International Journal of Environment and Climate Change

Volume 13, Issue 11, Page 1591-1602, 2023; Article no.IJECC.107794
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Influence of Different Portions of Vine and Plant Growth Regulators on Growth Parameters of Sweet Potato [*Ipomoea batatas* (L.) Lam.]

Lingamurthy, K. R. [a++*]**, Vasant M. Ganiger** [b#]**, Ramachandra Naik, K.** [c†]**, T. B. Allolli** [d‡]**, Venkateshalu** [e^]**, G. Bhuvaneshwari** [f^] **and S. M. Prasanna** [g##]

[a] *College of Horticulture, Munirabad, Koppal, University of Horticultural Sciences, Bagalkot, Karnataka, India.*
[b] *Directorate of Extension, University of Horticultural Sciences, Bagalkot, Karnataka, India.*
[c] *Students Welfare, University of Horticultural Sciences, Bagalkot, Karnataka, India.*
[d] *University of Horticultural Sciences, Bagalkot, Karnataka, India.*
[e] *Department of Entomology, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India.*
[f] *Department of Post Harvest Management, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India.*
[g] *Department of Soil Science and Agricultural Chemistry, College of Horticulture, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i113313

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/107794

Original Research Article

Received: 12/08/2023
Accepted: 18/10/2023
Published: 26/10/2023

[++] *Assistant Professor of Vegetable Science;*
[#] *Professor of Vegetable Science;*
[†] *Professor and Dean;*
[‡] *Professor and Registrar;*
[^] *Professor and Head;*
[##] *Assistant Professor;*
**Corresponding author: E-mail: lingamurthykr@gmail.com;*

ABSTRACT

A field experiment was conducted to study the potentiality of different portions of vine and plant growth regulators on growth performance of sweet potato during 2019 and 2020 at vegetable block, College of Horticulture, Munirabad (Koppal), located in the northern dry zone of Karnataka. The experiment was laid out in a Factorial Randomized Complete Block Design (RCBD) with thirteen treatments. Among the two factors, the first factor was different portions of vine for planting consisting basal portion (P_1), middle portion (P_2) and top portion (P_3) and the second factor was plant growth regulators consisting CCC @ 500 ppm (G_1), CCC @1000 ppm (G_2), Ethrel @ 150 ppm (G_3) and Ethrel @ 300 ppm (G_4). The control treatments were basal portion of vine (C_1), middle portion of vine (C_2) and top portion of vine(C_3) all without application of growth regulator. Among the different portions of vine used for planting, the top portion of vine recorded significantly higher vine length, Vine inter nodal length, Number of branches per plant and Leaf area. Application of CCC @ 500 ppm was recorded significantly higher growth attributes. The interaction effect of top portion of vine with CCC @ 500 ppm (P_3G_1) was found to be significantly superior with respect to growth parameters of sweet potato.

Keywords: Interaction effect; leaf area; portions of vine; plant growth regulators; vine length.

1. INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam.] is considered as a versatile food crop owing to its adaptability to diverse soil and climatic conditions. Sweet potato is a rich source of carbohydrate and β carotene and the seventh most important food crop of the world after wheat, rice, maize, potato, barley and cassava. Sweet potato is grown in 119 countries of the world in an area of 9202 thousand ha producing 112835 thousand tons with an average productivity of 12.16 t ha^{-1}. The Asian continent had second-largest area (43.17%) and first in terms of production (70.55%) of sweet potato with a productivity of 20.03 t ha^{-1}. In India it is cultivated in area 128.00 thousand ha with a production of 1460 thousand tons [1].

In addition to being used to make industrial goods like starch, glucose pectin, sugar, and alcohol, sweet potatoes are also used to directly feed people. The plant is cultivated for its edible tuberous roots, which have a high concentration of calcium, iron, vitamin A, and C and around 27 per cent carbohydrate.

Information on potentiality of different portions of vine along with foliar application of plant growth regulators in sweet potato under the Indian conditions is very scanty. In recent past the use of plant growth regulating chemicals have become an important component of agri-technical procedure for most of the cultivated crops gibberellic acid (GA_3), cycocel (CCC) and ethrel are important growth regulators that may modify the growth, yield and yield contributing characters of plant [2]. Growth regulators have been documented to enhance the yield of numerous horticultural crops, particularly those in which the underground component holds economic significance. The current study's objective was to ascertain the impacts of various PGRs and various vine portions on different growth and development parameters of sweet potato.

