Research Article

Effect of Plant Growth Regulators and Different Growing Media on Shooting of *(Momordica charanta L.)* Cuttings under Mist Condition

C. Kumar*, K. K. Nagar, S. Patil and S.K. Nagar

Department of horticulture, School of Agriculture & Allied Science, H.N.B. Garhwal University (A Central University) Srinagar (Garhwal)-246174, Uttarakhand, India

Abstract

A field experiment was conducted during winter season of 2015-16 to study "Effect of Plant Growth Regulators and Different Growing Media on Shooting of *(Momordica charanta L.)* Cuttings Under Mist Condition"." having 16 treatment combinations of tow growth regulators main factor IBA and NAA with concentration 300 ppm, 250 ppm and 200 ppm (C_1- NAA 300 ppm, C_2 NAA 250 ppm, C_3 NAA 200 ppm, C_4 IBA 300 ppm, C_5 IBA 250 ppm, C_6 IBA 200 ppm, C_7 IBA 300 ppm + NAA 300 ppm, C_8 IBA 300 ppm + NAA 250 ppm, C_9 IBA 300 ppm + NAA 200 ppm, C_{10} IBA 250 ppm + NAA 300 ppm, C_{11} IBA 250 ppm + NAA 250 ppm, C_{12} IBA 250 ppm + NAA 200 ppm, C_{13} IBA 200 ppm + NAA 300 ppm, C_{14} IBA 200 ppm + NAA 250 ppm, C_{15} IBA 200 ppm + NAA 200 ppm, C_0 Control) and tow growing media (M_1- Vermiculite and M_2- Perlite). The treatment C_7M_1 (IBA 300 ppm + NAA 300 ppm + Vermiculite) recorded the maximum number of days taken to defoliation (7.56 days), percentage of sprouted cuttings (56.88 %), number of sprouts/cutting (3.33), length of longest sprout (3.63 cm), diameter of thickest sprout (1.76 mm), number of leaves on new shoot (3.24), percentage of survival cuttings (85 %) and treatment C_0M_2 (control with perlite) recorded the maximum percentage of unsprouted cuttings (62.54%) The Shoot was found superior in compare to other growth regulator concentration and growing media.

Keywords: Cutting, Growth regulators and growing media

***Correspondence**
Author: C. Kumar
Email: cknagar43@gmail.com

Introduction

Bitter gourd (*Momordica charantia* L.) is an important commercial cucurbit belongs to the family cucurbitaceae with 2n=2x=22. It is a large genus with many species of annual and perennial climbers. It is known by different names such as balsam pear or bitter cucumber in English and Karela in Hindi. Its native home is Tropical Asia particularly East India and South China. In India, bitter gourd is cultivated over an area of 83,000 hectare, with a production of 9, 06,000 tonnes and productivity 10.9 tonnes per hectare [1]. The fruits contain 4.2 g carbohydrate, 1.6 g protein, 210 I.U vit. A, 88 mg vit. C, 70 mg phosphorus, 20 mg calcium per 100 g of edible portion [2]. Media is a substrate that provides the required elements and physical support to the growing plants. All soils used for media are not always perfect for the rooting of cutting. Rooting in containers have limited volume of soil and nutrients. Media should also have good water holding capacity, drainage and other physical and chemical properties which fulfills the requirements for maximum rooting and better plant growth. Vermiculite is the micaceous mineral which expands significantly when heated. Chemically it is hydrated magnesium, aluminium, iron, silicate. When expanded it is very light in weight. It is neutral in reaction and has good buffering properties. It is insoluble in water. Vermiculite is available in 4 Grades, out of which the Horticultural Grade No. 2 should be used for rooting. Perlite pieces create tiny air tunnels that allow water and air to flow freely to the roots. [3] reported that rooting occurred rapidly when vigorous tips of muskmelon with 4 to 5 nodes were prepared for rooting by immersing the cuttings into perlite with nutrient solution under high relative humidity and intermittent mist until roots had developed. Adventitious rooting (AR) is a multi-factorial response leading to new root in the base of stem cuttings and the establishment of a complete and autonomous plant. AR has two main phases: (a) induction, with a requirement for higher auxin concentration; (b) formation, inhibited by high auxin and in which anatomical changes take place [4]. Auxin plays an important role in cell elongation, cell division, initiation of cambium and early differentiation of xylem and phloem tissues in plants. [5] investigated that Indole Butyric Acid (IBA) is the leading plant hormone used to promote the formation of roots and to generate new roots in tomato plants through cuttings. Naphthalene Acetic Acid (NAA) can significantly

increase the number of root and root length [6]. The best root formation in bitter gourd cuttings in Commercial preparation (diluted 1:10 and 1:20) gave extensive rooting within five days after treatment [7].

