

Propagation Methods of Selected Horticultural Crops by Specialized Organs: Review

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Abstract

Horticultural crops are mostly reproduced by asexual methods of plant propagations to multiply their exact copy of selected clonal varieties even if the sexual propagation method has also practiced for different plants. This can be done naturally for those plants which are propagating by specialized organs or by human intervention for targeted propagation purposes. The Specialized plant organs are those plant parts which have used for storage of reserves and reproduction purposes. They reproduce by dividing and separating the organs from their mother plants and will have propagated to produce new clonal plants. Propagation by division is a form of plant propagation in which a group of plants or plant parts are cut or torn apart which each part of the divided plant contains one or more of the roots of the plant and a part of the stem of one or more stems. This method is commonly used for different economically important horticultural plants like Irish potato that reproduced by tuber, sweet potato by slips and/or vine cuttings, Ginger by Rhizome, Onion and Garlic by bulb and bulbils and Strawberry by runner. Also propagation by separation is common type in horticultural plant propagation method. It is form of asexual propagation in which easily detachable stems are severed from the mother plants and allowed to produce new plants. Different horticultural plants like Pine apple propagated by sucker crown and slip Enset by rhizome and Banana by sucker to produce their copy of new plants. In different field of horticultural crops propagation industry, identifying the appropriate plant parts that used for propagation and their methods of propagation are the basic important for plant propagators.

Keywords: Clonal; Asexual propagation; Division; Separation; Specialized organs

Introduction

Plants are the most fundamentally important things given to life exist on this world by providing the basic and immediate needs of humans for food and shelter as well as acting as an essential component of the biosphere for maintaining life on the planet that evolved to survive, thrive, and grow by adapting to ever-changing conditions [1]. From plant species found on the land surface, a higher plant species occupy a wide variety of habitats over the other species [2]. This wide adaptability determines the tendency to perpetuate in to particular environment by producing their offspring's to survive. This can happen by different reproduction methods viz. by sexual reproduction which is most important method for many plants and asexual reproduction method when reproduction by seed is limited [3]. A vegetative reproduction is the process of multiplication in which a portion of fragment of the plant body functions as propagules and develops into a new individual plant which involves the production of new plants without the act of fertilization or sexual union. Further can be said that, vegetative propagation of plant is a form of plant propagation in which the new individual plant arises from any vegetative part of the parents (root, stem, leaf and other organs), and possesses exactly the same characteristics of their parent plant from which it was obtained. According to Agrios [4], clonally propagated plants are categorized as those cultivated for vegetative product and those cultivated for a fruit or reproductive product that mostly practiced in fruit trees propagation. In higher plants, any part of the body may be capable of vegetative propagation. Many plants produce modified stems, roots, and leaves, especially for natural vegetative propagation. The most commonly known vegetative propagation of plant includes propagation by cuttings, which is obtained either from stem, leaf, root, by layering, by grafting, by modified specialized organ or by micro propagation methods. But, In case of lower plants, propagation occurs through binary fission, budding, fragmentation, gemmae, resting buds and soredia (in lichens). All these methods of plant propagation by vegetative organ occur naturally but at the same time, man too has developed various methods of artificial vegetative propagation for many useful plants which are widely used in the horticultural industry.

To do this, a Knowledge and skills of identification of plant organs which has to use for plant propagation is paramount important for horticulturalist in order to multiply as per requirements. Therefore the aim of this review paper is to discuss the propagation methods of selected horticultural crops by specialized organs.

Propagation by specialized organs

In order to continue life on this planet, plants are the basic and immediate needs of the living things including of human beings. Among the existed plant species, the higher plant has occupied wide habitats than the others. These plants reproduce to perpetuate their off springs by sexual and asexual means of reproduction. The Sexual reproduction method produces offspring by the fusion of gametes, resulting in offspring genetically different from the parent plants due to genetic exchange occur during fertilization which came from both parents. In the other ways, asexual means of reproduction produces new individuals without the fusion of gametes, genetically identical to the parent plants and each other, except when sudden change, 'mutation', is occurs [5]. The plant is composed of four primary organs viz. roots, stems, leaves and flowers, which can be used as material for propagation. The most commonly utilized form of plant reproduction by people is seeds. But, a number of asexual methods including cuttings, grafting, budding, layering, division, separation and micro propagations are utilized when seed propagation is not feasible. Also an asexual methods of plant propagation are important to multiply cultivars with individual desirable characteristics that do not come to true from the seeds, to ensures the faster initial plant growth and higher survival rate of the plant, to produce higher yield with quality product, to reproduce plants