2. MATERIALS AND METHODS

A field experiment was conducted during 2019 and 2020 at vegetable block, department of vegetable sciences, College of Horticulture, Munirabad (Koppal), University of Horticultural Sciences, Bagalkot, Karnataka, India at 15° 17' 33'' North latitude, 76° 19' 17'' East longitude and is at an altitude of 529 m above MSL.The experimental site is geographically situated in a location which receives an average annual rainfall of 569 mm with average rainy days of 31, distributed in four to six months (June to December). The average maximum temperature of the location is 36°C and the average minimum temperature is 20°C the relative humidity ranges from 60 to 90 percent. Design of experiment was factorial RCBD along with three control treatments. Two factors were *viz.,* different portions of vine for planting and plant growth regulators. Basal portion (P_1), middle portion (P_2) and top portion (P_3) were three different portions of vine. CCC @ 500 ppm (G_1), CCC @1000 ppm (G_2), Ethrel @ 150 ppm (G_3) and Ethrel @ 300 ppm (G_4) were four plant growth regulators. The control treatments were basal portion of vine without application of growth regulator (C_1), middle portion of vine without application of growth regulator (C_2) and top portion of vine without application of growth regulator (C_3). The experimental field was sandy loam in texture which was medium in organic carbon (0.45%). The soil was normal in reaction (pH 7.9), medium in available N (304.0 kg ha^{-1}), high in available phosphorus (62.0 kg ha^{-1}) and low in available potassium (129.0 kg ha^{-1}).

Data on the following parameters were recorded during the course of experimentation on five randomly selected labelled plants from the net plot area of each treatment and each replication. The data recorded on five plants per treatment was averaged and subjected to statistical analysis.

Fresh vine length -Vine length was measured in centimetre from ground level to tip of the longest branch. Vine length was recorded at 55, 75 days after planting (DAP) and at final harvest (90-110 days).

Vine inter nodal length- The length between fifth and sixth nodes from the base of the main stem was recorded in centimeter at 55, 75 DAP and at final harvest (90-110 days).

Number of branches per plant- The side branches arising from the basal portion of the main stem were counted at 55, 75 DAP and at final harvest.

Leaf area -The leaf area was measured at 55, 75 DAP and at final harvest by following disc method as suggested by Johnson [3] and expressed in (cm^2/ plant). Fifty discs of known area were taken from selected leaf samples from the uprooted three plants. All the leaves from the plants and fifty discs were oven-dried and the leaf area was calculated by adopting the following formula:

$$\mathrm{LA} = \frac{\mathrm{Wa} \times \mathrm{A}}{\mathrm{Wd}}$$

Where,

LA = Leaf area of all the leaves in a plant (cm^2)
Wa = Dry weight of all the leaves in a plant including leaf discs (grams)
Wd = Dry weight of 50 discs (grams)
A = Area of 50 discs (cm^2)

Schedule of spraying -The plants in the treatment plots were sprayed with respective growth regulator solution at 40 and 60 DAP, while the plants in the control plots were sprayed with distilled water.

3. RESULTS AND DISCUSSION

3.1 Vine Length

Among the different portions of vine used for planting, the maximum vine length of sweet potato was observed with a top portion of vine *i.e.,* P_3 (58.38, 128.77 and 160.9 cm at 55, 75 DAP and at harvest, respectively) which was significantly superior over all other treatments. The treatment with basal portion of vine recorded significantly lower vine length (46.06, 104.12 and 130.06 cm at 55, 75 DAP and at harvest, respectively). Unlike basal portion of vine, top portion have new and active cells which support the development of lateral roots through the supply of auxin from growing apical point. Apical cuttings supply the establishing roots with starch stored in the stem cells since they have higher starch level than lignin. The growing tip of the apical cutting also grow nippily and support growth of new shoots that in turn photosynthesize to supply roots with photosynthates [4].

The vine length of sweet potato differed significantly for the application of growth regulators at all the stages. The application of CCC @ 500 ppm (G_1) was recorded significantly higher vine length (58.68, 129.38 and 169.90 cm at 55, 75 DAP and at harvest respectively), which was closely followed by treatment with the application of ethrel @ 150 ppm (G_3) 55.96, 123.94 and 157.53 cm, respectively). Significantly lower vine length (41.48, 94.95 and 113.13 cm, respectively) was observed with the application ethrel @ 300 ppm (G_4).

The interaction effect of different portions of vine in combination with growth regulators differed non-significantly with respect to the vine length except at 55 DAP. However, numerically higher vine length was recorded under top portion of vine with application of CCC @ 500 ppm (P_3G_1: 63.05 cm) and lower was observed under basal portion of vine with application of ethrel @ 300ppm (P_1G_4: 33.58 cm). At 75 DAP and at harvest, the interaction of top portion of vine with CCC @ 500 ppm (P_3G_1) recorded significantly highest vine length (138.10 cm and 178.08 cm at 75 DAP and at harvest, respectively). However, at 75 DAP, it remained on par with P_3G_3 (137.04 cm) and at harvest stage, it remained on par with P_3G_3 and P_2G_1 (175.57 cm and 174.15 cm, respectively). While, the interaction effect of basal portion of vine with ethrel application @ 300 ppm (P_1G_4) recorded significantly lowest vine length (79.15 cm and 94.70 cm, respectively).

