Journal of the American Pomological Society 77(3): 165-175 2023

Beach Plum: A Fruit for the Future

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Keywords: salt tolerance, drought tolerance, pioneer species

Abstract

Beach plum (*Prunus maritima* Marsh) is a native, stress tolerant plant that is found on sand dunes along the north Atlantic Coast of the United States. The plant produces a small drupe, typically red or purple, and frequently is used to produce jams and jellies. Being a pioneer species, beach plum serves as an excellent tool in ecosystem recovery efforts while additionally providing economic value through its fruit. Efforts to improve the culture and genetic potential of beach plum have been occurring for less than 100 years. With its large genetic diversity, beach plum has the potential to be developed into commercially significant fruit in the future.

Beach plum (*Prunus maritima* Marsh.) is a shrub native to Atlantic coastal sand dunes from Maine to Maryland (Uva, 2003a). The tree produces a small, distinctively flavored fruit collected from the wild for jam and preserves (Uva and Whitlow, 2007). John de Verrazano documented beach plum in 1524 while traveling through southern New York. He called them "damson trees" since they resembled the foliage of a damson plum (Wight, 1915). In 1785, botanist Humphry Marshall authored the first scientific description of *Prunus maritima* in 1785, referring to the plant as the "Sea side plum" (Mirel, 1973). Research efforts surrounding beach plum commenced during the 1930s in Massachusetts as cottage industries developed around the fruit. Throughout the 1930s, Massachusetts residents Ruth White and Ina Snow played instrumental roles in propagating and marketing beach plums in Cape Cod. Their plea to the state government for financial assistance in beach plum marketing was heard by Bertram Tomilson, an extension agent with the Massachusetts Agricultural Experiment Station. Tomilson later founded the Cape Cod Beach Plum Growers' Association in 1948, with a purpose "to encourage and develop the economics, culture, marketing, and processing of beach plums (Garrick, 2012)." He was awarded the first annual James R. Jewett Prize--endowed by Harvard Professor James R. Jewett in 1940--by the Arnold Arboretum for his "devotion to the scientific study and development of beach plum (Jewett, 1940)." The Cape Cod Beach Plum Growers' Association would see its membership increase to 90 in 1948, and the Association successfully petitioned the Massachusetts Department of Agriculture to establish grades (minimum standards) and labels for Cape Cod Fancy Grade beach plum jelly and beach plum juice (Garrick, 2012). However, consecutive years of poor beach plum crops, a lack of leadership within the organization, and new business opportunities in a rapidly changing Cape Cod economy caused interest in beach plum to dwindle. The Association met for a final time in 1959 (Garrick, 2012). In recent years, Jenny Carleo, a Rutgers Cooperative County Extension agent of Cape May County, led the Cape May County Beach Plum Association (CMCBPA) to promote further study and research of beach plum (Carleo, 2017).

Beach plum has made a resurgence starting in the 1990s, with researchers from institutions such as Cornell University and the University of Georgia conducting experiments with the plant (Uva, 2003a; Uva and Whitlow, 2007; Rieger and Duemel, 1993; Rieger,

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2001). In 2001, the plant was first introduced to China through Nanjing University (Zai et al., 2021). Since then, several studies from China have identified beach plum as a plant highly resistant to drought and saline stress (Wang et al., 2016; Zai et al., 2021; Zai et al., 2015; Zai et al., 2012; Zai et al., 2016; Zai et al., 2017).

Beach plum is an excellent stress tolerant shrub that can grow without irrigation in many circumstances, even on low-nutrient sandy soils, saline land, old-field, and coastal beach where many other plants cannot survive (Wang et al., 2012). The beach plum's success may be attributed to its root system consisting of a long taproot combined with coarse lateral roots (Uva, 2003a; Wang et al., 2012). Given its ability to colonize early successional sand dunes while tolerating drought, the beach plum offers value as a pioneer species in ecological restoration or as a commercial rootstock (Zai et al., 2009; Wang et al., 2012).

