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Propagation and rootstocks of dry land fruits: Annona, Aonla and Ber

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Abstract

Dry regions are economically fragile regions, which are highly vulnerable to environmental stress and shocks. The global dry, degraded salt-affected soils is now being projected and improved substantially by drought tolerant and salt excluder rootstocks for fruits. Rootstocks exhibit a great effect on tree vigour, adaptability, production efficiency, quality and resistance to stresses particularly edaphic on the scion variety. Seedling rootstocks are generally vigorous, since wild species produce more vigorous and hardy seedlings than the cultivated varieties. Fruit rootstock improvement for various purposes would be a great trial for arid zones. Utilization of dwarfing rootstocks is one way of encouraging early fruit bearing. Several research indicated a link between precocity and compact tree size. Usually *Z. nummularia* is used for dwarfing *Z. mauritiana* and is a better stock in high density plantation. Commonly employed rootstock for Annonas is, *A. reticulata* for its soil adaptability range. *Syzigium densiflora* is used as rootstock to impart resistance to termite attack. Information available so far, on arid fruit rootstocks and their characteristics and kind of propagation are reviewed in this paper.

Keywords: Arid, drought, dwarfing, fruits, GA3, I-budding, rootstock, shield budding, soft wood grafting, T-budding

Introduction

Degraded soils with multiple nutrient deficiencies with low water holding capacities and depleting ground water table directly contributes to low crop yields. Rootstocks has influence on the adaptability, tree vigour, production efficiency, yield quality, impart resistance to biotic and abiotic stresses. Rootstock play vital role in propagation of fruit crop. It protects the fruit crops from adverse effects of drought, salt stress and biotic stresses in Arid semi arid areas. It helps nutrient uptake from the soil and to improve yield and quality as well. In general, the dry land fruit crops are propagated by seed. Seedlings are vigorous and being used as rootstocks. Tap root of Ber seedlings help draw water from deeper layers by piercing through hardpan and aid in good anchorage in sloppy terrains. Seed originated plants as such may not be useful for commercial plantation due to phenotypic non-uniformity and genotypic variability. Biotic and abiotic problems in arid areas include drought, extremes of temperature, soil and water salinity, shallow, stony, rocky undulated soils, various pest and diseases which becomes acute over a period of time. Among the abiotic stresses, salinity is the major ones that affect growth and yield of plants in arid and semi-arid areas throughout the world (Chelli-Chaabouni *et al.*, 2010) [3]. Salt-excluder rootstock improves physio-biochemical responses of plants subjected to salinity stress. Rootstock improvement, successful grafting/budding methods and large-scale multiplication of planting material would be a great challenge in arid zones.

ANNONA group of fruit species, namely the custard apple, cherimoya, soursop, bullock's heart atemoya, pondapple, illama etc. are of major commercial importance. The Annonaceous acetogenins are promising new antitumor and pesticidal bioactive compounds found only in the plant family Annonaceae. Custard apple (*Annona squamosa*, Sitaphal, Sharifa, Sugar apple, Sweetsop) is the most widely distributed fruit and is an important arid terrain fruit of commerce. Traditionally Annonas are propagated by seeds. Seed originated plants are not true-to-type, lack precocity and vigour. Germination percentage and time of Annona seeds can be unpredictable and variable Scarifying and soaking seeds in water at room temperature for 12 or 24 hours can