Including control, results revealed that highest vine length of sweet potato was observed with the top portion of vine (C_3 : 69.63, 151.26 and 205.36 cm at 55, 75DAP and at harvest, respectively) and was closely followed by middle portion (C_2) of vine at 75DAP and harvest (66.93 cm, 145.85 cm and 195.35 cm, respectively).

3.2 Inter Nodal Length

On pooled data basis, at 55, 75 DAP and at harvest stage inter nodal length does not differed significantly with different portions of vine. However, numerically higher inter nodal length was recorded with top portion of vine *i.e.,* P_3 at 75 DAP and at harvest stage (3.39 and 3.82 cm, respectively).

Inter nodal length of sweet potato differed significantly for the application of growth regulators. The application of plant growth regulator CCC @ 500 ppm (G_1) recorded highest inter nodal length (2.60, 3.87 and 4.52 cm at 55,75 DAP and at harvest, respectively. Significantly lower inter nodal length (1.96, 2.85 and 3.08 cm, respectively) was observed with application ethrel @ 300 ppm (G_4). Among different levels of CCC, the length of internodes was optimum in the treatment of CCC application @ 500 ppm and the growth of internodes was short in the treatment of CCC application @ 1000 ppm, mainly due to cycocel which restrict cell division and elongation in apical meristem leading to decreased intermodal length. Kumar et al. [5] recorded the similar results with inter nodal length in CCC @ 600 ppm in okra.

Interactive effects of different portions of vine in combination with growth regulators for inter nodal length was found non-significant during both the years of experimentation.

Including control, results revealed that highest inter nodal length (3.25, 4.59 and 5.35 cm at 55, 75 and at harvest, respectively) of sweet potato was observed with the top portion of vine (C_3). However, lower inter nodal length (1.94, 2.82 and 3.05 cm, respectively) was observed in P_3G_4 at 55, 75 DAP and at harvest compared to all other interactions and control.

3.3 Number of Branches per Vine

Different portions of vine differ significantly for number of branches at 55, 75 DAP and at harvest. Among different portions of vine, top portion of vine (P_3) recorded significantly more number of branches of 3.32, 7.13, and 8.29, respectively as compared to middle portion of vine (2.94, 6.38 and 7.46, respectively). Growth regulators significantly affected the number of branches at 55, 75 DAP and at harvest. Among growth regulators, application of ethrel at 300 ppm (G_4) recorded significantly higher number of branches (4.36, 9.22 and 10.83, respectively). Significantly lower number of branches (2.14, 4.78 and 5.72, respectively) was observed with CCC application at 500 ppm (G_1). Reduced branching observed leading to competition by the increased number of leaves for the resources.

The interaction effect of different portions of vine in combination with growth regulators differed significantly with respect to the number of branches at all growth stages except at 55 DAP. Significantly higher number of branches was recorded with the interaction of P_3G_4 *i.e.,* top portion vine with application of ethrel at 300 ppm (10.00 and 11.50 at 75 and at harvest, respectively). However, significantly lower number of branches was observed with the interaction of P_1G_1 (4.17 and 5.17 at 75 and at harvest, respectively).

However including control, significantly higher number of branches (4.75, 10.0 and 11.50 at 55, 75 and at harvest, respectively) were recorded in top portion of vine with application of ethrel at 300 ppm (P_3G_4) compared to all other interaction and control. While, lower number of branches (1.34, 3.17 and 3.67, respectively) was recorded with basal portion of vine (C_1).

3.4 Leaf Area

On pooled data basis, at 55, 75 DAP and at harvest, leaf area differed significantly with different portions of vine. Maximum leaf area of sweet potato was observed with top portion of vine *i.e.,* P_3 (1722.5, 4134.0 and 6259.5 cm^2per vine at 55, 75 DAP and at harvest, respectively) which was significantly superior over all other treatments. While, the basal portion of vine (P_1) recorded significantly minimum leaf area (1502.2, 3605.3 and 5631.6 cm^2 per vine at 55, 75 DAP and at harvest, respectively). Top portion of vine had the relatively healthier and fresh cell which greatly contributed to the faster cell division in root meristem region and led to enhanced growth by the crop. Soft wood cutting of sweet potato vines were accelerate rate of leaf initiation after planting earlier to other ones. Highest number of leaves was observed in the treatment with soft wood cuttings. Soft wood cutting found to perform highly significant over semi hard wood and hard wood cuttings [6].

