International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(1): 1448-1453

Received: 19-11-2018
Accepted: 23-12-2018

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Propagation studies in Madhunashini (*Gymnema sylvestre* R. Br.) under shade house and shaded poly tunnel condition

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Abstract
The experiment was carried out at Medicinal and Aromatic Plants Unit, Saidapur farm, Department of Horticulture, University of Agricultural Sciences, Dharwad, Karnataka to study the effect of different growth regulator treatments on growth and root parameters under shade house (50%) and shaded (with 50% shade) poly tunnel condition in madhunashini (*Gymnema sylvestre* R. Br.) during the year 2014-15 and 2015-16. Terminal cuttings of madhunashini were treated with different concentrations of IBA (500 and 1000 ppm), NAA (500 and 1000 ppm), coconut water and cow urine and were placed under two environments *viz*., shade house (50%) and shaded (with 50% shade) poly tunnel condition. The experiment was conducted for two years and pooled data was presented herewith. The poly tunnels placed under shade house (50%) in combination with 500 ppm IBA was found suitable for getting higher per cent rooting (64.78 %), number of roots per cutting (8.26) and length of the longest root (17.35 cm). Use of low cost poly tunnel in combination with IBA 500 ppm treatment to cuttings is more practical and economic technique for commercial multiplication.

Keywords: Madhunashini, Environment, IBA, NAA, Rooting, Cuttings

1. Introduction
Among horticulture crops, medicinal and aromatic plants forms one of the important groups which have a unique role in sustaining pharmaceutical, perfumery and cosmetic industries in India (Raviprasad Sajjan and Venugopal, 2017) [12]. Out of thousands of medicinal plants, few have attained the status of commercial crops which are being cultivated on large scale. Madhunashini is one such medicinal plant which is being cultivated in India.

Madhunashini means "destroyer of sugar", which is traditionally used term for gymnema because chewing the leaves will abolish the taste of sweetness. The continuous increase in demand for madhunashini in both domestic and international market has compelled the country to increase its area under cultivation (Ashok, 2012) [2].

Madhunashini (*Gymnema sylvestre* R. Br.) is an important medicinal plant belonging to the family Asclepiadaceae. It is native to the tropical forests of Southern and Central India. It is widely distributed in India, Malaysia, Sri Lanka, Australia, Indonesia, Japan, Vietnam, tropical Africa and South western China. In India, this plant is found growing in abundance in the forests of Karnataka, Tamil Nadu and Bihar. Due to its heavy demand in South East Asian countries, the plant is becoming endangered and under cultivation in southern states of India, particularly in Tamil Nadu (Dipak, 2017) [5].

Madhunashini is a slow growing, perennial, medicinal woody climber valued for its medicinal properties. The stems are hairy, green in colour, milky latex, waxy layer, climber, large (185-485μ) and broad (9-25 μ), hairy, cylindrical, sparsely lenticellate; young branch lets pubescent, glabrescent. The leaves are 2– 6 cm in length and 1 - 4 cm in width and are simple, petiolate and opposite, with an acute apex and reticulate venation. They have a characteristic odour; the taste is slightly bitter and stringent. Flowers are small, yellow, in axillary and lateral umbel like cymes and follicles are terete, lanceolate, up to 3 inches in length (Giovanni *et al*., 2013) [6] and (Pandey, 2012) [11].

The medicinally active parts of the plant are the leaves and the roots. This climber is extensively used in almost all the Indian system of medicine as a remedy for rheumatism, cough, ulcer and pain in eyes. It is also useful in inflammations, dyspepsia, constipation, jaundice etc.

Leaves of this species yield acidic glycosides and anthroquinones which have anti-diabetic, anti-sweetener, anti-inflammatory, anti-microbial, anti-hyphal, anti-hyper cholesterolemic and hepatoprotective activities. Leaf extract from the plant is used in India as a stomachic, stimulant, laxative and diuretic. Roots have been reported as a remedy for snakebite. The anti-diabetic property of the plant is attributed to the presence of mixture of triterpnes and saponins in the leaves. These have been designated as gymnemic acids A, B, C and D, which have the gymnemagenin and gymnestrogenins (WHO, 2016) [15] and (Giovanni *et al.*, 2013) [6]. Because of multifarious use there is continuous demand of the species which has made it highly vulnerable in nature.

