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Influence of stem cutting size and growth regulators on propagation techniques and yield attributes of Ceylon spinach [*Talinum triangulare* (Jacq.) Willd] - An underutilized leafy vegetable

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ABSTRACT

Talinum triangulare (Jacq) Willd. is an underutilized herbaceous leafy vegetable plant that belongs to the family Portulacaceae. An experiment was carried out during 2018 and 2019 to study the effect of cuttings size and growth regulators on vegetative propagation, growth, and yield performance of the herb. The better growth performance of stem cuttings with significant hormonal effects was found in T_2, T_9, T_5, and T_{12}, respectively for first sprouting, number of leaves, length of sprouted shoots coupled with maximum biomass. Similarly, the maximum number of roots per cutting, along with the highest root length were also recorded in the treatment of T_2, and T_9, which were *at par* with T_5, and T_{12} as compared to control. The maximum rooting percentage coupled with the higher survival rate of cuttings was observed in T_2 (84.43%), T_9 (82.29%) *at par* with T_{12} (80.21%), as compared to control. The highest plant height, number of branches with the maximum leaves, and the better foliage yield performance were recorded in G_2 and G_4 as well as T_2, T_5, T_9, and T_{12}, as compared to control. A significant effect of growth regulators was found in the overall performance of the cuttings as compared to control. The stem cuttings irrespective of their length treated with IBA 500 ppm and IAA 500 ppm showed significantly superior performance. The present findings on the low-cost vegetative propagation technique would be useful for successful multiplication and commercial cultivation of the leafy vegetable as it is an easy, quick, and economical method of propagation.

1. Introduction

Talinum triangulare (Jacq) Willd is an erect underutilized perennial herbaceous fleshy leaved herb used as leafy vegetable that belongs to the Portulacaceae family. It is locally known as *Pirali paleng* (Assamese) with different common names as Ceylon spinach, Waterleaf, or Fame flower. Pirali-paleng is rich in Vitamin A, Vitamin C, and minerals such as iron, potassium, calcium and magnesium, protein, and pectin needed for the growth and development of children (Nya and Eka, 2015; Nduche and Otaka, 2019). Leafy vegetables serve as the indispensable constituents of the human diet, supplying the body with protein, vitamins, minerals, antioxidants, and certain hormone precursors in addition to dietary fibres and energy, thus, helping in immunity-boosting, providing nutritional security, and combating malnutrition. Entire North-East India is bountiful in vegetable biodiversity, yet research and development activities to tap these assets for economic development have remained at a low level. Propagation and cultivation techniques of underutilized vegetable plants are urgently needed to reduce pressure on them (Singh *et al.*, 2012). According to Ezekiel (2010), the low-cost vegetative propagation is a solution for domestication and conservation of indigenous and threatened plant species, while according to Konsam *et al.*, (2016) studies should be done to assess the cultivable potential of wild leafy vegetables and work towards developing propagation and agro-techniques to bring more potential wild species under domestication for sustainable utilization of natural resources.

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This widely used herbal leafy vegetable has been grown in household backyards without any scientific cultivation practices. Propagation of *Talinum triangulare* by seed is generally not practiced as the collection of very small seeds is difficult and propagation by seed is very slow, so propagation by stem cuttings is commonly practiced (Rabo *et al.*, 2003). So far, despite tremendous importance, not much research work has been done, for the development of mass propagation and cultivation technique of this leafy vegetable plant. As *Pirali paleng* is one of the most highly demanded underutilized leafy vegetables in one hand and collected from the wild and household backyards without any scientific cultivation practices on the other, the cultivation and management of the species are highly deserved. Keeping these facts in view, the present experiment was undertaken to find the suitable length of stem cuttings and the influence of growth regulators on vegetative propagation, growth, and foliage yield performance of the leafy vegetable.

2. Materials and Methods

The experiment was carried out in the Forestry Nursery of North Eastern Regional Institute of Science and Technology, Nirjuli, Arunachal Pradesh (27^{0}7'38" N Latitude and 93^{0}44'19" E Longitude at an Altitude of 112 m MSL) from September to December 2018 and 2019 consecutively for two years . The soil texture of the experimental plot was sandy, well-drained with pH 5.9 and low organic carbon of 0.07%. The initial nutrient status of soil was 0.07% N, 0.25% P, and 0.36% K respectively. At the time of final bed preparation, well rotten farm yard manure at the rate of 5 kg per bed was applied and mixed thoroughly.