Leaf area of sweet potato as influenced by different concentration of growth regulators differed significantly. Application of plant growth regulator CCC @ 500 ppm (G_1) recorded significantly the highest leaf area at 55(2052.0 cm^2 per vine), 75 DAP (4924.9 cm^2 per vine) and harvest (7114.7 cm^2 per vine). Significantly lower leaf area (1235.2 cm^2 per vine, 2964.4 cm^2 per vine and 4972.1 cm^2 per vine at 55 DAP, 75 DAP and at harvest, respectively) was observed with application ethrel @ 300 ppm (G_4). Meanwhile, without much reduction, the vine length was also higher in the treatment of CCC application @ 500 ppm (G_1) also added the weightage in increasing the photosynthetic area. The minimum reduction in vine length leads to optimum growth and the reason might be that cycocel contributed through inhibition of all cell division as reported by Pateliya *et al*. [7] in okra.

Cycocel inhibit the axis growth due to that lateral growth increase so that increased photosynthetic activity of plant and number of leaves also increases, Similar finding was also reported by Sengupta*et al*. [8] observed the effect of cycocel @ 200 ppm recorded maximum number of leaf area in ginger.

The interaction effect of different portions of vine in combination with growth regulators found significant during both the years of experimentation with respect to the leaf area except 55 DAP. Significantly higher leaf area was recorded at 75DAP (5195.4 cm^2 per vine) and at harvest (7399.1 cm^2 per vine) were recorded with the interaction of P_3G_1 *i.e.,* top portion of vine with the application of CCC @ 500 ppm which was on par with the interaction of P_2G_1 *i.e.,* middle portion of vine with the application of CCC @ 500 ppm (5114.0 cm^2per vine and 7348.8 cm^2per vine at 75 and at harvest, respectively). While, lower leaf area (2874.2 cm^2per vine and 4903.0cm^2 per vine, respectively) was recorded with the interaction of top portion of vine with the application of ethrel @ 300 ppm (P_1G_4).

However, including control, results revealed that highest leaf area (2177.7 cm^2 per vine, 5226.5 cm^2 per vine and 7421.4 cm^2 per vine at 55, 75 and at harvest, respectively) of sweet potato was observed with the top portion of vine (C_3) compared to all other interaction and control. However, it remained on par with P_3G_1 and P_2G_1 at all the stages of the crop growth. Significantly lower leaf area (1358.6cm^2per vine, 3260.5cm^2per vine and 5011.2 cm^2per vine at 55, 75 DAP and at harvest, respectively) was observed in basal portions of vine (C_1).

The cumulative effect of increased growth parameters viz., vine length, number of branches and leaf area shown the positive results on putting up good growth by the sweet potato crop when a top portion of vine was used for planting over all other treatments followed by middle portion of vine. The minimum growth parameters were observed when basal portion of vine was used for planting.

Meanwhile, after the crop establishment, the application of CCC @ 500 ppm leads to the optimum foliage growth which could facilitate the photosynthesis for enhanced storage of photosynthates. Application of the crop growth regulator has shown positive action on maintaining the crop growth to optimum level where all the resources were efferently used by the plant. It also ensured the lesser wastage of resources by the crop for growth by checking the excessive growth of the canopy. In absence of the foliar application of the CCC @ 500 ppm, plant might have put forth the extra growth by increasing the foliage and it might have led to increasing the demand for the recourses. Application of CCC @ 500 ppm maintained the balance between source and sink translocation process. The pronounced effect in terms above mentioned growth parameters are in agreement with reports of Lencha et al*.* [6] and Essilfie et al*.* [9].

According to Hejjegar Iranna et al*.* [10], the maximum number of branches per vine was recorded with CCC 500 ppm, whereas GA3 200 ppm registered the highest vine length, number of leaves per branch, leaf area, fresh weight and dry weight of branches per vine, and fresh weight and dry weight of leaves per vine. Regarding tuber metrics, all treatments notably varied. CCC 500 ppm recorded the largest tuber output per acre (40.06 t), as well as a maximum harvest index of (49.17%).

Table 1. Effect of different portions of vine and plant growth regulators on vine length (cm) of sweet potato