Madhunashini is propagated through seeds in its natural habitat. But, there are problems like flower-shed, low fruit-set and a very short span of seed viability. Besides overcoming problems in seed propagation, vegetative propagation is helpful for large scale multiplication of the plant during lean periods of seed availability (Ashok, 2012) [2].

Gymnema is also one of the best selling medicinal plant in the world market requiring a cost-effective and simple method of cultivation to meet its growing demand. The availability of the species in natural forests is decreasing very fast due to over and unsustainable harvesting. Present demand is mostly met from wild collection. Therefore, the only way to meet the increasing demand and reduce the pressure of harvest from wild is its large scale cultivation (WHO, 2016) [15].

Among the root inducing hormones which are being extensively used commercially, Auxins like IBA (Indole butyric acid) and NAA (Naphthalene acetic acid) have the greatest effect on root formation in cuttings. There are several reports of application of IBA and NAA to improve rooting efficiency. Auxins are playing a tremendous role in increasing rooting and apical bud dominance (Akshitha *et al.*, 2014) [1]. Therefore, effect of different concentrations of growth regulators (IBA and NAA) on rooting of madhunashini was investigated.

Coconut water contains some natural hormones such as, auxin, cytokinins and gibberellins and also other compounds that may stimulate germination and growth. Auxin has an important role on rooting formations of shoot cuttings. Auxin concentration as entry point is important to be measured in the cow urine and young coconut water as PGR. Coconut water appears to be an essential additive required for cell division, and thus promotes rapid growth during shoot bud multiplication (Harshavardhan *et al.*, 2016 [7] and Mudji *et al.*, 2016) [10].

Cow urine can be used as PGR because it contains hormones. Cow urine is known for presence of growth promoting auxin like IAA and rich in nutrients. Cow urine contains many of those elements that are needed by the plants, such as N, P, K, Ca, Fe, Mn, Zn, and Zu and its existence cannot be replaced by other nutrients for plant growth and development. In addition, cow urine also contains growth stimulating substances that can be used as a growth regulator that gives a positive effect on growth of plants Harshavardhan *et al.* (2016) [7] and Mudji *et al.* (2016) [10]. Therefore, effect of coconut water and cow urine on rooting of madhunashini was investigated.

The use of root inducing growth regulators and propagation structures are some methods to improve propagation efficiency. Even though mist house propagation is proven technology for successful propagation in many species, it has disadvantage of high cost and a requirement for continuous power supply (Venugopal *et al.*, 2008b) [14]. Hence there was need to identify an alternative propagation structure which can mimic the mist house ecosystem. Therefore, different environments *viz.*, shade house (50%) and shaded (with 50% shade) poly tunnel condition were tried under the study.

Keeping these points in view, the present experiment was conducted to study the effect of different growth regulator treatments on growth and root parameters under shade house and shaded poly tunnel condition in Madhunashini (*Gymnema sylvestre* R. Br.) cuttings.

2. Materials and Methods

An investigation was carried out at Medicinal and Aromatic Plants Unit, Saidapur farm, Department of Horticulture, University of Agricultural Sciences, Dharwad, Karnataka. Fresh cutting of 12-15 cm length with 2-4 nodes having diameter 11-15 mm were prepared. Lower end of cuttings were dipped in different concentrations of rooting hormones with quick dip method.

Terminal cuttings of madhunashini were treated with different concentrations of IBA (500 and 1000 ppm), NAA (500 and 1000 ppm), coconut water and cow urine. Treated cuttings were planted in polybags (containing red soil and FYM in equal proportion) and placed in different environments *viz.*, shade house (50%) and shaded (with 50% shade) poly tunnel condition. There were 12 treatment combinations *viz.*, T_1- Control, T_2- IBA 500 ppm, T_3- IBA 1000 ppm, T_4- NAA 500 ppm, T_5- NAA 1000 ppm, T_6- IBA 500+NAA 500 ppm, T_7- IBA 500+NAA 1000 ppm, T_8- IBA 1000+NAA 500 ppm, T_9- IBA 1000+NAA 1000 ppm, T_{10}- Coconut water and T_{11}- Cow urine. Each treatment was represented by 100 cuttings replicated thrice. The experiment was laid out in two factorial randomised block design. Five representative plants in each treatment and in each replication were randomly selected, tagged and observations on growth characters *viz.*, number of leaves, shoot length and inter nodal length and root characters *viz.*, number of roots per cutting, length of longest root and per cent rooting were recorded at the end of experiment and their mean values were recorded. The data were subjected to statistical analysis.

