Review Article

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ADOPTION OF THE GRAFTING TECHNIQUES AND POSSIBLE AVENUES IN MEDICINAL PLANTS: A REVIEW

Apoorva J M [1]*, Shivaprasada Hudeda [2]

[1]PG Scholar, Department of PG studies in Dravya Guna, JSS Ayurveda Medical College and Hospital, Mysore, Karnataka, India

[2]Professor, Department of PG studies in Dravya Guna, JSS Ayurveda Medical College and Hospital, Mysore, Karnataka, India

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***Corresponding author**
E-mail: apoorva.mylar@gmail.com

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ABSTRACT

Human beings since from the origin have a close connection with the plants. Dependency of the human beings on plants varies from shelter, food etc to medicine. Even today 70% of the world's population relies on herbs for the medicinal purpose. Due to this, to meet the demand of the herbal medicine to the world, pharmaceuticals procure the raw material from its natural habitat. In turn this led to not only destruction of medicinal plants in the natural habitat but also led to the extinction. Hence not only the conservation of herbs is important but also at the same time meeting the demand of the medicinal plants is important. Many advanced techniques like biotechnology, tissue culture, grafting etc came into light and these techniques help in this regard. Hence this paper discusses the importance of the grafting, adoption of the grafting techniques and possible benefits by using the technique on medicinal plants.

Keywords: Plants, Extinction, Conservation, Grafting technique.

INTRODUCTION

Plants have had a tremendous role in the human development ever since the early civilization and perhaps continue to shoulder much greater role in the future as well[1]. The intimate relationship between the human and plant world has evolved over generations and runs back to the beginning of the universe[2] when plants supplied much of the shelter, oxygen, food and medicine needed by higher life forms. India contains richest floral diversity among all the countries in the World due to the wide range of climate, topology and habitat in the country. India is home to more than 50,000 species of plants, including a variety of endemics[3].

According to World Health Organization (WHO), about 70 percent of the world's population relies on plants for their primary health care and some 35,000 to 70,000 species has been used as medicaments, a figure corresponding to 14-28% of the 250,000 plants species estimated to occur around the world, and equivalent to 35-70% of all species used world-wide[4].

Due to the excessive usage of the medicinal plants and consumption of the herbs from the natural habitat led the medicinal plants endangered and extinct. Therefore, by the implementation of various new techniques like Grafting, Fortification etc not only the yield of the medicinal plants can be increased but conservation of the plants can also be done.

Grafting is one of the horticultural techniques, the practice of grafting can be traced back 4000 years to ancient China and Mesopotamia. As early as 2000 years ago, people recognized the incompatibility problems that may occur when grafting olives and other fruiting trees[5].

DEFINITION OF GRAFTING

Grafting is a horticultural technique whereby tissues of plants are joined so as to continue their growth together[6]. In the simple sense Grafting can be explained as "It is the process of joining two plants together (an upper portion and a lower portion) to grow as one"[7].

FACTORS REQUIRED FOR THE SUCCESSFUL GRAFTING[8]

Compatibility of Scion and Stock : Because grafting involves the joining of vascular tissues between the scion and rootstock, plants lacking vascular cambium, such as monocots, cannot normally be grafted.

Cambium Alignment & Pressure: The vascular cambium of the scion and stock should be tightly pressed together and oriented in the direction of normal growth.

Completed during Appropriate Stage of Plant: The grafting is completed at a time when the scion and stock are capable of producing callus and other wound-response tissues.

Temperature: If the temperature is too warm, premature budding may result.

Proper Care of Graft Site: After grafting, it is important to nurse the grafted plant back to health for a period of time.

TOOLS REQUIRED FOR GRAFTING

Cutting Tools: It includes bud-grafting knives, surgical knives, and pruning knives.

Disinfecting Tools: A common sterilizing agent used is absolute alcohol.

Graft Seals: It includes specialized types of clay, wax, petroleum jelly, and adhesive tape.

Tying and Support Materials: It includes support equipment like strips made from various substances, twine, nails, and splints.