Treatment		Vine length (cm)								
		55 DAP			75DAP			At harvest		
		2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Portions of vine (P)										
P_1	Basal portion	45.69	46.43	46.06	103.38	104.85	104.12	134.21	125.90	130.06
P_2	Middle portion	53.74	51.91	52.83	119.50	115.83	117.66	151.48	144.70	148.09
P_3	Top portion	62.90	53.86	58.38	137.81	119.72	128.77	171.79	149.99	160.89
S. Em.±		**1.18**	**1.22**	**0.61**	**1.42**	**1.19**	**0.96**	**1.51**	**1.38**	**0.86**
C.D at 5 %		**3.46**	**3.57**	**1.78**	**4.15**	**3.49**	**2.81**	**4.44**	**4.04**	**2.54**
Plant growth regulators (PGR) (G)										
G_1	CCC @ 500 ppm	60.07	57.30	58.68	132.15	126.61	129.38	176.02	163.78	169.90
G_2	CCC @ 1000 ppm	55.35	51.78	53.57	122.71	115.54	119.12	148.53	141.10	144.82
G_3	Ethrel @ 150 ppm	56.62	55.30	55.96	125.25	122.62	123.94	165.29	149.77	157.53
G_4	Ethrel @ 300 ppm	44.40	38.55	41.48	100.81	89.09	94.95	120.13	106.13	113.13
S. Em.±		**1.36**	**1.41**	**0.70**	**1.63**	**1.37**	**1.11**	**1.75**	**1.59**	**1.00**
C.D at 5 %		**4.00**	**4.13**	**2.06**	**4.79**	**4.03**	**3.25**	**5.13**	**4.67**	**2.93**
Interaction (P x G)										
P_1G_1		53.65	54.05	53.85	119.32	120.10	119.71	162.35	152.60	157.48
P_1G_2		48.30	49.15	48.73	108.60	110.30	109.45	133.40	130.40	131.90
P_1G_3		46.70	49.45	48.08	105.40	110.90	108.15	142.50	129.80	136.15
P_1G_4		34.10	33.05	33.58	80.20	78.10	79.15	98.60	90.80	94.70
P_2G_1		60.05	58.25	59.15	132.14	128.52	130.33	177.30	171.00	174.15
P_2G_2		54.10	53.75	53.93	120.20	119.46	119.83	145.40	145.40	145.40
P_2G_3		57.85	56.75	57.30	127.73	125.53	126.63	166.73	155.00	160.87
P_2G_4		42.95	38.90	40.93	97.92	89.80	93.86	116.50	107.38	111.94
P_3G_1		66.50	59.60	63.05	145.00	131.20	138.10	188.42	167.74	178.08
P_3G_2		63.65	52.45	58.05	139.32	116.86	128.09	166.80	147.50	157.15
P_3G_3		65.30	59.70	62.50	142.63	131.44	137.04	186.63	164.50	175.57
P_3G_4		56.15	43.70	49.93	124.30	99.38	111.84	145.30	120.20	132.75
S. Em.±		**2.36**	**2.44**	**1.22**	**2.83**	**2.38**	**1.92**	**3.03**	**2.76**	**1.73**
C.D at 5 %		**NS**	**NS**	**NS**	**8.30**	**6.98**	**5.62**	**8.88**	**8.08**	**5.07**
Control (C)										
C_1	Basal portion without	60.75	63.45	62.10	133.48	138.93	136.21	182.74	180.94	181.84

Treatment		Vine length (cm)								
		55 DAP			75DAP			At harvest		
		2019	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**
	PGR									
C_2	Middle portion without PGR	66.50	67.35	66.93	145.00	146.70	145.85	198.00	192.70	195.35
C_3	Top portion without PGR	70.10	69.15	69.63	152.20	150.32	151.26	210.30	200.42	205.36
S. Em.±		**2.26**	**2.32**	**2.14**	**3.01**	**2.43**	**1.79**	**3.08**	**2.91**	**2.01**
C.D at 5 %		**6.56**	**6.73**	**6.20**	**8.72**	**7.03**	**5.20**	**8.93**	**8.44**	**5.84**

DAP: Days after planting

Table 2. Effect of different portions of vine and plant growth regulators on inter nodal length (cm) of sweet potato

Treatment		Inter nodal length (cm)								
		55 DAP			75 DAP			At harvest		
		2019	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**
Portions of vine (P)										
P_1	Basal portion	2.35	2.09	2.22	3.42	3.14	3.28	3.88	3.52	3.70
P_2	Middle portion	2.42	2.17	2.30	3.35	3.26	3.30	3.81	3.63	3.72
P_3	Top portion	2.41	2.17	2.29	3.54	3.25	3.39	4.02	3.62	3.82
S. Em.±		**0.05**	**0.05**	**0.03**	**0.11**	**0.07**	**0.05**	**0.13**	**0.07**	**0.05**
C.D at 5 %		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Plant growth regulators (PGR) (G)										
G_1	CCC @ 500 ppm	2.79	2.40	2.60	4.12	3.61	3.87	4.84	4.19	4.52
G_2	CCC @ 1000 ppm	2.15	1.98	2.07	3.77	2.97	3.37	4.14	3.22	3.68
G_3	Ethrel @ 150 ppm	2.60	2.29	2.45	2.99	3.43	3.21	3.50	3.91	3.70
G_4	Ethrel @ 300 ppm	2.02	1.89	1.96	2.86	2.84	2.85	3.13	3.03	3.08
S. Em.±		**0.05**	**0.06**	**0.03**	**0.13**	**0.09**	**0.06**	**0.15**	**0.09**	**0.06**
C.D at 5 %		**0.16**	**0.17**	**0.09**	**0.38**	**0.25**	**0.17**	**0.43**	**0.25**	**0.19**
Interaction (P x G)										
P_1G_1		2.73	2.33	2.53	3.98	3.50	3.74	4.68	4.10	4.39
P_1G_2		2.15	1.98	2.07	3.82	2.97	3.40	4.20	3.22	3.71
P_1G_3		2.50	2.18	2.34	3.05	3.27	3.16	3.54	3.75	3.65
P_1G_4		2.00	1.88	1.94	2.84	2.82	2.83	3.10	3.00	3.05

