Plant Archives Vol. 21, Supplement 1, 2021 pp. 685-692 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.103

A REVIEW ON THE USE OF ORGANIC ROOTING SUBSTANCES FOR PROPAGATION OF HORTICULTURE CROPS

Rony Paul Rajan[1] and Gurpreet Singh[2]*
Department of Horticulture, School of Agriculture, Lovely Professional University, Punjab
*Corresponding author email: gurpreetraje@rediffmail.com

ABSTRACT

The objective of the current review is to identify the research work on the organic rooting substances on rooting and root growth of cuttings of Horticulture crops for their propagation. Endogenous and exogenous factors affect the rooting of cuttings. Most of the time auxin like IBA and NAA is widely used to propagate horticultural plants through cutting and layering. As most of the consumers are realizing the importance of organic fruits, there is a need to explore the non-chemical substances for propagating horticultural plants. It is also required to get organic certification. Use of organic rooting substances is also cheaper alternative to synthetic rooting hormone. Organic rooting substances like vermin wash, Coconut water, willow leaf water, honey, humic acid, Seaweed extract, Aloe Vera, cinnamon powder are considered ideal for rooting of cuttings. A good rooting substance must be easily available, economically attractive, ecologically sound mean of reducing external inputs. Using of organic rooting substances is smart because it reduces the synthetic hormone and improves the quality and quantity of rooting of cutting. Organic rooting substances increase sustainability of the soil and make it more productive.

***Keywords*:** natural rooting hormone, non-chemical rooting substances, cuttings, layering, root promoting substances, alternative rooting substances

Introduction

Horticulture crops like fruit and tree crops are mostly propagated by vegetative method. Many new plants can be produced in limited space from few stock plants in vegetative type of propagation. The vegetative method like cutting and layering propagation is always preferred over the seed propagation because it provides true to type and early bearing plants producing fruits of uniform quality (Santoso and Parwata, 2014). It is inexpensive, rapid and simple and doesn't require the special techniques necessary in grafting and budding. In addition, vegetative propagation can divert the germination phase to reduce the rotation period of the species. Stem cutting is the most common method of vegetative propagation for woody and herbaceous plants. Popularity of vegetative propagation generally due to the low cost and cost effectiveness (Waziri *et al.,* 2015) and easiness of propagation (Dawa *et al.,* 2017) related with the utilization of the technique. The success of propagation by cutting may be related with the planthormones (Bhardwaj *et al*., 2017), donor plant age (Ambebe *et al*., 2017), medium of growth (Ashiono *et al*., 2017), type of cutting taken from mother plant (Washa, 2014), size of the cutting taken from mother plant and donor plant characters (Kramer and Kozlowski, 2014).

Endogenous and exogenous factors affect the rooting of cuttings. Treatment with organic substances or hormones is an important exogenous factor in rooting. Most of the time auxin like IBA and NAA are used for rooting. Hormone treatment is one of the most important factors due to enhance the initiation of the root primordia and growth through cell multiplication (Fogasa and Fett- Neto, 2005). Hormones support mobilization of sugars and nutrients by the hydrolysis of starch to the base of the cuttings (Das *et al*., 1997). The plant growth regulators like auxin are used to increase the percentage of rooting in stem cuttings for quick root initiation and to increase number of roots per cutting. (Garande *et al.,* 2002).

Therefore use of organic rooting substances or organic hormones is considered as an important non-chemical method of propagation of horticultural crops to avoid the use of synthetic hormones. (El Deeb *et al.,* 2008).

Production of any crop is influenced mainly by use of quality planting material (Ambebe *et al*., 2017, Washa, 2014). But productivity of horticulture crops showed reduction due to salinity in soil, chlorides in irrigation water, drought and also nematodes. In order to sustain the production under these adverse conditions, use of growth regulators and organic substances is the most effective and convenient means of maintaining optimum development of roots and nutrient supplies according to the specific requirement. The natural rooting hormones are available as vermin wash, Coconut water, willow leaf water, honey, humic acid, Seaweed extract, Aloe Vera, cinnamon powder.

Natural root promoting substances are a costless and safe to use alternative for rooting of horticulture crops. They are environmental friendly and can be used as a substitute for synthetic plant growth hormones like IBA. (El-Sherif *et al.,* 2017).

Natural rooting hormone like vermin wash, Coconut water, willow leaf water, honey, humic acid, Seaweed extract, Aloe Vera, cinnamon powder provide a cheap and economically sound mean for propagation and improving the quantity of rooting. These rooting substances reduce external inputs and improve root quality. They are sustainable, cost effective, and environment-friendly and improve crop growth and quality by providing hormone. They increase sustainability of the soil and make it more productive. This indicates that organic substances can be beneficial for increasing the rooting and growth of cuttings by producing growth regulators (Chen and Aviad, 1990). Objective of present article is to review about different organic rooting substances on rooting behavior of various horticulture crops.

