IMPROVEMENT OF THREE VALUABLE FODDER TREE SPECIES TROUGH VEGETATIVE PROPAGATION

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Introduction

The possibilities of increasing fodder resources in India seem to be very bleak in view of rapid increase in the livestock population. The existing livestock population in India accounts for about 15% as against only 2% of the world's geographical area and the fodder produced is not sufficient to meet the increasing existing requirement of the livestock population. Moreover, the low productivity of our domestic livestock population is mainly due to underfed and poor nutritive quality of the fodder. To compensate the milk production and to get large quantities of dung for fuel, the farmers generally maintain large unproductive herds of cattle. Therefore, there is an urgent need to develop easy and cheap methods for fodder trees production, so that regular supply of foliage feed from the available trees in the agro-social forestry systems is ascertained.

In sub-tropical to temperate hill farm forestry systems of the Himalayas, three *Ficus* species i.e., *Ficus roxburghii, Ficus cunia,* and *Ficus gibbosa* are widely used as high mulching, preferred and palatable fodder tree species. The fodder obtained from these Himalayan farm forestry tree species is much relished by animals as it is rich in protein and other contents (Joshi, 1981; Singh, 1982). Consequently, these tree species are heavily lopped during winter season, when green fodder is generally scarce, which results in their low seed production. Therefore, immediate steps must be taken for multiplication of the superior fodder strains of these species by vegetative means.

Vegetative propagation is not a breeding method but a way to rapidly multiply nand disseminate the desired clonal material according to its genetic potential. In vegetative propagation, the genetic potential of a species, including the non-additive variance, is automatically transferred to the new plant (Puri and Khara, 1992). However, in nature the tree populations are highly heterozygous and the vegetative population helps to utilise maximum genetic gains in the shortest possible time. The success of vegetative propagation depends upon a proper environment, genetic component and the physiological status of cuttings etc. (Cunningham, 1986; Puri and Thompson, 1989).

Keeping in view the aforesaid facts, this study of vegetative propagation was aimed to draw definite conclusions for improvement by understanding the effects of various concentrations of growth hormones on rooting and sprouting behaviour of cuttings of three important fodder tree species i.e., (i) *Ficus roxburghii,* (ii) *Ficus gibbosa* and (iii) *Ficus gibbosa*, of Himalayan farm forestry system.

Material and Methods

Branch cuttings of three important milching fodder tree species viz, (i) *Ficus roxburghii,* (ii) *Ficus gibbosa* and (iii) *Ficus gibbosa*, were obtained from juvenile and healthy growing trees. The cuttings of 15-18 cm length, with 5-6 nodes each, were prepared from 2^{nd} year shoots . The basal end of each cutting was cut at an angle of approximately 45^{o}. The test solutions of 100ppm, 200ppm and 500ppm of some identified growth promoting substances i.e., Indole Acetic Acid (IAA), Indole Butyric Acid (IBA), Naphthalene Acetic Acid (NAA), 2-4-D, and Thiamine were prepared using double distilled water. Five replicates of each species were made (15 cuttings each) and the basal end of the cuttings (2-5cm) were dipped in test solutions and kept for 24 hours for giving them treatment of the appropriate solution. Treated cuttings were planted in the polybags containing sand, soil and FYM (Farm Yard Manure) in the ratio 1 : 1 : 1. The basal ends of the cuttings were inserted in the soil by keeping their two to three nodes under the soil level in the polybags and the rest terminal nodes were exposed to the atmosphere. The cuttings were watered regularly and the sprouting response of the cuttings was recorded at 30^{th}, 60^{th} and 90^{th} days after planting. The percentages of rooted and dead cuttings were recorded at the aforesaid time intervals separately, but rooted cuttings were finally harvested for knowing the number of roots and length of roots after 12 weeks of planting.

Results and Discussion

The growth behaviour of cuttings of each selected fodder tree species in relation to the various treatments has been observed and the results were recorded after 30, 60 and 90 days of hormonal treatments. Observations on survival percentage, number of sprouts, number of lateral roots and root length were recorded, for each treatment and given in Tables 1 and 2. These results are being summarised as follows :

Ficus roxburghii : The applications of growth regulators have considerably stimulated the rooting potential and vegetative growth of the cuttings. The rooting of cuttings after exogenous treatment of all the selected growth hormones was different. No rooting was observed in auxin treated juvenile cuttings after 30 days. IBA (100ppm) was more successful in rooting of juvenile cuttings (76.2 1.35%). On the other hand higher concentrations of auxins have inhibited the root initiation. Enough sprouting was noticed in the lower concentration of all the auxins after 30 days of treatment. In general, the number of sprouts decreased considerably in the cuttings which did not root after 30 days. Remarkable number of roots (22.0 2.86 after 90 days) and root length (4.40 0.74 cm after 60 days) was observed in the cuttings treated with IBA (100ppm).