Treatment		**Inter nodal length (cm)**								
		55 DAP			**75 DAP**			**At harvest**		
		2019	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**
P_2G_1		2.82	2.43	2.63	4.38	3.65	4.02	5.10	4.23	4.67
P_2G_2		2.13	1.97	2.05	3.38	2.95	3.17	3.74	3.20	3.47
P_2G_3		2.66	2.35	2.51	2.70	3.52	3.11	3.20	3.99	3.60
P_2G_4		2.07	1.93	2.00	2.92	2.90	2.91	3.18	3.10	3.14
P_3G_1		2.83	2.45	2.64	4.01	3.67	3.84	4.73	4.25	4.49
P_3G_2		2.17	2.00	2.09	4.10	3.00	3.55	4.48	3.25	3.87
P_3G_3		2.65	2.34	2.50	3.23	3.51	3.37	3.75	3.98	3.87
P_3G_4		2.00	1.87	1.94	2.83	2.80	2.82	3.10	3.00	3.05
S. Em.±		**0.09**	**0.10**	**0.05**	**0.23**	**0.15**	**0.10**	**0.26**	**0.15**	**0.11**
C.D at 5 %		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Control (C)										
C_1	Basal portion without PGR	3.40	3.01	3.21	4.46	4.52	4.49	5.25	5.10	5.18
C_2	Middle portion without PGR	3.32	2.90	3.11	4.67	4.35	4.51	5.48	4.98	5.23
C_3	Top portion without PGR	3.47	3.03	3.25	4.64	4.54	4.59	5.50	5.20	5.35
S. Em.±		**0.09**	**0.10**	**0.09**	**0.23**	**0.16**	**0.17**	**0.26**	**0.16**	**0.18**
C.D at 5 %		**0.27**	**0.28**	**0.25**	**0.66**	**0.47**	**0.49**	**0.76**	**0.46**	**0.53**

DAP: Days after planting

Table 3. Effect of different portions of vine and plant growth regulators on number of branches per vine of sweet potato

Treatment		**Number of branches per vine**								
		55 DAP			**75DAP**			**At harvest**		
		2019	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**
Portions of vine (P)										
P_1	Basal portion	2.96	2.79	2.88	6.42	6.08	6.25	7.33	7.50	7.42
P_2	Middle portion	2.96	2.92	2.94	6.42	6.33	6.38	7.17	7.75	7.46
P_3	Top portion	3.34	3.29	3.32	7.17	7.08	7.13	7.92	8.67	8.29
S. Em.±		**0.11**	**0.10**	**0.10**	**0.15**	**0.14**	**0.12**	**0.17**	**0.19**	**0.11**
C.D at 5 %		**0.31**	**0.30**	**0.30**	**0.45**	**0.41**	**0.34**	**0.49**	**0.55**	**0.33**