Different organic substances reported for rooting of cuttings:

Many organic rooting substances are reported for propagation of horticulture crops. Natural rooting substances can be utilized for the propagation of hardwood and softwood cuttings of horticulture crops. Synthetic growth regulators have restrictions in some countries including European Union. In this regard the use of natural rooting hormones is highly significant in propagation of horticulture crops (Pacholczak *et al.,* 2016). Hence there is a need of utilizing alternative hormone for the propagation of cuttings. Different organic rooting substances and their benefits are mentioned in different studies. One study showed that the roots of grapevine treated with Vermi-extract were 15% longer in length (16.1cm) than other treatments (Flores, 2014). It is assumed that Vermi extract is having essential plant growth hormones which can effectively control rooting and growth of cuttings. It is studied and found that there is a rich diversity of natural PGRs and Phytochemicals like cytokinins, auxin, gibberellins, brassinosteroids and phenolic acid are present in vermicompost leachate. There is presence of IAA in a range between 0.55–0.77 picomol/mL and 18 Gibberellic Acids in vermicompost leachate. These 18GAs are present in biologically active form and as final products of metabolic process in vermicompost leachate.

Vermicompost tea is reported to have plant growth regulators, plant available nutrients and organic acids (Edwards *et al.,* 2006) as well as macro and micro nutrients and growth regulators like Gibberellins, Indole acetic acid (IAA) and Cytokinin (Arancon *et al.,* 2005) which is having positive effect on plant growth.

Vermicompost tea is used to treat before planting by (Choechit *et al.,* 2013) and found that it is having significant influence on increasing root biomass and root number in cassava.

Ibironke *et al.* (2017) studied on IBA, Coconut water; Tetracycline and found coconut water treatment had significant effect on rooting with respect to Muraya cuttings. Coconut water is reported to have primary type of auxin i.e. Indole-3- acetic acid which is the present in plants (Ma *et al.,* 2008 and Wu *et al.,* 2009) and trans- zeatin, which is the cytokinin, identified by Letham, (1974) whereas verification of the presence of two "trans-zeatin and trans-zeatin riboside" in water of coconut is done by Stadens and Drewes, (1975) Coconut water is also detected to have the presence of Gibberellic acid i.e, GA1 and GA3 (Ge *et al.,* 2007). It has been predicted by "auxin-cytokinin hypothesis that cytokinins, along with auxins, play an essential role in morphogenesis" of plant by managing the root and shoot formation and relative growth moderation (Werner *et al.,* 2001).

Knapke, (2018) reported that willow cuttings contain natural growth substance IBA and salicylic acid. He mentioned that home-produced rooting hormone for propagation of other cuttings can be made with the help of willow cuttings. Soaking of willow cuttings in water will give "willow water" which can be used as a natural rooting hormone. Water soluble diffusates of *Salix erythroflexus* (willow) was tested as a root-promoting substance on semihardwood cuttings of *Chionanthus retusus* (Arena *et al.,* 1997).

Presence of a natural plant biochemical Salicylic acid in bark of willow is known to have properties of growth increment and antisenescence (Raskin, 1995). Salicylic Acid reverses ABA-induced closing of stomata and abscission of leaf; it increases growth of plant height and stimulates adventitious root initiation (Malamy and Klessig, 1992).

Dunsin *et al.,* (2014) used honey in an experiment, as an alternative hormone on *Parkia biglobosa.* Honey showed less mortality rate of cutting (2.33) than control (2.667). Firth, (2018) reported honey can be used for treating *Hemigraphis* cuttings and it showed higher percentage of rooting (94%) and heavier roots (4.08g). Some have mentioned that honey is commercially used as rooting hormone and 0.5% proteins and polyphenols (Singh *et al.,* 2012 and Nair *et al.,* 2018).

Honey is reported to have high concentration of sugar, dextrose, levulose and sucrose (White *et al.,* 1980). It has been reported that besides growth regulators and hormones, another main criterion affects rooting phenomenon is sucrose (Abo *et al.,* 2018). It is clear that there is a positive effect on root induction and growth by oligosaccharides deposited in the cell wall of plants (Mehrabani *et al*., 2016). There are several vitamins like Vitamin C and Vitamin B1 which are present in honey and thus honey is a natural source of vitamins, which has found initiation of root in cuttings in many plants (Turetskaya and Polikarpova, 1968). From a long been it has found that vitamins are the promoter of root forming factors in several plant species (Chee, 1995).

Rajkumar *et al.,* (2018) treated grape hardwood cutting of cv, Muscat with humic acid @ 2% showed 90.50 % survival and assured comparative performance with IBA (94.61%).

Baldott, (2014) examined the adventitious roots on the Brazilian red clock and Sanchezia after using humic acids. This study found that at a concentration of 33.6 mmol per litre humic acid increased the fresh and dry mass of the shoots in the Brazilian red watch and in Sanchezia at a concentration of 19.5 mmol per liter an increase of 35.9% of the root dry matter compared to control. Humic acids are bioactive part of moistened organic substances (Piccolo, 2001) and can alternatively be used in cuttings from ornamental plants, which also promote root formation. Humic acids are proved to be effective in promoting development and plant growth in multiple plants (Zandonadi *et al.,* 2007). "These effects are reflected in the increased rate of root growth, the increased plant biomass and changes in the structure of the roots" (Baldotto *et al*., 2012)

Gaber, (2017) reported that seaweed extract have IAA

0.03% when treated on Rosemary cuttings showed increased fresh weight (1.73g). Seaweed extract contained all three categories of plant hormones viz. gibberellins, cytokinins and auxins. It enhances micro and macro elements uptake and their translocation within plants, increases in the rate of respiration and growth of root and take part in photosynthesis and other metabolic activities. It beneficially affects the resistance of plant to stresses, speed up setting of flowers (Bai *et al.,* 2007).