SCOPE OF GRAFTING

- In tomato plants, yield is positively affected by grafting due to the increase in fruit index, number of fruits/truss and fruit weight. Thus, grafted plants offer increased yield and consequently higher profits. Lycopene content and pH values remained unchanged, and various acid contents was slightly increased by grafting[9].
- Yield in the grafted plants increased when compared to the control and self grafted plants. Analyses showed that the fruit concentration of calcium in grafted plants[10].
- The grafting combinations with the two commercial rootstocks routinely surpassed those of other rootstocks or control plants in growth rate and fruiting capacity in both stressful and non-stressful high tunnel environments, confirming the inherent advantages of stocks that have been selected specifically for root system superiority[11].
- Grafting of the watermelon enhanced average fruit size. Fruits from grafted plants had greater firmness than those from non grafted plants without affecting the content of soluble solids[12].

GENERAL PROCEDURE OF GRAFTING[13]

The general steps involved in the process of grafting irrespective of the type of graft is as follows:

Vertical incision: Make four 3-inch vertical incisions through the rootstock's bark, starting at the top. Slip a small rubber band on the rootstock, stopping just below these vertical cuts. With the point of a knife, separate the bark from the wood at the tip of the rootstock and peel the bark (Fig 1).

Fig 1

Preparation of scion: Prepare the scion by trimming 1/2 inch off the bottom to show fresh, green wood. Slice a shallow, 2-inch cut into the wood at the bottom end of the scion. This cut exposes cambium tissue, which carries sap through the tree. Repeat this in order to create four evenly-spaced cuts (Fig 2).

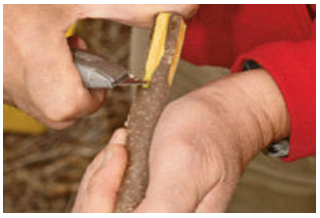


Fig 2

Connect scion and rootstock: Place the cut end of the scion inside the four flaps, lining up each cut surface with a flap (Fig 3).

Fig 3

Secure the graft: Now is the time to use the rubber band to hold the flaps in place. Make sure the cambium tissue of the scion is seated against the cambium tissue of the rootstock (Fig 4).

Fig 4

Protect the graft: Protect the graft by wrapping it with a piece of heavy-duty aluminum foil, then a piece of plastic (Fig 5).

Fig 5

Maintain the plant: Tape the plastic lightly around the graft using masking tape. New buds should appear in 15 to 30 days. You may want to write the date and tree variety on the tape to keep track of multiple trees (Fig 6).

Fig 6

Picture Courtesy: Progressive Farmer (http://www.progressivefarmer.com). Link :- https://www.instructables.com/id/Grafting-Made-Simple/

Types of Grafting[14]: The upper part of the combined plant is called the scion, while the lower part is called the rootstock. There are several techniques of grafting followed in different plants, suitable in different situation. Adoption of any suitable technique facilities, sources available etc.

Table 1: Various methods of grafting and its adoption

Graft Technique	Adoption
Bark or Rind Graft (Fig 7)	Performed on flowering and fruiting trees, joins multiple scions to a single rootstock.
Bridge Graft. (Fig 8)	It is used to "bridge" a diseased or damaged area of a plant.
Cleft Graft. (Fig 9)	Cleft grafting attaches a less hardy scion variety to a hardy rootstock.
Inarch Graft. (Fig 10)	It is used to bypass or support a damaged or weakened area of a plant stem.
Side Graft. (Fig 11)	It works well on conifers, rhododendrons and camellias.
Splice Graft. (Fig 12)	This method mainly adopted for herbaceous plants.
Saddle (Wedge) Graft. (Fig 13)	This is a method of grafting used for hybrid Rhododendrons that is carried out in spring.
Whip and Tongue Graft. (Fig 14)	Mainly adopted for deciduous trees but works on woody plants.