Materials and Methods

The experiment was conducted at Horticultural Research Centre and Department of Horticulture, Chauras Campus, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand, India during the Sep. to Nov. 2015. The experiment was conducted to find out the best growing media and appropriate concentration of plant growth regulators for improving the rooting potentially of cuttings, when propagated through shoot cuttings.The experiment consisted having 16 treatment combinations of tow growth regulators main factor IBA and NAA with concentration 300 ppm, 250 ppm and 200 ppm (C_1- NAA 300 ppm, C_2 NAA 250 ppm, C_3 NAA 200 ppm, C_4 IBA 300 ppm, C_5 IBA 250 ppm, C_6 IBA 200 ppm, C_7 IBA 300 ppm + NAA 300 ppm, C_8 IBA 300 ppm + NAA 250 ppm, C_9 IBA 300 ppm + NAA 200 ppm, C_{10} IBA 250 ppm + NAA 300 ppm, C_{11} IBA 250 ppm + NAA 250 ppm, C_{12} IBA 250 ppm + NAA 200 ppm, C_{13} IBA 200 ppm + NAA 300 ppm, C_{14} IBA 200 ppm + NAA 250 ppm, C_{15} IBA 200 ppm + NAA 200 ppm, C_0 Control) and tow growing media (M_1- Vermiculite and M_2- Perlite). The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The observations length of longest sprout was recorded in centimeters from ground to tip of the sprout, diameter of think sprout recorded in centimeter, number of leaves produced was counted after emergence of shoot, number of sprout per cutting counted.

Statistical analysis

The experiment was laid out in the Factorial Randomized Block Design (FRBD) with three replications as described by [8]. The recorded data on different parameters were statistically analyzed using AGRES software (two factors) to find out the significance of variation resulting from the experimental treatments. The mean for the treatments was calculated and analysis of variance for each of the characters was performed by F (variance ratio) test. The differences between the treatment means were evaluated by LSD test at 5% probability.

Result

The result present in **Table 1** indicated that Days taken to defoliation were found significant in respect of concentrations of plant growth regulators. The highest no. of days taken to defoliation (6.78) was recorded when treated by C_8 (IBA 300 + NAA 300 ppm) followed by (6.55) in C_8 (IBA 300 + NAA 250 ppm). The minimum no. of days taken to defoliation (3.78) was recorded under C_0 (control) treatment.

The result present in **Table 2** indicated that Days taken to defoliation were found significant in respect of growing media. The highest no. of days taken to defoliation (5.14) was recorded under M_1 (vermiculite) growing media followed by (4.7) in M_2 (perlite) growing media.

The result present in **Table 3** indicated that effect of interaction between concentration of growth regulators and growing media were also found not significant. The maximum no. of days taken to defoliation (7.56) were recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination followed by (6.56) in C_8M_1 while the minimum no. of days taken to defoliation (3.22) was recorded under C_0M_2 (control with perlite) treatment combination.

The result present in Table 1 indicated that percentage of sprouted cuttings was found significant in respect of concentrations of plant growth regulators. The highest percentage of sprouted cuttings (57.59%) were recorded when planted with C_7 (IBA 300 + NAA 300 ppm) treatment followed by (54.81%) in C_8 (IBA 300 + NAA 250 ppm). The minimum percentage of sprouting cuttings (38.83%) was recorded under C_0 (control) treatment.

The result present in Table 2 indicated that percentage of sprouted cuttings was found significant in respect of growing media. The highest percentage of sprouted cuttings (47.61%) was recorded under M_1 (vermiculite) growing media followed by (46.5%) in M_2 (perlite) growing media.

The result present in Table 3 indicated that effect of interaction between growth regulators treatments and growing media were also found significant. The maximum percentage of sprouted cuttings (59.67%) was recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination followed by (56.88%) in C_8M_1 and $C_{10}M_2$ (IBA 300 + NAA 250 ppm with vermiculite and IBA 250 + NAA 300 ppm with perlite) while the minimum percentage of sprouted cuttings (46.5%) was recorded under C_0M_2 (control with perlite) treatment combination.