Aloe Vera and cinnamon powder is having Salicylic Acid which helps in rooting of cuttings. Aloe Vera is showed to be best in rooting of *Vitex diversifolia* semihardwood cuttings than IBA (Shidiki *et al.*, 2019). Aloe vera leaf extract is confirmed to have phytohormones and nutrients like GA3 16 mg/100gm fresh weight, IAA 0.6 mg/100gm fresh weight, ABA 3.1 mg/100gm fresh weight, Glucose 3 g/100g, Protein 1.0 mg/g.

Plant extracts of the genus Aloe have been reported to be a source of nearly 75 biologically active ingredients, including various types of salicylic acid, minerals, sugar, vitamins, saponins, lignins, and amino acids. That promotes cell preservation and proliferation (Dagne *et al.,* 2000). Aloe has also been reported to contain hormones between auxins and gibberellins that promote root growth in plants.

Surjushe *et al.,* (2008) mention that other natural materials like honey and yeast and also extracts of some plants, such as ginger, licorice and cinnamon have been used as alternatives to promote rooting (Hameed *et al.,* 2019). Cinnamon contains cinnamic acid, cinnamon aldehyde, cinnamyl acitate, cinnamyl alcohol, eugeuol, tannin and minerals (Gunjan and Anart, 2009).

(a) Organic substances on root length per cutting of Horticulture crops:

There are different parameters to determine effectiveness of organic rooting substances on horticulture crops. Natural rooting substances showed significance increase in root length of different cuttings. This is due to combined effect of IAA and minerals present in different rooting substances. There is report that aloe vera gel has IAA and it could be used as an alternative hormone (El-Sherif, 2017). Aloe vera gel contains growth hormones like gibberellin and salicylic acid (Sahu et al., 2013) which promotes growth of the plant. Many have similar findings that application of aloe vera gel is helpful in increasing root length of cuttings. Ginger + Cinnamon aqueous extract is found significance in developing root length of 8.90 than control 2.07 of aerial hayany date palm offshoots in a study by Deeb *et al.,* (2008). A study was conducted with coconut water extract on propagation by softwood canes and cuttings for the vegetative reproduction of *Dracaena purplecompacta* L. by (Agampodi *et al.,* 2009). This study confirmed the effect of coconut water on adventitious root development. Five different concentrations of Coconut Water extracts that includes 28 µM, 57 µM, 143 µM, 286 µM, 571 µM of natural IAA were tested. They carried out another set of treatment with the similar concentration of authentic IAA rooting hormone for comparison of effect. The study found that Coconut Water extract at the rate of 143- µM IAA had the best induction of roots and development and that the root expression was faster (that is within 5 weeks) with the use of the this novel technique than IAA (6 weeks). The root length was found to be 300mm in coconut water treatment than standard IAA (250 mm) after five replications. Dunsin *et al.,* (2014) showed that cuttings of *Parkia biglobosa* which is treated with Moringa leaf extract had longest root length than control and treatments with honey, coconut water.

Flores, (2014) studied the effect of Vermi-extract roots treatment on grapevine. He applied steer compost at different rate and Vermi-extract at the rates of 2.5mL, 5mL, 10mL, and 20mL. The result showed that there is a significant difference between steer compost and vermi-extract. He obtained 15% longer roots that were treated with vermi-extract than roots treated with steer compost.

Rajkumar *et al.,* (2018) showed that treatment with Humic acid @ 2% in grapes cuttings has effective root length (6.23cm) near to the IBA @3000ppm treatment (6.90cm).

In an experiment by Shidiki *et al.,* 2019 he examined the effect of using plant extracts for rooting of *Vitex diversifolia* cuttings. He selected IBA, Aloe Vera and Coconut Water and combination of Aloe Vera + Coconut Water. He found that treatment with Aloe Vera and Coconut Water and combination of Aloe Vera + Coconut Water had more root length (15, 15, 17mm respectively) than IBA (8mm).

Jamal Uddin *et al.,* (2020) studied the effect of natural substances in comparison to synthetic hormone in grapevine cutting. In Aloe vera gel treatment longest root length (12.9 cm) observed followed by IBA (10.9 cm) whereas the smallest root length (5.2 cm) was measured in the control treatment. He concluded that aloe vera gel is the best natural substance which can be a potential alternative rooting hormone to synthetic rooting hormone for propagation of grapevine. Abbasifar *et al.,* (2020) give the report of using garlic extract on rooting of grapes cuttings. He found the highest root length (19.67 cm) was in 50 g/L garlic extract application than the highest root length (12 cm) of control. He arrived to a conclusion that garlic extract is having significant impact on rooting and root length of grapevine.

Table 1 : Root length of Horticulture crops treated with different organic substances

Serial No.	Organic rooting substances	Horticulture crops	Root length mean (cm)/ highest root length (cm)	References
1.	Aloe vera gel (100%)	Grapes cuttings	12.9 cm	Uddin *et al.,* (2020)
2.	Garlic extract 50 g/L	Grapevine	19.67 cm	Abbasifar *et al.,* (2020)
	Garlic extract 50 g/L	Wild privet	6.92 cm	Abbasifar *et al.,* (2020)
3.	Sea Weed extract (2 ml/l)	*Dracaena Marginata*	15.00 cm	Ibrahim, (2020).
4.	Coconut water (100%)	*Annona muricata*	4.70 cm	Dada *et al.,* (2019)
5.	Aloe Vera and coconut water (100%)	*Vitex diversifolia*	17 cm	Shidiki *et al.,* (2019)
6.	Moringa leaf extract	*Parkia biglobosa*	12.457 cm	Dunsin *et al.,* (2018)
7.	Sea Weed extract 20%	Grapes cuttings	12.99 cm	Shaima *et al.,* (2018)
8.	Vermi wash 10%	Peppermint	12.9 cm	Seren *et al.,* (2017)