The shrub may grow singly or in thickets. The shrub typically reaches a height of approximately 3-4 m (Zai et al., 2009). Aesthetically, it is appreciated for its profuse white blooms in spring and beach plum can maintain its greenery until late autumn (Wang et al., 2015). Hardy in zones 3 to 8, beach plum can work in an ornamental setting. A mature plant is 1 – 1.5 meters tall and wide and is best planted in full sun where it will produce masses of 1 cm white flowers in the spring (Wang et al., 2012).

The plant responds well to fertilizer nitrogen. While pruning methods have not been documented, buds/unit (branch) and fruit set are strongly correlated with yield (Uva, 2003a). Beach plum often bloom late nearly two months after commercial plums (Wang et al., 2012). Several other species of *Prunus* are at high risk of frost injury, so the beach plum could provide growers with a less risky crop, especially in the era of greater fluctuating spring temperatures (Miranda et al., 2005).

Beach plum fruits range from purple to deep blue to red to yellow. Beach plum fruits grow up to 2.5 cm in diameter and ripen in late August through September (Wang et al., 2012). It serves as an excellent fruit for making jams, jellies, and wines (Uva, 2003a; Uva and Whitlow, 2007; Garrick, 2012; Wang et al., 2012). Beach plums have reported health benefits as well; the United States Department of Agriculture (USDA) reports health benefits associated with beach plums. Beach plums have a high antioxidant capacity and they contain a class of tannins known as proanthocyanidins which can reduce adhesion of urinary tract bacteria (USDA, 2010; Howell and Foxman, 2002). In one study, the soluble solids (Brix readings) in the juice samples ranged from 9.4 to 29.0. The acidity varied from 0.7% to 3.2% (expressed as citric acid) and the pH values ranged from 3.1 to 4.1 (Wang et al., 2012). The antioxidant capacity of water-soluble substances of selected samples ranged between 87 and 397 mg per 100 g of fruit, indicating that beach plums are very good source of antioxidants (Uva and Whitlow, 2003).

Despite the multitude of promising characteristics that gives beach plum commercial potential, there are several challenges in establishing a market for the costal shrub, including suboptimal propagation and cultural methods, lack of availability of crop protection chemicals, marketing challenges, and the availability of appropriate plant material (Uva, 2003a). An unpublished 1997 market survey of merchants and condiment producers from Massachusetts Cooperative Extension estimated the demand for beach plum was nearly 10,000 pounds (4540 kg) annually from the tourist trade, far higher than the amount of beach plums produced commercially (Uva and Whitlow, 2007).

Traditional orchardists are often skeptical of producing beach plum on the commercial level because of irregular fruit bearing habits combined with little current, detailed management information (Uva and Whitlow, 2007). Biennial bearing, a common phenomenon in beach plum, is caused by the depressive effect of the growing fruit on flower bud formation and is characteristic of many perennial plants, particularly fruit trees (Couranjou, 1989; Uva, 2003a). Thus, annual crop yield is unpredictable and sometimes poor (Garrick, 2012). Methods of fruit thinning, pruning and nutrition could be explored to adjust to this pattern (Uva, 2003a). Only small markets for beach plums have appeared in coastal regions and further explains the lack of production and seed shortages from commercial orchardists and nursery growers (Uva and Whitlow, 2007). The seeds also exhibit slow germination relative to other members of *Prunus*; beach plum needed an additional three months to reach the same phenological stage as other *Prunus* species (Rieger and Duemmel, 1993) upon germination.

Propagation Methods

Hardwood and softwood cuttings in beach plum propagation

Beach plum can be propagated from seed with controlled stratification. The seed should be stored at 4°C (40°F) in moist sand or sphagnum moss for two or three months (Fiola, 2021). Dao-liang et al., (2009) found applying an electromagnetic field at a strength of 97 kA/m, while growing beach plum on growing media with NAA and zeatin (ZT), served as a viable way to increase beach plum seed germination and increase the plant's availability, although the biological mechanism elicited by the field was not identified.

