

Influence of different portions of vine and plant growth regulators on growth parameters of Sweet potato [*Ipomoea batatas* (L.) Lam.]

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 (P₁), middle portion (P₂) and top portion (P₃) and the second factor was plant growth regulators consisting CCC @ 500 ppm (G₁), CCC @ 1000 ppm (G₂), Ethrel @ 150 ppm (G₃) and Ethrel @ 300 ppm (G₄). The control treatments were basal portion of vine (C₁), middle portion of vine (C₂) and top portion of vine (C₃) 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 (P₃G₁) was found to be significantly superior and found to be optimum with respect to growth parameters of sweet potato.

Keywords: Portions of vine, Plant growth regulators, Interaction effect, Vine length, Leaf area.

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.

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 (Alexopoulos *et al.* , 2006). Growth regulators have been documented to enhance the yield of numerous horticultural crops, particularly those in which the underground component holds economic significance.

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, Bagalkote, Karnataka, India at $15^{\circ} 17' 33''$ North latitude, $76^{\circ} 19' 17''$ 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 $36^{\circ}C$ and the average minimum temperature is $20^{\circ}C$ 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.

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.

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 (1961) and expressed in (cm²/ 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:

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

Where,

LA = Leaf area of all the leaves in a plant (cm²)

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 (cm²)

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.*, P₃ (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. (Netsai *et al.* 2019).

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.* (2018) 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^2 per 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 (Lencha *et al.*, 2016).

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.*(2008) 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.* (2008) 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 P₂G₁ *i.e.*, middle portion of vine with the application of CCC @ 500 ppm (5114.0 cm²per vine and 7348.8 cm²per vine at 75 and at harvest, respectively). While, lower leaf area (2874.2 cm²per vine and 4903.0cm² per vine, respectively) was recorded with the interaction of top portion of vine with the application of ethrel @ 300 ppm (P₁G₄).

However, including control, results revealed that highest leaf area (2177.7 cm² per vine, 5226.5 cm² per vine and 7421.4 cm² per vine at 55, 75 and at harvest, respectively) of sweet potato was observed with the top portion of vine (C₃) compared to all other interaction and control. However, it remained on par with P₃G₁ and P₂G₁ at all the stages of the crop growth. Significantly lower leaf area (1358.6cm²per vine, 3260.5cm²per vine and 5011.2 cm²per vine at 55, 75 DAP and at harvest, respectively) was observed in basal portions of vine (C₁).

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.*, (2016) and Essilfieet *al.* (2016).

Conclusion:

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.