9.	Coconut water (100ml)	*Bougainvillea spectabilis*	12.05 cm	Ibironke, (2016).
	3% chitosan	*Ficus triangularis*	15.3 cm	Gamlath *et al.,* (2010)
10.	3% chitosan	*Ficus microcarpa*	38.8 cm	Gamlath *et al.,* (2010)
	Ginger + Cinnamon aqueous extract	Date palm	8.90 cm	Deeb *et al.,* (2008)

(b) Organic substances on number of roots per cutting of Horticulture crops:

Number of roots in cuttings will ensure the well establishment of plants. Natural hormones play a major role in increasing root numbers in cuttings. Increase in number of roots will play a major role in faster growth of cuttings. Many researchers have reported the effect of natural substances in increasing root number of horticulture crops. Application of root promoting substances can be widely used for the propagation of easy to root cuttings. Use of aqueous diffusates of willow extract enhanced rooting of Semihardwood cuttings of *Chionanthus retusus.* It was examined by treating willow diffusate in cuttings for 24 hour. Observation confirmed that after 75 days of treatment willow diffusates with IBA produced greater number of roots than locust diffusate and IBA treatments (Arena *et al.,* 1997). Extract of macerated seed (Terrabal Organico™) used as a root promoting product to understand the effect on propagation of organic olive (*Olea europaea L.).* cultivar Cornicabra cuttings. Rooted cuttings without callus were higher in Terrabal Organico™ (31.5) than IBA (11.1) and had effective number of roots (5.42) than IBA (2.86 a). Terrabal Organico™ applied for 1 hour, 4 hour, and 8 hour and found that it could be a valid alternative to IBA for propagating cv. Cornicabra of organic olive plants by the application of it to the basal cut portion of cuttings for 1 hr. It produced (4) number of roots near to IBA (6.1). It can be used for propagation of organic olive plants to get organic certification Centeno *et al.,* (2008).

More number of roots was reported on coconut water treatment by Agampodi *et al.,* (2009) than standard IAA on rooting of *Dracaena purplecompacta* L. They found that the number of roots was higher in coconut water (20) than standard IAA (18). From an experiment Choechit *et al.,* (2013) proved the influence of vermicompost tea on cassava stem cutting rooting. The concluded that the numbers of roots of the 3 cassava varieties RY7, RY9, and KU50 treated with 50% and 100% vermicompost teas (34, 20, 28 and 30, 25, 25 respectively) significantly higher than 0% Vermicompost tea and the control (17, 18, 20 and 23, 15, 12) were observed after 21 DAP.

A study into rooting of stem cuttings with Babylon weeping willow extracts on olive (*Olea europaea* L.) cultivar 'Nabali' revealed its effectiveness in propagation. It has been proved that average number of roots had a significant increase per rooted cutting of olive (3.9) when soaking the cuttings in shoot extract or leaf extract or bark extract for 2 hour (Al-Amad *et al.,* 2014). Recent study found that *Dioscoreophyllum Cumminssi* and Serendipity Berry treated with coconut water at 100% had highest number of roots (21.25) than IBA (16.00) treatment (Bamigboye *et al.,* 2016). Coconut Milk (75%) treated rosemary cuttings had maximum number of roots (6.20) than IBA by a study of Gaber, (2017). Grapes treated with Licorice extract 100% found 36.70 mean number of roots nearer to IBA 39.04 in an experiment from Shaima *et al.* (2018). Chakraborty, (2018) reported that cuttings treated with humic acid @ 2% had (12.90) better number of roots next to IBA @2000ppm (13.10).

Shaima *et al.* (2018) studied the effect of two natural extracts (licorice and seaweed) at different concentrations in a comparison with indole butyric acid (IBA) on rooting of a hard rooting grape rootstock namely Dog Ridge. The obtained results showed that, licorice was close to IBA in promoting rooting quality since both treatments increased root numbers/ cutting, fresh and dry weights, plant height and number of leaves number/ plant. Dog Ridge cuttings had produced highest number of roots 39.90 due to IBA and 37.93 with 100% licorice treatment. While, seaweed enhanced average of root length and leaf area more than IBA did. They concluded that licorice and seaweed extracts have an effective impact in rooting and it might be a cheap natural IBA alternative that suits clean cultures. An investigation on stem cuttings of *Annona muricata* give a result that the treatment of 100% coconut water had highest number of roots (5.25) than IAA (4.00) and IBA (1.75) (Dada *et al.,* (2019)

Shidiki *et al.* (2019) has studied the primary and secondary roots number in *Vitex diversifolia,* after treating it with IBA, Aloe Vera and Coconut Water and combination of Aloe Vera + Coconut Water. He concluded that treatment with Aloe Vera (4) is having more number of primary roots than Coconut Water, combination of Aloe Vera + Coconut Water and IBA (3, 2, 1 respectively) whereas secondary root is more in number in Coconut Water (65) than Aloe Vera, Aloe vera + Coconut Water and IBA (60, 55 and 20 respectively).

