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C:N RATIO AS INFLUENCED BY SEASON AND IBA TREATMENT DURING THE RHIZOGENESIS IN WEST INDIAN CHERRY CUTTINGS

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Abstract

C:N ratio as influenced by season and IBA treatment during the rhizogenesis in west Indian cherry cuttings was studied under Venkataramannagudem, Andhra Pradesh conditions, during the year 2015-16. Carbohydrates, proteins, phenols, survival percentage of rooted cuttings, percentage of establishment of rooted cuttings were found to be maximum with the cuttings planted in the month of July. They only recorded maximum percentage of establishment of rooted cuttings, but they were found to have the minimum value of C:N ratio at the end of rooting experiment. Hard wood type of cuttings treated with IBA at the concentration of 3000 ppm were found to be better as compared to other combinations of cuttings type and IBA cocentrations.

Key words : Cherry, cuttings, IBA, C:N ratio.

Introduction

The West Indian cherry fruits are soft, juicy, thin skinned and are light to deep crimson coloured when mature. The three-lobed fruits are borne on leaf axils, singly or in clusters of two or three. The flesh is yellowish orange and is a rich source of vitamin C (ascorbic acid), proteins and minerals. In Andhra Pradesh very few West Indian cherry plantations are available with known sources of planting material, on account of deficiency of suitable and popular method of propagation. Vegetative propagation in West Indian cherry is utmost desirable in order to propagate true-to-type plants. West Indian cherry can be propagated by air –layering, cleft or modified crown grafting but the most common method of propagation is by stem cutting. Propagation of this crop by stem cuttings is known to give a well-developed and strong frame work in considerably less time. This type of vegetative propagation is inexpensive, rapid and simple and does not require the special techniques as in case other methods.

Materials and Methods

The study on rhizogenesis in west Indian cherry cuttings was conducted during 2015-2016 at Horticulture College and Research Institute, Dr.Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District, Andhra Pradesh, India. The experiment was laid out in factorial completely randomized design with three factors *viz.,* month of planting (4 levels), type of cutting (2 levels) and IBA concentration (2 levels), making sixteen treatment combinations which were replicated thrice. Semihard wood and hard wood cuttings were planted during the months of July, August, September and October after treating with IBA at 1500 ppm and 3000 ppm levels. After the treatment with IBA the cuttings were planted in the normal potting mixture consisting of soil, sand and FYM in 2:1:1 proportion and the observations on various parameters were recorded as presented below.

Results and Discussion

Carbohydrates (%)

The carbohydrates content present in cuttings of West Indian cherry differed significantly due to month, type of cuttings and IBA concentration at 30, 60 and 90 DAP (table 1 and fig. 1). At 90 DAP, the cuttings planted in the month of July had the minimum percentage of carbohydrates (4.99%), which was followed by August (5.16%). Maximum percentage of carbohydrates was found in October (6.22%). The hardwood cuttings were showing the highest carbohydrates (5.49%) compared to those semi hardwood cuttings (5.32%).

Similarly, cuttings treated with IBA at 3000 ppm recorded the highest carbohydrates content (5.62%) as compared to those treated by IBA at 1500 ppm (5.41%).

Table 1 : Effect of time, type of cuttings and IBA concentration on periodical changes in carbohydrate content (%) in West Indian cherry.