Like many other woody perennials, beach plum can be propagated from both hardwood and softwood cuttings (Zai et al., 2007; Zai et al., 2009). Beach plum hardwood cuttings establish root systems that are deeper than softwood cuttings; the number of primary roots, the length of longest primary root, and the dry weight of roots of hardwood cuttings were much greater than those of the softwood cuttings (Zai et al., 2009). Propagation by hardwood cuttings is a better choice for cloning superior genotypes in a limited time, but propagating beach plum via cuttings remains challenging and does not always have high rates of success. Cuttings may be treated with a rooting hormone to improve the success rate. Naphthaleneacetic acid (NAA) and indole-3-butyric acid (IBA) both successfully induced rooting of beach plum cuttings (Doran and Bailey, 1957; Doran and Bailey, 1944; Dao-liang et al., 2009; Snell et al., 2018). Treated cuttings should be held in sand or perlite and misted until rooted, at which time they can be transplanted to containers (Snell 2018).

Inoculation with arbuscular mycorrhizal fungi (AMF) on hardwood and softwood cuttings

Earlier exploratory studies revealed that conventional methods of propagation often resulted in poor rooting, a prolonged nursery phase, poor growth, and low survival of transplanted cuttings (Zai et al., 2007). Inoculation with arbuscular mycorrhizal fungi is a common practice used in promoting plant germination as AMF fungi can enhance plant growth through increasing nutrient and water uptake, and by the production of growth hormones (Emmanuel and Babaloa, 2020; Aprahamian et al., 2016). Koske and Gemma (1992) observed a consistent presence of AMF on beach plum roots in its native habitat, suggesting the plant forms strong relations with AMF (Gemma and Koske, 1997. Among the three different species of AMF fungi tested on beach plum, *Glomus mosseae* outperformed *G. etunicatum* and *G. diaphanum* (Zai et al., 2007). *G. mossease* inoculation resulted in the highest percentage of root colonization and spore count among the three *Glomous* species. In addition, *G. mosseae* gave the highest percentage rooting, the maximum number of lateral fine roots and the largest dry weight of roots; beach plum inoculated with *G. mosseae* was most effective in its uptake of macronutrients (P, K, Mg, Ca) and micronutrients ((Mn, Cu, Zn) (Zai et al., 2007). *G. mosseae* increased shoot weight, the height of the cuttings and the leaf area relative to the other *Glomus* species as well (Zai et al., 2007).

Genetic diversity and elite cultivars

Morphological traits have proven to be poor indicators of relationships among *Prunus* species. Examining molecular data provides additional insights, but no clear patterns. The earliest work to employ molecular tools suggested that *P. maritima* belongs to a clade more closely related to sect. *Prunus* and subg. *Cerasus* than to *Prunocerasus* (Mowrey and Werner, 1990). Shimada et al. (1999) investigated the genetic diversity of 42 different plum species and discovered that beach plum, along with another North American plum 'Glow,' was genetically distinct from the others surveyed. These genotypes portrayed different random amplified polymorphic DNA (RAPD) patterns which suggested they were genetically different than Japanese or European plums. Within the three clades of *Prunocerasus*, little phylogenetic resolution was found (Shaw and Small, 2004). Haplotypes add to the confusing phylogenetic relationships among species. *P. maritima* var. gravesii (a single clonal accession near Groton, CT) shares the beach haplotype with *P. geniculata* (a plum species endemic to Florida) and with some, but not all accessions of *P. maritima* var. maritima (Shaw and Small, 2005). Wang et al. (2015) evaluated the relationship between geographical distribution and genetic relationships among beach plum genotypes with molecular makers but did not find strong correlations.

