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Propagation of mango by using different techniques: A review

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Abstract
The mango is a type of tropical fruit that is farmed primarily for its edible fruit. It is a member of the genus Mangifera. The mango is a fruit native to South Asia that has spread throughout the world to become one of the most widely grown tropical crops. Mangoes are prized for their flavourful, juicy flesh and unique scent. The simplest methods of mango propagation can be done by seeds. However, that mango trees grown from seeds may not have the exact features of the parent tree. Grafting and cutting can also exercise for propagation. Grafting is a widely used method for propagation of mango trees with specific characteristics. Each and every different method has its own advantages and contemplations, successful propagation often requires attention to detail, proper care to obtain a healthy plant.

Keywords: Mango, propagation types, grafting, seed germination, seed treatment etc.

Introduction
The mango, or *Mangifera indica* L, is a fruit crop that belongs to the Anacardiaceae family of plants with flowers that may produce fruit. Asia has been believed to be the mango's original home, accounting for 77% of the world's production each year (Nayarko *et al*., 2020) [13]. The cultivation of mangoes spread across continents, adapting to diverse climates and giving rise to an astonishing array of cultivars. From the velvety sweetness of the Alphonso to the tangy complexity of the Ataulfo, each variety offers a unique sensory experience, reflecting the rich tapestry of agricultural ingenuity and biodiversity. To investigate the effect of seed husk and placing the seeds in the seedbed on the rate of germination and growth of the rootstock seedling, use a plastic house or a green-house coated in plastic. Based to this finding, seed needs to be sown or husked to achieve the highest germination velocity, germination percentage, and standard growth of the seedlings (Abbas *et al.*, 2015) [1]. Seed propagation is one of the traditional methods of growing mango trees, although it's less commonly used for commercial purposes due to the variability in seed-grown trees. However, it's a simple and accessible way for home gardeners and enthusiasts to grow mango trees. Improving the germination and growth of seeds is necessary for rapidly developing healthy plants. The primary goal is to figure out how pre-germination seed treatments affect the seed's quality and plant growth (Patel, 2016) [16]. Breaking dormancy in mango seeds is a crucial step in initiating germination. Mango seeds have a thick, protective outer shell that needs to be softened and permeated to allow water and oxygen to reach the embryo inside. By removing the seed coat of the seed gives a fast germination rate comparing to coated seed. Yet, in order to disperse the seed within it quickly and without harming its kernel, this process calls for a high level of competence. As a result, employing this sort of treatment substantially for growing mango rootstocks is challenging (Hamed, 2009) [5]. Aseptic hybrid seed extraction from immature ovules is followed by *in vitro* protection on a semi-solid, half-strength modified growth medium supplemented with casein hydrolysate. After 12 to 14 weeks, fully developed seedlings were moved to non-sterile surroundings with similar environmental conditions in order to harden the seed (Sahijram, 2005) [25]. Vegetative propagation is a common method used to propagate mango trees, particularly for commercial orchards, as it allows for the replication of desirable traits and faster fruit production compared to growing from seeds.

The science and art of growing fruits, vegetables, decorative plants, and therapeutic plants is known as horticulture. The demand for horticultural crops has increased in recent years due to their nutritional, medicinal and aesthetic value. The propagation of horticultural crops is a crucial aspect of horticulture as it involves the production of plants from seeds, vegetative parts. The four propagation types of asexual plant propagation are budding, cutting, layering, and grafting (Yadav and Singh, 2018) [33].

Mango propagation types

Sexual propagation can be done with fully mature seed and disease free seed much be designated for propagation. True to type plant can be obtained from seed. The fertilization and pollination of a seed include the sex organs of flowers in the sexual form as in rootstocks with seed propagation (Usha *et al.*, 2015) [31]. Propagation of plant can be defined as the procedure of generating new crop. It's a fundamental technique used in horticulture, agriculture, forestry, and landscaping to reproduce plants with desired characteristics and traits (Sable *et al*, 2020) [24]. The different methods of asexual propagation are consistent in different types of the fruit plants has significantly transformed the fruit business of the country (Singh, 2010). Asexual propagation can be performed by using different vegetative parts of a plant. Healthy and disease-free plant can be obtained from vegetative propagation methods. The vegetative organs have the ability to restore them, allows this type of propagation effectively. In the vast majority of cases, different types of vegetative techniques are used to increase the production of fruit plants (Rathore and Kumar, 2023) [19].