Table 1 Effect of concentrations of plant growth regulator on shooting of cutting

Concentrations (C)	No. of Days taken to defoliation	% of sprouted cutting	% of unsprouted cutting	No. of sprouts/ cutting	Longest length of shoot (cm)	Thickest diameter of shoot (mm)	No. of leaves on new shoot	Survival %
C_1	4.04	42.31	57	2.57	2.91	1.31	2.2	64.17
C_2	3.89	41.62	58.38	2.56	2.87	1.3	2.17	62.5
C_3	3.83	40.25	59.74	2.45	2.86	1.17	2.13	61.67
C_4	4.5	43.02	56.98	2.66	2.98	1.33	2.2	68.33
C_5	4.17	43	57.69	2.55	2.9	1.32	2.32	65.83
C_6	4.05	41.62	58.38	2.53	2.87	1.3	2.21	65.83
C_7	6.78	57.59	42.41	3.23	3.59	1.7	3.03	82.5
C_8	6.06	54.81	45.19	3.2	3.53	1.64	2.97	80.83
C_9	5.39	52.06	47.93	3.03	3.45	1.42	2.72	77.5
C_{10}	5.61	53.41	46.59	3.14	3.52	1.57	2.59	74.17
C_{11}	5.39	50.67	49.17	3.03	3.44	1.48	2.53	75.83
C_{12}	5.33	47.88	52.12	2.94	3.44	1.42	2.45	70
C_{13}	5.6	51.38	48.62	3.1	3.39	1.52	2.61	72.5
C_{14}	5.28	50.68	49.31	3.01	3.32	1.41	2.43	69.17
C_{15}	4.67	43.7	56.3	2.64	2.9	1.35	2.32	69.17
C_0	3.78	38.83	61.21	2.4	2.84	1.15	2.11	60.83
S.Em.±	0.45	1.6	1.62	0.05	0.03	0.01276	0.05	2.04
C.D. at 5%	0.91	3.21	3.23	0.09	0.06	0.0255	0.11	4.08

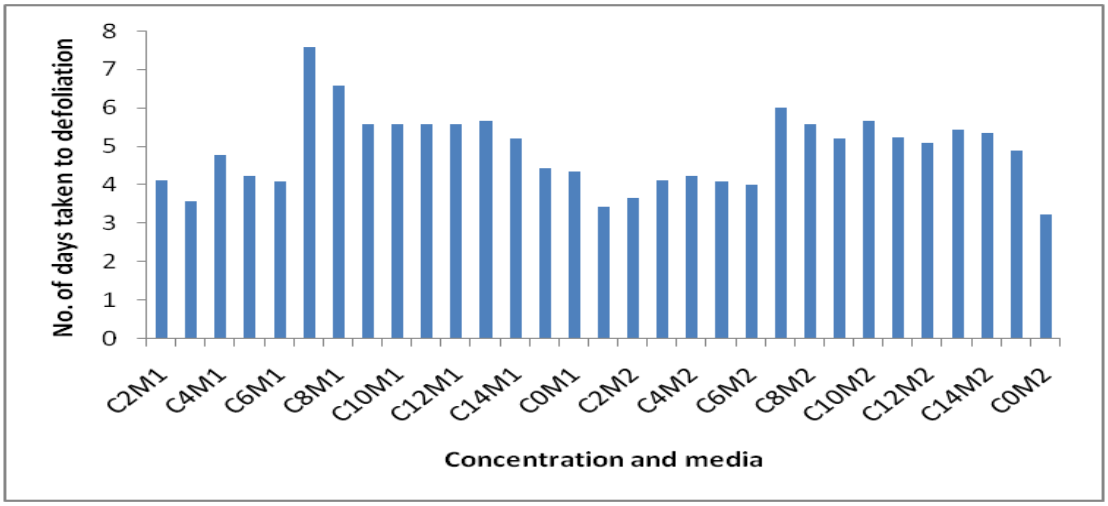

Figure 1 Effect of plant growth regulator and different growing media on days taken to defoliation

Table 2 Effect of growing media on shootinf of cutting

Media (M)	No. of Days taken to defoliation	% of sprouted cutting	% of unsprouted cutting	No. of sprouts/ cutting	Longest length of shoot (cm)	Thickest diameter of shoot (mm)	No. of leaves on new shoot	Survival %
M_1	5.14	47.61	52.37	2.9	3.21	1.43	2.5	71.67
M_2	4.7	46.5	53.5	2.77	3.13	1.38	2.43	68.43
S.Em.±	0.16	0.56	0.57	0.02	0.01	0.00451	0.02	0.72
C.D. at 5%	0.32	1.13	1.14	0.03	0.02	0.00902	0.04	1.44

The result present in Table 1 indicated that percentages of unsprouted cuttings were found significant in respect of various concentrations of plant growth regulators. The highest percentage of unsprouted cuttings (61.21%) were recorded when planted C_0 (control) followed by (59.74%) in C_3 (NAA 200 ppm) growth regulator concentration. The minimum percentage of unsprouting cutting (42.41%) was recorded under C_7 (IBA 300 + NAA 300 ppm) growth regulator concentration.