Type of cutting (B)	IBA Concentration (C)	Month of Planting (A)														
		30 DAP					60 DAP					90 DAP				
		Jul.	Aug.	Sep.	Oct.	Mean	Jul.	Aug.	Sep.	Oct.	Mean	Jul.	Aug.	Sep.	Oct.	Mean
Semi hard wood	1500 ppm	6.32	6.18	6.34	6.89	**6.43**	5.62	5.50	5.64	6.13	**5.72**	4.86	4.94	5.28	5.99	**5.27**
	3000 ppm	6.59	6.40	6.40	6.92	**6.58**	5.86	5.70	5.69	6.16	**5.85**	4.99	5.12	5.33	6.02	**5.37**
	Mean	**6.45**	**6.29**	**6.37**	**6.91**	**6.50**	**5.74**	**5.60**	**5.67**	**6.15**	**5.79**	**4.93**	**5.03**	**5.31**	**6.01**	**5.32**
Hard wood	1500 ppm	6.59	6.65	6.94	7.31	**6.87**	5.87	5.92	6.17	6.51	**6.12**	5.07	5.32	5.78	6.36	**5.63**
	3000 ppm	6.81	6.85	7.15	7.89	**7.18**	6.06	6.10	6.37	7.02	**6.39**	5.16	5.48	5.96	6.86	**5.87**
	Mean	**6.70**	**6.75**	**7.04**	**7.60**	**7.02**	**5.96**	**6.01**	**6.27**	**6.77**	**6.25**	**5.00**	**5.18**	**5.53**	**6.25**	**5.49**
For comparing month of planting (A) and IBA concentration(C)																
1500 ppm		6.45	6.41	6.64	7.10	**6.65**	5.74	5.71	5.91	6.32	**5.92**	4.97	5.13	5.53	6.18	**5.45**
3000 ppm		6.70	6.63	6.77	7.41	**6.88**	5.96	5.90	6.03	6.59	**6.12**	5.08	5.30	5.65	6.44	**5.62**
Mean		**6.58**	**6.52**	**6.71**	**7.25**	**6.76**	**5.85**	**5.80**	**5.97**	**6.46**	**6.02**	**4.99**	**5.16**	**5.50**	**6.22**	**5.47**
Comparing means of		SE(m)		C.D			SE(m)		C.D			SE(m)		C.D		
		0.06		0.17			0.05		0.15			0.09		0.28		
B		0.06		0.19			0.05		0.17			0.02		0.06		
C		0.03		0.08			0.02		0.07			0.02		0.06		
AxB		0.11		0.34			0.10		0.30			0.11		0.32		
BxC		0.08		0.26			0.07		0.23			0.04		0.12		
AxC		0.08		0.24			0.07		0.21			0.10		0.32		
AxBxC		0.14		0.42			0.12		0.37			0.12		0.38		

Proteins (%)

The protein content in the cuttings of West Indian cherry differed significantly due to month, type of cuttings and IBA concentration at 30, 60 and 90 DAP (table 2 and fig. 2). At 90 DAP, the cuttings planted in the month of July had the maximum percentage of proteins (4.87%) followed by August (4.58%). Minimum percentage of protein was found in October (4.05%). The hardwood cuttings showed the highest protein content (4.49%) compared to semi hardwood cuttings (4.33%). The cuttings treated with IBA at 3000 ppm recorded significantly higher protein content (4.62%) as compared to those treated by IBA at 1500 ppm (4.44%).

C:N ratio

The C:N ratio in the cuttings of West Indian cherry showed significant variations due to month, type of cuttings and IBA concentration as well their interactions at 90 DAP (table 3). The cuttings planted in the month of July recorded the minimum value of C:N ratio (6.40) which was on par with August (7.03). Maximum C:N ratio was found in the cuttings planted in October month (9.59). Hardwood cuttings exhibited a C:N ratio of 7.69 as against 7.74 in semi hardwood cuttings. The IBA treatment at 3000 ppm concentration recorded lesser C:N ratio (7.68) as compared to the same treatment at 1500 ppm concentration (7.75).

It is interesting to note that July planted cuttings recorded significantly lesser value of C:N ratio at 90 DAP as compared to those planted in other months, which might be due to a gradual and maximum transition of

Table 2 : Effect of time, type of cuttings and IBA concentration on periodical changes in protein content (%) in West Indian cherry.