The experiment was designed in Factorial Randomized Block Design (FRBD) with three replications consisting of 14 treatments involving two stem cutting lengths *viz.* L_1 (5 - 8 cm stem cutting) and L_2 (12 - 15 cm stem cutting) as well as two growth regulators namely Indole Butyric Acid (IBA) and Indole-3 Acetic Acid (IAA). The growth regulator concentrations were G_0=Distilled water (control), G_1=500 ppm IBA, G_2=1000 ppm IBA, G_3=1500 ppm IBA, G_4=500 ppm IAA, G_5=1000 ppm IAA and G_6=1500 ppm IAA. The treatment combinations: T_1 = L_1 + Distilled water (control), T_2 = L_1 + IBA 500 ppm, T_3 = L_1+ IBA 1000 ppm, T_4 = L_1 + IBA 1500 ppm, T_5 = L_1+ IAA 500 ppm, T_6 = L_1 + IAA 1000 ppm, T_7 = L_1 + IAA 1500 ppm, T_8 = L_2 + Distilled water (control), T_9 = L_2 + IBA 500 ppm, T_{10} = L_2+ IBA 1000 ppm, T_{11} = L_2 + IBA 1500 ppm, T_{12} = L_2+ IAA 500 ppm, T_{13} = L_2 + IAA 1000 ppm and T_{14} = L_2 + IAA 1500 ppm.

Stem cuttings of L_1 (5 - 8 cm) and L_2 (12 - 15 cm) sizes were prepared from pencil thickness tender shoots maintaining polarity. The basal portions of the stem cuttings were treated with previously prepared IBA and IAA solutions by the quick dip method. Total 672 number of treated cuttings with 16 numbers of treated cuttings per bed of 1 m x 1 m size were planted. Watering was done twice a week throughout the experimental period. Observations were recorded periodically from the five randomly selected plants for different parameters. Data obtained from the experiments were statistically analysed following Analysis of Variance (ANOVA) described by Gomez and Gomez (1984). Pooled data of two years on various propagation, growth, and yield parameters are presented in the tables and figures.

3. Results and Discussion

Effect on shooting parameters

The vigour of the propagules was assessed in terms of the number of sprouts per cutting, length of the sprouted shoot (cm), the number of leaves per cutting, and biomass produced (Figure 1). The results revealed that minimum days taken to first sprout 5.83 days after planting (DAP) was observed in T_9 , which was *at par* with T_2, while the maximum time of 8.17 DAP was noticed in T_8 and T_1. L_1 cuttings sprouted slightly earlier than L_2 cuttings, while the minimum 5.75 DAP was taken for sprouting in G_1 over the G_0 (8.17 DAP). The first sprouting of the cuttings indicates the initiation of rooting. This might be because auxins induce stimulus for regeneration of roots. A similar finding was also reported by Swetha (2005). The maximum number of sprouts per cutting was recorded in T_2 (3.79), which was *at par* with T_9 (3.67), against the minimum number of sprouts per cutting in T_1, and T_8 (Table 1). Producing more sprouts in T_2 followed by T_9 and T_5 might have resulted due to the more physiological activities influenced by the growth regulators in cuttings due to initiation of early rooting and sprouting. The highest length of the sprouted shoot was observed in T_2 (17.72 cm), followed by T_9 (16.23 cm), which was *at par* with T_6, while a minimum shoot length of 11.00 cm was found in T_1. The maximum length of the sprouted shoot was recorded in G_1 (16.98 cm) against the minimum length of shoot under control G_0 (11.47 cm) (Table 1).