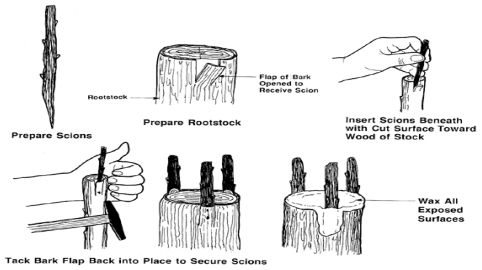


Fig 7

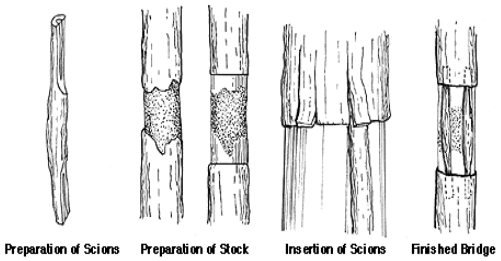


Fig 8

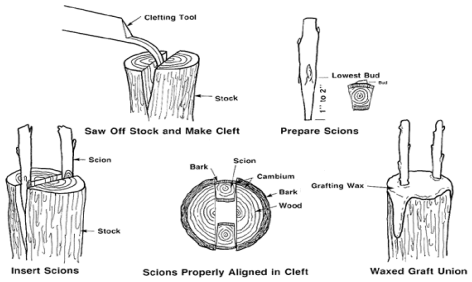


Fig 9

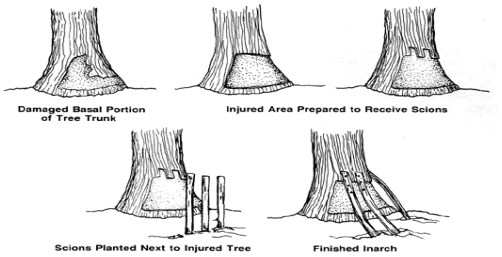
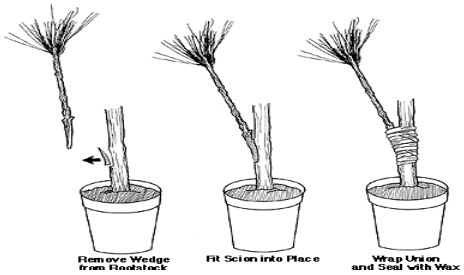


Fig 10



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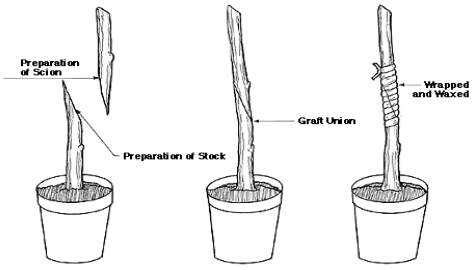

Fig 12

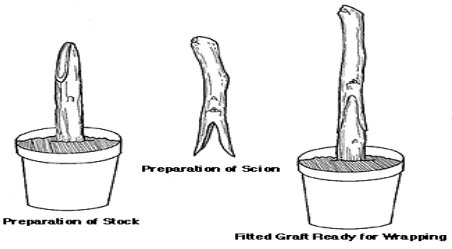

Fig 13

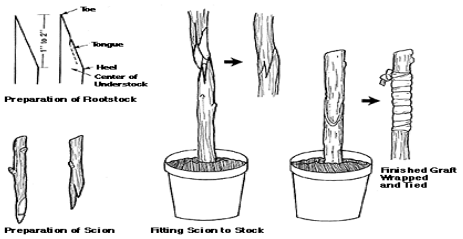

Fig 14

Picture Courtesy: Grafting and Budding Nursery Crop Plants. Author: Ted Bilderback et al. Link:- https://content.ces.ncsu.edu/grafting-and-budding-nursery-crop-plants

Table 2: Advantages and Disadvantages of Grafting

ADVANTAGES[15]	DISADVANTAGES[16]
Propagation: It is the only method to preserve the desirable characteristics of the seedless hybrids.	Costs : Increase in the cost of using double seed, more green house space for double seedling in transplant etc.
Resistance to pest and soil diseases.	Incompatibility: A bad execution of the graft can affect the development of the plant, presenting physiological disorders of plants.
Genetic improvement: Grafting creates a new plant being a technology of improvement faster than conventional methods.	
Physiological improvement: Root vigor is granted by the rootstock, as well as an increase in the quality, number and size of fruits.	
Retrench of space: The density per hectare can be reduced by half, because the vigor of a grafted plant allows it to be handled on two stems and replaces the crops with one stem.	
Increased productivity	

POSSIBLE AVENUES OF ADOPTING GRAFTING IN MEDICINAL PLANTS

Grafting is such a process in which two plants are joined together to continue their growth together. In grafting, selection of the rootstock is very important since the ability to absorb and for the translocation of ions, as well as for the translocation of photosynthesis, hormones, alkaloids and viruses, is affected by the type of rootstock and scion.
Possible outcomes expected by the adoption of Grafting technique are with respect to Size of the fruit, Production of the fruit, Phytoconstituents of the fruit, Acclimatization of the plants etc.