Ficus cunia : This species is difficult to root and therefore, only after the application of auxins the rooting in juvenile cuttings was possible. Although nearly all the concentrations of IBA, IAA and NAA were found effective for rooting of the cutting in *Ficus cunia,* where as 2, 4-D and Thiamine have shown little

Table 1

Rooting response of cuttings of Ficus roxburghii, F. cunia and F. gibbosa under various treatments.

Treatments	*F. roxburghii*	*F. cunia*	*F. gibbosa*
IBA-100	76.2 1.35	60.4 1.43	40.0 0.70
IBA-200	70.4 2.69	51.8 1.28	35.2 1.77
IBA-500	65.0 3.86	45.2 1.39	31.6 0.92
IAA-100	70.6 1.07	52.2 2.74	44.7 2.74
IAA-200	66.2 1.88	51.6 1.96	41.4 0.50
IAA-500	56.4 0.92	42.6 1.32	37.0 0.71
NAA-100	60.4 1.66	49.0 1.30	30.5 0.91
NAA-200	48.6 4.28	47.4 1.91	29.6 2.11
NAA-500	48.4 4.02	41.2 1.15	26.4 0.92
2,4-D-100	29.2 1.24	28.8 1.15	24.7 0.94
2,4-D-200	47.8 3.65	27.2 1.94	23.2 0.73
2,4-D-500	33.6 2.94	31.2 1.39	22.2 0.86
Tha-100	22.6 2.29	29.6 0.50	23.9 1.10
Tha-200	47.8 3.56	28.8 0.86	21.8 0.86
Tha-500	29.6 0.92	33.4 1.07	22.8 2.15
Mean	51.52	41.36	30.33
Range	22.6-76.2	27.2-60.4	21.8-44.7
CV%	32.86	26.06	25.35

impact in this regard. The maximum rooting (60.4 1.43%) was achieved in 100ppm of IBA. Lower concentration of IBA (100ppm) produced maximum sprouting (2.20 0.35) in juvenile cuttings in 30 days. Auxin treatments also promoted adventitious root formation in juvenile cuttings. No rooting was observed until 30 days in water-treated cuttings, while few auxin treated cuttings rooted. A maximum number of roots (1.90 2.91) with an average length (5.10 0.72cm) were observed in the cuttings treated with 100ppm IBA after 90 days of planting.

The origin of the root was observed to be acropetal (from the base to apex of the cuttings), irrespective of juvenile or hard cuttings. Initially new roots were formed at the base of cuttings. Interestingly, the lower portion (up to 3-5 cm) of the cuttings swelled before roots were seen. The extent of the swelling was greater in cuttings treated with higher concentrations of auxin. Rooted cuttings usually formed 3-4 major and vigorous adventitious roots, which in turn formed numerous short lateral roots after 90 days.

Ficus gibbosa : The highest number of

Table 2

Sprouting, rooting and root length of the cuttings of Ficus roxburghii, F. cunia, and F. gibbosa, under various treatments.