The maximum number of leaves per cutting was recorded in T_2 (35.39), followed by T_9 (35.17) and the minimum number of leaves 24.78 in T_1, the highest number of leaves produced in G_1 (35.28) as compared to the lowest leaves found in G_0 (Table 1). This might be due to the initiation of the maximum number of roots and leaves which helped in better nutrition and water absorption in T_2 and T_9 as compared to T_1 and T_8. Increased length of shoots might also be attributed to initiation of more roots coupled with the production of more sprouts and leaves, resulting in the synthesis of more reserved food materials towards elongation of shoots. The biomass of the planting materials under different treatments was evaluated in terms of the fresh weight of sprouted shoots and roots. Figure 2 shows that the highest biomass in terms of fresh weight of shoot and roots was found in T_2 (24.03 g) and G_1 (22.77 g), while the lowest biomass per cutting was observed in T_1 (11.39 g) and G_0 (12.09 g). These results were in close conformity with the findings of Kaur and Kaur (2017), Siddiqua *et al.*, (2018).

Effect on Rooting performance

Perusal of data presented in Table 2 revealed that significant variation was also observed among different factors and treatments on rooting parameters like the number of roots per cutting, length of the longest root (cm), and rooting percentage. The highest number of roots per cutting was found in T_2 (11.34), which is *at par* with T_9 (11.17), while the minimum number of roots was recorded in T_1 and T_8 (7.50). This might be due to the influence of growth regulators in metabolic activities and the increased synthesis of food materials in leaves. Similar findings were also reported by Patel *et al.* (2017). However, the maximum length of the root was also recorded in T_9 (10.49 cm), which is *at par* with T_2 (10.30 cm), as compared to the shortest length of the root was observed in T_8 (7.10 cm) (Table 2). It might be attributed to the fact that the application of growth regulators might have enhanced the formation of callus and differentiation of vascular tissue resulting in elongation of roots. The percentage of rooting was significantly highest in T_2 (83.00 %), which was *at par* with T_9 (79.50%), while the lowest rooting percentage was recorded in T_8 (61.33%) (Table 2). The performance of rooting with the maximum number of longest roots was also found significantly higher in G_1. This might be due to the optimum concentration of IBA 500 ppm that lead to better root formation. Grewal *et al.*, (2005) also observed similar results.

The success of the stem cuttings was assessed in terms of survival rate among the factors and different treatments. Substantial variation between the factors and treatments was also found in survival propagating materials (Table 2). The highest survival rate of 84.43% was recorded in T_2, followed by T_9 (82.29%) and T_{12} (80.21%), while the lowest survival percentage of 56.25% was recorded in T_8. Similarly, the maximum survival rate found in G_1 (83.34 %), and the lowest results were recorded in G_0 (59.38%). The increase in the survival rate of the stem cuttings in T_2, T_9, and T_{12} as compared to T_1 and T_8 might be due to profuse rooting and shoot production with more leaves as influenced by the concentration of growth regulators. The results conform with the findings of Pandey *et al.*, (2011).

Effect on growth and foliage yield performance

A significant effect of growth regulators and treatments on the performance of various growth and foliage yield attributes was found at the harvest stage of *Talinum triangulare*. The data presented in Table 3 showed that the highest plant height was recorded in G_2 (46.23 cm) and T_2 (46.67 cm) followed by G_4 (42.36 cm) and T_9 (45.79 cm), while the shortest plant height was found in G_0 (32.71 cm) and T_8 (31.89 cm). Nduche and Otaka, (2019) also reported that *Talinum triangulare* is an erect herb with 30 –100 cm succulent stems, while Nya and Eka, (2015) found plant height ranged between 33.73 cm to 58.08 cm at maturity. A significantly increased number of branches and number of leaves per plant were also recordedin G_2 and T_2, while the minimum number of branches and leaves per plant were recorded in G_0 and T_8. The maximum foliage yield per plant was recorded in G_2 (112.44 g/plant) and T_2 (121.70 g/plant) followed by G_4 (102.26 g/plant) and T_5 (105.63 g/plant), while minimum foliage yield per plant was recorded in G_0 and T_1 (Fig. 3). Similarly, the highest foliage per hectare was recorded in G_2 (150.58 Q/ha) and T_2 (164.67 Q/ha), followed by G_4 (128.59 Q/ha) and T_9 (136.50 Q/ha), while minimum foliage yield per plant was recorded in G_0 and T_1 (Table 3). These might be due to the influence of plant growth regulators plants with the production of more branches and leaves per plant. Such positive increase in growth and foliage yield performance of the stem cuttings in G_1 as well as T_2 and T_9, might be due to profuse root and shoot production as influenced by the growth regulators and more metabolic activities. These results conform with the findings of Rabo *et. al.*, (2003); Nya and Eka (2015). It was observed that among the different treatments with IBA and IAA, the lower concentration of both the hormone *i.e.*, IBA 500 ppm and IAA 500 ppm showed comparatively better results in both the L_1 and L_2 cuttings. Further, there was no significant difference of rooting and shooting effect observed between the lengths of stem cuttings.

