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Effect of levels of nutrients and combination of soil drenching and foliar nutrition of water soluble fertilizers on quality of sweet potato

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Abstract

A field experiment was conducted from November 2024 to February 2025 with an objective to evaluate the effect of different levels of nutrients; and soil drenching and foliar nutrition of water soluble fertilizers on the quality of sweet potato tubers. The study consisted of (2x3)+1 treatments laid out in RCBD with two levels of NPK (I₁: 75% recommended dose of NPK, I₂: 50% recommended dose of NPK) and four different combinations of soil drenching and foliar nutrition (Foliar application of n₁: nano urea @ 0.2%+PSAP@ 0.2% at 45 DAP, n₂: nano urea @ 0.2% at 30 DAP +PSAP @ 0.4 at 45 DAP, n₃: nano urea @ 0.4% at 30 DAP + PSAP @ 0.2% at 45 DAP, n₄: nano urea @ 0.4% at 30 DAP + PSAP @ 0.4% at 45 DAP; along with soil drenching of 0.4% PSAP given uniformly to all treatments) and was compared with KAU POP (75:50:75 kg NPK ha⁻¹), served as control. The study concluded that 75 per cent of recommended dose of NPK resulted in the highest vitamin C (22.03 ± 1.40 mg per 100 g) and total sugar contents (3.683 ± 0.58%) in sweet potato tubers. Whereas, soil drenching with PSAP @ 0.4% at 15 DAP, followed by foliar application of nano urea @ 0.4% at 30 DAP and PSAP @ 0.4% at 45 DAP recorded the highest carotene content in tubers (0.48 ± 0.15 mg per 100 g).

Keywords: Sweet potato, PSAP, nano urea, foliar nutrition, soil drenching, quality

Introduction

Sweet potato (*Ipomoea batatas* L.) is a globally significant root crop, valued for its high nutritional quality, wide adaptability, and contribution to food and nutritional security. It is a rich source of carbohydrates, dietary fibre, β-carotene, and essential micronutrients, making it more important in addressing malnutrition and vitamin A deficiency in developing countries. Sweet potato is a short duration crop with an efficient photosynthetic system having tolerance to drought and poor soil conditions. This makes the crop more suitable for sustainable production under different agro-climatic conditions. Sweet potato has considerable industrial importance in manufacturing starch, ethanol, and livestock feed production, thereby supporting agro-industries and rural economies.

The levels of essential nutrients, particularly nitrogen, phosphorus, and potassium, have a profound impact on the growth dynamics, yield performance, and quality attributes of sweet potato. Adequate and balanced nutrient supply is critical for maintaining efficient physiological and biochemical functions, including photosynthesis, carbohydrate translocation, and tuber bulking. Nitrogen promotes canopy development and chlorophyll synthesis; phosphorus supports root initiation and energy metabolism, and potassium enhances translocation of assimilates and improves tuber quality, dry matter content, and stress tolerance. Both deficiency and excess of these nutrients can disrupt source-sink relationships, leading to suboptimal yield and inferior storage root quality. Therefore, determining the appropriate levels of nutrients and optimizing their application rates are fundamental for achieving higher productivity, nutrient use efficiency, and sustainable sweet potato cultivation under diverse agro-ecological conditions. A balanced nutrient regime is important for the growth of sweet potato because the crop's canopy development, storage-root initiation, assimilate partitioning, and final root quality

respond strongly to the supplied nutrient level. In particular, soil drenching can improve root-zone nutrient availability and sustain uptake during critical growth phases, while foliar application provides a rapid corrective supply when soil movement or root uptake is constrained. This is especially relevant for phosphorus because foliar P can raise tissue P status and biomass production, even though its effect may be transient. Similarly, nano urea is designed for foliar delivery and has been reported to improve nitrogen use efficiency and maintain yields even with reduced conventional N fertilization, supporting it as a useful complement to soil applied fertilizers in nutrient management strategies (Upadhyay *et al.*, 20323) ^[9]. In sweet potato, integrating soil drenching of PSAP (Potassium Salt of Active Phosphorus) with foliar nutrient delivery through PSAP and nano urea may therefore help to synchronize nutrient supply with crop demand, enhance source–sink balance, and improve storage-root yield and quality under field conditions. A study was conducted at the Department of Agronomy, College of Agriculture, Vellayani, Thiruvananthapuram. The objective of the study was to evaluate the effect of levels of nutrients, and foliar nutrition and soil drenching of different nutrients on the quality of sweet potato (*Ipomoea batatas* L.).