Interest in beach plum as a commercial fruit began in 1872 when the first cultivar was released. 'Basset's American' was selected for its large fruit in Hampton, New Jersey, but was largely ignored by researchers and growers (Uva 2003b). Several cultivar evaluations had taken place in the 1940s, but the results of these trials are lost (Uva 2003b). Today, there are several commercial varieties of beach plum in production. 'Autumn' is a low spreading bush that produces annual crops with excellent fruit size and quality (Fiola, 2021). 'Stearns' has superb ornamental value in addition to its well-processed fruit (Fiola, 2021). 'Northneck' and `Squibnocket' are also valuable as ornamentals (Fiola, 2021). Breeders are also focusing on enhancing beach plum's role in sand dune stabilization; the Cape May Plant Materials Center (Natural Resources Conservation Service) released 'Ocean View' to support coastal sand dunes (Uva, 2003b). Breeding efforts funded by the USDA's Sustainable Agriculture Research and Education Program (SARE) focus on key traits to promote beach plum as a commercial fruit, such as its resistance to brown rot, consistency of yield, and level of antioxidant content (Uva, 2003b). Since Uva (2003a) found that buds/branch unit,(a branch unit is defined as two years of woody growth with associated buds) and fruit set had the strongest effects on beach plum yield, these traits are excellent candidates for selection.

Response to NaCl (Salt) Stress

Effect of salt stress on physiology of beach plum

Many horticultural crops do not perform optimally under salt stress since the mechanisms they have developed for absorbing, transporting, and utilizing mineral nutrients from non-saline substrates do not operate effectively under saline conditions (Grattan and Grieve, 1998). Beach plum is a halophyte, or salt-tolerant plant, that can perform well in the presence of limited NaCl. Beach plum plants growing in 50 mM NaCl solutions exhibited increased root fresh and dry weight and leaf fresh weight relative to the control treatment (0 mM NaCl) and the 150 mM NaCl treatment (Wang et al., 2018). The ultrastructure of *P. maritima* root cells were unaffected by low salinity (Wang et al., 2018). However, Rieger (2001) maintained beach plum plants in 25 mM NaCl for two weeks before increasing the concentration to 50 mM NaCl where he then observed decreased leaf, stem, root, and total biomass over the next six weeks. The discrepancy could be related to the difference in the way the plants were grown. Rieger (2001) grew beach plums hydroponically in a greenhouse whereas Wang et al. (2018) grew plants outdoors with sandy loam soil.

Salt levels higher than 100 mM NaCl lowered the photosynthetic rate, transpiration, stomatal conductance, and intercellular CO_2 level in beach plum at both 100 mM NaCl and 170 mM NaCl compared to the control treatment (Wang et al., 2016; Zai et al., 2021). However, *Prunus maritima* had the highest threshold for Na^+ and Cl^- ion toxicity in leaves as the beach plum exhibited 26-29% less foliar injury than *P. persica* and *P. mexicana* (Reiger, 2001). Increased vacuolar volume could explain how the plant sequesters high concentrations of Na^+ and Cl^-, a common mechanism employed by halophytes (Tester and Davenport, 2003). The ability for beach plum to sequester Na^+ and Cl^- ions at a higher concentration than other *Prunus* species permits the plant to maintain higher photosynthetic rates. When four genotypes of beach plum, in addition to Chinese plum (*P. salicina),* wild peach (*P. persica*) and purple-leaf plum (*P. cerasifera*) were evaluated under salt stress, two of the beach plum genotypes—B1 and B5—showed the lowest reduction in net photosynthesis rate in response to the 100 mM NaCl treatment. B1 followed the same trends in transpiration, stomatal conductance, and intercellular CO_2 concentration, exhibiting the lowest reduction among all beach plum genotypes (Wang et al., 2016). Among all four species tested, beach plum maintained the highest photosynthetic rate in 100 mM NaCl conditions (Wang et al., 2016). The maintenance of high rates of photosynthesis could be attributed to the high-water content of the leaves when plants were subjected to salt stress; salinity did not inhibit the movement of water from the roots to the leaves (Wang et al., 2018). Under high saline conditions, 150 mM NaCl, beach plum had the highest concentration of Mg^{2+}, Ca^{2+}, and K^+ present in the leaves relative to the low salinity treatment at 50 mM NaCl and the control treatment without NaCl. The increased concentrations of inorganic ions in plant tissue could drive the uptake of water in saline soils (Wang et al., 2018).