The findings of the present investigation suggested that the vegetative propagation of *Talinum triangulare* by stem cuttings was promising and can be utilized for mass propagation, and cultivation of the potential underutilized leafy vegetable crop. The stem cuttings irrespective of the length treated with IBA 500 ppm and IAA 500 ppm recorded significantly superior performance over the control and cuttings treated with higher concentrations of IBA and IAA. It can be concluded that the present findings on low-cost vegetative propagation technique by stem cuttings would be useful for successful commercial cultivation, as it is an easy, quick, and economical method of *Talinum triangulare* propagation.

4. References

Ezekiel, A (2010). Viable options and factors in consideration for Low-cost Vegetative propagation of tropical trees. *International Journal of Botany*, 6(2): 187-193.

Gomez KA and Gomez AA (1984). Statistical Procedures for Agricultural Research (2nd Edn.), John Wiley & Sons Inc, New York.

Grewal, HS, Kumar S and Chauhan R (2005). Effect of IBA and NAA on rooting of chrysanthemum (*Dendranthema grandiflora* Tzevlev) terminal cuttings. *Journal of Ornamental Horticulture*, 8(3): 230-232.

Kaur A and Kaur A (2017). Effect of IBA concentrations on success of cuttings of fig cv. Brown turkey. *International J. Sci. Res.*, 8(11): 1576-1579.

Konsam S, Thongam B and Handique AK (2016). Assessment of wild leafy vegetables traditionally consumed by the ethnic communities of Manipur, Northeast India. *Journal of Ethnobiology and Ethnomedicine*, 12(9): 1-15.

Nduche MU and Otaka CL (2019). Phytochemical screening and antimicrobial activity of *Talinum triangulare* (Jacq) Willd, *Ocimum gratissimum* L, *Chromoleana odorata* L. and *Aloe vera* Burm. F. *International J. of Research in Pharmacy and Bioscience*, 6(2): 1-12.

Nya EJ and Eka MJ (2015). Morphological characterization and hybridization of *Talinum triangulare* Land races for desirable metric characters in South Eastern Nigeria. *The International J. Sci and Tech.*, 3 (7): 192-197.

Pandey A, Sushma T and Dinesh G (2011). Role of auxin on adventitious root formation and subsequent growth of cutting raised plantlets of *Ginkgo biloba* L. *International Journal of Biodiversity and Conservation*, 3(4): 142-146.

Patel HR, Patel MG and Singh S (2017). Effect of different levels IBA and NAA on rooting of hardwood and semi hardwood cutting in fig. *Journal of Agric. Sci. Res.*, 7(4): 519 – 523.

Rabo ET, Eze HN and Donli PO (2003). Growth of water leaf (*Talinum triangulare* (Jacq) Willd) from root cuttings and stem cuttings in the semi-arid zone of Nigeria. *Biosci. Res. Communications*, 15(1): 1-5.

Siddiqua A, Thippesha D, Shivakumar BS, Adivappar N and Ganapathi M (2018). Effect of growth regulators on rooting and shooting of stem cuttings in dragon fruit [*Hylocereus undatus* (Haworth) Britton & rose]. *Journal of Pharmacognosy and phytochemistry*, 7(5): 1595-1598.

Singh SJ, Batra VK, Singh SK and Singh TJ (2012). Diversity of underutilized vegetable crops species in North-East India with special reference to Manipur: A review. *NeBio*, 3(2): 87-95.