Seed treatment

In a CRD, three replications of a factorial idea were used to allocate different treatments for a total of four levels of seed treatments, three levels of nursery beds/growing surroundings, poly bags, and three levels of growing media. The results of the treatment of seeds showed that GA3 300 ppm greatly reduced the number of days needed for germination and improved the percentage of germination (Yanev *et al.*, 2011) [34]. The impact that husk seed, the GA3, potassium nitrate3, and seed orientation have on the percentage of embryos that germinate and develop into rootstock seedlings. The results of this study showed that husking treated seeds considerably outperformed the control for the parameters evaluated, resulting in the greatest percentage of germination and sprouting velocity of mango seeds and standard seedling development (Abbas, 2015) [1]. Many pre-germination treatments have a significant impact on the quantity and height of leaves, the amount of time required for a seed to germinate, and the seedlings of an extensive range of crops (Kumar and Katharkun, 2016) [8]. In developing nations, efficient seed systems for non-true seed crops are crucial for preserving the accessibility of planting materials for various farmers. Farmers' access to high-quality planting material is restricted by regulatory bodies' persistent disdain for the distinctive biological features of non-true seed crops, heightening the risk of spreading pest and disease (Madege and Nzogela, 2023) [10].

Seed soaking treatment

To enhance seed germination, a variety of seed treatments can be used. There were four distinct treatments applied to the seeds: those without seed coats were soaked in cool water at 5ºC for 12 hours prior to sowing, those with seed coats were sown and served as the control (SC), and seeds without seed coats were soaked in hot water at 15 ºC for one minute beforehand sowing (Nyarko *et al*., 2020). Fruits harvested between six and eight weeks after pollination for use in embryo culture. After being aseptically removed from immature ovules, hybrid embryos were inoculated *in vitro* onto modified medium (MS) that was semi-solid and half strength, with casein hydrolysate and 4.5 percent sucrose added. Well-developed seedlings were moved to non-sterile settings with equal climatic conditions after twelve to fourteen weeks for the first hardening-off period (Sahijram *et al*., 2005) [25]. Nevertheless, after soaking in water, there were no appreciable variations between the treated seeds because the absence of their seed coats made it easier for the water to immersion and other development elements to reach the seeds. All treated seeds outperformed the control group in terms of stem diameter height, germination percentage, and leaf function (Yadav *et al*., 2018) [33]. Regrow of an immature mango embryo into a full plantlet on enhanced MS basal medium. In 72 percent of the culture media under this treatment, full plantlet development was seen (Chandra, 2003) [3].

Seed germination effective method

Pendimethalin herbicides that had expired seven, five and a year ago, respectively, were used to investigate the impact of expired herbicide on the growth of seedlings and the germination of mango seeds. The treatment concentrations for the investigation were two distinct types of concentrations, 100 and 150 mg/l of the expired herbicides separately. The control treatment consistently had a greater germination rate than all of the herbicide treatments combined, with the exception of the herbicide treatment. Mango seedlings showed no signs of growth slowing or injury from herbicides (Olorunmaiye *et al*., 2014) [4]. The relationship between seed weight and seedling dry weight, stem height, the quantity of leaves, and number of seedlings per seed. The findings demonstrated that, while not statistically significant, the seed weight influenced a number of the morpho-physiological factors taken into consideration (Fatoba *et al*., 2011) [4]. While there was very little seed germination response in all of the media, different forms of seed germination of depulped and undepulped bush mango fruits somewhat enhanced the proportion of germination in the mixed media. This result demonstrates that depulped fruit mixtures of TS+SD can be sown to produce very high percentages of seed germination because the medium can absorb and hold large amounts of water, which will foster an environment that is favourable for seed germination, especially during dry seasons (Mbakwe, 2004) [11]. Mango seed stones are stored inside the fruit for four distinct lengths of time—two, four, eight, and twelve weeks—depending on the germination percentage. The two temperatures are room temperature (28–40 C) and refrigerated (10–12 C). The findings indicate that the percentage of seeds that germinated was significantly impacted by the way mango seed stones were stored within the fruit (Yoon and Kathakur, 2016) [35].