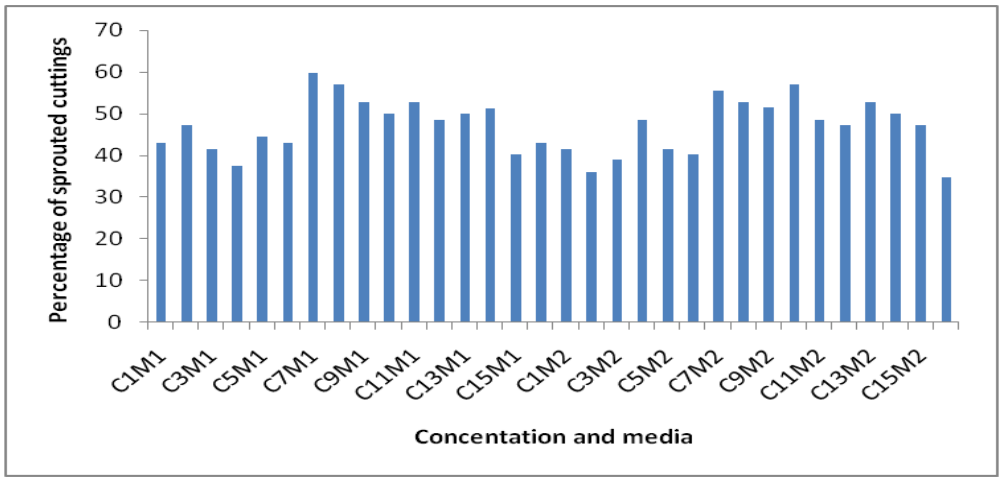

Figure 2 Effect of plant growth regulators and different growing media on percentage of sprouted cuttings

Table 3 Effect of concentrations of plant growth regulator and growing media on shooting of cutting

Inter action (C x M)	No. of Days taken to defoliation	% of sprouted cutting	% of unsprouted cutting	No. of sprout/ cutting	Longest length of shoot (cm)	Thickest diameter of shoot (mm)	No. of leaves on new shoot	Survival %
$C_1 M_1$	4.66	43	55.62	2.61	3.15	1.34	2.24	68.33
$C_2 M_1$	4.11	47.17	52.83	2.37	2.87	1.34	2.2	68.33
$C_3 M_1$	3.56	41.62	58.38	2.55	2.89	1.35	2.24	65
$C_4 M_1$	4.78	37.45	62.54	2.44	3.24	1.37	2.47	70
$C_5 M_1$	4.22	44.38	57	2.62	2.81	1.22	2.12	68.33
$C_6 M_1$	4.1	43	57	2.88	2.8	1.21	2.03	58.33
$C_7 M_1$	7.56	59.67	40.33	3.33	3.63	1.76	3.24	85
$C_8 M_1$	6.56	56.88	43.12	3.3	3.58	1.68	3.14	83.33
$C_9 M_1$	5.56	52.74	47.24	3.11	3.5	1.43	2.62	78.33
$C_{10} M_1$	5.56	49.95	50.04	3.03	3.42	1.54	2.63	75
$C_{11} M_1$	5.56	52.74	46.91	3.11	3.54	1.53	2.59	76.67
$C_{12} M_1$	5.56	48.59	51.41	3.03	3.39	1.48	2.53	73.33
$C_{13} M_1$	5.67	50	50	3	3.47	1.53	2.44	73.33
$C_{14} M_1$	5.21	51.37	48.623	3.08	3.38	1.43	2.56	71.67
$C_{15} M_1$	4.44	40.25	59.75	2.66	2.94	1.38	2.41	63.33
$C_0 M_1$	4.33	43	57.1	2.73	2.87	1.28	2.22	68.33
$C_1 M_2$	3.44	41.62	58.38	2.51	2.68	1.29	2.16	60
$C_2 M_2$	3.67	36.09	63.91	2.77	2.87	1.25	2.14	56.67
$C_3 M_2$	4.11	38.88	61.12	2.37	2.83	0.99	2.02	58.33
$C_4 M_2$	4.22	48.59	51.41	2.88	2.71	1.3	2.33	66.67
$C_5 M_2$	4.1	41.62	58.38	2.48	2.97	1.41	2.51	63.33
$C_6 M_2$	4	40.24	59.74	2.18	2.93	1.4	2.4	73.33
$C_7 M_2$	6	55.5	44.5	3.14	3.53	1.64	2.82	80
$C_8 M_2$	5.56	52.74	47.24	3.11	3.5	1.61	2.79	78.33
$C_9 M_2$	5.21	51.38	48.62	2.95	3.4	1.41	2.81	76.67
$C_{10} M_2$	5.67	56.88	43.12	3.25	3.61	1.6	2.54	73.33
$C_{11} M_2$	5.22	48.59	51.41	2.95	3.34	1.42	2.48	75
$C_{12} M_2$	5.1	47.17	52.83	2.84	3.5	1.38	2.37	66.67
$C_{13} M_2$	5.44	52.74	47.24	3.19	3.3	1.52	2.77	71.67
$C_{14} M_2$	5.33	50	50	2.95	3.27	1.39	2.3	66.67
$C_{15} M_2$	4.89	47.17	52.83	2.62	2.87	1.33	2.23	75
$C_0 M_2$	3.22	34.67	65.33	2.08	2.82	0.98	2	53.33
S.Em. ±	0.65	2.27	2.28	0.07	0.04	0.01804	0.08	2.88
C.D. at 5%	1.29	4.56	4.56	0.13	0.09	0.03606	0.15	5.76