Treat-ments	30days		60 days						90 days					
	No. of sprouts		No. of sprouts		No. of roots		Root length (cm)		No. of sprouts		No. of roots		Root length (cm)	
1	2		3		4		5		6		7		8	
							Ficus roxburghii							
IBA-100	2.80	0.27	2.82	0.37	2.88	0.43	4.40	0.74	2.86	0.35	22.0	2.86	6.34	1.30
IBA-200	2.00	0.37	1.86	0.41	4.40	0.50	2.62	0.21	1.92	0.38	21.0	2.50	4.03	0.83
IBA-500	1.86	0.40	1.88	0.42	3.20	0.37	3.00	0.15	1.90	0.45	20.2	1.86	4.13	0.30
IAA-100	2.53	0.22	2.55	0.32	3.00	0.31	3.22	0.27	2.60	0.43	19.8	1.39	4.32	0.34
IAA-200	2.20	0.38	2.08	0.43	3.40	0.50	2.92	017	2.10	0.42	18.4	1.32	3.96	0.53
IAA-500	2.00	0.25	1.90	0.33	3.20	0.37	2.82	0.12	1.90	0.31	18.3	2.09	3.56	0.43
NAA-100	2.13	0.29	2.16	0.34	2.80	0.20	2.56	0.30	2.16	0.30	12.6	1.20	2.44	0.34
NAA-200	1.73	0.40	1.76	0.57	3.00	0.77	3.44	0.21	1.78	0.30	11.8	0.86	1.84	0.34
NAA-500	1.26	0.34	1.30	0.36	2.80	0.37	3.64	0.46	1.36	0.32	15.4	1.76	1.95	0.76
2,4D-100	1.73	0.34	1.83	0.37	3.00	0.31	3.20	0.28	1.93	0.41	11.0	2.80	2.66	0.20
2,4D-200	1.46	0.35	1.20	0.35	3.20	0.58	3.04	0.19	1.52	0.30	10.4	2.42	1.47	0.30
2,4D-500	1.40	0.36	1.52	0.36	3.21	0.37	2.88	0.11	1.42	0.62	10.9	2.12	2.25	0.43
Thai-100	1.33	0.39	1.36	0.47	3.60	0.50	3.16	0.08	1.36	0.36	9.80	1.39	2.60	0.28
Thai-200	1.26	0.35	1.26	0.31	3.80	0.37	2.92	0.17	1.26	0.29	9.40	0.92	2.68	0.92
Thai-500	1.10	0.38	1.06	0.38	3.40	0.24	2.76	0.12	1.12	0.33	12.3	1.28	2.04	0.35
							Ficus cunia							
IBA-100	2.20	0.35	2.20	0.40	4.20	0.37	2.90	0.15	2.26	0.40	19.0	2.91	5.10	0.72
IBA-200	1.80	0.39	1.80	0.42	2.60	0.50	2.06	0.12	1.82	0.36	16.4	2.15	3.34	0.29
IBA-500	1.66	0.36	1.63	0.37	3.60	0.40	2.94	0.10	1.70	0.36	17.5	1.87	4.02	0.43
IAA-100	1.73	0.28	1.70	0.42	3.80	0.37	2.74	0.14	1.75	0.30	17.4	1.96	3.34	0.34
IAA-200	1.33	0.41	1.36	0.42	2.60	0.40	3.18	0.27	1.36	0.38	16.2	1.46	2.13	0.86
IAA-500	1.46	0.30	1.50	0.33	3.40	0.24	3.04	0.18	1.50	0.30	16.2	2.18	2.87	0.73
NAA-100	1.66	0.36	1.72	0.38	3.00	0.31	2.44	0.23	1.70	0.35	13.2	1.24	2.34	0.35
NAA-200	1.40	0.37	1.38	0.39	2.60	0.50	1.52	0.47	1.43	0.36	12.2	0.86	2.07	0.16
NAA-500	1.26	0.34	1.30	0.33	4.60	0.81	2.64	0.25	1.30	0.26	13.1	1.78	3.29	0.12
2,4D-100	1.33	0.37	1.28	0.41	2.80	0.58	2.64	0.19	1.36	0.38	11.8	2.71	2.42	0.18
2,4D-200	1.53	0.42	1.56	0.45	2.80	0.37	3.08	0.32	1.60	0.36	11.0	2.34	2.34	0.29

Contd...