3. Results and Discussion

Vegetative parameters

The data pertaining to various growth parameters as influenced by different growth regulators under shade house (50%) and shaded (with 50% shade) poly tunnel condition in madhunashini are presented in Table 1. The experiment was conducted for two years and pooled data is presented herewith. The different concentrations of growth regulators (IBA and NAA), coconut water and cow urine treatments had a significant effect on different growth parameters. There was a significant influence of treatments on growth characters *viz.*, number of leaves, shoot length and inter nodal length.

In shade house (50%) condition, the higher number of leaves (30.63%) was recorded in the cuttings treated with combination of 500 ppm IBA and 1000 ppm NAA and was on par with cuttings treated with 500 ppm IBA (28.99%). And in shaded (with 50% shade) poly tunnel condition, the higher number of leaves (30.75%) was recorded in the cuttings treated with combination of IBA and NAA at 1000 ppm each. In comparison with combination of IBA and NAA, the treatment with IBA alone was found to be better. The higher number of leaves obtained with cuttings treated with 500 ppm IBA may be due auxins which may help in better utilization of stored carbohydrates, nitrogen and other factors. Auxins have remarkable physiological property to regulate shoot apical dominance in plants and it stimulates the lateral buds so ultimately it increases number of leaves. These findings are in conformity with Kiuru *et al*. (2015) [9] and Pandey (2012) [11].

The cuttings placed in shade house (50%) condition registered significantly higher shoot length (39.49 cm) when treated with 1000 ppm IBA. And in shaded (with 50% shade) poly tunnel condition, the higher shoot length (43.56 cm) was recorded in the cuttings treated with combination of 1000 ppm IBA and 500 ppm NAA. Among overall treatments, IBA when applied solely performed better than combinations of IBA and NAA. The higher shoot length obtained with cuttings treated with 500 ppm IBA may be attributed to enhanced hydrolysis of carbohydrates, stimulative and promotive effects of auxins on cell division and cell elongation which inturn has effect on growth of plants and increase in length of the shoot. These results coincides with the findings of Devendrakumar *et al.* (2014) [4], Ingle and Venugopal (2009) [8] and Chavda *et al.* (2015) [3].

Inter nodal length.

The maximum inter nodal length (2.91 cm) in shade house (50%) condition was obtained in the cuttings treated with 500 ppm NAA and was on par with cuttings treated with 500 ppm IBA (2.44 cm). Whereas, in shaded (with 50% shade) poly tunnel condition, the maximum inter nodal length (3.09 cm) was obtained in the cuttings treated with combination of 1000 ppm IBA and 500 ppm NAA and was on par with cuttings treated with 500 ppm IBA (2.58 cm). In comparision with combination of IBA and NAA, the treatment with IBA alone was found to be better. The maximum inter nodal length obtained with cuttings treated with 500 ppm IBA may be due to the application of growth regulators which cause greater metabolic activity of sugar and nitrogen substances from stem and leaves which inturn helps in increasing the inter nodal length. IBA have potential to enhance rapid cell division and elongation; hence it may have increased the inter-nodal length of plants which ultimately increase the shoot length. These results are in conformity with Chavda *et al.* (2015) [3], Pandey (2012) [11] and Dipak (2017) [5].

Root parameters

The data pertaining to various root parameters as influenced by different growth regulators under shade house (50%) and shaded (with 50% shade) poly tunnel condition in madhunashini are presented in Table 2. The different concentrations of growth regulators (IBA and NAA), coconut water and cow urine treatments had a significant effect on different root parameters. There was a significant influence of treatments on root characters *viz*., number of roots per cutting, length of longest root and per cent rooting.