Materials and Methods

A field experiment was conducted from November 2024 to

February 2025 at the Instructional farm, attached to College of Agriculture, Vellayani. The study consisted of (2x3)+1 treatments laid out in RCBD with two levels of NPK (l₁: 75% recommended dose of NPK, l₂: 50% recommended dose of NPK) and four different combinations of soil drenching and foliar nutrition (Foliar application of n₁: nao urea @ 0.2%+PSAP@ 0.2% at 45 DAP, n₂:nao urea @ 0.2% at 30 DAP +PSAP @ 0.4 at 45 DAP, n₃: nano urea @ 0.4% at 30 DAP + PSAP @ 0.2% at 45 DAP, n₄: nano urea @ 0.4% at 30 DAP + PSAP @ 0.4% at 45 DAP; along with soil drenching of 0.4% PSAP), compared with control (KAU POP -75:50:75 kg NPK ha⁻¹). The mean maximum temperature of experimental field ranged from 30.17 °C to 31.94 °C and the mean minimum temperature, from 22.19 °C to 24.23 °C. Mean maximum relative humidity recorded was between 82.57 per cent and 94 per cent and mean minimum relative humidity, between 74 per cent to 84.5 per cent. A total of 725.57 mm rainfall was recorded during the cropping period. After harvest, tuber samples were analysed for quality parameters such as total sugars, vitamin C, and carotene content (Table 1). The collected data were statistically analysed using ANOVA.

Table 1: Method of analysing the quality parameters of sweet potato tubers

Quality Parameters	Method	Reference
Total Sugars	Titrimetric method	Sadasivam and Manickam (1996) ^[6]
Vitamin C	2,6-Dichlorophenolindophenol (DCPIP) Titration Method	Harris and Ray (1935) ^[2]
Carotene Content	Acetone-Petroleum Ether Extraction followed by Spectrophotometric Determination	Ranganna (1986) ^[5]

Results

The data on the quality parameters of sweet potato tubers as influenced by nutrient levels, soil drenching, foliar nutrition, and their interaction effects, are given in Table 2. The data revealed that levels of nutrients had a significant effect on the total sugar content of sweet potato tubers. The treatment l₁ (75% of the recommended dose of NPK) resulted in significantly higher total sugar content (3.68%) than l₂ (50% of the recommended dose of NPK). However, soil drenching and foliar nutrition, and their interaction, did not have any considerable influence on the total sugar content of sweet potato tubers. Vitamin C content of sweet potato tubers was significantly influenced by levels of nutrients but not by soil drenching and foliar nutrition as well as LxN interaction. Between two levels of nutrients, l₁ (75% of recommended dose of NPK) showed a superior value in vitamin C content (22.03 mg per 100 g) when compared to l₂ (50% of the recommended dose of NPK). The data on the carotene content of sweet potato tubers, as influenced by nutrient levels, soil drenching, and foliar nutrition, revealed that nutrient levels did not have a significant effect on carotene content, whereas soil drenching and foliar nutrition had a considerable impact. Among different combinations of soil drenching and foliar nutrition, treatment n₄ (Soil drenching (PSAP) @ 0.4% at 15 DAP + Foliar application of nano urea @ 0.4% at 30DAP and PSAP @ 0.4% at 45 DAP) resulted in the highest carotene content (0.70 mg per 100 g). The interaction effect between nutrient levels and the combination of soil drenching and foliar nutrition was also not significant. Contrast analysis between treatment and control means of different quality parameters in sweet potato tubers revealed that control mean was not significantly different from the treatment mean.

Table 2: Effect of levels of nutrients, soil drenching and foliar nutrition on quality parameters of sweet potato tuber

