (V*N)				
SEm	**7.69**	**0.22**	**4.98**	**0.33**
LSD (0.05)	**23.02**	**NS**	**NS**	**1.01**

V_1- SreeArun, V_2- Sree Kanaka; N_0- 0% Nitrogen application (N @ 0 $kgha^{-1}$), N_1- 25% Nitrogen application (N @ 12.5 $kgha^{-1}$), N_2- 50% Nitrogen application (N @ 25 $kgha^{-1}$), N_3- 100% Nitrogen application (N @ 50 $kgha^{-1}$), N_4- 125% Nitrogen application (N @ 62.5 $kgha^{-1}$)

Table 3: Mean length of vine as influenced by the variety x nitrogen interaction

	N_0	N_1	N_2	N_3	N_4	Mean
V_1	121.66	142.44	184.66	224.44	278.11	190.26
V_2	57	126.11	190.66	230.11	236.89	168.15
Mean	89.33	134.27	187.66	227.27	257.5	
SEm	**7.69**					
LSD (0.05)	**23.02**					

Table 4: Mean leaf area index (LAI) as influenced by the variety x nitrogen interaction

	N_0	N_1	N_2	N_3	N_4	Mean
V_1	1.51	1.99	2.31	2.72	2.90	2.28
V_2	4.14	4.72	6.04	7.33	8.03	6.05

Table 5: Yield attributes as influenced by various levels of nitrogen on two contrast varieties of sweet potato (mean of two seasons)

Treatment	Tuber length (cm)	Tuber diameter (cm)	No. of tubers vine^{-1}	Yield (t ha^{-1})
Varieties				
V_1	15.29	9.54	5.28	13.56
V_2	12.97	7.47	4.71	10.44
SEm	**0.27**	**0.18**	**0.19**	**0.5**
LSD (0.05)	**0.81**	**0.56**	**-**	**1.5**
Nitrogen (kg ha^{-1})				
N_0	13.06	8.01	3.04	7.24
N_1	13.31	8.22	4.07	9.94
N_2	14.35	8.35	4.95	12.38
N_3	14.55	8.85	6.08	14.48
N_4	15.38	9.09	6.83	15.97
SEm	**0.43**	**0.29**	**0.31**	**0.79**
LSD (0.05)	**1.29**	**-**	**0.93**	**2.37**
Interaction (V*N)				
SEm	**0.61**	**0.42**	**0.44**	**1.12**
LSD (0.05)	**-**	**-**	**-**	**-**

Table 6: Quality parameters as influenced by various levels of nitrogen on two different varities of sweet potato (mean of two seasons)

Treatment	Crude protein(%)	Crude fibre(%)	Tuber moisture content (%)
Varieties			
V_1	5.10	2.31	68.76
V_2	5.55	2.3	70.33
SEm	**0.03**	**0.01**	**0.53**
LSD (0.05)	**0.1**	**NS**	**NS**
Nitrogen (kg ha^{-1})			
N_0	4.78	2.13	63.94
N_1	5.05	2.22	66.3
N_2	5.34	2.31	69.67
N_3	5.56	2.39	72.21
N_4	5.91	2.49	75.62
SEm	**0.05**	**0.01**	**0.84**
LSD (0.05)	**0.16**	**0.05**	**2.52**
Interaction (V*N)			
SEm	**0.07**	**0.02**	**1.19**
LSD (0.05)	**-**	**-**	**-**