In shade house (50%) condition, the higher number of roots per cutting (8.79) was recorded in the cuttings treated with 1000 ppm IBA and it was on par with the cuttings treated with 500 ppm IBA (7.18). And in shaded (with 50% shade) poly tunnel condition, the higher number of roots per cutting (9.13) was recorded in the cuttings treated with combination of IBA and NAA at 1000 ppm each and it was on par with the cuttings treated with 500 ppm IBA (8.26). In comparision with combination of IBA and NAA, the treatment with IBA alone was found to be better. The higher number of roots per cutting obtained with cuttings treated with 500 ppm IBA may be attributed to auxin application which is a common feature in many herbaceous perennial crops. The increased number of roots to optimum concentration of IBA may be also due to increased rate of respiration, accumulation of higher level of amino acids at their bases. This pattern is continued with nitrogenous substances accumulating in basal part of treated cuttings, apparently mobilized in the upper part and translocated as aspargine and also higher partitioning of photosynthates and utilization of stored carbohydrates and phenols towards root development (Akshitha *et al*, 2014) [1]. These findings are well corroborated with the findings of Venugopal *et al*. (2008b) [14] and Ashok (2012) [2].

The maximum length of root (17.16 cm) in shade house (50%) condition was obtained in the cuttings treated with 500 ppm IBA and 1000 ppm NAA and was on par with cuttings treated with 500 ppm IBA (13.55 cm). Whereas, in shaded (with 50% shade) poly tunnel condition, the maximum length of root (17.35 cm) was obtained in the cuttings treated with 500 ppm IBA. In comparison with combination of IBA and NAA, the treatment with IBA alone was found to be better in producing equally good quality roots. The maximum length of root obtained with cuttings treated with 500 ppm IBA may be attributed to auxins which accelerate the translocation of nutrients from upper part of the cuttings to their basal ends by increasing the activity of enzymes. This increases hydrolysis of carbohydrates for providing enough energy in rooting respond of the cells. It may also be attributed to slow translocation or slow destruction property by auxin destroying enzyme system. As reported by Akshitha *et al.* (2014) [1] occasionally IBA treatment seems to stimulate cell division in the ray cells between the primary bundles which improves root length and increased uniformity of rooting. These findings are in conformity with the findings of Chavda *et al.* (2015) [3] and Devendrakumar *et al.* (2014) [4].

The cuttings placed in shade house (50%) condition registered significantly higher per cent rooting (61.28%) was significantly higher in the cuttings treated with 500 ppm IBA and 1000 ppm NAA and it was on par with cuttings treated with 500 ppm IBA (58.03%). Whereas, in shaded (with 50% shade) poly tunnel condition, the per cent rooting (68.67%) was significantly higher in the cuttings treated with 500 ppm IBA and 1000 ppm NAA and it was on par with cuttings treated with 500 ppm IBA (64.78%). In comparision with combination of IBA and NAA, the treatment with IBA alone was found to be better. The higher per cent rooting obtained with cuttings treated with 500 ppm IBA may be due to the action of IBA, which has caused enhanced hydrolysis and translocation of carbohydrates and nitrogenous substances at the base of cuttings and resulted in accelerated cell elongation and cell division in suitable environment. Growth regulators play tremendous role in increasing rooting and apical bud dominance (Kiuru *et al*., 2015) [9]. These results of the present investigation are in close agreement with various workers like Venugopal *et al*. (2008b) [14] and Akshitha *et al.* (2014) [1].

Combination of IBA and NAA and its effect

Growth regulators such as, NAA and IBA are the most widely used auxins in commercial vegetative propagation practices in madhunashini. They are chosen because of their rhizogenic efficacy, which results from their high stability in plant tissues. The mechanisms by which IBA stimulate root formation in stem cuttings and conversion to IAA, increasing internal free-IBA, enhance tissue sensitivity to IAA, enhance the endogenous IAA synthesis or the action of IAA synergistically, while the stimulatory effect of NAA to induce root formation was probably associated with inhibition of IAA-oxidase (IAAO) activity, thus preventing IAA degradation and increase its activity. These findings are in conformity with the findings of Chavda *et al.* (2015) [3] and Devendrakumar *et al.* (2014) [4].