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improve germination. The seed viability lasts for 3-4 years but fresh seeds germinate better. Hard seed-coat can be softened either by soaking the seeds in water for 2-3 days or keeping them under running water for 50-70hr. Treating seeds with GA3 at 500 ppm assists germination. *Annona* species are grafted or budded, whereas seed is raised for rootstocks. However, variability in seedling rootstock performance is also a concern of fruit quality reduction. Sugar Apple is often grafted by shield budding or inarching onto either seedlings of Sugar Apple or Bullock's Heart (*Annona reticulata*) rootstock. In recent years softwood grafting has become popular because of its added advantages over other methods. (Dhutraaj *et al.*, 2018) [4] Usually in dry land condition, softwood grafting is commercially adapted for custard apple multiplication where seeds are raised for rootstocks. Custard Apple is tolerant of a wide range of soil salinity conditions normally exhibit good growth in coarse-textured, rocky soils. It prefers to grow on undulated uneven terrains having shallow gravelly soils but it does not tolerate water-logged soils. The trees are drought-tolerant but humid atmospheric conditions promote pollination. However, *Annona glabra* prefers moist, swampy soils. *A. squamosa*, *A. reticulata*, *A. cherimola* and *A. atemoya* are grafted or budded on their own species and each other. *A. muricata* can be grafted on *A. reticulata* and *A. glabra*. However, *Annona reticulata* promotes vigour and shows good graft congeniality is commonly employed as a rootstock for most of the *Annonas*. On the other hands, Pond apple (*Annona glabra* L.) due to its tolerance and its adaptability to water logged conditions, shows potential as a flood-tolerant rootstock for commercial *Annona* species. Usually pond apple occurs at the margin of sloughs, streams and lakes. Shinde, *et al.*, 2015 [8] reported Chandsili, a local (Akola) variety of custard apple is a good rootstock grafted with Balanagar scion. Pond apple is a flood as well as salt-tolerant species which has great potential to be used in high-salinity coastal landscapes (Elisea Núñez *et al.*, 2000) [5]. Softwood grafting in custard apple is easy, less expensive and can produce large number of grafts in less time (Joshi *et al.*, 1999) [6]. For Soft wood grafting 6-8 month scion shoot are selected when plants shed their leaves and goes in dormant condition (April-May). These scion shoots are grafted in 8-12 month old root stock and give >90% success under semi-arid condition. The softwood grafting performed using cv. 'Arka Sahan' as scion on Ramphal (*Annona reticulata*) rootstock yielded the best outcomes including overall graft success and survivability. (Tsering Lanzes *et al.*, 2023) [11]. Shield or T-budding carried out in spring is most effective. Patch and chip budding are other methods equally good. Large buds, about 4 cm in length, collected from 1-year-old wood after the leaf drop give good success. The graft should be uncovered once it has taken, in order to avoid rots. Since propagation by cuttings and air-layers gives poor results, they are not widely practiced. Commercial production of plants through tissue culture is not yet successful. However, multiple shoot production from leaf explants of seedlings and root initiation from shoots are successful.

AONLA (*Embllica officinalis*) is also referred as Indian gooseberry, which is indigenous to India. Owing to hardy nature suitability to various waste-lands, high productivity/unit, area (15-20t/ha) and nutritive and therapeutic value, Aonla have become an important fruit. The tree can tolerate winds and frost. Mature trees of aonla can also tolerate freezing temperature and hot temperatures as high as 46 degrees. The fruit remains dormant during summer. So, it is best suited crop for arid region. Fruits are a rich source of vitamin 'C', highly valued among indigenous medicines.

Aonla has long been raised through seeds and inarching. Prolonged juvenility and wide variability is observed in plants from seed propagation. On the other hand only limited scope inarching owing to upright tree habit. Out of grafting techniques, soft wood grafting is experienced to be most successful but veneer and cleft grafting is also attempted successfully.

It can be successfully propagated through patch/modified ring budding in north India during mid-May to September with 60-100% success. 'Desi' aonla seedlings of six months to one-year-old are being used as rootstock. Mature aonla fruits are collected during January-February and their seeds are extracted after drying. Seeds are used to raise seedlings on which the desired variety or scion are grafted. Most of the fruit crop seeds germinate poorly and unevenly and require more time for seedling emergence as in the case of Aonla also. Seed propagation of aonla has demerits of lacking true to type plants, variable and inferior type of plants and long duration for fruiting. Seeds attain full maturity by February in north India and October in western India. Seedlings are raised from local strain and used as root stocks. Freshly harvested seeds of aonla do not germinate even if exposed to favourable conditions of germination owing to seed dormancy (Srimathi *et al.*, 2000) [10]. For better germination and healthy seedlings, seeds should be soaked in 500 ppm GA3 for 24 hours. Propagation of Aonla in polybag, polytube, "root trainer" or in-situ orchards needs to be standardized and commercialized. Seeds sown in first week of March in nursery bed or in perforated polythene bag (30cm x15cm size) become ready for budding in June-July, which saves about six months, and helps in effective nursery management than conventional methods. Among the various methods of vegetative propagation, Patch budding has been found most efficient and successful being commercially followed for propagation of Aonla. Healthy scion bud of desired varieties is used for patch budding during the period from May to September for optimum success. Under rainfed semiarid conditions of Gujarat, in-situ patch budding in May- June before onset of rain, gives more than 94% success and survival. In-situ patch budding is more efficient and practical followed by soft wood grafting and ring budding in semi-arid region of India. This method takes less number of days for sprouting and better vegetative growth in terms of length and vigour of sprouted shoot. Plantlet regeneration from cultured endosperm has also been reported when BA (0.2 mg/l) and IBA (0.1 mg/l) were used in the media. Scientific cultivation of aonla (Singh *et al.*, 2020) [9].

BER, the Indian Jujube (*Zizyphus mauritiana*) is an ideal fruit crop for arid and semi arid regions. Fruit species is indigenous to India. The drought hardy ber gives good yield of high quality fruit even under fragile environmental conditions of arid region, since its reproductive phase coincide with the maximum moisture availability period. Ber is grown in hot arid regions of India, including Telangana and Andhra Pradesh. Ber crop exhibits xerophytic characters with wider adaptability to adverse soils and climatic conditions. It sheds its leaves and enters into a resting period in May and June. Being a least care-requiring crop, it is suitable to rehabilitate as the extensive resource for poor man's health in poor man's areas and poor soils. (Vikas Sheoran *et al.* 2018) [14].