Type of cutting (B)	IBA Concentration (C)	Month of Planting (A)														
		30 DAP					60 DAP					90 DAP				
		Jul.	Aug.	Sep.	Oct.	Mean	Jul.	Aug.	Sep.	Oct.	Mean	Jul.	Aug.	Sep.	Oct.	Mean
Semi hard wood	1500 ppm	3.59	3.42	3.31	3.13	**3.36**	4.30	4.11	3.97	3.75	**4.03**	4.68	4.35	4.10	3.80	**4.23**
	3000 ppm	3.64	3.54	3.52	3.37	**3.52**	4.37	4.25	4.22	4.05	**4.22**	4.84	4.50	4.32	4.05	**4.43**
	Mean	**3.61**	**3.48**	**3.41**	**3.25**	**3.44**	**4.34**	**4.18**	**4.10**	**3.90**	**4.13**	**4.76**	**4.43**	**4.21**	**3.93**	**4.33**
Hard wood	1500 ppm	3.86	3.76	3.73	3.47	**3.71**	4.63	4.52	4.48	4.17	**4.45**	5.00	4.76	4.60	4.19	**4.64**
	3000 ppm	3.90	3.93	3.86	3.61	**3.82**	4.68	4.72	4.63	4.33	**4.59**	5.14	4.96	4.75	4.38	**4.81**
	Mean	**3.88**	**3.85**	**3.79**	**3.54**	**3.77**	**4.66**	**4.62**	**4.55**	**4.25**	**4.52**	**4.88**	**4.60**	**4.40**	**4.07**	**4.49**
For comparing month of planting (A) and IBA concentration(C)																
1500 ppm		3.72	3.59	3.52	3.30	**3.53**	4.47	4.31	4.22	3.96	**4.24**	4.84	4.56	4.35	4.00	**4.44**
3000 ppm		3.77	3.74	3.69	3.49	**3.67**	4.53	4.48	4.43	4.19	**4.41**	4.99	4.73	4.54	4.22	**4.62**
Mean		**3.75**	**3.66**	**3.60**	**3.40**	**3.60**	**4.50**	**4.40**	**4.33**	**4.07**	**4.32**	**4.87**	**4.58**	**4.37**	**4.05**	**4.47**
Comparing means of			SE(m)		C.D			SE(m)		C.D			SE(m)		C.D	
			0.03		0.08			0.03		0.09			0.06		0.18	
	B		0.04		0.12			0.05		0.14			0.02		0.06	
	C		0.02		0.05			0.02		0.06			0.02		0.07	
	A x B		0.06		0.18			0.07		0.22			0.07		0.22	
	B x C		0.05		0.16			0.06		0.19			0.04		0.12	
	A x C		0.04		0.12			0.05		0.14			0.07		0.23	
	A x B x C		0.08		0.23			0.09		0.28			0.09		0.28	

carbohydrates to proteins in July planted cuttings. The results obtained on root and shoot parameters are also in conformity with this. July planted cuttings exhibited maximum utility of carbohydrates and maximum formation of proteins as well as maximum content of nitrogen. Similar trend was also seen in case of IBA treatments in that the treatment with IBA at 3000 ppm excelled in nitrogen as well as protein content at 90 DAP.

The July planted cuttings and IBA (3000 ppm) treated cuttings were influenced by higher root promoting effects which might be to a certain extent due to the utilization of carbohydrates in the root forming region. Regeneration took place mainly through utilization of soluble sugars. The high nitrogen content at 90 DAP could be indicative to the response of cuttings to applied auxins. Assimilation of maximum nitrogen through strong root system coupled with a relatively active energy metabolism as evident from the depletion or utilisation of carbohydrates might be conducive for the formation of proteins that act as root promoting substances and eventually encouraging good shoot growth also. These factors were also coupled with a less amount of phenolic compounds that might otherwise act as inhibitors and could reduce the rate of root formation in the cuttings. The results obtained on the content of phenols at 90 DAP is also in line with this.

Survival percentage of rooted cuttings (%)

There were significant differences in respect of survival percentage of rooted cuttings among the different months, type

Table 3 : Effect of time, type of cuttings and IBA concentration on periodical changes in C: N ratio in West Indian cherry.