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which have a short life span and seed dormancy and to propagate a plants which are sterile to reproduce by seeds [5]. Early (2008) clearly elaborated the role of vegetative propagated crops that almost all of the plants sold as perennials, bulbs, corms, trees and shrubs are vegetative propagated because most of them are hybrids which will not breed true to type from seeds. In many plant organs modifications are exist to enable natural vegetative propagations. Of these, the stem is the most important one which produces a bud that completely grow to new plant with roots, stems and leaves. All daughter plants produced from these organs are identical called 'clones' of the mother plant and may serve as food stores. These stored foods enable to quickly burst growth of plants in the spring (e.g. iris rhizomes) [6]. According to McKey et al. [7] clonally propagated food crops encompass a huge range of Phylogenetic, morphological and ecological diversity. Different parts of clonally propagated plants have been selected to provide food and clonal propageules such as stems, roots, leaves, fruits, under or above ground specialized storage organs and even seeds. The specialized vegetative structures includes runners, suckers, crown, offsets, bulbs, corms, tubers, tuberous roots, rhizomes and pseudo bulbs are used primarily for the storage of foods, nutrients and water during adverse environmental conditions and for propageules [8]. Plants possessing these modified plant parts are generally herbaceous perennials, in which the shoots die down at the end of a growing season but the fleshy vegetative structure usually do not die and remains in the soil, which put forth new vegetative growth in the next season [9]. Plants that survive as underground storage organs are called genotypes that can withstand period of adverse growing conditions in their regular growth cycles and used as propageules. For instance, potato tubers are modified stems that store starch in swollen underground structures known as tubers which serve as a seed for raising commercial potato Crops. Different horticultural crops propagated by specialized organs either dividing them or separating from their mother plants in order to get smaller planting materials.

Propagation by division

Propagation by division is a form of plant propagation in which a group of plants or plant parts are cut or torn apart which each part of the divided plant contains one or more of the roots of the plant and a part of the stem of one or more stems. Division is probably the simplest form of plant propagation which is suitable for most clumps and rosette forming perennials [6]. Most perennial plants benefited from division as they get older and begin to lose their vigor. It involves little more than breaking up established clumps in to a number of smaller pieces. The only complications come in knowing just when to divide and establishing a minimum size for the divisions. The success rate of plant rose from division is very high compared to the other propagation methods. Plants that have fibrous, rhizomatous roots, and plants that form clumps or crowns, are typically split up for propagation in to new plants. The dividing line between fibrous rooted perennials, crown rhizome perennials and rhizomes are somewhat indistinct. Rhizomes are purely underground stems and separated from the crown of roots around the base of the plant [6]. He also suggested that, plants suitable for division can be put in to three categories. Firstly, plants that form clumps of rosettes or offsets which can simply be cut up or broken apart in to rooted pieces and immediately regarded as new plants. This sort of division can in most cases be done any time of the year. Many of these types of plants will also produce runners or offsets which can be separated from the parent plants. Likewise any plants which produce suckers can be propagated by removing the rooted suckers and growing them on. Secondly, there are plants that have distinct foliage clusters but fibrous crown. These plants will usually require careful cutting up

and many in some cases have only a few roots per division. This can necessitate planting in some sort of nursery bed until establishment, although in most cases they will survive if planted out straight away. This division can undertake when the plant are not growing too actively and the weather is not too warm. Thirdly, those plants which fleshy crowns with foliage emerging at many points. These will require careful cutting and many in some case have distinct growth points. Each division will need at least one growth point if it is to strike. This sort of division is best done just as the plants are emerging from dormancy. The line between division and natural layering is overlap. Many perennials and shrubs, particularly ground covers will strike roots wherever they come in contact with in the ground. If cut off at the appropriate point these aerial roots will then develop as normal subterean roots. The actual size of the divide plant varies enormously depending on the plant. Different horticultural crops can be propagated by different specialized organs 'propagation by division' [6].