Ber plants propagate naturally from seed, Seedling trees are vigorous hardy owing to its deep root system. Seedlings of wild trees possess the qualities of a good rootstock and are generally used as rootstock. The seed stones can also be sown as such but it takes nearly one month to germinate. Germination can be improved by soaking them for 48 hr in water or dipping into a

salt solution of 17% concentration for 24 hours or for 6hr in concentrated sulphuric acid or in 200ppm Gibberellic acid. In-situ T (shield) or I budding on rootstock seedlings is common scion propagation method in arid areas. The asexually propagated fruit plants are true to type, take lesser time for fruiting, uniform in fruit quality. The disadvantage of clonal roots is that it does not produce deeper roots. The seeds take 10-15 days for germination. Since the development tap root system is very fast in ber as well as in wild species, when seedlings attain two leaves stage, they are transplanted in the main field in pits of size 1x1x1 m. The treated seeds can also be sown directly in to the pits @ 2-3 seeds per pit at a depth of 3 cm. The desired varieties are budded in situ on this rootstock seedlings after 90 days. If we want to bud the seedlings raised in polybags, large sized polybags have to be used, since the tap root grows long very fast. Maximum bud-take is in June to august. The ber species available as seedling rootstocks for budding Ber are *Zizyphus nummularia* (Jhar ber), *Z. jujuba*, *Zizyphus spinachristi*, *Z. xylocarpa*, *Zizyphus rotundifolia* (Boradi) etc. Several research findings indicated a link between precocity and compact tree size. Utilization of dwarfing rootstocks for achieving dwarfness is one way to encourage early fruit bearing. *Zizyphus nummularia* is dwarfing rootstock genetically, as it has slow rate of growth, thus shows dwarfing effect. Inverted bottle neck symptoms at graft union observed when budded with 'Gola' cultivar with (Verma *et al.*, 2000) [12] *Z. nummularia* due to most slow growth of rootstock compared to scion. There are chance of breakage at bud union so, *Z. rotundifolia* is preferred in heavy wind prone areas.

Boradi is being common root stock for commercial ber orchards. As rootstock play an important role in growing of fruit plants in problematic soil. *Z. rotundifolia* locally called Boradi is the wild species, regular and prolific bearer grow easily in a barren land and adverse climatic conditions, where most of the other fruits cannot be grown successfully (Kumar *et al.*, 2017) [7]. The commercial cultivar 'Umran' can be successfully raised on *Z. nummularia* from Punjab and Rajasthan under alkaline soil conditions. Gola Ber is most tolerant to saline soils. Research findings of Verma *et al.*, 2018 [13] revealed that Ber cultivars has varied response to salinity levels (0, 4.0, 8.0, 12.0, 16.0 dSm⁻¹ EC). High salt levels tolerated by Ber cultivars Banarasi Karaka, Narendra Ber Sel.-2 and Ponda are highly tolerant followed by Narendra Ber Sel.-1 and Gola. Seedlings of which can be recommend as rootstocks for commercial cultivation. Gola, Seb and Mundia are found suitable for extreme dry areas of arid regions. Seedlings are raised by sowing seed kernels extracted by breaking the stone (endocarp). These germinate in about one week. The other important *Zizyphus* species that can be exploited and standardized are *Z. jujuba*, *Z. spina-christi*, *Z. rugosa*, *Z. lotus* etc.

In-situ technique of propagation and planting: Seeds of *Z. rotundifolia* are extracted by breaking the stones. Two seeds are sown in each tube which germinate within 10 days. In rain fed areas, seeds are sown in 300gauge polythene tubes of 25 cm length and 10 cm diameter. As ber taproot grows very fast, seedlings are transplanted in main field at two leaf stage. Alternatively, 2-3 seeds can be sown during July-August directly in the field as per layout to raise rootstocks in-situ. After 10 months rootstock bushes develop into multi-stem bushes. These multi-stem rootstocks are cut back to the ground level during end of May. Within a month, the rootstock throws as many as 8-10 shoots from the ground level. 2-3 vigorous shoots retained by thinning out others. These shoots are lopped at 45 cm height in

July- August and are budded with desired cultivar at 15-20 cm height by I method or T (shield). The scion buds sprouts in a week. Wild sprouts below the bud joint are continuously removed. When bud success ensured rootstock portion above bud union is lopped.

Conclusion

Identifying ideal rootstock, and developing standardized method of propagation and large scale multiplication in arid /semi arid fruit crops remain as a great challenge. Traditionally, seeds indigenous wild species are being used as rootstocks. For sustainable fruit production rootstock should be scion compatible, edaphoclimatic stress tolerant, and can be easily vegetatively / clonally propagated.

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