Inhibitory effect of NAA at higher concentration (1000 ppm)

It is worth noting that higher concentrations of auxin did not substantially produce a better result of rooting. Increasing the concentration of NAA beyond the supra-optimal concentration resulted in significant reduction both in the growth and root parameters. This might be related to the fact that higher concentrations of NAA was inhibitory both to root induction and elongation in madhunashini. Increased concentrations of auxins stimulate natural ethylene production which is inhibitory to rooting. The inhibitory effect caused by high exogenous auxin also occurs in many other plants. These results coincides with the findings of Pandey (2012) [11], Dipak (2017) [5], Kiuru *et al*. (2015) [9] and Chavda *et al.* (2015) [3].

Coconut water and cow urine

Among the treatments, under shade house (50%) and shaded (with 50% shade) poly tunnel condition, the coconut water and cow urine had no significant effect on growth and root parameters. Though coconut water and cow urine treatments had resulted in significantly higher values with respect to growth and root parameters than control, but was found to have significantly lower values compared to cuttings treated with 500 ppm IBA.

Coconut water had significant effect on growth and root parameters than control. Coconut water also contains some natural hormones. Hormones which are present in coconut water are auxin, cytokinins and gibberellins. Auxin has an important role on rooting formations of shoot cuttings. The significant increase in growth and root parameters than control in coconut water may be due to, coconut water which aids in rapid growth of callus and cell division which occurs due to the presence of IAA and the purine bases adenine, which is one form of cytokines. This is also due to the presence of cytokines and gibberellin hormone, which contained in coconut water because gibberellin can stimulate cell elongation that has positive correlation with growth and root parameters. These findings are well corroborated with the findings of Harshavardhan *et al*. (2016) [7] and Mudji *et al*. (2016) [10].

Cow urine had significant effect on growth and root parameters than control. Cow urine is known for presence of growth promoting auxin like IAA and rich in nutrients. Cow urine also contains many of those elements that are needed by plants, such as N, P, K, Ca, Na, Fe, Mn, Zn and others and its existence cannot be replaced by other nutrients for plant growth and development. The significant increase in growth and root parameters than control in cow urine may be due to, cow urine which is found helpful in enhancing the carbohydrate accumulation and photosynthesis in plants might be the possible reason in achieving higher emergence of plants and improved growth and root parameters. These results of the present investigation are in close agreement with various workers like Harshavardhan *et al*. (2016) [7] and Mudji *et al*. (2016) [10].

Different environments

The chain of developments during the process of root formation is influenced by several internal and external factors. The physiological and the biochemical activation of stem cuttings during rooting markedly depend on maintenance of congenial propagation environment. Among the different environments, the cuttings treated with IBA under shaded (with 50% shade) poly tunnel condition (polytunnel + shade) produced highest growth and root parameters than shade house environment. The interaction of poly tunnel and shade house condition along with IBA 500 ppm have recorded significantly high rooting success and produced equally good quality roots compared to shade house (50%) environment. The shaded (with 50% shade) poly tunnel has given better results than shade alone. This may be due to maintenance of high humidity and optimum temperature inside the poly tunnel with improved microclimate complemented by the root initiating action of IBA. Moisture supply is maintained throughout at the same ideal level. These observations are in line with the findings of Ingle and Venugopal (2009) [8] who reported that use of polythene covering on tunnels ensures almost saturation of relative humidity inside the structure. This high rate of success may be attributed to the congenial propagation environment provided by shaded (with 50% shade) poly tunnel condition and the complementary effect of IBA treatment and thereby ensuring high leaf water potential of cutting which triggers profuse rooting. The IBA treatment complements by activating hydrolyzing enzymes at the rooting site which catalyses the starch degradation and thereby enable availability of sugars for rapidly multiplying cells at the site of root initiation. These findings are well corroborated with the findings of Venugopal *et al*. (2008a) [13], Devendrakumar *et al.* (2014) [4] and Venugopal *et al*. (2008b) [14].

Therefore poly tunnels placed under shade house created similar condition as existing in mist house. Since the poly tunnels are low cost, easy to construct with locally available materials and easily movable anywhere as such it is more practical technology for large scale commercial multiplication of madhunashini as it has cost advantage and zero power requirements.