Grafting propagation and successful grafting percentage

The scion plant needs to be robust, healthy, and prolific. The scion is in close proximity to the stock. Using a sharp knife, a thin slice of bark (6–8 cm long and 1/3 inch thick at its tallest) is cut from the stock around 20 cm above the ground. The scion has a cut that is comparable. As a result, the cambium layers of the scion and stock are visible. Using a polythene strip, these cuts are pulled together and securely fastened (Ullah *et al*., 2017) [32]. Mango softwood grafting had the best success rate (84%) in July. Two distinct years of softwood grafting from March to April and July to September. In August, there was an

increase in the success rate (90%) (Singh and Srivastava., 2012) [26]. Examining the grafted plant's survival rates with 5- and 10-day-old rootstock indicated the method's appropriateness. Stone or epicotyl grafting was proven to be effective for the continued existence and development of the graft when 10-day-old rootstock was utilized for the grafting process (Singh *et al*., 2014). The Dashehari variety scion is utilized for distinct, unidentified commercial cultivars, while mango stones are used as scion for developing seedling rootstocks. The growth medium utilized in the soil + sawdust composition was determined to be the most straightforward growing mixture in terms of stone graft survival, sprouting, and overall performance over other growing mixtures (Kumar, 2012) [19].

Suitable season for grafting propagation

Mango plant propagation frequently employs grafting propagation. In order to determine the ideal time and method for grafting mangos, it was reported that the highest percentage of successful grafting—67%—was recorded on April 4. After ninety days, the maximum success rates for side grafting and softwood grafting were 65.7 percent and 63.7%, respectively, and 47.5% higher than shield budding. Following 180 days, these grafted samples had a 55 percent gown scion percentage and a 57.9 cm scion length, respectively (Sabeky, 2005) [29]. Highest growth parameters, including secondary length root (23.73 cm), height of sprout (6.02 cm), and length of shoot (27.97 cm), have also been confirmed in grafts of the Kesar variety when strict guidelines were adhered to (Bobade *et al.*, 2018) [2]. Baneshan Mallika and Khader were used in a study to watch softwood grafting in mangos in order to determine which type grows faster. September grafting revealed that early sprouting, which lasts for 24 days, is carried out at different times during grafting (Prasanth *et al*., 2007) [17]. The percentage of successful grafting was higher in July and August (78.8%) compared to January and March (75%). However, winter grafted plants showed a higher inclusive rate of graft growth (Jacob *et al*, 2001) [7]. Using a sharp knife, a thin cut of bark (6–8 cm long and 1/3 inch thick at its tallest) is cut from the stock around 20 cm above the ground. The scion has a cut that is comparable. Inarching, also known as repair grafting, is typically used to replace or repair damaged root systems (Ullah *et al*., 2017) [32].

Scion Characteristics

From a donor plant, a healthy stem or bud is picked based on desired attributes including disease resistance, fruit quality, or ornamental qualities. The term "scion" refers to this branch or bud. Precured scions yielded higher success (78.96%) in veneer grafting in mango Banganapally, Tirupati, than non-precured scions (52.75%). With 100-day-old scions, the success rate was highest (71.08%), while with 120-day-old scions, it was lowest (62.67%). When material grafted in the nursery is removed and potted after grafting, substantial mortality frequently occurs. The mean graft survival following potting was 75.39% with precured scions and 52.28% with non-precured scions (Prasad *et al*, 1990) [18]. During August and November, a grafting study utilizing wedge and splice procedures was conducted. Splice grafting yielded up to 80% success, however survival was low. The scion's vascular tissues link to the rootstock's, allowing hormones, nutrients, and water to move between the two sections (Majumder *et al.*, 2012) [12]. The best results were achieved in July and August when 6-month-old scions were grafted onto 2-year-old rootstocks. Soil combined with sawdust has been determined to be the most effective growth mixture for stone grafts in terms of sprouting, survival, and overall performance compared to other growing medium types (Nalage *et al.*, 2010) [14].