Plant growth regulators (PGR) (G)										
G_1	CCC @ 500 ppm	2.25	2.03	2.14	5.00	4.56	4.78	5.78	5.67	5.72
G_2	CCC @ 1000 ppm	2.03	2.59	2.31	4.56	5.67	5.11	5.00	6.89	5.94
G_3	Ethrel @ 150 ppm	3.64	3.08	3.36	7.78	6.67	7.22	8.67	8.11	8.39
G_4	Ethrel @ 300 ppm	4.42	4.31	4.36	9.33	9.11	9.22	10.44	11.22	10.83
S. Em.±		**0.12**	**0.12**	**0.12**	**0.18**	**0.16**	**0.13**	**0.19**	**0.21**	**0.13**
C.D at 5 %		**0.36**	**0.35**	**0.35**	**0.52**	**0.48**	**0.39**	**0.56**	**0.63**	**0.38**
Interaction (P x G)										
P_1G_1		1.92	1.75	1.84	4.33	4.00	4.17	5.33	5.00	5.17
P_1G_2		1.75	2.42	2.09	4.00	5.33	4.67	4.33	6.33	5.33
P_1G_3		3.75	3.25	3.50	8.00	7.00	7.50	9.00	8.00	8.50
P_1G_4		4.42	3.75	4.09	9.33	8.00	8.67	10.67	10.67	10.67
P_2G_1		2.42	1.92	2.17	5.33	4.33	4.83	6.00	5.67	5.83
P_2G_2		1.75	2.59	2.17	4.00	5.67	4.83	4.67	6.67	5.67
P_2G_3		3.59	2.75	3.17	7.67	6.00	6.83	8.33	7.67	8.00
P_2G_4		4.09	4.42	4.26	8.67	9.33	9.00	9.67	11.00	10.33
P_3G_1		2.42	2.42	2.42	5.33	5.33	5.33	6.00	6.33	6.17
P_3G_2		2.59	2.75	2.67	5.67	6.00	5.83	6.00	7.67	6.83
P_3G_3		3.59	3.25	3.42	7.67	7.00	7.33	8.67	8.67	8.67
P_3G_4		4.75	4.75	4.75	10.00	10.00	10.00	11.00	12.00	11.50
S. Em.±		**0.21**	**0.21**	**0.21**	**0.31**	**0.28**	**0.23**	**0.33**	**0.37**	**0.22**
C.D at 5 %		**NS**	**NS**	**NS**	**0.90**	**0.83**	**0.68**	**0.97**	**1.09**	**0.66**
Control (C)										
C_1	Basal portion without PGR	1.42	1.25	1.34	3.33	3.00	3.17	4.00	3.33	3.67
C_2	Middle portion without PGR	1.75	1.59	1.67	4.00	3.67	3.83	4.67	4.33	4.50
C_3	Top portion without PGR	2.25	1.75	2.00	5.00	4.00	4.50	5.67	4.67	5.17
S. Em.±		**0.20**	**0.19**	**0.19**	**0.28**	**0.26**	**0.16**	**0.31**	**0.34**	**0.22**
C.D at 5 %		**0.57**	**0.55**	**0.54**	**0.82**	**0.75**	**0.47**	**0.90**	**0.98**	**0.63**

DAP: Days after planting

Table 4. Effect of different portions of vine and plant growth regulators on leaf area per vine (cm^{2}) of sweet potato

Treatment		Leaf area per vine (cm^2)								
		55 DAP			75 DAP			At harvest		
		2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Portions of vine (P)										
P_1	Basal portion	1539.5	1464.9	1502.2	3694.8	3515.8	3605.3	5678.4	5584.9	5631.6
P_2	Middle portion	1658.2	1647.3	1652.8	3979.8	3953.5	3966.6	6087.6	6047.2	6067.4
P_3	Top portion	1736.8	1708.3	1722.5	4168.2	4099.9	4134.0	6270.1	6248.9	6259.5
S. Em.±		**37.5**	**38.6**	**27.3**	**63.3**	**62.7**	**53.9**	**73.1**	**91.7**	**62.5**
C.D at 5 %		**110.1**	**113.2**	**80.1**	**185.6**	**183.8**	**158.2**	**214.3**	**268.9**	**183.2**
Plant growth regulators (PGR) (G)										
G_1	CCC @ 500 ppm	2055.6	2048.5	2052.0	4933.4	4916.4	4924.9	7130.2	7099.2	7114.7
G_2	CCC @ 1000 ppm	1747.9	1658.6	1703.2	4194.9	3980.7	4087.8	6144.7	6119.6	6132.1
G_3	Ethrel @ 150 ppm	1521.0	1504.8	1512.9	3650.5	3611.4	3631.0	5771.1	5680.4	5725.8
G_4	Ethrel @ 300 ppm	1254.9	1215.4	1235.2	3011.7	2917.0	2964.4	5002.1	4942.1	4972.1
S. Em.±		**43.3**	**44.6**	**31.5**	**73.1**	**72.3**	**62.3**	**84.4**	**105.9**	**72.1**
C.D at 5 %		**127.1**	**130.7**	**92.5**	**214.4**	**212.2**	**182.7**	**247.4**	**310.5**	**211.6**
Interaction (P x G)										
P_1G_1		1866.9	1854.2	1860.5	4480.5	4450.2	4465.3	6597.3	6595.1	6596.2
P_1G_2		1708.4	1507.5	1608.0	4100.3	3618.0	3859.1	5680.2	5678.1	5679.1
P_1G_3		1353.4	1332.1	1342.8	3248.3	3197.0	3222.6	5448.0	5248.0	5348.0
P_1G_4		1229.3	1165.8	1197.6	2950.4	2798.0	2874.2	4988.0	4818.2	4903.1
P_2G_1		2133.1	2128.6	2130.9	5119.4	5108.7	5114.0	7393.3	7304.3	7348.8
P_2G_2		1743.5	1734.3	1738.9	4184.3	4162.2	4173.3	6284.8	6261.4	6273.1
P_2G_3		1502.0	1497.2	1499.6	3604.8	3593.2	3599.0	5668.3	5648.2	5658.3
P_2G_4		1254.4	1229.2	1241.8	3010.6	2950.0	2980.3	5004.2	4975.0	4989.6
P_3G_1		2166.8	2162.7	2164.7	5200.3	5190.4	5195.4	7400.1	7398.1	7399.1
P_3G_2		1791.7	1734.1	1762.9	4300.0	4161.9	4231.0	6469.1	6419.3	6444.2
P_3G_3		1707.7	1685.0	1696.4	4098.4	4044.1	4071.2	6197.0	6144.9	6171.0
P_3G_4		1280.9	1251.3	1266.1	3074.2	3003.0	3038.6	5014.2	5033.2	5023.7
S. Em.±		**75.1**	**77.2**	**54.6**	**126.6**	**125.3**	**107.9**	**146.1**	**183.4**	**125.0**
C.D at 5 %		**NS**	**NS**	**NS**	**371.3**	**367.5**	**316.4**	**428.6**	**537.8**	**366.5**