Treatments	Total Sugar (%)	Vitamin C (mg per 100 g)	Carotene content (mg per 100 g)
Levels of nutrients (L)			
l ₁	3.683 ± 0.58 ^a	22.03 ± 1.40 ^a	0.48 ± 0.15
l ₂	3.119 ± 0.43 ^b	20.47 ± 1.70 ^b	0.46 ± 0.17
SE(m)±	0.11	0.453	0.02
CD(0.05)	0.339	1.375	NS
Soil drenching and Foliar nutrition (N)			
n ₁	3.220 ± 0.56	21.11 ± 1.38	0.31 ± 0.05 ^c
n ₂	3.233 ± 0.44	21.32 ± 1.95	0.47 ± 0.07 ^b
n ₃	3.390 ± 0.535	21.68 ± 1.95	0.41 ± 0.08 ^b
n ₄	3.760 ± 0.719	20.885 ± 1.901	0.70 ± 0.06 ^a
SEm(±)	0.15	0.64	0.03
CD(0.05)	NS	NS	0.079
LXN Interaction			
l ₁ n ₁	3.497 ± 0.464	21.23 ± 1.80	0.34 ± 0.05
l ₁ n ₂	3.167 ± 0.306	22.90 ± 0.72	0.44 ± 0.05
l ₁ n ₃	3.673 ± 0.584	21.50 ± 1.80	0.45 ± 0.08
l ₁ n ₄	4.393 ± 0.176	22.47 ± 1.01	0.70 ± 0.09
l ₂ n ₁	2.943 ± 0.592	20.99 ± 1.22	0.29 ± 0.04
l ₂ n ₂	3.300 ± 0.624	19.75 ± 1.26	0.50 ± 0.08
l ₂ n ₃	3.107 ± 0.367	21.87 ± 2.48	0.36 ± 0.08
l ₂ n ₄	3.127 ± 0.241	19.30 ± 0.70	0.69 ± 0.02
SEm (±)	0.22	0.90	0.04
CD (0.05)	NS	NS	NS
Control (KAU POP)	3.68±0.38	21.83 ± 0.76	0.35±0.010
Treatments vs Control	NS	NS	NS

Discussion

Levels of nutrients had a significant effect on the total sugar

content and vitamin C content of sweet potato tubers. Treatment I₁ (75% of the recommended dose of NPK) resulted in the highest total sugar and vitamin C contents of tubers. Significantly higher total sugar and vitamin C contents at 75 per cent of the recommended NPK dose may be attributed to the attainment of an optimum nutritional balance that favoured both assimilate production and translocation to the storage roots. Sweet potato tubers are major sinks for carbohydrates, and adequate potassium is particularly important in enhancing photosynthetic efficiency, carbohydrate transport, and starch-sugar metabolism, while balanced nitrogen supply supports canopy development and chlorophyll formation without inducing excessive vegetative growth (Guo *et al.*, 2024) ^[1]. Similar results were reported by Hayati *et al.* (2020) ^[3].

The higher vitamin C content at 75% NPK may also reflect improved physiological activity and better metabolic status of the plants, since ascorbic acid accumulation in sweet potato is closely associated with active carbohydrate metabolism and overall plant vigor. Thus, the superiority of 75% NPK over 50% NPK suggests that a moderate fertilizer regime was sufficient to support efficient source-sink relationships and quality enhancement, whereas the lower dose imposed a nutrient limitation that constrained both sugar biosynthesis and vitamin C accumulation (Wang *et al.*, 2016) ^[7].

The higher carotenoid content in T₄ (soil drenching of PSAP @ 0.4% at 15 DAP followed by foliar application of nano urea @ 0.4% at 30 DAP and PSAP @ 0.4% at 45 DAP) can be attributed to the foliar application of PSAP at critical growth stages of sweet potato. Adequate P supply during active growth stages enhances the carotene content, since P is a major component of the pyrophosphate intermediate carotenoid biosynthesis (Oliveira *et al.*, 2024) ^[8]. Along with P, the appropriate amount of K also contributed to elevated carotene content, since K enhances carotenoid biosynthesis by stimulating photosynthetic efficiency and assimilate translocation to storage root (Hayati *et al.*, 2025) ^[4].

Conclusion

The study concluded that soil application of 75 per cent of recommended dose of NPK enhanced vitamin C and total sugar contents of sweet potato tubers by 18 per cent and 7.6 per cent respectively compared to 50 per cent of recommended dose of NPK. Whereas carotene content in tubers could be enhanced by 48.93% with soil drenching of PSAP @ 0.4% at 15 DAP followed by foliar application of nano urea @ 0.4% at 30 DAP and PSAP @ 0.4% at 45 DAP compared to next best treatment, soil drenching of PSAP @ 0.4% at 15 DAP followed by foliar application of nano urea @ 0.2% at 30 DAP and PSAP @ 0.4% at 45 DAP.

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