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Vegetative growth, yield and quality of sweet potato influenced by various plant spacing

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Abstract
During the months of August 2015 to February 2016, research at the SKNA University's Horticulture Farm in Jobner (Jaipur) studied how different distances influenced sweet potato growth, yield, and quality. The experiment used a randomized complete block design with four different spacings: 30 cm × 30 cm (S1), 45 cm x 30 cm (S2), 60 cm x 30 cm (S3), and 75 cm x 30 cm (S4) (S4). Different spacing levels resulted in significant differences in growth, yield, and quality. In the S4 spacing level, the maximum vine length (170.1cm), tuber weight (356.61g), tuber length (15.25cm), tuber diameter (9.07 cm), tuber yield (13.31kg/plot), tuber yield (246.54q/ha), NPK content (0.352 percent, 0.311 percent, and 0.641 percent, respectively), starch (13.30%), protein (2.20 percent), and ascorbic acid content (44.00mg/100).

Keywords: Sweet potato, growth, tuber yield, tuber quality, spacing

Introduction
Sweet potato (*Ipomoea batatas* Lam.) is a member of the Convolvulaceae family that has played a significant part in the search for sustenance and the struggle for human life in a number of nations. In India, it is referred to as "Sakar Kand." It began in Central America and has since spread throughout the world. Sweet potato is a starchy food crop that is widely produced in tropical and subtropical climates. It is a warm-season crop that thrives in bright sunlight, temperatures over 24 °C, sandy loam soil, and 850-900 mm of rainfall each year. Depending on the variety, it matures in 3-9 months or longer (CIP, 2003) [4]. Sweet potato is grown on 106 hectares in India, with a production of 1088 million tonnes. Except in Jammu and Kashmir, sweet potatoes are commonly grown throughout India. Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Maharashtra, and Karnataka are the key sweet potato-growing states. It occupies a total area of 643 hectares in Rajasthan, with a production of 1979 tonnes and a productivity of 3038 kg per hectare (Anonymous, 2014) [1]. As compared to rice, wheat, maize, and cassava, sweet potato is a very highly nutritious, providing significantly more edible energy per acre per day. Per 100 g of edible component, it includes 12.7 g of starch, 4.2 g of sugar, 709 g of vitamin A, and 1.6 g of protein.

Proper spacing and application of varying doses are among the diverse cultural practises (USDA, 2009) [22]. It's commonly used in canning, dehydration, and flour production as a boiled and fried vegetable.

Despite its importance as a food and vegetable, there has been little focus on improving cultural norms. Sweet potatoes are the primary source of carbohydrate and alcohol, containing 10% starch and 3-6% sugar. Tubers are high in vitamins A, B, and C, as well as minerals including phosphorus, iron, and calcium. Carotene concentration is higher in yellow and orange flesh variants (Choudhary, 2014) [3].

Plant population is one of the most important factors contributing to high yield of sweet potato (Sarkar, 1985) [17]. Wider plant spacing not only leads to excessive vegetative growth but also accelerates evaporative water losses from the bare ground, making optimal plant population a vital part of crop productivity. On the other hand, when plant populations grow, the struggle for survival intensifies due to intense competition for light, water, and nutrients (Sharma, 1990) [18].

Proper spacing and implementation of cultural practises are among the different cultural practises. Crop spacing can be adjusted based on climate conditions, soil fertility, and cultivar suitability to a specific region. The plant was more vigorous in terms of leaf size when the spacing was wider, which could be due to less competition for light, nutrients, and moisture as compared to closer spacing (Rai *et al*., 2003) [15].

Of fertiliser at the right time are critical, especially in Rajasthan's semi-arid conditions, to maintain an adequate plant population per unit area.

Materials and Methods

During the 2015 kharif season, the field experiment was done at Horticulture Farm, S.K.N. College of Agriculture (S.K.N. Agriculture University) Jobner, District Jaipur. In the Jaipur region of Rajasthan, the experiment area is located at 26° 05' North latitude and 75° 28' East longitude, at an elevation of 427 metres above mean sea level. The state's agroclimatic zone III-A (Semi-Arid Eastern Plain Zone) encompasses this area. The climate in this region is typically semi-arid, with extremes in temperature in both summer and winter. Summer temperatures can reach up to 48 °C, while winter temperatures can drop to as low as -1 °C. The average yearly rainfall in this area is between 300 and 400 millimetres. Soil samples were taken at random depths between 0 and 15 cm in the experimental plot and analysed, yielding nitrogen 132.75 kg ha-1, phosphorus 17.84 kg ha-1, potassium 161.50 kg ha-1, and organic carbon 0.13 percent. Four different spacing levels were used denoted as S1, S2, S3 and S4.

S1 = 30 cm x 30 cm
S2 = 45 cm x 30 cm
S3 = 60 cm x 30 cm
S4 = 75 cm x 30 cm

Three replications were used in the Randomized Block Design (RBD) experiment. The entire experimental area, which was divided into three blocks, measured 24.5 m x 19.9 m. Each block was then subdivided into 20 plots, yielding 60 (20 3) unit plots. In each block, the treatments were assigned at random. The unit plot was 2.40 m x 2.25 m in size. Two adjacent blocks and plots were separated by 1.0 m and 0.5 m. The land was adequately prepared, manured, and intercultural activities were carried out. In each plot, five plants were chosen for observation. After harvesting, yield and quality metrics were measured, while growth factors such as leaf area and chlorophyll content were measured 45 and 50 days after seeding, respectively.