Swetha H (2005). Propagation of Indian lavender (*Bursera delpechiana* Poiss.) through cuttings under mist M.Sc. (HorTi.) Thesis, University of Agric. Sci., Dharwad, Karnataka, p. 32.

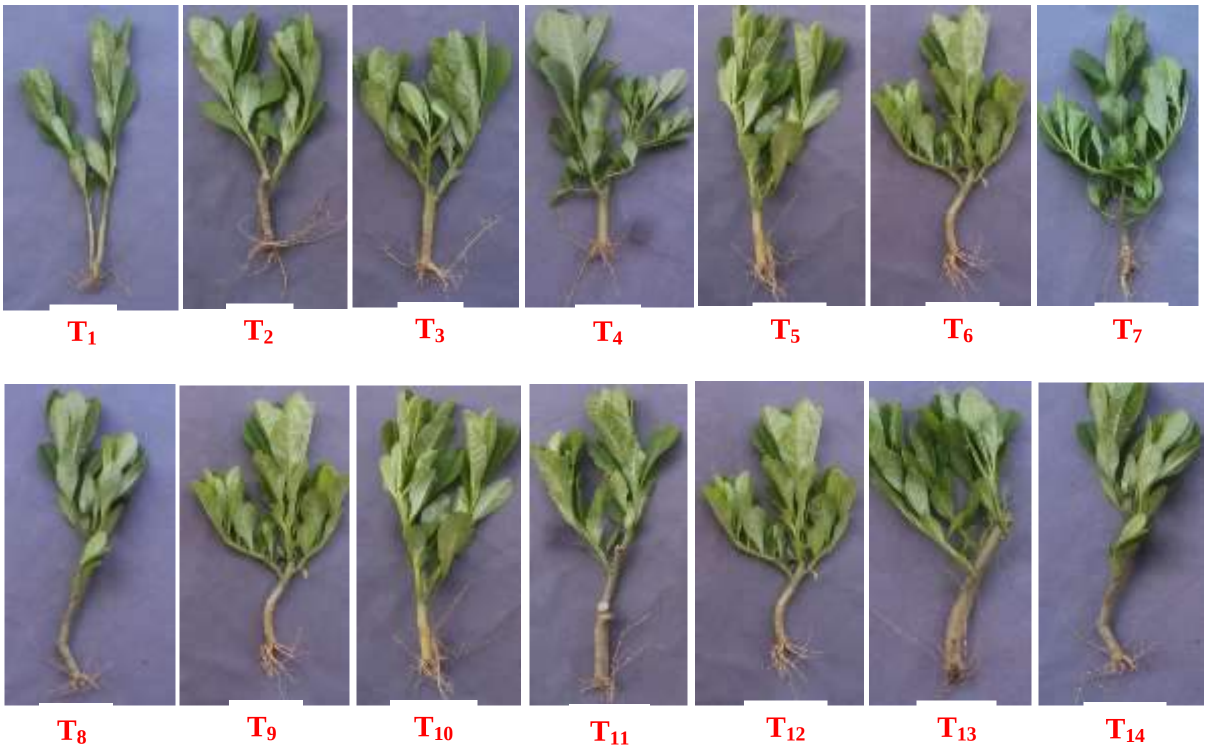

Figure 1. Shooting and rooting performance of *Talinum triangulare* stem cuttings under treatments: T_1- Control, T_2 -500 ppm IBA, T_3 -1000 ppm IBA, T_4 -1500 ppm IBA, T_5 -500 ppm IAA, T_6 -1000 ppm IAA and T_7 -1500 ppm IAA. T_8- Control, T_9 -500 ppm IBA, T_{10} -1000 ppm IBA, T_{11} -1500 ppm IBA, T_{12} -500 ppm IAA, T_{13} -1000 ppm IAA and T_{14} -1500 ppm IAA.