Propagation of potato (*Solanum tuberosum* L.) by tuber: Potato is propagated by vegetative propagation 'division' of tubers. Tubers are divided into sections each containing one or more eyes. Tubers are thickened underground stems that often develop at the tip of stolons or rhizomes and serve as storage organs. Tubers have no basal plate since they do not originate from the base of a stem. In potatoes (*Solanum tuberosum* L.) and many other tuberous plants, many tubers may raise from a single plant. Tubers are anatomically the same as stems having internodes and nodes from which eyes develop containing one or more shoot buds. Tuberous plants produce tubers each season. The tubers then serve as an overwintering storage site producing new roots and shoots during the following season. The new shoots use the reserves from the tuber for initial growth and produce new tubers for the following season. Many tuberous plants are propagated asexually by division of the tubers which divided into sections each containing one or more eyes. Potato can be planted directly as whole or divided to smaller parts of tuber which have a bud at the node for shoot development. According to the findings, planting different size of potato tubers has a direct effect on potato yields [10]. They concluded that the larger size and whole/half cut of potato tuber produces the higher tuber yields and are less susceptible to late blight potato disease as compared to the smaller size of the tubers

Propagation of sweet potato (*Ipomoea batatas* L.): The sweet potato is modified root called tuberous root is perennial which grown as annual. It is an important traditional crop which is grown extensively in tropical countries for its nutritional and economic benefits [11,12]. The sweet potato crop can be planted either for food and/or for animal feed depending on the purpose and season of production. The propagation sweet potato can be done by two methods viz. by stem cuttings and by its sprouts (slips). The sprout (slips) propagation is very important to produce virus free plant and to produce vigorous tuber. Prior to planting the sweet potato from the storage roots, producing the sprout (slips) is very important practices which may take about 3-4 weeks according to the environmental conditions (temperature, humidity and ventilation). The other propagation method of sweet potato is by vine cuttings. Woolfe reports that the Tip cuttings of sweet potato is about 30-45 cm long with approximately eight nodes vines are collected from the nursery bed, or the last established planting are used for propagation [11]. He further elaborated that the tip cuttings should be taken from crops that are old enough to provide material without excessive damage. These cuttings should be planted at an angle of 45° into heaps as this promotes well, even root development. There propagation sweet potato, selecting the appropriate planting material is crucial in order to get the higher production of the crop

Propagation of ginger (*Zingiber officinale*) by rhizome: Ginger is herbaceous perennial plant that is grown as an annual in commercial production which is widely used as a spice crop plant [13]. It is a subterranean stem (rhizome) modified for the vegetative propagation and storage of food materials. A rhizome is a swollen modified stem that runs horizontally under the ground that has contained vegetative buds which can be used for propagation by cutting into sections that each has at least one bud. The sections are planted horizontally as the same way they were growing in the parent plant. The rhizome size has a direct proportional effect on the yield and yield components of ginger productions. Mahender et al. reported that a larger size of ginger rhizome that planted has been showed early sprout of the shoot and produced higher yield and quality of oil as compared to the smaller size ones [14].

Propagation of onion (*Allium cepa* L.) by bulbs: Onion (*Allium cepa* L.) is an important vegetable crop that is grown worldwide. It is propagated either by seed or bulb [15]. Bulbs are a specialized underground organ consists of short, fleshy, usually vertical stem axis, at apex growing point and enclosed by thick flexi scales. Bulb scales morphologically are the continuous sheathing leaf bases. There are two kinds of bulbs; tunicate and non-tunicate bulbs. The Tunicate bulbs have outer modified leaves, which are dry and paper thin. Non-tunicate or scaly bulbs lack this protective (papery) covering and are more easily damaged. Meristems (lateral buds) develop between the scales and stem axis to form bulblets, known as offsets when grown to mature size. The bulb size of onion has a direct effect on onion yield production. Some times when onion has propagated by bulb, the upper portion of the bulb removed in order to facilitate rapid initial growth of the bulb [16].