Abbasifar *et al.* (2020) give the first report of effect of garlic extract on rooting of cuttings of grapes and Wild privet. He found that number of roots (16.33)/ (44.33) was higher in 25 g/L garlic extract treatment than number of roots (7.33)/ (42) of control in grapes/Wild privet. In poplar tree he found that 50 g/L garlic extract treatment had higher number of roots (18.67) than number of roots (15.33) of control. He reaches to a conclusion that garlic extract treatment had significant influence in rooting of grapes.

(c) Organic substances on rooting percentage of Horticulture crops

Natural hormones have significant effect on rooting percentage of cuttings. This suggests that it can be beneficial in rooting of a large number of horticulture crops. Organic substances can be widely used for large scale treatment of cuttings. It is having wider scope in ornamental crops and soft wood cuttings. Increased rooting by natural substances point out that it is capable for industrial use. Higher percentage of rooting is observed in Softwood cuttings of *Chionanthus virginicus* after treatment with aqueous diffusate of willow stems than locust diffusate. Treatment was given for 24 hour with aqueous diffusate of willow stems and then IBA. The result showed that 80% success rate in rooting of Softwood cuttings of *Chionanthus virginicus* (Arena *et al.,* 1997).

To test the effect of Babylonian weeping willow extract on the rooting of cuttings, four experiments were carried out in which 'Nabali' olive stem cuttings were soaked in bud extract of willow, willow leaf extract, willow wood extract and bark extract of willow and immersed in a 4000 ppm K-IBA solution. Results show that soaking cuttings in bark extract for 48 hours resulted in a significant elevation in root percentage (46.9%) than soaking in willow shoot extract or leaf extract of willow or willow wood extract or IBA (46%) (Al-Amad *et al*., 2014).

Usman *et al.* (2015) used coconut water for treating Bullock ex Hoyl single node stem cuttings with a concentration of 25%, 50% and 100%. They showed that coconut water is effective with highest sprouting percentage (76.39%) and callusing (0.23) than IBA (58.33%, 0.13) and NAA (56.94%, 0.05). Number of leaves was more (4.30) in cuttings treated with coconut water than IBA (3.38) and NAA (3.34). Rosemary cuttings treated with Honey (50 %), Yeast extract (6 g / L) showed 5.90 % rooting and Coconut Milk (75 %) showed 6.25 rooting percentage reported by Gaber, (2017).

Firth, (2018) reported that the *Hemigraphis* cuttings dipped in honey showed higher percentage of rooting (94%) and heavier roots (4.08g).

Grape cuttings treated with humic acid @ 2% showed 90.50% rooting percentage in an experiment by Shaima *et al.* (2018).

Aloe vera leaf extract, Coconut water, IBA and Aloe vera leaf extract + Coconut water are used to propagate semi hardwood cuttings of *Vitex diversifolia* and *Cordia milleneii.* It has been noted from this study that Aloe vera + Coconut water improved the rooting with highest rooting percentage (80%) than IBA (60%) (Shidiki *et al.,* 2019).

Hameed *et al.,* in 2019, an inspection of the effect of cinnamon extract on the root formation and vegetative growth of cuttings from the bottle brush plant Melaleuca viminalis L was carried out.

From their study they showed that treatment with cinnamon extract without wound is having higher rooting percentage (42.22%) than control (24.44%).

A study was conducted to examine the most suitable liquid medium for better rooting and survival of peppermint. The result indicated that within a period of week, the stem cuttings of peppermint dipped in vermiwash @10% had higher rooting percentage (98%) and growth of shoots (Thuraisingham *et al.,* 2019).

Shidiki *et al.* (2019) found 80% rooting percentage in *Vitex diversifolia* and *Cordia milleneii* which is treated with Aloe Vera and coconut water.

Table 2 : Rooting percentage of Horticulture crops treated with different organic substances

Serial No.	Organic rooting substances	Horticulture crops	Rooting percentage	References
1.	Vermi wash @ 10%	Peppermint	98%	Thuraisingham *et al.* (2019)
2.	Aloe Vera and coconut water (100%)	*Vitex diversifolia* and *Cordia milleneii*	80%	Shidiki *et al.* (2019)
3.	Humic acid @ 2%	Grape cuttings	90.50%	Rajkumar *et al.* (2018)
4.	Humic acid @ 2%	Grape cuttings	90.50%	Shaima *et al.* (2018)
5.	Coconut milk @ 75%	Rosemary cuttings	62.5%	Gaber *et al.* (2017)
6.	Honey (2 cups of boiled water mixed with 2 tablespoons of honey)	*Hemigraphis alternata*	94%	Firth *et al.* (2017)
7.	Seaweed extract (Spray Goteo 0.2% 2 times)	*Physocarpus opulifolius* cv. Dart's Gold	85%	Pacholczak *et al.* (2016)
	Seaweed extract (Spray Goteo 0.2%1 time)	*Physocarpus opulifolius cv. Dart's Gold Red Baron*	85.3%	Pacholczak *et al.* (2016)
8.	Willow water leaf extract	olive	43.1%	Al-Amad *et al.* (2014)
9.	Terrabal	olive	56.0%	Centeno *et al.* (2008)

Conclusion

Present review reveals the scope of organic rooting substances and its benefits in propagating crops. Treatment of cuttings is a crucial step in adventitious root formation of horticulture crops because it is a major exogenous factor affecting root formation and development of cuttings. Use of phytohormones and growth regulators has been reported in agriculture and horticulture from several years. The search for natural products and organic rooting substances as substitutes for the use of phytohormones and PGR is becoming very popular. This is due to the high cost of hormones and the risk of toxicity to plants, humans and animals because of an overdose. Extracts of some plant species have been found the presence of phytohormones in tissues due to which it exhibits root-promoting activities. The use of plant extracts and natural products that contain a lot of active compounds could be a successful alternative to synthetic hormones and plant growth regulators which are of chemical nature in improving root formation. Hormones are rich in natural plant extracts, which can be used to improve and stimulate growth of other plant species. From the review we can conclude that organic substances shows better performance in rooting of cuttings of many horticultural crops and showed significance in root formation of cuttings than control and IBA. Hence it can be recommended for the propagation of horticulture crops aiming in organic crop production.