Type of cutting (B)	IBA Concentration (C)	Month of Planting (A)														
		30 DAP					60 DAP					90 DAP				
		Jul.	Aug.	Sep.	Oct.	Mean	Jul.	Aug.	Sep.	Oct.	Mean	Jul.	Aug.	Sep.	Oct.	Mean
Semi hard wood	1500 ppm	11.01	11.29	11.98	13.75	**12.01**	8.17	8.36	8.88	10.22	**8.91**	6.48	7.06	8.00	9.82	**7.84**
	3000 ppm	11.32	11.31	11.36	12.84	**11.71**	8.39	8.38	8.43	9.51	**8.68**	6.48	7.11	7.72	9.26	**7.64**
	Mean	**11.16**	**11.30**	**11.67**	**13.30**	**11.86**	**8.28**	**8.37**	**8.66**	**9.86**	**8.79**	**6.48**	**7.08**	**7.86**	**9.54**	**7.74**
Hard wood	1500 ppm	10.68	11.06	11.64	13.18	**11.64**	7.92	8.19	8.62	9.76	**8.62**	6.34	7.00	7.81	9.49	**7.66**
	3000 ppm	10.92	10.91	12.12	13.67	**11.90**	8.10	8.07	8.60	10.15	**8.73**	6.29	6.94	7.84	9.80	**7.72**
	Mean	**10.80**	**10.99**	**11.88**	**13.43**	**11.77**	**8.01**	**8.13**	**8.61**	**9.95**	**8.68**	**6.32**	**6.97**	**7.83**	**9.65**	**7.69**
For comparing month of planting (A) and IBA concentration(C)																
1500 ppm		10.84	11.18	11.81	13.47	**11.82**	8.05	8.28	8.75	9.99	**8.76**	6.41	7.03	7.91	9.66	**7.75**
3000 ppm		11.12	11.11	11.74	13.26	**11.81**	8.25	8.23	8.52	9.83	**8.70**	6.39	7.02	7.78	9.53	**7.68**
Mean		**10.98**	**11.14**	**11.77**	**13.36**	**11.81**	**8.15**	**8.25**	**8.63**	**9.91**	**8.73**	**6.40**	**7.03**	**7.84**	**9.59**	**7.72**

Comparing means of	30 DAP SE(m)	30 DAP C.D	60 DAP SE(m)	60 DAP C.D	90 DAP SE(m)	90 DAP C.D
	0.18	0.55	0.13	0.41	0.23	0.71
B	0.01	0.03	0.01	0.04	0.01	0.02
C	0.00	0.01	0.01	0.02	0.01	0.02
A x B	0.18	0.55	0.14	0.43	0.23	0.69
B x C	0.01	0.04	0.02	0.06	0.01	0.04
A x C	0.17	0.53	0.14	0.41	0.23	0.69
A x B x C	0.18	0.56	0.15	0.45	0.23	0.71

of cuttings and IBA concentrations at 90 DAP in West Indian cherry (table 4 and fig. 3). The cuttings planted in the month of July were found to have maximum survival percentage of rooted cuttings (54.67%) and was on par with August (52.10%) whereas, the minimum percentage of rooting (30.00%) was observed in October month. The hard wood cuttings showed the best survival percentage of rooting (47.55%) compared to those semi hardwood cuttings (44.00%). Similarly cuttings treated with IBA at 3000 ppm recorded the highest survival percentage (46.74%) as compared to those treated by IBA at 1500 ppm (44.81%).

The superior performance of July planted cuttings can be attributed to the fact that the ability to produce callus, parenchyma and to differentiate the vascular systems with respect to the prevailing season of operation, that might ultimately influence the bud sprouting and their eventual growth as well as survival. Initially there were lesser values of shoot sprouts, leaves *etc* in the July planted and hard wood cuttings but they were sustained without mortality till the end of their polybag life. On the other hand the initial surge on shoot sprouts was not balanced with root growth in the other treatments. Thus, the hard wood cuttings planted in July were more successful in achieving the highest survival percentage.

There were warm and humid conditions after July month prevailing up to September. The rainy days and quantum of rainfall was significantly more during the period from July to September and therefore humidity was also maintained at high level. Since the experiment was conducted under

Table 4 : Survival percentage of rooted cuttings as influenced by time, type of cuttings and IBA concentration in West Indian Cherry (90 DAP).

Type of cutting (B)	IBA Concentration (C)	Month of Planting (A)				
		July	**August**	**September**	**October**	**Mean**
Semi hard wood	1500 ppm	52.22	50.00	44.60	25.55	**43.09**
	3000 ppm	54.26	51.20	45.30	28.88	**44.91**
	Mean	**53.24**	**50.60**	**44.95**	**27.22**	**44.00**
Hard wood	1500 ppm	54.44	52.66	46.80	32.22	**46.53**
	3000 ppm	57.77	54.55	48.66	33.33	**48.58**
	Mean	**56.11**	**53.61**	**47.73**	**32.78**	**47.55**
For comparing month of planting (A) and IBA concentration(C)						
1500 ppm		53.33	51.33	45.70	28.89	**44.81**
3000 ppm		56.02	52.88	46.98	31.11	**46.74**
Mean		**54.67**	**52.10**	**46.34**	**30.00**	**45.78**

Comparing means of	SE(m)	C.D
A	1.85	5.64
B	0.42	1.28
C	0.23	0.70
A x B	2.15	6.58
B x C	0.61	1.88
A x C	1.97	6.02
A x B x C	2.37	7.24

Table 5 : Percentage of establishment of rooted cuttings as influenced by time, type of cuttings and IBA concentration in West Indian Cherry (at 90 DAP).