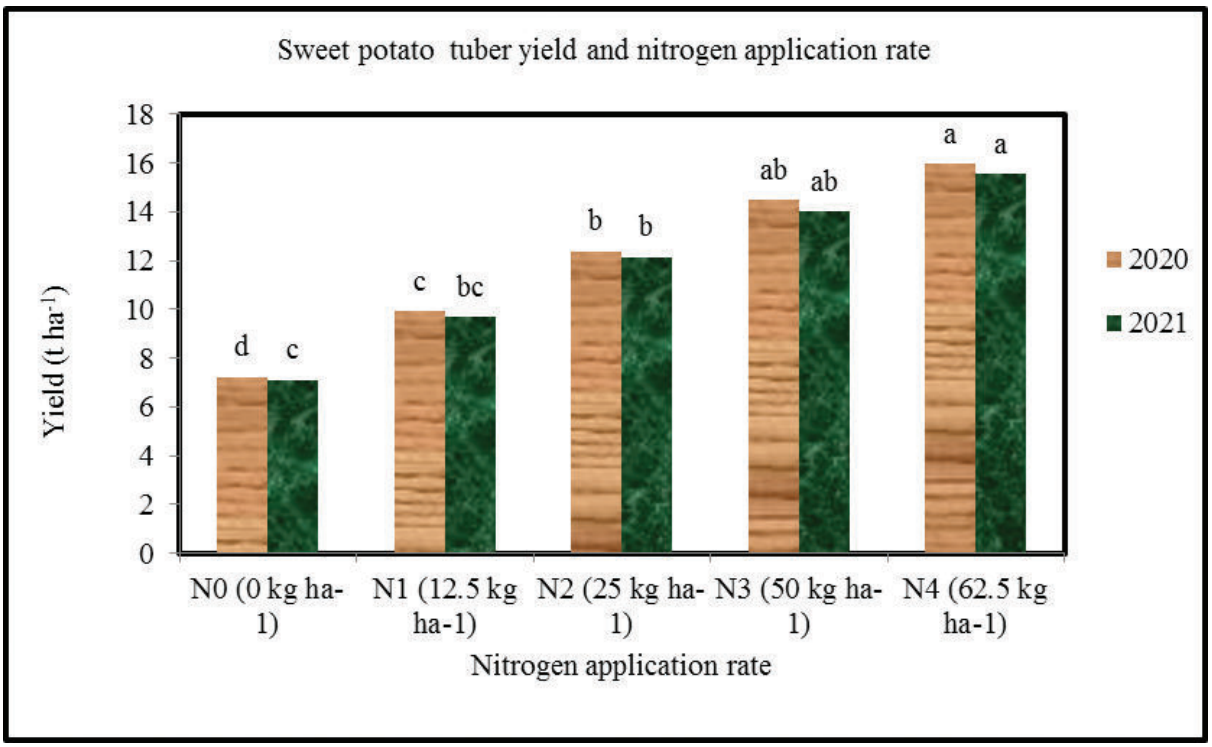

Fig. 1: Nitrogen application rate and tuber yield of sweet potato

Table 7: Production economics of sweet potato under influence of various levels of nitrogen on two different varieties of sweet potato

Treatment	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
Varieties			
V1	94,962.00	56,945.67	2.49
V2	83,541.34	45,525.00	2.19
SEm	**3,729.42**	**3,729.42**	**0.09**
LSD (0.05)	**11,166.53**	**11,166.53**	**0.29**
Nitrogen (kg ha^{-1})			
N0	54,196.67	16,540.34	1.43
N1	73,788.34	35,982.03	1.95
N2	92,150.00	54,193.66	2.42
N3	1,07,558.30	69,301.98	2.81
N4	1,18,565.00	80,158.66	3.08
SEm	**5,896.73**	**5,896.73**	**0.15**
LSD (0.05)	**17,655.83**	**17,655.83**	**0.46**
Interaction (V*N)			
SEm	**8,339.24**	**8,339.24**	**0.21**
LSD (0.05)	-	-	-

significantly higher crude protein (5.55%). Significantly higher quality parameters for crude protein (5.91%), crude fibre (2.49%) and tuber moisture content (75.62%) were observed when super optimal (125%) level of nitrogen (62.5 kg ha^{-1}) was given.Interaction effect between the two factors were not contributing much to make a significant change in quality parameters.

Since nitrogen is an important component of amino acids, proteins, nucleic acids, ATP and phospholipids, increasing nitrogen supply generally improves the crude protein, fibre and tuber moisture. The results presented in the Table 6 prove that, the application of nitrogen improved the quality parameters. These results are in line with the findings of Shehu *et al*. (2010) and Relente and Asio, (2020).

Production economics

From the Table 7 it is clear that application of super optimal level of nitrogen fertilizer had significantly improved the net monetary return (Rs. 80158.66) of sweet potato production. Varietal selection also had a significant contribution in increasing the income from the sweet potato cultivation. Highest B:C ratio (3.08) was recorded with super optimal level of nitrogen (62.5 kg ha^{-1}) application.

CONCLUSION

The sweet potato tuber yield was recorded high at 62.5 kg ha^{-1} of N but not significantly higher to 50 kg ha^{-1}. Hence it can be concluded that the optimum N fertilizer rate for higher yield of both the varieties of sweet potato are 50 kg ha^{-1}. For tuber quality the application of N at 62.5 kg ha^{-1} can be recommended.

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