References

Al-Amad, I. and Qrunfleh, M. (2014). Effect of Babylon weeping willow (Salix babylonica L.) extracts on rooting of stem cuttings of olive (*Olea europaea* L.)'Nabali'. In *XXIX International Horticultural Congress on Horticulture: Sustaining Lives,*

Livelihoods and Landscapes (IHC2014): 1130 (pp. 391-396).

Abo El-Enien, H. E., & Omar, M. A. (2018). Effect of some growth substances on rooting and endogenous hormones of Casimiroa edulis L. cuttings. *Zagazig Journal of Agricultural Research*, *45*(3), 891-904.

Abbasifar, A.; Valizadehkaji, B.; Karimi, M.; & Bagheri, H. (2020). The first report: The effect of garlic extract on rooting of cuttings of some ornamental plants and fruit trees. Advances in Horticultural Science, 34(2): 191-204.

Agampodi, V.A. and Jayawardena, B. (2009). Effect of coconut (Cocos nucifera L.) water extracts on adventitious root development in vegetative propagation of Dracaena purplecompacta L. Acta physiologiae plantarum, 31(2): 279-284.

Ambebe, T.F.; Akenji, M.J. and Njoya, M.T.M. (2017). Growth responses of branch cuttings of Cordia africana to physiological age. Journal of Horticulture and Forestry 9(10): 91-97.

Aremu, A.O.; Stirk, W.A.; Kulkarni, M.G.; Tarkowská, D.; Turečková, V.; Gruz, J. and Strnad, M. (2015). Evidence of phytohormones and phenolic acids variability in garden-waste-derived vermicompost leachate, a well-known plant growth stimulant. Plant growth regulation, 75(2): 483-492.

Arena, M.J.; Schwarz, O.J. and Witte, W.T. (1997). Experiments with locust and willow diffusates on rooting cuttings. HortScience, 32(4): 590D-590.

Ashiono, F.A. Wangechi, H.K. and Kinyanjui, M.J. (2017). Effects of sawdust, forest soil and cow dung mixtures on growth characteristics of blue gum (Eucalyptus saligna) seedlings in South Kinangop Forest, Nyandarua, Kenya. Open Journal of Forestry, 7(4): 373-387.

Bai, N.R.; Banu, N.R.L.; Prakash, J.W. and Goldi, S.J. (2007). Effects of Asparagopsis taxiformis extract on the growth and yield of Phaseolus aureus. J. Basic Appl. Biol.; 1(1): 6-11.

Baldotto Lílian, E.B. and Baldotto, M.A. (2014). Adventitious rooting on the Brazilian red-clock and sanchezia after application of indole-butyric and humic acids, Horticultura brasileira, 32: 434-439.

Baldotto, L.E.B.; Baldotto, M.A.; Soares, R.R.; Martinez, H.E.P. and Venegas, V.H.A. (2012). Adventitious rooting in cuttings of croton and hibiscus in response to indolbutyric acid and humic acid. Revista Ceres, 59(4): 476-483.

Bamigboye, T.O.; Kayode, J. and Obembe, M. (2016). Effects of Rooting Hormones on the Juvenile Stem Cuttings of Dioscoreophyllum Cumminssi (Stapf) Diels (Serendipity Berry). International Journal of Research in Agricultural Sciences, 3(2): 2348-3997.

Bhardwaj, D.R.; Singh, R.; Lal, H.; Nath, V. and Singh A.K. (2017). Effect of node number and auxin concentration on propagation of ivy gourd (*Coccinia cordifolia* Cogn) through stem cuttings. Vegetos 30(1).

Centeno, A. and Gomez-del-Campo, M. (2008). Effect of root-promoting products in the propagation of organic olive (*Olea europaea* L. cv. Cornicabra) nursery plants. HortScience, 43(7): 2066-2069.

Firth, C.S. (2017) Honey as an alternative rooting stimulant for cuttings, university of Hawaii, pp. 1-5.

Chee, P.P. (1995). Stimulation of adventitious rooting of Taxus species by thiamine. Plant Cell Reports, 14: 753-757.

Chen, B. and Aviad, V. (1990). Sociology, Organic Farming, Climate change and SoilScience. 9(1): 229-230.

Choeichit, J.; Iwai, C.B. and Ta-Oun (2013). Pre-Planting Treatments of Stem Cutting with Vermicompost Tea Affecting Rooting and Growth Yields of Different Cassava Varieties. International Journal of Environmental and Rural Development (2013) 4-1.

Knapke, D .; Readal, M.; Stravinsky, D.; Wells, L. and Wilson, M.J. (2018). The herb society of America's notable native herbal tree 2018 willow Salix L. species. The Herb Society of America.

Dada, C.A.; Kayode, J. and Arowosegbe, S. (2019). Effects of rooting hormones on the juvenile stem cuttings of *Annona muricata* Linn.(Annonaceae). World News of Natural Sciences. An International Sientific Journal, 23.