While not examined widely in the literature, beach plum may have biochemical adaptations that enhance its aboveground salt tolerance. The sugar alcohol sorbitol is the dominant polyol in the Rosaceae/Amygdaloideae subfamily (Wallaart, 1980). Sorbitol, as a low molecular weight organic compound, can participate in osmotic adjustment during salinity stress; halophytes such as P. crassifolia and P. coronopus can accumulate sorbitol in the roots and shoots when exposed to saline environments (Pleyerová et al. 2022). Within the subgenera Prunophora, mature beach plum leaves had one of the highest sorbitol to sucrose ratios under optimal conditions (Moing et al. 1997). Given that Wang et al, (2018) observed the water content of leaves increase during salinity stress in beach plum, it is possible sorbitol was transported to the roots and shoots, which had lower water concentrations than the leaves respectively. Further studies are needed to validate the role of sorbitol in beach plum stress metabolism.

The ultrastructure of root cells of *P. maritima* subjected to high salinity showed a decrease in chromatin density and starch content compared with those of control plants. Moreover, organelle degradation was observed under high salinity conditions (Wang et al., 2018). The damage to the root tissue further suggests beach plum's susceptibility to salt stress at 150 mM NaCl. Often, roots are less susceptible to NaCl stress relative to the shoots because both Na^+ and Cl^- are loaded into the xylem and transported throughout the plant, or because the root can expel both ions back into the soil solution. As Zai et al. (2021) observed, the impact of salinity at 170 mM NaCl was more pronounced in shoots, with dry weight reduced by 40% compared to roots where the dry weight was reduced by only 20%. There is no significant evidence Na^+ and Cl^- can move from the shoots back to the roots (Tester and Davenport, 2003).

Role of AMF in salt stress alleviation

Given how AMF improved the propagation of beach plum, the relationship between AMF and beach plum was investigated under salinity (Zai et al., 2007; Zai et al., 2009). Salinity hindered the formation of arbuscular mycorrhizal fungi (AMF) colonies found on beach plum roots and lowered the spore density produced by AMF (Zai et al., 2021; Xueming et al., 2014; Zai et al., 2015; Zai et al., 2016; Juniper and Abbott, 2006). However, beach plum plants inoculated with AMF generally had higher photosynthetic rates and electron transport efficiency than those not inoculated. Beach plum inoculated with *G. mosseae* had higher Chl content and Chl a/b ratio and higher quantum yield in both dark-adapted and light-adapted states than nonmycorrhizal plants under salt stress (Xueming et al., 2014; Zai et al., 2012; Zai et al., 2021). Furthermore, associations with mycorrhizal fungi improved the gas exchange capacity, photosynthetic rate, stomatal conductance, transpiration rate and decreased intercellular CO_2 concentration under salt stress compared with maize plants without an AMF relationship. Increased photosynthesis was reflected by the increased dry weights of the root and shoots inoculated with AMF (Zai et al., 2012; Zai et al., 2021).

AMF-inoculated beach plum also exhibited improved nutrient uptake under saline conditions. Salinity reduced the concentration of P and K in the roots, but stimulated K movement in the shoots (Zai et al., 2021). Inoculation with AMF improved the concentration of P in the roots and shoot, since AMF contain genes coding for phosphate transport proteins that translocate phosphate from the mycelium to the cortical cells in the root (Zai et al., 2021; Karandashov and Bucher, 2005). Inoculation with AMF improved K concentrations in the roots, shoots, and total K in beach plum subject to NaCl stress (Zai et al., 2021). Interestingly, salinity did not lower N concentrations in the roots or shoots of beach plum, but inoculation with both AMF and phosphate-solubilizing fungus (PSF) separately improved the levels of N in the plant (Zai et al., 2021). Beach plum's association with AMF could also help explain the plant's enhanced photosynthetic response as uptake of Mg^{2+} can be enhanced by AMF (Chen et al., 2017; Wu et al., 2010).