Table 1: Growth parameters as influenced by different growth regulators under shade house and shaded poly tunnel condition in Madhunashini (*Gymnema sylvestre* R. Br.) cuttings

Treatments		Shade house condition								
		Number of leaves			Shoot length (cm)			Inter nodal length (cm)		
		I	II	Pooled	I	II	Pooled	I	II	Pooled
T_1	Control	19.00	17.00	18.10	15.3	15.8	15.50	2.00	2.23	2.10
T_2	IBA 500 ppm	28.33	29.53	28.99	33.3	31.3	32.36	2.67	2.61	2.44
T_3	IBA 1000 ppm	18.00	21.00	19.52	38.7	40.2	39.49	2.73	2.79	2.74
T_4	NAA 500 ppm	22.67	23.61	23.18	30.0	32.3	31.28	2.83	2.89	2.91
T_5	NAA 1000 ppm	9.33	10.31	9.80	17.3	18.4	17.94	2.60	2.76	2.69
T_6	IBA 500+NAA 500 ppm	20.67	23.67	22.17	36.0	39.4	37.01	2.77	2.83	2.70
T_7	IBA 500+NAA 1000 ppm	31.00	30.25	30.63	34.0	34.0	34.10	2.27	2.29	2.21
T_8	IBA 1000+NAA 500 ppm	22.00	22.50	22.25	28.3	28.9	28.26	2.77	2.57	2.69

T_9	IBA 1000+NAA 1000 ppm	21.00	21.35	21.18	18.3	18.7	18.53	2.67	2.69	2.60
T_{10}	Coconut water	21.00	21.50	21.25	15.7	15.4	15.59	2.67	2.63	2.62
T_{11}	Cow urine	22.33	21.63	21.98	19.0	19.5	19.01	2.23	2.28	2.11
	SEm+	1.32	1.34	1.35	1.21	1.23	1.20	0.20	0.22	0.21
	CD@0.01	5.27	5.25	5.24	4.82	4.81	4.84	0.80	0.81	0.82
Treatments		**Shaded poly tunnel condition**								
		Number of leaves			**Shoot length (cm)**			**Inter nodal length (cm)**		
		I	**II**	**Pooled**	**I**	**II**	**Pooled**	**I**	**II**	**Pooled**
T_1	Control	10.00	10.25	10.16	16.67	16.88	16.22	2.47	2.68	2.52
T_2	IBA 500 ppm	23.67	24.67	23.09	28.67	30.64	29.31	2.60	2.70	2.58
T_3	IBA 1000 ppm	12.33	12.81	12.55	24.33	25.38	24.03	2.83	2.89	2.81
T_4	NAA 500 ppm	16.00	16.86	16.44	20.00	22.00	21.41	2.33	2.56	2.48
T_5	NAA 1000 ppm	30.00	30.50	30.26	38.67	36.67	37.69	2.77	2.77	2.79
T_6	IBA 500+NAA 500 ppm	19.67	20.43	19.91	30.03	30.03	30.05	2.50	2.50	2.53
T_7	IBA 500+NAA 1000 ppm	18.33	18.33	18.36	40.00	40.00	40.01	3.00	3.00	3.06
T_8	IBA 1000+NAA 500 ppm	18.00	18.35	18.07	42.00	44.15	43.56	3.00	3.17	3.09
T_9	IBA 1000+NAA 1000 ppm	30.00	31.50	30.75	31.67	32.67	31.93	2.50	2.40	2.42
T_{10}	Coconut water	16.00	16.50	16.25	24.33	24.74	24.64	2.17	2.19	2.15
T_{11}	Cow urine	18.33	18.79	18.53	21.00	21.50	21.25	2.00	2.09	2.02
	SEm+	1.30	1.32	1.33	1.23	1.26	1.25	0.58	0.57	0.59
	CD@0.01	5.18	5.20	5.24	4.91	4.94	4.90	2.11	2.08	2.07

Table 2: Root parameters as influenced by different growth regulators under shade house and shaded poly tunnel condition in Madhunashini (*Gymnema sylvestre* R. Br.) cuttings