Propagation of strawberry (*Fragaria × ananassa*) by runner: Strawberry is one of the most important fruit crops which produced by specialized stems called runner that develops from the axial of a leaf at the crown of a plant which grows horizontally along the ground and forms a new plant at one of the nodes. One plant may have several runners and one runner may grow several nodes. The long and flexible runners are easy to bend and positioned according to the desire of the person cloning them. When runner separated from the mother plant with intact roots, it serves as units of propagation. Growing strawberry plants from a runner is the easiest and quickest way of propagating method. Runner is strictly a horticultural term; botanically they are simply classified as stolons. According to Hasan et al., strawberry runners have been affected by photo period. As the day length has increased from 15 to 17 h, the number and length of strawberry runners also increased proportionally. So it is important producing of the runners under a long period of light to get higher and vigor runners [17].

Propagation by separation

Separation and division are the easiest and quickest ways to propagate many plants. Separation is form of asexual propagation in which easily detachable stems are severed from the mother plants and allowed to produce new plants. Stems usually have initiated roots before being severed from the mother plants and can easily grow in to new area where it will be transplanted. Separation uses naturally occurring vegetative structures which the Individual organs are separated from a clump [6].

Propagation of banana (*Musa* spp.) by sucker: Banana is one of the most important fruit crops which have produced by sucker separation. A sucker is a lateral shoot that develops from the rhizome and

usually emerges close to the mother plant. Sucker is the primary and major source of propagation material in banana [18]. Propagation by sucker follows digging the sucker, separating from the mother plant, and growing as individual plants [19]. The number of suckers produced varies with the type of cultivars. Sometimes the sucker of banana selected to replace the parent plant after fruiting is called the **follower** or **ratoon** [20]. *The sucker production capacity varies in different banana clones and is a function of numerous internal (genetic factors) and external factors like* planting seasons, planting depth, and spacing [18]. They added that Sucker invigoration techniques has been under taken at different areas which is important for good bunch yields with quality of fingers that contribute for the productivity of the plants.

Propagation of pineapple (*Anana cosmos* L.) by sucker: Pine apple is an important tropical fruit crop which is propagated by crowns, suckers and slips. The production of pineapple plants is mostly carried out by means of crowns propagation. However, the sucker allowed fast growth of pine apples compared to the traditional methods of planting crowns. Suckers are found between leaves of fully-grown pineapple plants. It can be used for next plantation after mother plants are harvested called ratoon crop [21]. But, these suckers can be used for only one cycle of culture to limit contaminations and always have renewed suckers. Propagating of pine apple is important for rapid multiplication of the plants with in short period of time relatively comparing with crown propagation of the crop [22]. The size of the sucker has positive effects on plant vigouesity and productivity of the crop [23].

Propagation of enset (*Ensete ventricosum* (welw.) Cheesman) by corm: Enset (*Ensete Ventricosum* (Welw.) Cheesman) is a perennial herbaceous and monocotyledonous crop which is propagated by its corms. The corm is a short, solid and thickened underground modified stem with basal plate. Small corms are called cormels. The corms are usually flat in shape having numerous roots at the bottom, and the tuft of leaves at the top. They are distinguished from the bulbs with their lack of fleshy leaves but having a covering of dry papery leaves. Corms stored food in the stem, unlike the bulbs which store food reserves in the leaves. According to Buke findings, the corm size and its position has effect on sucker regeneration capacity, growth parameters and yield potential of Enset. The larger the corm taken for sucker production gave the highest number of suckers compared with the smaller one and the corm which was taken from the apical part the mother corms regenerated easily than the bottom parts [24-26].

Conclusion

Almost all of the living creature on this planet has directly or indirectly depends on the plant products either for food or another utilization purposes. These important plants multiplies through different plant propagation techniques which either by natural phenomena or by human interferences. Generally, plants can be reproducing sexually by seed and asexually rather than seed by different plant organs which the propageules possesses an identical genetic copy of the original parent plants. Different horticultural plants propagated differently by their specialized organs either by separating or dividing of their organ to produce a new copy of the original plants. Crops like Irish potato, sweet potato, onion, ginger, strawberry, banana, pine apple, Enset and garlic are reproduced by these specialized organs. Knowing and applying of this propagation methods are paramount important for plant propagators in order to increase production and productivities of each respective crops.

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