Result and Discussion

Table 1: Effect of spacing on vine length at harvest average, leaf area at 45 DAP and total chlorophyll content of sweet potato

Treatments	Vine length (cm)	Leaf area (cm^2)	Total chlorophyll content (mg/g)
Spacing			
S1	152.5	165.3	1.033
S2	161.4	169.4	1.070
S3	168.9	171.1	1.093
S4	170.1	172.0	1.102
S.Em+	2.3	3.9	0.028
CD (P=0.05)	6.7	NS	NS

Growth parameters

In this experiment, statistically data was measured that vine length showed significant variances due to different spacings. The highest vine length was recorded at treatment S4 and minimum S1. The vine under the treatment of S4 (75 cm x 30 cm) had enough space for vegetative growth and had less nutrition competition compared to other vines sown under the treatment S1 (30 cm x 30 cm), S2 (45 cm x 30 cm) and S3 (60 cm x 30 cm). This could be because the individual plants were able to use more water, nutrients, light, and air because of the greater spacing. Plant population per unit area was higher with closer spacing, resulting in fierce competition among the plants and poor growth. Joshi (1987) [7], Sounda *et al*. (1989) [21], Kumar *et al*. (2012) [9], and Sharma *et al*. (2013) [19] have all shown similar results in radish. Leaf area and total chlorophyll concentration, on the other hand, yielded non-significant findings.

Table 2: Effect of spacing on yield attributes of sweet potato

Treatments	Tuber length (cm)	Tuber weight (g)	Diameter of tuber (cm)	Tuber yield (kg/plot)	Tuber yield (q/ha)
Spacing					
S1	11.61	173.80	5.61	6.45	119.45
S2	13.51	291.15	7.11	10.81	200.21
S3	14.71	347.11	8.79	12.88	238.48
S4	15.25	356.61	9.07	13.31	246.54
S.Em+	0.27	3.40	0.11	0.16	3.56
CD (P=0.05)	0.77	9.73	0.31	0.45	10.19

Yield parameters

The maximum length of tuber (15.25 cm) the similar results were observed by Rashid and Shakur (1986) [16] in carrot, weight of tuber (356.61 g) the similar results were observed by Sirkar *et al.* (1998) [20] in radish, maximum diameter of tuber (9.07 cm). The findings agreed with McCollum *et al.* (1986) [11] in carrot. Tuber yield (13.31 kg/plot) and tuber yield (246.54 q/ha) were recorded under wider spacing S4 (75 cm x 30 cm) which were significantly higher over closer spacing S1, S2 and S3, respectively. A similar result was observed by Muck (1980) [12] in carrot. This could be owing to the fact that each plant has more acreage available to it. Plants that were widely spread had reduced rivalry for nutrient uptake, water, light, and air, allowing them to obtain more nutrients, water, light, and air, resulting in higher yield characteristics. This finding is in conformity with the result of Pervez *et al.* (2004) [13] in radish, Lavanya *et al.* (2012) [10] in radish and Ashraful Kabir *et al*. (2014) [2] in carrot.

Table 3: Effect of spacing on quality parameters of sweet potato

Treatments	TSS (%)	N content (%)	P content (%)	K content (%)	Starch content (%)	Protein content (%)	Ascorbic acid (mg/100g)
Spacing							
S1	4.15	0.218	0.269	0.536	10.92	1.36	34.51
S2	4.25	0.285	0.296	0.591	11.78	1.78	38.50
S3	4.33	0.331	0.309	0.635	12.61	2.07	42.21
S4	4.36	0.352	0.311	0.641	13.30	2.20	44.00
S.Em±	0.10	0.007	0.004	0.015	0.24	0.04	0.70
CD (P=0.05)	NS	0.020	0.011	0.042	0.70	0.12	2.00

Quality parameters

The TSS (%) was not significantly changed due to spacing's. Similar results were observed by Sharma *et al.* (2013) [19] in radish. The maximum NPK content (0.352, 0.311 and 0.641%, respectively), starch content (13.30%), protein content (2.20%) and ascorbic acid content (44.00 mg/100g) were recorded under wider spacing S4 (75 cm x 30 cm) Which were significantly higher over closer spacing S1, S2 and S3, respectively. This improvement could be attributed to enhanced moisture holding capacity, micronutrient delivery, and major nutrient availability in soil as a result of the favourable conditions provided by spacing. For all of these quality measures, the wider spacing outperformed the other spacings significantly. The present results are in close conformity with the findings of Joshi and Patil (1992) [8], Gonge *et al.* (2003) [5], Preeti *et al.* (2009) [14], Grabowska *et al.* (2009) [6] and Lavanya *et al.* (2012) [10].

Conclusion

On the basis of the findings of this study, it can be stated that using different plant spacing levels in the best plant spacing of 75 cm x 30 cm improved sweet potato growth, production, and quality.

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