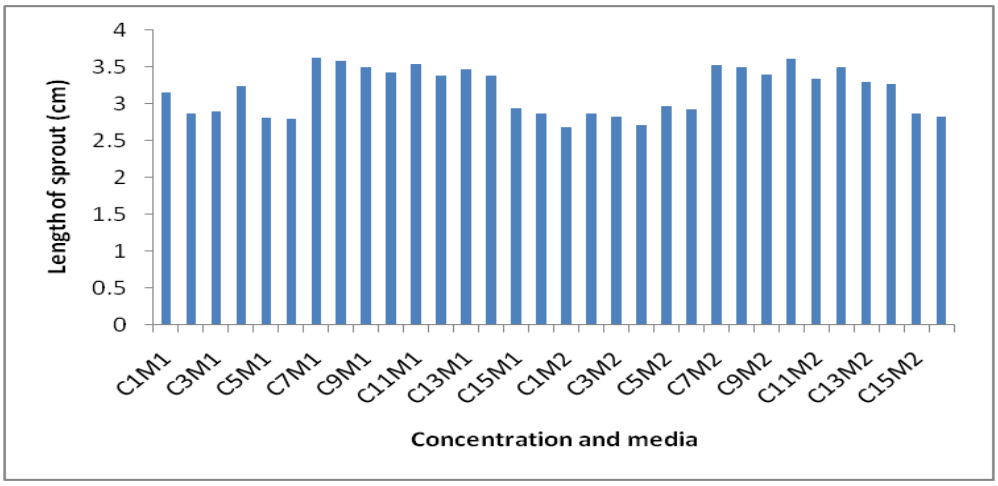

Figure 3 Effect of plant growth regulators and different growing media on length of longest sprout (cm)

The result present in Table 2 indicated that percentages of unsprouted cuttings were found significant in respect of growing media. The maximum percentage of unsprouted cuttings (53.50%) were recorded under M_2 (perlite) growing media while the lowest percentage of unsprouted cuttings (52.37%) was recorded under M_1 (vermiculite) growing media.

The result present in Table 3 indicated effect of interaction between plant growth regulators concentration and growing media were also found significant. The maximum percentage of unsprouted cuttings (65.33%) were recorded under C_0M_2 (control with perlite) treatment combination followed by (62.54%) in C_4M_1 (IBA 300 ppm with vermiculite). The minimum percentage of unsprouted cuttings (40.33%) was recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination.

The result present in Table 1 indicated that average number of sprouts per cutting was found significant in respect of concentrations of plant growth regulators. The highest average number of sprouts per cutting (3.23) was recorded when planted C_7 (IBA 300 + NAA 300 ppm) planting time followed by (3.20) in C_8 (IBA 300 + NAA 250 ppm) planting time. The minimum average number of sprouts per cutting (2.40) was recorded under C_0 (control) treatment.

The result present in Table 2 indicated that average number of sprouts per cutting was found significant in respect of growing media. The highest average number of sprouts per cutting (2.90) was recorded under M_1 (vermiculite) growing condition while the lowest average number of sprouts per cutting (2.77) was recorded under M_2 (perlite) growing media.

The result present in Table 3 indicated that effect of interaction between concentrations of plant growth regulators and growing media were also found significant. The maximum average number of sprouts per cutting (3.33) was recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination followed by (3.30) in C_8M_1 (IBA 300 + NAA 250 ppm with vermiculite). The minimum average number of sprouts per cutting (2.08) was recorded under C_0M_2 (control with perlite) treatment combination.