Treatments		**Shade house condition**								
		No. of roots per cutting			**Length of longest root (cm)**			**Percent rooting (%)**		
		I	**II**	**Pooled**	**I**	**II**	**Pooled**	**I**	**II**	**Pooled**
T_1	Control	3.33	3.58	3.46	6.67	7.17	6.92	13.30	16.50	14.86
T_2	IBA 500 ppm	6.67	7.68	7.18	13.00	14.00	13.55	56.50	59.55	58.03
T_3	IBA 1000 ppm	8.67	8.91	8.79	10.83	11.14	10.99	45.60	49.40	47.41
T_4	NAA 500 ppm	7.33	7.91	7.62	10.83	11.88	11.36	46.70	49.80	48.25
T_5	NAA 1000 ppm	6.67	6.91	6.79	8.67	9.06	8.87	41.30	44.70	43.10
T_6	IBA 500+NAA 500 ppm	7.67	7.59	7.63	16.00	18.10	17.08	58.40	62.20	60.35
T_7	IBA 500+NAA 1000 ppm	7.00	7.24	7.10	17.00	17.32	17.16	59.10	63.40	61.28
T_8	IBA 1000+NAA 500 ppm	7.67	7.76	7.72	16.00	16.87	16.44	56.80	59.80	58.29
T_9	IBA 1000+NAA 1000 ppm	8.00	8.10	8.08	12.33	11.33	11.83	48.50	51.50	50.12
T_{10}	Coconut water	6.00	6.15	6.08	12.67	12.97	12.82	26.67	27.67	27.17
T_{11}	Cow urine	6.20	6.30	6.22	8.67	8.89	8.78	33.33	33.78	33.56
	SEm+	0.36	0.56	0.35	1.09	1.14	1.09	1.46	1.22	1.17
	CD@0.01	1.42	2.24	1.37	4.36	4.56	4.35	4.56	4.66	4.53
Treatments		**Shaded poly tunnel condition**								
		No. of roots per cutting			**Length of longest root (cm)**			**Percent rooting (%)**		
		I	**II**	**Pooled**	**I**	**II**	**Pooled**	**I**	**II**	**Pooled**
T_1	Control	6.00	6.60	6.28	6.33	6.58	6.46	20.40	23.40	21.90
T_2	IBA 500 ppm	7.89	8.54	8.26	16.33	18.37	17.35	65.40	64.10	64.78
T_3	IBA 1000 ppm	12.67	13.52	13.10	13.00	14.40	13.64	53.33	57.11	55.17
T_4	NAA 500 ppm	6.67	6.83	6.75	5.67	5.60	5.64	53.33	55.11	54.20
T_5	NAA 1000 ppm	8.33	8.86	8.60	11.17	12.12	11.65	40.40	44.40	42.42
T_6	IBA 500+NAA 500 ppm	6.00	6.57	6.29	12.67	13.23	12.95	58.90	62.53	60.72
T_7	IBA 500+NAA 1000 ppm	6.67	6.69	6.68	11.31	12.31	11.81	66.70	70.70	68.67
T_8	IBA 1000+NAA 500 ppm	6.67	6.85	6.76	15.67	15.95	15.81	61.60	64.50	63.05
T_9	IBA 1000+NAA 1000 ppm	9.00	9.26	9.13	9.17	9.38	9.28	53.33	56.33	54.83
T_{10}	Coconut water	8.67	8.87	8.75	6.67	6.95	6.81	26.67	27.89	27.28
T_{11}	Cow urine	7.33	7.83	7.58	12.67	12.87	12.77	33.33	35.33	34.24
	SEm+	1.25	1.05	0.91	1.12	1.02	0.92	1.33	1.43	1.11
	CD@0.01	4.77	4.17	3.73	4.31	4.07	3.60	5.67	5.87	4.34

4. Conclusion

Thus, based on the study it can be concluded that, among different environments, the cuttings under shaded (with 50% shade) poly tunnel condition (poly tunnels placed under shade house) was found suitable for getting highest number of roots, longest root and highest per cent rooting followed by shade alone. Among different concentrations of growth regulators, the cuttings treated with 500 ppm IBA treatment will ensure high rooting percentage with robust and healthy cuttings. Thus, low cost poly tunnels placed under shade house (50%) in combination with 500 ppm IBA is recommended for farmers to get high yield. The use of low cost polytunnels which can be constructed with locally available materials is more practical technology for large scale commercial multiplication of madhunashini as it has lot of advantages. Thus, based on the study it can be concluded that low cost poly tunnels placed under shade house (50%) in combination with 500 ppm IBA is found suitable for getting higher per cent rooting, number of roots per cutting and length of the longest root.

5. References

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