Co-inoculation of AMF and PSF for alleviation of salt stress

P deficiency is a widespread problem in agricultural soils because there is often little available P in the soil solution due to its extreme reactivity (Srinivasan et al., 2012). PSF can solubilize P that is bonded to Ca^{2+}, Mg^{2+}, and Zn^{2+} in saline soils by lowering the pH and increasing plant-available P in the soil (Grattan and Grieve, 1999; Zhang et al., 2011. The released P cannot be transferred to the roots by PSF but may be taken up by the external mycelium of AMF (Zai et al., 2015). Moreover, the co-inoculation of AMF and PSF increased the concentration of P in the root system of the beach plum (Zai et al., 2015; Zai et al., 2016; Zai et al., 2021; Xeuming et al., 2014). The increased P uptake may result in a lower uptake of Na^+, which is indirectly related to K^+ uptake (Xueming et al., 2014; Allen and Cunningham, 1983; Giri et al., 2003). The dual inoculation of AMF and PSF improved the beach plum's ability to uptake K^+ from the soil solution and increased the K^+/Na^+ ratio in the soil solution (Xueming et al., 2014). Therefore, the co-inoculation of AMF and PSF improved beach plum's absorption capacity for essential mineral nutrients under NaCl stress, bolstering the plant's root and shoot growth relative to plants without fungal inoculants (Zai et al., 2015; Zai et al., 2016; Zai et al., 2021; Xeuming et al., 2014).

The increased root and shoot growth of beach plum co-inoculated with AMF and PSF may result from higher rates of photosynthesis. Co-inoculants exhibited the highest maximum PSII efficiency, photochemical quenching, and actual PSII efficiency values under salt stress relative to beach plum that were not inoculated with either fungi, or with AMF and PSF separately (Zai et al., 2021).

Beach plum co-inoculated with AMF and PSF have altered soil microbiota in the rhizosphere as well. They had higher concentrations of bacteria, and actinomycetes on the root surface and rhizoplane relative to plants inoculated with only AMF, PSF (Zai et al., 2015; (Zai et al., 2017).

The increase in hydrolysable-N concentrations in the rhizosphere soil of inoculated plants was probably due to an increase in the number of indigenous N-transforming or N-fixing bacteria on the root surface promoted by the release of P by both AMF and PSF. Urease and protease activities promoted by microbe inoculation can also account for the increase in hydrolysable-N concentrations (Zai et al., 2017).

Drought Stress

Members of the *Prunus* genus generally have more shoot structures associated with drought stress than root structures (Rieger and Duemel, 1993). However, the beach plum's long primary root and increased number of lateral roots relative to fine roots makes it stand apart from other *Prunus* species (Uva, 2003a). In fact, specific leaf area was lower in beach plum compared to other mesic *Prunus* species due to its thickened cuticle, a result of facing salt spray in its native habitat (Rieger and Duemel, 1993; Uva 2003a; Boyce, 1954; Barbour, 1978). As a result of the modified leaf structures, beach plum had the highest water use efficiency and the lowest stomatal conductance of the *Prunus* species measured (Rieger and Duemel, 1993). Uva and Whitlow (2007) later evaluated beach plum in agricultural field soil with 2.5 cm of irrigation water per week via micro sprinklers from May-October to determine the crop's water requirement in agricultural soil. They found that irrigation had no effect on beach plum yield. In fact, irrigation lowered beach plum yield in 1998, but the added water in a year with heavy rainfall might have contributed to excessive nutrient leaching out of the root zone (Uva and Whitlow, 2007). Regardless, beach plum's high water use efficiency makes it a desirable crop to produce in arid climates where water is a limiting factor.