The data presented in Table 1 indicated that concentrations of plant growth regulators were found significant. The highest length of longest sprout (3.59 cm) was recorded when planted C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulators followed by (3.53 cm) in C_8 (IBA 300 + NAA 250 ppm). The minimum length of longest sprout (2.84 cm) was recorded under C_0 (control) concentration of growth regulators.

The data presented in Table 2 indicated that growing media were found significant. The highest length of longest sprout (3.21 cm) was recorded under M_1 (vermiculite) growing media while the lowest length of longest sprout (3.13 cm) was recorded under M_2 (perlite) growing media.

The data presented in Table 3 indicated that effect of interaction between concentrations of plant growth regulators and growing media were also found significant. The maximum length of longest sprout (3.63 cm) was recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination followed by (3.58 cm) in C_8M_1 (IBA 300 + NAA 250 ppm with vermiculite). The minimum length of longest sprout (2.8 cm) was recorded under C_6M_1 (IBA 250 ppm with vermiculite) treatment combination.

The result present in Table 1 indicated that diameter of thickest sprout was found significant in respect of concentrations of plant growth regulators. The highest diameter of thickest sprout (1.70 mm) was recorded when planted C_7 (IBA 300 + NAA 300 ppm) concentration of plant growth regulators followed by (1.64 mm) in C_8 (IBA 300 + NAA 250 ppm). The minimum diameter of thickest sprout (1.15 mm) was recorded under C_0 (control) concentration.

The result present in Table 2 indicated that diameter of thickest sprout was found significant in respect of growing media. The highest diameter of thickest sprout (1.43 mm) was recorded under M_1 (vermiculite) growing media while the lowest diameter of thickest sprout (1.38 mm) was recorded under M_2 (perlite) growing media.

The result present in Table 3 indicated that effect of interaction between concentrations of plant growth regulators and growing media were also found significant. The maximum diameter of thickest sprout (1.76 mm) was recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination followed by (1.68 mm) in C_8M_1 (IBA 300 + NAA 250 ppm with vermiculite). The minimum diameter of thickest sprout (0.98 mm) was recorded under C_0M_2 (control with perlite) treatment combination.

The result present Table 1 indicated that numbers of leaves on new shoot was found significant in respect of concentrations of plant growth regulators (Appendix VIII). The highest number of leaves on new shoots (3.03) were recorded when planted C_7 (IBA 300 + NAA 300 ppm) concentration followed by (2.97) in C_8 (IBA 300 + NAA 250 ppm). The minimum number of leaves on new shoots (2.11) was recorded under C_0 (control) concentration of growth regulators.

The result present Table 2 indicated that numbers of leaves on new shoots were found significant in respect of growing media. The highest number of leaves on new shoots (2.50) was recorded under M_1 (vermiculite) growing media followed by (2.43) in M_2 (perlite) growing media.

The result present Table 3 indicated that effect of interaction between concentrations of growth regulators and growing media were also found significant. The maximum number of leaves on new shoots (3.24) were recorded under C_7M_1 (IBA 300 + NAA 300 with vermiculite) treatment combination followed by (3.14) in C_8M_1 (IBA 300 + NAA 250 with vermiculite). The minimum number of leaves on new shoots (2.0) were recorded under C_0M_2 (control with perlite) treatment combination.

The result present in Table 1 indicated that concentrations of growth regulators were found significant regarding percentage of survival cuttings. The highest percentage of survival cuttings (82.50%) were recorded when planted C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulators followed by (80.83%) in C_8 (IBA 300 + NAA 250 ppm). The minimum percentage of survival cuttings (60.83%) was recorded under C_0 (control).

The result present in Table 2 indicated that growing media were found significant regarding percentage of survival cuttings. The highest percentage of survival cuttings (71.67%) were recorded under M_1 (vermiculite) growing media followed by (68.43%) in M_2 (perlite) growing media.

The result present in Table 3 indicated that effect of interaction between various concentrations of growth regulators and growing media were also found significant. The maximum percentage of survival cuttings (85.0%) were recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination followed by (83.33%) in C_8M_1 (IBA 300 + NAA 250 ppm with vermiculite). The minimum percentage of rooted cuttings (53.33%) were recorded under C_0M_2 (control with perlite) treatment combination.