Root Stock Attributes

Tolerance to salinity and dwarfism that tolerance to salinity and dwarfism are the most demanded characteristics for mango rootstock and that tolerance to flooding and dry conditions as well as tolerance to pest and diseases are among the most cited as good characteristics for a rootstock. Mango varieties Amrapali scions were chosen for grafting on rootstocks that were two to three years old in May when the highest survival rates (56.82 and 52.98%) were observed. One hundred and twenty days following the grafting operation, the rootstock and scion were evaluated for growth and survival. With grafting, which was completed in the month of April, Rootstock's growth was apparent at 44.57 cm. The cultivar with the greatest survival rate (66.13%) was found to be Amrapali rootstock (Islam *et al.*, 2004) [6]. The highest percentage of sprouting grafts and greatest number of sprouted grafts, lowest number of days for leaf emergence, maximum number of leaves per graft (003), girth (above the union), lowest percentage of graft mortality, and highest percentage of graft survival when grafts were produced on rootstock that was 6 cm tall. As a result, grafts made on mango cv rootstock that was 10 cm tall showed the greatest growth in terms of height and girth (below the union) (Rebeiro *et. al.*, 2002). The soil plus sawdust growth mixture outperformed the other growing media included in the study in terms of stone graft survival, sprouting, and overall performance. While other types of media mixtures can also be employed, stone grafting benefits from the use of sand and sawdust (Nalage *et. al.*, 2010) [14].

Cutting propagation

It is essential that the cambium layers of the rootstock and scion be exposed. The polythene strip must be used to secure the chopped rootstock and scion together. Select branches and take cuttings from them using clean, sharp pruning scissors. Make precise cuts immediately below a leaf node at a 45-degree angle. In order to prevent moisture loss and promote root growth, remove any leaves from the lowest portion of the cutting (Rao, 2005) [20]. One- or one-half-year-old shoots should be chosen to practice cutting propagation during the dormant season. Depending on the species, cuttings should be collected at lengths of between 10 and 74 cm and diameters between 0.6 and 3 cm. Every cutting needs two or three buds (Singh, 2010). Apply a rooting hormone gel or powder to the cut end of each cutting to promote rooted. By encouraging root growth, this raises the likelihood of successful propagation. Place each cutting's treated end into a propagation medium that drains well, such as a mixture of a mixture of peat moss and perlite as a or vermiculite. Plant the cuttings vertically, burying at least two-thirds of the length into the propagation medium. Firmly press the medium around the base of each cutting to provide support. Plant hormones can be used in hard root cuttings, generally three types of cuttings Semi-hardwood cutting and Hardwood cutting which is used for propagation is Softwood cutting. Application of various growth regulators for plants Maximum shoot growth, root growth, percentage of rooted cuttings, and survival rate are notably observed in fig cuttings with 1000 ppm IBA+1000 ppm NAA (Rahman *et al*., 2004) [23].

Conclusion

One essential component of the horticulture sector is the proliferation of horticultural crops. It is the process of using

sexual or asexual methods to divide an existing plant into a new one. Plants are propagated by horticulturists using a variety of methods, such as vegetative and seed propagation. Since only poly-embryonic seeds yield true to type (clones) of the parent, grafting is frequently required to solve this issue. Grafting also results in regular fruit size, quality, and yield from trees. On the other hand both sexual and vegetative propagation methods play integral roles in the cultivation of mango trees, contributing to the abundance of this beloved tropical fruit worldwide. Whether through the natural beauty of seed propagation or the precision of grafting techniques, mango propagation continues to captivate growers and enthusiasts alike, ensuring the perpetuation of this iconic fruit for generations to come.

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