1	2	3	4	5	6	7	8
2,4D-500	1.13 0.30	1.23 0.39	3.00 0.70	2.70 0.26	1.23 0.31	12.3 1.62	2.71 0.70
Thai-100	1.67 0.37	1.63 0.35	3.20 0.37	2.90 0.20	1.67 0.36	8.20 0.80	2.70 0.19
Thai-200	1.26 0.31	1.20 0.30	3.60 0.50	2.56 0.28	1.24 0.31	7.80 0.58	1.86 0.35
Thai-500	1.08 0.42	1.08 0.37	2.82 0.15	3.00 0.31	1.10 0.36	10.2 1.53	1.82 0.30
			Ficus gibbosa				
IBA-100	1.46 0.30	1.63 0.33	3.60 0.50	2.30 0.18	1.66 0.38	20.2 2.71	6.52 1.38
IBA-200	1.73 0.38	1.53 0.37	3.80 1.07	2.14 0.28	1.60 0.34	15.8 1.50	3.90 0.40
IBA-500	1.80 0.29	1.46 0.34	3.20 0.63	2.21 1.13	1.50 0.29	16.1 2.56	3.76 0.27
IAA-100	1.53 0.37	1.55 0.33	3.60 0.67	1.72 0.27	1.55 0.39	18.0 1.31	4.60 0.44
IAA-200	1.40 0.34	1.37 0.35	4.00 0.70	1.79 0.32	1.43 0.27	15.8 0.91	3.42 0.54
IAA-500	1.33 0.34	1.32 0.26	4.00 0.17	2.10 0.73	1.36 0.27	10.4 2.03	3.51 0.27
NAA-100	1.73 0.35	1.26 0.38	2.60 0.40	2.28 0.12	1.26 0.30	11.0 0.72	4.20 0.24
NAA-200	1.66 0.41	1.60 0.52	4.80 0.37	2.01 0.13	1.60 0.25	10.8 0.73	3.32 0.28
NAA-500	2.13 0.53	1.13 0.43	5.20 1.06	1.54 0.81	1.17 0.31	15.4 1.15	3.18 0.43
2,4D-100	1.40 0.40	1.36 0.35	4.20 0.66	2.16 0.33	1.42 0.30	10.0 2.41	3.82 0.21
2,4D-200	1.30 0.41	1.30 0.39	6.00 0.70	2.33 0.73	1.31 0.16	9.40 2.01	3.24 0.23
2,4D-500	1.26 0.39	1.08 0.35	3.60 0.50	2.10 1.34	1.13 0.33	14.9 2.10	3.06 0.41
Thai-100	1.32 0.38	1.26 0.35	3.40 0.50	2.10 0.29	1.30 0.34	8.80 1.39	4.06 0.55
Thai-200	1.20 0.32	1.20 0.30	5.00 1.22	1.95 0.26	1.22 0.30	8.40 1.21	3.50 0.29
Thai-500	1.20 0.36	1.14 0.37	3.80 0.37	1.78 0.34	1.14 0.30	12.3 1.10	3.64 0.32

rooted cuttings (44.7 2.74%) was recorded in 100ppm of IAA, however, the response of rooting in 100ppm of IBA was also good. Rest of the hormones have not shown any close affinity to the rooting of cuttings in this species. The maximum bud sprouting (2.13 0.53) was observed in the cuttings treated with NAA 500ppm after 30 days of planting. The lower concentration of IBA (100ppm) has produced maximum number of roots (20.2 2.71) and root length (6.52 1.38 cm) after 90 days of planting (Table 2).

It is apparent from Table 2 that the lower concentrations of IBA and IAA were proved to be the best medium for the growth of cuttings in all the selected tree species. The maximum number of sprouts in *Ficus roxburghii* (2.86 0.35), *Ficus cunia* (2.26 0.40) and *Ficus gibbosa* (1.66 0.38), were recorded in IBA-100 ppm concentration. Similarly maximum number of roots and root length in *Ficus roxburghii* (22.0 2.86 and 6.34 1.30 cm), *Ficus cunia* (19.0 2.91 and 5.10 0.72 cm), and *Ficus gibbosa* (20.2 2.71 and 6.54 1.38 cm) were also observed in IBA-100 ppm after 90 days (Table 2). Therefore, IBA-100 ppm was considered to be the best solution for inducing the sprouting, rooting and root length in the cuttings of these important fodder tree species of Himalayan farm forestry system (Table 2).

These results indicate wide variation in rooting ability of all the three species studied. In *Ficus roxburghii* and *Ficus* *gibbosa,* the initiation of rooting is occurring after 30 days of planting, whereas, in *F. cunia* the root initiation is occurring before 30 days. It is an established fact that the auxins (either natural or artificially applied) are required for initiation of adventitious roots in cuttings (Nanda, 1975; Puri and Shamet, 1988) and, indeed for the division of the first root initiation (Haissig, 1979).

The variation in rooting potential of cuttings may be due to the physiological nature of cuttings, variation in external factors or a combination of both. Depending on the endogenous level of growth regulating substances, exogenous application of growth hormones may promote, inhibit or have no effect at all on rooting (Nanda, 1970). Many workers have found that stem cuttings taken from young seedlings, root easily than those from older plants (Puri and Khara, 1992). Success in rooting of coppice cuttings in *Eucalyptus* (very difficult to root) was obtained by Hartney (1980) and Heth *et al.* (1986) However, in the present study, rooting of coppice shoots in these species showed little success in the water treated cuttings (as control). However, the cuttings rooted better only after the application of growth hormones.