Discussion

The highest no. of days taken to defoliation was recorded under C_8 (IBA 300 + NAA 300 ppm) concentration of growth regulators. M_1 (vermiculite) growing media take the highest no. of days to defoliation which was significantly higher than other growing media. The effect of interaction of concentration of growth regulators and growing media was also not significant. The maximum no. of days taken to defoliation was associated in C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination. Leaf presence has a profound effect on the rooting of bitter melon stem cutting. Apparently, leaf presence promotes rooting through increase in the levels of putrescine, and perhaps spermidine, in the rooting zone of the bitter melon stem cutting. These finding also agree with the findings of [7] in respect to average number of days to defoliation in bitter gourd cutting.

The highest percentage of sprouted cuttings was recorded under C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulators. M_1 (vermiculite) growing media produced the highest percentage of sprouted cuttings which was significantly higher than perlite growing media. The effect of interaction of concentration of growth regulators and growing media was also significant. The maximum percentage of sprouted cuttings was associated in C_2M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination. Carbohydrate reserves in the cuttings are responsible for the maximum sprouting. It may be affected by season and several factors such as temperature, light and nutrient availability to the survival percentage of cuttings. These finding also agree with the findings of [9] in respect to average number of sprouted cutting in bitter melon.

The effect of various concentrations of growth regulators on percentage of unsprouted cuttings was significantly influenced. C_0 (control) showed inferiority over other concentration of growth regulators. The maximum percentage of unsprouted cuttings was recorded when cuttings were M_2 (perlite) growing media. The interaction between

concentrations of growth regulators and growing media was found significant. The maximum percentage of unsprouted cuttings was noticed under the C_0M_2 (control with perlite) treatment combination [10]. postulates that lack of sprouting of cutting were mainly due to lack of root initiation in response to applied auxin.

The highest average number of sprouts per cutting was observed with C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulators. The average numbers of sprouts per cutting were significantly higher when cuttings were M_1 (vermiculite) growing media. The interaction of planting time and growing condition was found significant. The higher average numbers of sprouts per cutting were recorded under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination. The better number of sprouts per cutting with optimum concentration of growth regulators and growing media might be ascribed due to better root growth which augmented absorption and translocation of nutrients from soil which take active part in various plant metabolic processes [11]. The findings of present study are similar to the findings of [12] in *Cucumis sativus* vars, sativus and hardwickii.

Significantly the highest length of longest sprout was found under C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulator. The maximum average length of longest sprout was recorded under M_1 (vermiculite) growing media. This may be due to favourable environmental conditions to the length of sprout per cutting. The interaction between concentration of growth regulators and growing media was found significant in respect of average length of longest sprout. The maximum length of longest sprout was produced under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination. Sprout length may be due to better utilization of stored carbohydrates, nitrogen and other factors with the aid of growth regulators. The present findings are similar to the findings of [13] in *Citrullus lanatu*s cv. Round Dragon.

Significantly the highest average diameter of thickest sprout was observed under C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulators. Temperature and relative humidity prevailing during this period is responsible for the higher diameter. M_1 (vermiculite) growing media exhibited the maximum diameter of thickest sprout. The interaction between concentration of growth regulators and growing media was found significant. The maximum average diameter of thickest sprouts was produced under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination. The invigorated growth of shoot with IBA 300 + NAA 300 ppm growth regulators synchronized due to maximum diameter of thickest sprouts in these treatments which might have produce more assimilates and resulted in thickest shoot growth. These findings also agree with the findings of [14] in Pointed Gourd.

Number of leaves on new shoots was found significant. The maximum average number of leaves on new shoots was obtained under C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulators. The maximum average number of leaves on new shoots was recorded under M_1 (vermiculite) growing media. The interaction between concentration of growth regulators and growing media was found significant in respect of average number of leaves on new shoots. The maximum average number of leaves on new shoots was produced by C_7M_1 (IBA 300 + NAA 300 with vermiculite) treatment combination. The appropriate growing media, application of IBA and NAA as well as genetic makeup of genotype use may have played some role in augmenting the number of leaves per cutting [15]. These findings are agreed with the findings of [16] in fluted pumpkin **(***Telfairia occidentalis***)**.

Growth regulators and growing media affected the survival percentage significantly. C_7 (IBA 300 + NAA 300 ppm) concentration of growth regulators exhibited higher survival percentage. Carbohydrate reserves in the cuttings are responsible for the maximum sprouting. It may be affected by season and several factors such as temperature, light and nutrient availability to the survival percentage of cuttings. Among various growing media, M_1 (vermiculite) growing media produced the maximum survival percentage. The interaction of planting time and growing condition was also found significant. The maximum shoot percentages were produced under C_7M_1 (IBA 300 + NAA 300 ppm with vermiculite) treatment combination. The present study substantiated the earlier findings of [17] in cucumber cuttings.