Type of cutting (B)	IBA Concentration (C)	Month of Planting (A)				
		July	**August**	**September**	**October**	**Mean**
Semi hard wood	1500 ppm	75.00	75.00	65.00	55.00	**67.50**
	3000 ppm	85.00	80.00	65.00	60.00	**72.50**
Mean	**80.00**	**77.50**	**65.00**	**57.50**	**70.00**	
Hard wood	1500 ppm	85.00	65.00	75.00	60.00	**71.25**
	3000 ppm	100.00	85.00	65.00	65.00	**78.75**
	Mean	**92.50**	**75.00**	**70.00**	**62.50**	**75.00**
For comparing month of planting (A) and IBA concentration(C)						
1500 ppm		80.00	70.00	70.00	57.50	**69.38**
3000 ppm		92.50	82.50	65.00	62.50	**75.63**
Mean		**86.25**	**76.25**	**67.50**	**60.00**	**72.50**

Comparing means of	SE(m)	C.D
A	1.89	5.76
B	0.59	1.80
C	0.74	2.25
A x B	2.35	7.19
B x C	1.26	3.85
A x C	2.49	7.61
A x B x C	3.05	9.32

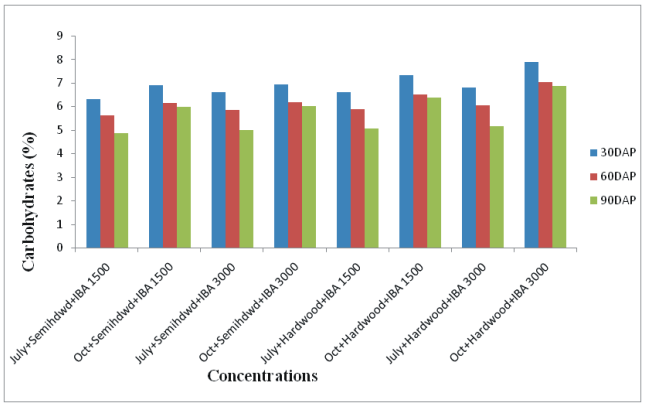

Fig. 1 : Effect of time, type of cuttings and IBA concentration on carbohydrates content (%) in West Indian cherry cuttings.

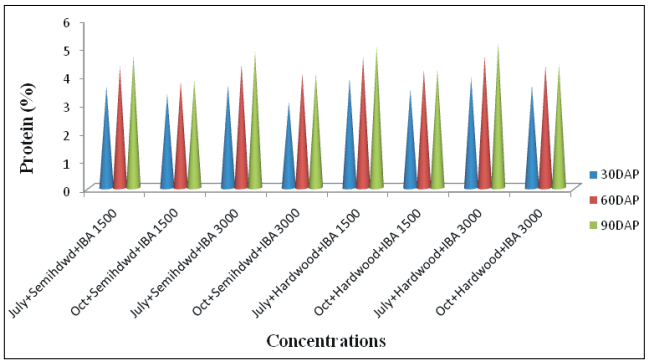

Fig. 2 : Effect of time, type of cuttings and IBA concentration on protein content (%) in West Indian cherry cuttings.

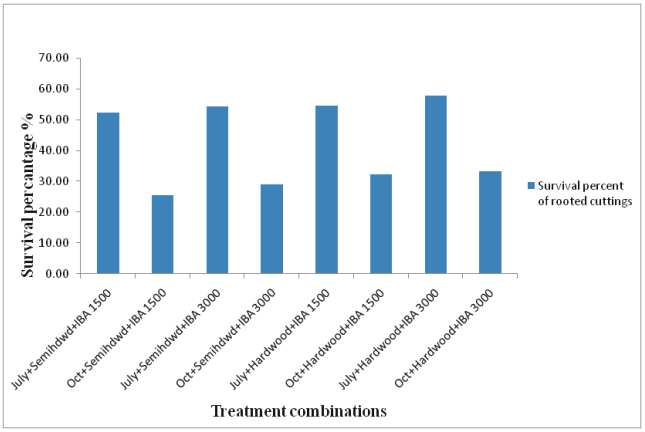

Fig. 3 : Effect of time, type of cuttings and IBA concentration on survival percentage of rooted cuttings (%) in West Indian cherry at 90 DAP.

shade net the temperatures were not very harsh as in open conditions. Thus, the prevailing weather parameters might be congenial for callus formation and further sustenance of the sprouted shoots so as to have maximum success. During and after the month of October, the humidity was in a decreasing trend and also the ambient temperatures exhibited lower values which could have not supported proper formation of root primordial and their nourishment for sustained growth.