Dagne, E.; Bisrat, D.; Viljoen, A. and Van Wyk, B.E. (2000). Chemistry of Aloe species. Curr. Org. Chem., 4: 1055-1078.

Das, P.; Basak, U. and Das, A. (1997). Metabolic changes during rooting in pre-girdled stem cuttings and air-layers of Heritiera Bot Bull Acad Sin., 38: 91-95.

Dawa, S.; Rather, Z.A.; Tundup, P. and Tamchos, T. (2017). Effect of growth regulators and growth media on rooting of semi hardwood cuttings of rose root stocks. International Journal of Current Microbiology and Applied Sciences 6(4): 1042-1051.

Edwards, C.A.; Arancon, N.Q. and Greytak, S. (2006). Effects of vermicompost teas on plant growth and disease. Biocycle, 47(5): 28.

El-Deeb, M.D.; Sourour, M.M. and Marwa, M.M. (2008). Vegetative propagation of date palm (*Phoenix dactylifera* L.) by rooting small off shoots. Environmental and Agricultural Sciences, Suez Canal University, The third International Conference on Date Palm, 13(2) : 2025/4.

El-Shaima, M.; El-Botaty and Saleh, M.M.S. (2018). Effect of Some Natural Substances on Grape Cuttings Rooting. Middle East Journal of Agriculture, Volume : 07, Issue : 04 ,Oct.-Dec. 2018.

El-Sherif, F. (2017). Aloe vera leaf extract as a potential growth enhancer for Populus trees grown under in vitro conditions. American Journal of Plant Biology, 2(3): 101-105.

Flores, K.M. (2014). Root stimulation using vermi-products in grape vine propagations, Wine and Viticulture Department, Viticulture concentration, California polytechnic State University, 1-13.

Fogasa, C.M. and Fett-Neto, A.G. (2005). Role of auxin and its modulators in the adventitious rooting of *Eucalyptus* species differing in recalcitrance. Plant Growth Regulation 4(1):1-10.

Gamlath, M.; Abeywickrama, K. and Wickramarachchi, S. (2010). Root growth promotion of Ficus species during air-layering. Ceylon Journal of Science (Biological Sciences): 39(1).

Garande, V.K.; Gawade, M.H.; Sapkal, K.T. and Gurav, S.B. (2002). Effect of IBA and number of internodes on rooting of stem cuttings of grapes rootstocks. Agriculture Science Direct 22(3): 176-178.

Ge, L.; Peh, C.Y.C.; Yong, J.W.H.; Tan, S.N.; Hua, L.; Ong, E.S. Analyses of gibberellins by capillary electrophoresis-mass spectrometry combined with

solid-phase extraction. J. Chromatogr. A 2007, 1159, 242–249.

Gunjan, S. and Anart, R.N. (2009). Influence of explants type and plant growth regulators on in vitro multiple shoots regeneration of laurel from Himalaya. Nature and Science, 7(9): 1-7.

Hameed, R.L. and Adil, A.M. (2019). Effect of Wounding, Auxins and Cinnamon Extract on the rooting and vegetative growth characteristics of bottle brush plant (*Melaleuca viminalis* L.) cuttings. Scientific Journal of Flowers and Ornamental Plants, 6(2): 105-111.

Hekmat, Y. & Massoud, M. and Gaber, M.G. (2017). Effect of Some Natural Products As an Alternative Chemical Growth Regulators on Rooting Response, Growth and Chemical Composition of Rosemary Cutting. 8: 797-803.

Ibironke, O.A. (2016). Effects of rooting hormones on the propagation of bougainvillea from cuttings. International Journal of Research in Agriculture and Forestry. 3(1): 57-62.

Ibironke, O.A. (2017). Response of Selected Ornamentals to Rooting Hormone in Different Propagating Media. Journal of Botany Research, 1(1): 22-28.

Ibrahim, O.H. (2020). Developing air layering practices for propagation of dracaena marginata lam. utilizing phloroglucinol and seaweed extract as iba-synergists or alternatives. Scientific Journal of Flowers and Ornamental Plants, 7(2): 185-197.

Rao, K.K. (2004). Studied on the propagation of grape rootstocks through hardwood and softwood cuttings M.Sc. (Horticulture) Thesis submitted to Acharya N G Ranga Agricultural University, Rajendranagar, Hyderabad, pp. 1-97.

Kramer, P.J. and Kozlowski, T.T. (2014). Physiology of woody plants, Academic Press, San Diego, CA.

Letham, D.S. (1974). Regulators of cell division in plant tissues. XX. The cytokinins of coconut milk. Physiol. Plant. 32: 66–70.

Letham, D.S. (1974). Regulators of cell division in plant tissues. XXI. Distribution of coefficients for cytokinins. Planta, 118: 361–364.

Ma, Z.; Ge, L.; Lee, A.S.Y.; Yong, J.W.H.; Tan, S.N.; Ong, E.S. (2008). Simultaneous analysis of different classes of phytohormones in coconut (*Cocos nucifera* L.) water using high-performance liquid chromatography and liquid chromatography-tandem mass spectrometry after solid-phase extraction, Anal. Chim. Acta., 610: 274–281.

Malamy, J. and Klessig, D.F. (1992). Salicylic acid and plant disease resistance. The Plant Journal, 2(5): 643-654.