Response to burial

On coastal sand dunes, burial is a repeated form of abiotic stress that is imposed upon the surrounding vegetation due to coastal winds. The process can be associated with species richness and diversity, shifts in dominant species, and species replacement; thus, burial has mixed effects on species inhabiting sand dunes (Dech, 2004). Complete burial of beach plum along sand dunes within a single growing season is a common occurrence (Uva, 2003a). In areas of active sand deposition, tolerance to sand burial may exist in woody plants common in vegetation zones dominated by forbs and grasses (Uva, 2003a). Under conditions of abiotic stress, perennial plants tend to allocate more nutrients to their storage organs or less productive regions of the canopy allowing for increased survival (Puijalon, 2008; Uva, 2003a). Beach plum had the least amount of leaf area allocated to the lower parts of the canopy out of several other woody species: *Prunus serotina*, Ehrh., *Prunus virginiana* L., and *Myrica pensylvanica* Loisel (Uva, 2003a). In addition, the beach plum had the highest levels of dark respiration relative to the other *Prunus* species (Uva, 2003a). Burial also affects the root number and root: shoot ratio as burial tolerance depended on the ability to adjust resource allocation patterns and support stem elongation and adventitious root formation (Dech, 2004). With burial, root:shoot ratio and root weight decreased in all species except *P. maritima* suggesting the beach plum has a greater ability to allocate resources to its below ground biomass relative to the other *Prunus* species (Uva, 2003a). Sanding would have a similar effect as alternate year pruning on beach plum, causing an allocation of resources away from less productive parts of the canopy (Strik and Poole, 1995; Uva, 2003a).

Beach Plum in Ecosystem Restoration

The term "pioneer" is used to describe the species that first colonize new habitats created by disturbance (Dalling, 2008). Pioneer species play crucial roles in restoring degraded land. For example, pioneer plants, regardless of species, initiate the development of soils in mine waste deposits through organic matter accumulation and increased biological activities (Arocena et al., 2010). More specifically, significant increases in infiltration of water in the mine waste deposits, especially in the vicinity of root crowns through rainfall interception, throughfall and stemflow, favor the formation of soils (Arocena et al., 2010). Pioneer vegetation improves the establishment of seedlings (Zanini and Ganade, 2005). For beach plum specifically, the indigenous shrub could be grown in restoration areas and amenity plantings near its native range to serve the dual purposes of land restoration and fruit production (Uva, 2003a). Given its reputation as stress-tolerant crop and the high economic value associated with its fruit, the plant has been used in restoration efforts in China as well (Zai et al., 2009). Beach plum was introduced into three sites with infertile land in China: Fujiabian Farm, Pukou Farm and Jinhai Farm (Zai et al., 2009). The Fujiabian and Pukou Farms were located on abandoned infertile land and the Jinhai Farm was located on a saline wasteland (Zai et al., 2009). Through clonal propagation of seedlings and improved germination media, beach plum established well on all three locations; each site was transformed into arable land four years after the project started (Zai et al., 2009). Thus, the project indicates the potential of beach plum as a pioneer species and as an agent of ecosystem restoration.

Conclusion

While further research is needed to explore beach plum in agroecosystems, the plant displays promise to thrive on low fertility and saline soils. The genetic diversity of beach plum shows a great potential for developing elite genotypes via selection and breeding to improve productivity and fruit quality while serving as a valuable rootstock for other Prunus species in commercial production. Beach plum's associations with arbuscular mycorrhizal fungi and phosphate-solubilizing fungi, its tolerance to abiotic stress and adaptability to land with a low nutrient profile, combined with its ability to yield an excellent processing fruit makes it a good candidate for fruit production as well as land restoration.

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