Similar results were reported by Bharad *et al*. (1999) in Tamarind. Temperature, Relative Humidity, Bright sunshine has exhibited moderately correlation related to survival percentage of rooted cuttings but in negative direction. A better auxin concentration favoured good growth of roots as well shoots. The performance of IBA at 3000 ppm appeared to have favoured good root as well as shoot growth.

The possible explanation to these findings lies in better development of root systems with more number of roots, greater root length, fresh and dry weight of roots might have enabled the rooted cuttings to survive till the end in the polybag study thereby recording the highest survival. These findings are supported by Navaneetha *et al*. (1991), Sun and Bassuk (1991), Pratima and Rana (2014) and Sivudu *et al*. (2014).

Percentage of establishment of rooted cuttings (%)

Significant influence of month, type of cuttings and IBA concentration was observed on percentage of establishment of rooted cuttings at 90 DAP (Table 5). The cuttings planted in the month of July have recorded maximum percentage of establishment of rooted cuttings (86.25%) followed by August (76.25%), minimum percentage of establishment of rooted cuttings was observed by those planted in October month (60.00%). Hardwood showed significantly higher percentage of establishment of rooted cuttings (75.00) as compared to semi hardwood cuttings (70.00). Among the IBA treatments, IBA at 3000 ppm recorded the best percentage of establishment of rooted cuttings (75.63) as compared to the same treatment at lower concentration *i.e.* at 1500 ppm (69.38).

It is interesting to note from the above results that the treatment combinations that could record significantly high percentage of rooting could sustain their performance in the survival percentage of rooted cuttings as well as field establishment of the same.

A good rooted cutting should have reasonable amount of dry matter partitioned into roots and could win the race in better search and imbibition of food material from the growing media thus leading to better survival as well as field establishment at later stages of study. The cuttings made and kept for rooting in the month of July might have received more congenial weather conditions that might led to better initiation of rooting primordia and further development of root system for optimum support of growing shoots along with leaves as evident from the results on number of shoots and leaves recorded by the cuttings planted in this month. Similar opinion was

expressed by Bharad *et al*. (1999).

Similarly hard wood cuttings could have accumulated relatively higher quantity of carbohydrates as compared to semi hard wood cuttings thus holding a superior position to synthesise more proteins which in turn could have triggered better rooting by the hard wood cuttings as compared to semi hard wood cuttings. By the time, the rooted cuttings are bagged, the hard wood cuttings developed stronger root system that might have sourced the strength to record a higher survival and establishment of rooted cuttings. Zirari and Lionakis (1994) also expressed that hard wood cuttings performed well in avocado. This is also in conformity with the findings on biochemical parameters at different intervals. The positive effect is also attributed to its ability to increase sensitivity of cuttings to auxin treatments. The interaction effect of type of cutting with IBA treatment was also found significant in some of the desirable parameters in the present study. This could be due to the positive effect of type of cutting which is in synergistic action with IBA treatments as opined by Hartmann *et al*. (2002).

The positive effect of IBA on survival percentage and field establishment was explained by the corresponding superiority on rooting percentage, number of roots, length of primary roots, length of longest root, fresh and dry weight of roots, root-shoot ratio by several workers and the effect was attributed to the promotive effect of auxins (Manish Kumar, 2009).

However, IBA treatment was found to be more effective at 3000 ppm compared to 1500 ppm. It is interesting to note that most of survival attributing parameters *viz.*, rooting percentage, number of shoots *etc* were higher in the cuttings treated with IBA 3000 pppm only as compared to the same treatment at 1500 ppm and therefore the treatment with IBA at 3000 ppm was found superior in the propagation of West Indian cherry. Similar results were also obtained by Preet and Rana (2014) and Sivudu (2014).

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