Treatment		**Leaf area per vine (cm^2)**								
		55 DAP			**75 DAP**			**At harvest**		
		2019	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**
Control (C)										
C_1	Basal portion without PGR	1369.0	1348.1	1358.6	3285.5	3235.5	3260.5	4990.1	5032.2	5011.2
C_2	Middle portion without PGR	1974.9	1970.1	1972.5	4739.8	4728.2	4734.0	6940.1	6928.0	6934.1
C_3	Top portion without PGR	2186.9	2168.5	2177.7	5248.4	5204.5	5226.5	7438.5	7404.3	7421.4
S. Em.±		**70.5**	**72.1**	**50.2**	**139.0**	**126.3**	**97.6**	**173.3**	**177.3**	**119.0**
C.D at 5 %		**204.3**	**208.9**	**145.5**	**402.5**	**365.8**	**282.7**	**502.1**	**513.7**	**344.7**

DAP: Days after planting

4. CONCLUSION

The results of the experiment suggest that plant growth regulators have a considerable impact on sweet potato growth, production, and quality. Planting of top portion of vine followed by application of CCC @ 500 ppm at 40 and 60 days after planting resulted in higher and optimum growth attributes in sweet potato. In general, irrespective of growth regulators, planting with basal portion of vine recorded lower growth components.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Prakash P, Jaganathan D, Sivakumar PS, Sheela Immanuel, Kishore P, Kumar P. Does the APMC market increase farmer's income? Evidence from value chain analysis of sweet potato in Karnataka. Indian Journal of Agricultural Economics. 2018;73(3):342-357.
2. Alexopoulos AA, Akoumianakis KA, Passam HC. Effect of plant growth regulators on the tuberisation and physiological age of potato (*Solanum tuberosum* L.) tubers grown from true potato seed. Canada J. Plant Sci. 2006;86(3):1217-1225.
3. Johnson RE. Comparison of methods for estimating cotton leaf area. Agronomy J., 1961;60:1894-95.
4. Netsai N, Moses M, Tuarira M. Effect of cutting position and vine pruning level on yield of Sweet Potato (*Ipomoea Batatas* L.). J. Arid land Agric. 2019;5(2):1-5.
5. Kumar P, Haldankar PM, Haldankar PC. Study on effect of plant growth regulators on vegetative growth of summer okra (*AbelmoschusesculentusL.* Moench) Var. VarshaUphar. Int. J. Chem. Stud. 2018; 6(3):2489-2492.
6. Lencha B, Adanech B, Genet D. The evaluation of growth performance of sweet potato (*Ipomoea batatas* L.) Awassa Var. by using different type of vine cuttings. Food Sci. Quality Managt. 2016;54(2): 55-65.
7. Pateliya CK, Parmar BR, Tandel YN. Effect of different growth retardants on flowering, yield and economics of okra (*Abelmoschus esculentus* L. Moench) cv.GO-2 under south Gujarat conditions. Asian J. Hort. 2008;3(2):317-318.
8. Sengupta S, Sudha V, Apurva M, Varsha R. Effect of bio regulators on growth parameters of sweetpotato (*Ipomoea batatas* L.). Int. J. Curr. Microbiol. App. Sci. 2018;7(2):816-821.
9. Essilfie ME, Dapaah HK, Tevor JW, Darkwa K. Number of nodes and part of vine cutting effect on the growth and yield of sweet potato *(Ipomoea batatas*(L.) in Transitional Zone of Ghana. Int. J. Plant Soil Sci. 2016;9(5):1-14.
10. Hejjegar Iranna, Lakshminarayana D, Seenivasan N, Naik Saida. Studies on the influence of plant growth regulators and their time of application on growth and tuber yield of sweet potato (*Ipomoea batatas* L.) cv. Kiran under southern Telangana conditions. 2018; 2254-2257.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/107794