Mehrabani, L.V.; Kamran, R.V.; Hassanpouraghdam, M.B.; Kavousi, E. and Aazami, M.A. (2016). Auxin concentration and sampling time affect rooting of *Chrysanthemum morifolium* L. and *Rosmarinus officinalis* L. Azarian J. Agric.; 3: 11-16.

Nair, V.; Pal, N.; Jain, A. and Das, S. (2018). Achieving oral health the natural way: Part IV-Honey. Journal of Medicine and Health Research, 8-15.

Dunsin, O.; Aboyeji, C.M.; Adekiya, A.O.; Adegbite, K.A.; Adebiyi, O.T.V.; adeyemo, T.O.; Joseph, A. and Dunsin, D.M.F. (2014). Effects of alternative hormones on the root ability on Parkia biglobosa. Scientia Agriculturae, 13(2): 113-118.

Pacholczak, A.; Nowakowska, K.; Mika, N. and Borkowska, M. (2016). The effect of the biostimulator Goteo on the rooting of ninebark stem cuttings. Folia Horticulturae, 28(2): 109-116.

Krishnan, P.R.; Kalia, R.K.; Tewari, J.C. (2014). Plant nursery management: principles and practices. Central Arid Zone Research Institute, Jodhpur, 40.

Piccolo, A. (2001). The supramolecular structure of humic substances. Soil Science, 166: 810-832.

Raskin, I. (1995). Salicylic acid. In: Davis PJ (ed) Plant hormones. Kluwer Academic Publishers. The Netherlands, pp188–205.

Santoso, B.B. and Parwata, I.G.M.A. (2014). Seedling growth from stem cutting with different physiological ages of *Jatropha curcas* L. of West Nusa Tenggara genotypes. International Journal of Applied Science and Technology, 4(6): 5-10.

Sahu, K.P.; Giri, D.D.; Singh, R.; Pandey, P.; Gupta, S.; Shrivastava, A.K.; Kumar, A. and Pandey, D.K. (2013). Effect of Aloe vera on some annual plants. Scientific Research of Pharmacology and Pharmacy, 4: 599-610.

Shidiki, A.A.; Ambebe, T.F. and Mendi, A.G. (2019). A comparative evaluation of Indole-3- Butyric Acid and plant extracts as potential rooting enhancers in cuttings of *Vitex diversifolia* and *Cordia milleneii*. International Journal of Forest, Animal and Fisheries Research, 3(4).

Chakraborty, S and Rajkumar, M. (2018). Effect of growth regulators and organic substances on rooting of grapes (*Vitis vinifera* L.) cv.Muscat. Asian Journal of Science and Technology, 09(07): 8418-8421.

Singh, M.P.; Chourasia, H.R.; Agarwal, M.; Malhotra, A.; Sharma, M.; Sharma, D. and Khan, S. (2012). Honey as complementary medicine:-a review. International Journal of Pharma and Bio Sciences, 3(2).

Staden, J.V. and Drewes, S.E. (1975). Identification of zeatin and zeatinriboside in coconut milk. Physiologia Plantarum, 34(2): 106-109.

Surjushe, A.; Vasani, R. and Saple, D. (2008). Aloe vera: A short review. Ind. J. Dermatol. 53(4): 163-166.

Turetskaya, R. and Polikarpova, F. (1968). Plant propagation using plant growth regulators. Publ. Science, Moscow (In Russian).

Thuraisingham, V. and Seran, T. (2019). Response of Rooting Atributes of Peppermint (*Mentha piperita* L.) Stem Cuttings to Natural Rooting Stimulators. International Journal of Crop Science and Technology, 5(1): 20-27.

Uddin, A.J.; Rakibuzzaman, M.; Raisa, I.; Maliha, M. and Husna, M.A. (2020). Impact of natural substances and synthetic hormone on grapevine cutting. Journal of Bioscience and Agriculture Research, 25(01): 2069-2074.

Usman, I.A. and Akinyele, A.O. (2015). Effects of Growth Media and Hormones on the Sprouting and Rooting ability of *Massularia acuminata* (G. Don) Bullock ex Hoyl, jfewr publications ISBN: 2141-1778: 157-145.

Washa, B.W. (2014). Effective cutting type in the rooting of *Dalbergia melanoxylon* in Tanzania. International Journal of AgriScience 4(4): 256-259.

Waziri, M.S.; Kyari, B.A.; Ibrahim, M.; Apagu, B.; Yunana, B.; Askira, M.N.; and Benisheikh, B.A. (2015). Effect of different soil media on the rooting and growth of Delonix regia stem cuttings in Maiduguri. International Journal of Innovative Agriculture and Biology Research 3(1): 6-11.

Werner, T.; Motyka, V.; Strnad, M.; Schmulling, T. (2001). Regulation of plant growth by cytokinin. Proc. Natl. Acad. Sci. USA, 98: 10487–10492.

White, J. and Doner, L.W. (1980). Honey composition and properties. Agricultural Research Service, United States Department of Agriculture, 82-91.

Wu, Y. and Hu, B. (2009). Simultaneous determination of several phytohormones in natural coconut juice by hollow fiber-based liquid-liquid-liquid microextraction-high performance liquid chromatography, J. Chromatogr. 1216, 7657–7663.

Zandonadi, D.B.; Canellas, L.P. and Façanha, A.R. (2007). Indolacetic and humic acids induce lateral root development through a concerted plasmalemma and tonoplast H^+ pumps activation. Planta, 225:1583-1595.