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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 ₁ G ₁		53.65	54.05	53.85	119.32	120.10	119.71	162.35	152.60	157.48
P ₁ G ₂		48.30	49.15	48.73	108.60	110.30	109.45	133.40	130.40	131.90
P ₁ G ₃		46.70	49.45	48.08	105.40	110.90	108.15	142.50	129.80	136.15
P ₁ G ₄		34.10	33.05	33.58	80.20	78.10	79.15	98.60	90.80	94.70
P ₂ G ₁		60.05	58.25	59.15	132.14	128.52	130.33	177.30	171.00	174.15
P ₂ G ₂		54.10	53.75	53.93	120.20	119.46	119.83	145.40	145.40	145.40
P ₂ G ₃		57.85	56.75	57.30	127.73	125.53	126.63	166.73	155.00	160.87
P ₂ G ₄		42.95	38.90	40.93	97.92	89.80	93.86	116.50	107.38	111.94
P ₃ G ₁		66.50	59.60	63.05	145.00	131.20	138.10	188.42	167.74	178.08
P ₃ G ₂		63.65	52.45	58.05	139.32	116.86	128.09	166.80	147.50	157.15
P ₃ G ₃		65.30	59.70	62.50	142.63	131.44	137.04	186.63	164.50	175.57
P ₃ G 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 PGR	60.75	63.45	62.10	133.48	138.93	136.21	182.74	180.94	181.84
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 ₁ G ₁	2.73	2.33	2.53	3.98	3.50	3.74	4.68	4.10	4.39
	P ₁ G ₂	2.15	1.98	2.07	3.82	2.97	3.40	4.20	3.22	3.71
	P ₁ G ₃	2.50	2.18	2.34	3.05	3.27	3.16	3.54	3.75	3.65
	P ₁ G ₄	2.00	1.88	1.94	2.84	2.82	2.83	3.10	3.00	3.05
	P ₂ G ₁	2.82	2.43	2.63	4.38	3.65	4.02	5.10	4.23	4.67
	P ₂ G ₂	2.13	1.97	2.05	3.38	2.95	3.17	3.74	3.20	3.47
	P ₂ G ₃	2.66	2.35	2.51	2.70	3.52	3.11	3.20	3.99	3.60
	P ₂ G ₄	2.07	1.93	2.00	2.92	2.90	2.91	3.18	3.10	3.14
	P ₃ G ₁	2.83	2.45	2.64	4.01	3.67	3.84	4.73	4.25	4.49
	P ₃ G ₂	2.17	2.00	2.09	4.10	3.00	3.55	4.48	3.25	3.87
	P ₃ G ₃	2.65	2.34	2.50	3.23	3.51	3.37	3.75	3.98	3.87
	P ₃ G 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 ₁ G ₁		1.92	1.75	1.84	4.33	4.00	4.17	5.33	5.00	5.17
P ₁ G ₂		1.75	2.42	2.09	4.00	5.33	4.67	4.33	6.33	5.33
P ₁ G ₃		3.75	3.25	3.50	8.00	7.00	7.50	9.00	8.00	8.50
P ₁ G ₄		4.42	3.75	4.09	9.33	8.00	8.67	10.67	10.67	10.67
P ₂ G ₁		2.42	1.92	2.17	5.33	4.33	4.83	6.00	5.67	5.83
P ₂ G ₂		1.75	2.59	2.17	4.00	5.67	4.83	4.67	6.67	5.67
P ₂ G ₃		3.59	2.75	3.17	7.67	6.00	6.83	8.33	7.67	8.00
P ₂ G ₄		4.09	4.42	4.26	8.67	9.33	9.00	9.67	11.00	10.33
P ₃ G ₁		2.42	2.42	2.42	5.33	5.33	5.33	6.00	6.33	6.17
P ₃ G ₂		2.59	2.75	2.67	5.67	6.00	5.83	6.00	7.67	6.83
P ₃ G ₃		3.59	3.25	3.42	7.67	7.00	7.33	8.67	8.67	8.67
P ₃ G 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 (cm²) 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 ₁ G ₁		1866.9	1854.2	1860.5	4480.5	4450.2	4465.3	6597.3	6595.1	6596.2
P ₁ G ₂		1708.4	1507.5	1608.0	4100.3	3618.0	3859.1	5680.2	5678.1	5679.1
P ₁ G ₃		1353.4	1332.1	1342.8	3248.3	3197.0	3222.6	5448.0	5248.0	5348.0
P ₁ G ₄		1229.3	1165.8	1197.6	2950.4	2798.0	2874.2	4988.0	4818.2	4903.1
P ₂ G ₁		2133.1	2128.6	2130.9	5119.4	5108.7	5114.0	7393.3	7304.3	7348.8
P ₂ G ₂		1743.5	1734.3	1738.9	4184.3	4162.2	4173.3	6284.8	6261.4	6273.1
P ₂ G ₃		1502.0	1497.2	1499.6	3604.8	3593.2	3599.0	5668.3	5648.2	5658.3
P ₂ G ₄		1254.4	1229.2	1241.8	3010.6	2950.0	2980.3	5004.2	4975.0	4989.6
P ₃ G ₁		2166.8	2162.7	2164.7	5200.3	5190.4	5195.4	7400.1	7398.1	7399.1
P ₃ G ₂		1791.7	1734.1	1762.9	4300.0	4161.9	4231.0	6469.1	6419.3	6444.2
P ₃ G ₃		1707.7	1685.0	1696.4	4098.4	4044.1	4071.2	6197.0	6144.9	6171.0
P ₃ G 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
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