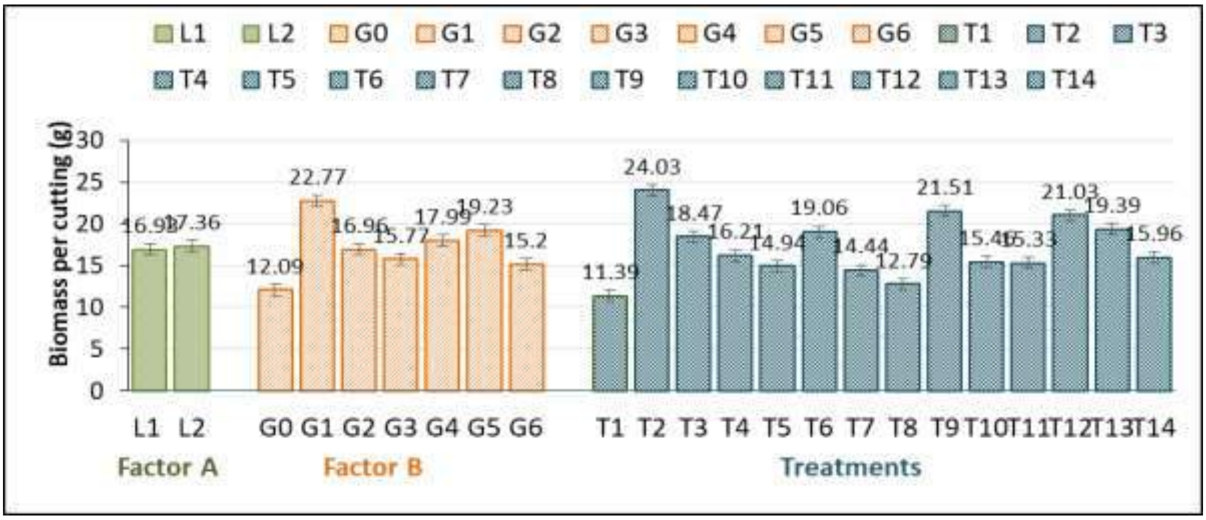

Figure 2. Effect of cutting size and growth regulators on biomass (g) per cutting.

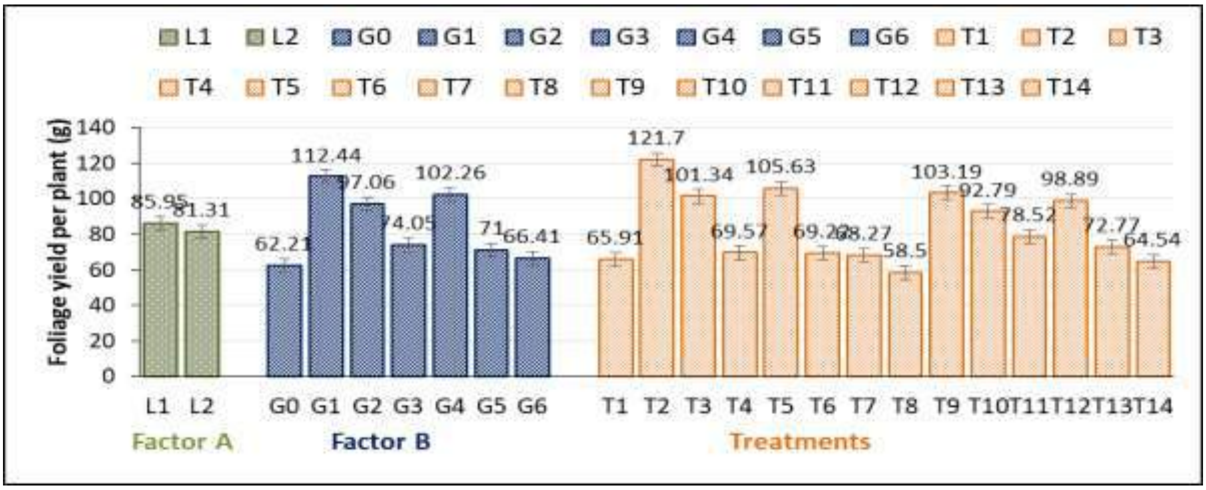

Figure 3. Effect of cutting size and growth regulators on foliage yield (g) per cutting.

Table 1. Effect of cutting size and growth regulators on performance of shoot parameters of *Talinum triangulare* cuttings at 30 DAP.