In general higher concentrations of all hormones (i.e., 500ppm) have exhibited less effect on rooting of cuttings in all the three selected fodder tree species. However, lower concentrations of IBA, IAA and NAA were particularly found most effective in this regard (Table 1). In *Ficus roxburghii* and *Ficus cunia,* 100ppm of IBA has manifested highest percentage of rooted cuttings (76.2 1.35% and 60.4 1.43% respectively), whereas in *Ficus gibbosa,* 100ppm of IAA was proved to be ideal for rooting maximum number of cuttings (44.7 2.74%) along with 100ppm of IBA (40.0 0.70%), which were recorded to be the most suitable media for successful rooting of cuttings in all the three selected fodder species (Table 1). Thus it could be concluded that the lower concentrations of IBA and IAA were found significantly favourable for obtaining maximum rooting in all the three selected species (Table 1). However, the root length was particularly favoured by the lower concentrations of 2,4-D and Thiamine in *Ficus gibbosa* (Table 2).

During vegetative propagation, early sprouting depends on the food reserve available in the cuttings (Wright, 1975). This followed by root formation , which enables the plant to absorb nutrients from the root. However, where root formation/ differentiation is delayed or does not take place, survival rate becomes very low and the plants usually die (Puri and Thompson, 1989). Good sprouting was observed in these species, even if in some cases where root formation was delayed or did not take place. Such cuttings eventually wilted, sooner or later. According to Adriance and Brison (1955), a low CHO/N ration encouraged better shoot growth, but poor root formation. Thia (1977) suggested that early shoot formation might have an unfavourable effect on root initiation, because this creates a competitive situation between root and shoot for nutrients reserves within the cuttings.

Conclusion and Recommendations

The requirement of auxins to induce rooting in tree species in which cuttings deposed rooting is already known (Nanda *et al*., 1968). Application of IBA has also been shown to stimulate cambial activity, resulting in mobilisation of reserve food materials to the site of root initiation. With increasing degradation of fodder tree species through heavy lopping, attempts to develop more fodder trees, using vegetative propagation techniques should receive priority, owing to the ease through which large number of planting material can be developed within a short time and at little expenses.

SUMMARY

Exogenous application of different concentrations of IAA, IBA, NAA, 2,4-D and thiamine wasw tried to propagate vegetatively the three valuable fodder tree species (viz. *Ficus roxburghii, F. cunia* and *F. gibbosa*) of Himalayan farm forestry system. Significant rooting of branch cuttings was achieved in the lower concentrations of IBA and IAA (100ppm) after 12 weeks of treatment. The application of lower concentrations of auxins have also favoured the number of sprouts and number of lateral roots in all the three species, whereas, the root length was prolific in lower concentrations of IBA, IAA (*Ficus roxburghii* and *Ficus cunia*) and 2,4-D and thiamine (*Ficus gibbosa*).

वर्धी प्रर्वधन द्वारा तीन मूल्यवान चारा वृक्ष जातियों में किया गया सुधार

डी०पी० नौटियाल, एस०के० घिल्डियाल व सी०एम० शर्मा

सारांष

इण्डोल एसेटिक अम्ल, इण्डोल ब्युटिरिक अम्ल, न्यूक्लिइक एसेटिक अम्ल, 2,4–डी और थायीमीन का बाह्यजात अनुप्रयोग हिमालयी फार्म वानिकी प्रणाली में तीन मूल्यवान चारा वृक्ष जातियों (अर्थात *फाइकस रॉक्सबर्घिआई, फा० कूनिया* और *फा० गिब्बोसा*) का वर्धीप्रवर्धन कराने को परीक्षित किया गया। इण्डोल ब्यूटिरिक अम्ल और इण्डोल एसेटिक अम्ल का कम संकेन्द्रण (100 भाग प्रति दस लाख भाग पानी में मिलाकर) उपयोग करने पर उपचार के बारह सप्ताह बाद शाखा कलकों में काफी जड़ें निकलना प्राप्त कर लिया गया। आक्सिनों का अनुप्रयोग भी इन तीन जातियों में अंकुरो की संख्या और पार्श्व जड़ों की संख्या बढ़ाने में अनुकूल रहा परन्तु जड़ों की लम्बाई की प्रचुरता इण्डोल ब्यूटिरिक अम्ल, इण्डोल एसेटिक अम्ल (*फाइकस राक्सबर्घिआई* और *फाइकस कूनिया*) का कम संकेन्द्रण उपयोग करने पर और 2,4–डी और थायामीन (*फाइकस गिब्बोसा*) उपयोग करने पर मिली।

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