Size of the fruit: Various studies have been proved that by grafting there is a marked increase in the size and the quality of the fruit.
Grafting of the medicinal plants like Brihathi (*Solanum indicum*) with Brinjal (*Solanum melongena*) species or with Indravaruni (*Citrullus colocynthis*) or with other Cucumber species – not only increases the size of the fruit but also there is a chance of increase in the quality of Fruit.

Production rate: Yield of the fruits will be increased by grafting. Grafting the low yielding medicinal plants with the suitable wild species of the same family can increase the yield of the fruit.
For example: Grafting the medicinal plants like Tejohva (*Zanthoxylum alatum*) or Bilva (*Aegel marmelos*) with that of the Nimbuka (*Citrus limon*) species may helps in increasing the yield.

Phytoconstituents: Researches which are conducted on grafting till date mainly concentrated over the vegetable crops. So there is need of research with respect to changes occurring in the phytochemicals in the grafted products. Detection of any variation either it may be the addition or the deletion of the phytochemicals in the grafted plant helps us in the development of new plant with more therapeutic value.
For example: By grafting Mandukaparni (*Centella asciatics*) with Dhanyaka (*Coriandrum sativum*)– if the properties of the mandukaparni (*Centella asciatics*) is induced in dhanyaka (*Coriandrum sativum*) then by the usage of dhanyaka (Coriandrum sativum) itself benefits of both the plants will be obtained that too by the consumption of the dhanyaka (*Coriandrum sativum*) on daily basis.

Acclimatization of the plants: Some of the medicinal plants are grown only in Himalayan region due to the availability of suitable environment. By grafting these types of medicinal plants with the suitable regional wild variety rootstock, it may be made possible for the Himalayan plants to survive in other environment too. It helps in the conservation and the production of such plants which helps in meeting the demand.

For example: Various studies has to be undertaken regarding the grafting of Kusta (*Saussurea lappa*), Daruharidra (*Berberis aristata*) with the south Indian plant belonging to the same family. This may help in growing such endangered plants in all the regions and its utilization in medicine.

In addition to this, Grafted seedling have the ability to absorb inorganic ions from the soil even when the soil temperature is very low due to the role of specific enzymes[17]. Grafting can be effectively used to control the soil borne diseases and to increase the yield of the susceptible cultivars. Use of the resistance rootstock helps in preventing the soil borne diseases which makes plants organic[18].
Abiotic environmental stresses like cold, wet or dry, hypoxia, salinity, heavy metal contaminations, excessive and insufficient nutrient availability, and soil pH stress can affect the plant growth. Grafts were generally used to induce resistance against low and high temperatures. Grafting shows tolerance against salt and flooding, improved water use efficiency, increased nutrient uptake and alkalinity tolerance[19].

CONCLUSION

Grafting is the most commonly preferred artificial vegetative method of plant propagation. Grafting of the vegetables and commercial crops shown so many beneficial effects when compared to the crops grown through natural vegetative propagation. Application of the grafting procedure not only for vegetables and agricultural crops but also for medicinal plants helps in incorporating the properties like disease resistant property, higher yielding properties etc. Due to the commercial impact grafting is limited mainly to the vegetables and to the commercial plants, in due of which application is required for the medicinal plants. Grafting of medicinal plants not only in increases the yield but may also help in increasing the quality or the potential of the plant. Probably there may be no side effects by grafting and it may not modify the genetic pattern but in turn they help in the improvement of the plant in terms of increasing the yield of fruit, quality of the plant. Further research is required to understand the variation that may occur at the phytoconstituent level in medicinal plants by grafting.

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