Conclusion

Among various concentration of growth regulators and growing media, it may be concluded that combination of IBA 300 + NAA 300 with vermiculite give the best performance of cuttings of bitter gourd in terms of shoot parameters.

Reference

[1] Anonymous, 2015. Indian Horticulture Database, National Horticulture Board, Ministry of Agriculture, Government of India.

[2] Thriveni, V.; Mishra, H. N.; Pattanayak, S. K.; Sahoo G. S. and Thomson, T. (2015). Effect of inorganic, organic fertilizers and biofertilizers on growth, flowering, yield and quality attributes of bitter gourd, Momordica charantia L. International Journal of Farm Sciences, 5(1): 24-29.
[3] Khan, M. M.; Khan, A. M.; Abbas, M.; Jaskani, M. J.; Ali, M. A. and Haider, A. (2006). Evaluation of potting media for the production of rough lemon nursery stock. Pak. J. Bot., 38(3): 623-629.
[4] Costa, D.; Almeida, M. R.; Ruedell, C. M.; Schwambach, J.; Maraschin, F. S. and Fett-NetoA. G. (2013) . Hormonal controls of adventitious rooting in cuttings. Plant Cell Biology, 133: 1-19.
[5] Rao, V. K.; Kasula, K.; Umate, P.; Sree, T.; Rao A. V. and Abbaganisadanandam. (2005). Introduction of multiple shoots from leaf segments, in vitro flowering and fruiting of dwarf tomato. J. Pl. Physiol., 162(8): 959-962.
[6] Sridhar, G.; Koti, R. V.; Chetti, M. B. and Hiremath, S. M. (2009). Effect of naphthalene acetic acid and mepiquat chloride on physiological components of yield in bell pepper (Capsicum annuum L.). J. Agric. Res., 47(1): 53-62.
[7] Malik, N. S. A.; Perez, J. L. and Kunta, M. (2012). The effect of leaf presence on the rooting of stem cutting of bitter melon and on changes in polyamine levels, 7: 936-940.
[8] Cochran, W.G. and Cox, G.M., (1992). Experimental Designs. John Wiley and Sons, Inc., New York.
[9] Nag, S.; Saha, K. and Choudhuri, M. A. (2001). Role of auxin and polyamines in adventitious root formation in relation to changes in compounds involved in rooting. Journal of Plant Growth Regulation, 20: 182-194.
[10] Mansur, M. A. Z.; Haque, M. S.; Nasiruddin, K. M. and Hossain, M.S. (2009). In vitro propagation of bitter gourd (Momoridica charantia L.) from nodal and root segments. Plant Tissue Culture and Biotechnology, 19: 45-52.
[11] Singh, A.K. (2001b). Effect of auxins on rooting and survival of jasmine (Jasminum sambac Ait.) stem cuttings. Prog. Hort., 33(2): 174-177.
[12] Punja, Z. K.; Abbas, N.; Sarmento, G.G. and Tang, F. A. (1990). Regeneration of Cucumis sativus vars, sativus and hardwickii, C. melo and C. metuliferus from explants through somatic embryogenesis and organogenesis. Influence of explant source, growth regulator regime and genotype. Plant Cell Tiss. Organ Cult., 21: 93-102.
[13] Ganasan, K. and Huyop, F. (2010). In vitro regeneration of Citrullus lanatus cv. Round Dragon. J. Biol. Sci., 10: 131-137.
[14] Kumar, S.; Singh, M.; Singh, A. K.; Srivastava, K. and Banerjee, M. K. (2003). In vitro Propagation of Pointed Gourd (Trichosanthes dioica Roxb.). Cucurbit Genetics Cooperative Report, 26: 74-75.
[15] Singh, A. K. and Singh, V. B. (2002). Influence of wood maturity and auxin on the regeneration of Bougainvillea cuttings. Prog. Hort., 34(2): 196-199.
[16] Balogun, M. O.; Akande, S. R. and Ogunbodede, B. A. (2007). Effects of plant growth regulators on callus, shoot and root formation in fluted pumpkin (Telfairia occidentalis). African Journal of Biotechnology, 6(4): 355-358.
[17] Jasim, A. H. and Abed, H. M. (2013). Effect of some treatments on rooting of cucumber cuttings (Cucumis sativus L.). Euphrates Journal of Agriculture Science, 5(4): 11-16.

Publication History
Received 23rd June 2017
Revised 12th July 2017
Accepted 15th July 2017
Online 30th July 2017