	First sprouting (DAP)	Number of sprouts per cutting	Length of sprouted shoot (cm)	Number of leaves per cutting	Biomass per cutting (g)
Factor A (Stem cuttings)					
L_1 = 5 – 8 cm cutting	6.90	2.98	13.86	29.51	16.93
L_2 =12 – 15 cm cutting	7.07	3.05	13.97	27.79	17.36
CD (0.05)	0.47*	0.27	0.98	1.33	1.16*
Factor B (GRs)					
G_0 = Control	8.17	2.35	11.47	24.89	12.09
G_1 = IBA 500 ppm	5.75	3.73	16.98	35.28	22.77
G_2 = IBA 1000 ppm	6.835	2.79	14.14	29.91	16.96
G_3 = IBA 1500 ppm	7.00	2.72	12.45	28.34	15.77
G_4 = IAA 500 ppm	6.335	3.46	15.70	27.97	17.99
G_5 = IAA 1000 ppm	7.335	3.18	15.31	25.94	19.23
G_6 =IAA 1500 ppm	7.50	2.78	11.36	25.54	15.20

CD (0.05)	0.87*	0.50*	1.85*	2.48*	2.17*
Treatments (A x B)					
T_1 =L_1 + Control	8.17	2.31	11.00	24.78	11.39
T_2 =L_1 + IBA 500 ppm	5.67	3.79	17.72	35.39	24.03
T_3 =L_1 + IBA 1000 ppm	6.84	2.81	14.23	32.83	18.47
T_4 =L_1 + IBA 1500 ppm	6.84	2.66	11.56	29.11	16.21
T_5 =L_1 + IAA 500 ppm	6.17	3.51	15.11	27.28	14.94
T_6 =L_1 + IAA 1000 ppm	7.34	2.95	16.22	26.28	19.06
T_7 =L_1 + IAA 1500 ppm	7.33	2.78	11.17	25.56	14.44
T_8 =L_2 + Control	8.17	2.39	11.94	25.00	12.79
T_9 =L_2 + IBA 500 ppm	5.83	3.67	16.23	35.17	21.51
T_{10} =L_2+ IBA 1000 ppm	6.84	2.78	14.06	27.00	15.46
T_{11} =L_2 + IBA 1500 ppm	7.17	2.78	13.33	27.56	15.33
T_{12} =L_2 + IAA 500 ppm	6.50	3.50	16.28	28.66	21.03
T_{13} =L_2 + IAA 1000 ppm	7.34	3.39	14.39	25.61	19.39
T_{14} =L_2 + IAA 1500 ppm	7.67	2.78	11.56	25.50	15.96
S. Em ±	0.28	0.43	0.40	0.62	0.60
CD (0.05)	1.23*	0.71*	2.61*	3.52*	3.07*

* Significant at P=0.05, DAP = Days after planting, ppm=Parts per million

Table 2. Effect of cutting size and growth regulators on performance of rooting parameters and survival rate of *Talinum triangulare* at 30 DAP.

	Number of roots per cutting	Root length (cm)	Rooting percentage (%)	Survival rate (%)
Factor A (Stem cuttings)				
L_1 = 5 – 8 cm	10.19	8.81	72.24	72.62
L_2 =12 – 15 cm	9.89	8.72	68.19	70.69
CD (0.05)	0.62*	0.43*	2.43*	4.75*
Factor B (GRs)				
G_0 = Control	7.50	7.43	63.50	59.38
G_1 = IBA 500 ppm	11.25	10.39	81.25	83.34
G_2 = IBA 1000 ppm	10.09	9.58	71.75	73.44
G_3 = IBA 1500 ppm	10.34	9.22	64.09	70.83
G_4 = IAA 500 ppm	10.59	8.88	78.67	78.65
G_5 = IAA 1000 ppm	10.42	8.06	67.33	70.31
G_6 =IAA 1500 ppm	10.09	7.79	64.92	65.63
CD (0.05)	1.17*	0.80*	4.55*	8.87*
Treatments (A x B)				
T_1 =L_1 + Control	7.50	7.75	65.67	62.50
T_2 =L_1 + IBA 500 ppm	11.34	10.30	83.00	84.43
T_3 =L_1 + IBA 1000 ppm	10.00	8.98	75.17	73.96
T_4 =L_1 + IBA 1500 ppm	10.84	10.07	65.83	70.83
T_5 =L_1 + IAA 500 ppm	10.33	8.57	78.33	77.08
T_6 =L_1 + IAA 1000 ppm	10.84	8.10	70.00	71.88
T_7 =L_1 + IAA 1500 ppm	10.50	7.90	67.17	67.46
T_8 =L_2 + Control	7.50	7.10	61.33	56.25
T_9 =L_2 + IBA 500 ppm	11.17	10.49	79.50	82.29
T_{10} =L_2+ IBA 1000 ppm	10.17	10.18	68.34	72.92
T_{11} =L_2 + IBA 1500 ppm	9.83	8.38	62.34	70.83
T_{12} =L_2 + IAA 500 ppm	10.84	9.18	78.50	80.21

T_{13} =L_2 + IAA 1000 ppm	10.00	8.02	64.67	68.75
T_{14} =L_2 + IAA 1500 ppm	9.67	7.67	62.67	63.54
S. Em $\pm$	0.22	0.19	1.21	1.53
CD (0.05)	1.64*	1.14*	6.44*	12.55*

* Significant at P=0.05

Table 3. Effect of cutting size and growth regulators on growth and foliage yield performance of *Talinum triangulare* at harvest.

	Plant height (cm)	Number of branches per plant	Number of leaves per plant	Foliage yield per plant (g)	Foliage yield per ha (Q ha^{-1})
Factor A (Stem cuttings)					
L_1 = 5 – 8 cm cutting	39.26	7.28	68.59	85.95	102.73
L_2 =12 – 15 cm cutting	37.22	6.90	65.89	81.31	96.84
CD (0.05)	1.08*	0.47*	4.15*	2.78*	4.93*
Factor B (GRs)					
G_0 = Control	32.71	5.73	51.78	62.21	65.67
G_1 = IBA 500 ppm	46.23	8.56	84.61	112.44	150.58
G_2 = IBA 1000 ppm	40.20	7.94	69.72	97.06	115.58
G_3 = IBA 1500 ppm	36.36	6.50	60.36	74.05	84.08
G_4 = IAA 500 ppm	42.36	7.98	79.42	102.26	128.59
G_5 = IAA 1000 ppm	35.50	6.67	63.78	71.00	80.92
G_6 =IAA 1500 ppm	34.37	6.25	61.06	66.41	73.09
CD (0.05)	2.02*	0.86*	7.75*	5.20*	9.25*
Treatments (A x B)					
T_1 =L_1 + Control	33.52	5.95	58.72	65.91	69.50
T_2 =L_1 + IBA 500 ppm	46.67	8.95	85.00	121.70	164.67
T_3 =L_1 + IBA 1000 ppm	41.05	7.95	73.28	101.34	120.00
T_4 =L_1 + IBA 1500 ppm	38.72	6.78	60.61	69.57	79.00
T_5 =L_1 + IAA 500 ppm	43.05	8.17	77.22	105.63	130.34
T_6 =L_1 + IAA 1000 ppm	37.00	7.00	62.45	69.22	79.33
T_7 =L_1 + IAA 1500 ppm	34.84	6.17	62.89	68.27	76.34
T_8 =L_2 + Control	31.89	5.50	44.83	58.50	61.83
T_9 =L_2 + IBA 500 ppm	45.78	8.17	84.22	103.19	136.50
T_{10} =L_2+ IBA 1000 ppm	39.34	7.95	66.17	92.79	111.17
T_{11} =L_2 + IBA 1500 ppm	34.00	6.22	60.11	78.52	89.17
T_{12} =L_2 + IAA 500 ppm	41.67	7.78	81.61	98.89	126.84
T_{13} =L_2 + IAA 1000 ppm	34.00	6.33	65.11	72.77	82.50
T_{14} =L_2 + IAA 1500 ppm	33.89	6.33	59.22	64.54	69.83
S. Em $\pm$	0.76	0.19	1.92	3.02	4.84
CD (0.05)	2.87*	1.22*	10.95*	7.36*	13.07*

* Significant at P=0.05