P. juliflora Management at the Brazilian Northeast

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Introduction

The versatility of *Prosopis juliflora* (Sw) DC, whose leaves and pods are used as animal fodder; its fruits as a source of food in the form of flour, beverages and syrup; its wood as fuel, charcoal, railroad sleepers, stakes and poles; its effectiveness in erosion and desertification control, dune stabilization, reclamation of salinized soils and as support for apiculture, calls for a thourough study on its management in our semi-arid region.

This paper analyzes some practices performed by farmers, companies and research institutions, as regards establishment, growth and care of *P. juliflora* in the Brazilian Northeast.

Seedling Production Methods

P. juliflora reproduces through seeds or cuttings. The most widespread method in the Northeast is raising seedlings from seeds.

For the establishment of populations exhibiting high output of pods with good protein and sugar content, free of thorns, it is recommended to raise seedlings from cuttings obtained from parent trees having the characteristics desired, as the cross pollination of *Prosopis* makes it difficult to keep the traits of the parent tree.

Seed extraction

In this region, *P. juliflora* selection has been made by obtaining seeds from trees with the desired phenotypic characteristics such as absence of thorns, large pods, fruit shape, size and healthiness. Collection is performed directly by picking up fruit from the ground.

The common process for seed extraction among farmers is to soak the pods in water for some 12 hours, thereafter slicing the pod lengthwise with a knife along the narrow side (Gomes, 1961).

Seed extraction with chemicals is expensive and difficult to handle by peasants. Souza *et al.* showed the viability of obtaining *P. juliflora* seeds with a fodder machine, from sundried pods. This process reduces costs of manual extraction by almost 45%, even considering the amount of seeds lost.

Minute cracks form in the tegument of the seeds so extracted, a feature which helps scarification. Thus, seeds do not require further pregermination treatment, and germination rates exceed 70%. Trials are being performed on seeds obtained with this process and, 30 months after storage in plastic bags both in cold room and at room temperature they show perfect phytosanitary conditions and germination capability.

The number of *P. juliflora* seeds per kilogram is about 28,400 (Carvalho, 1976), and they must be fumigated prior to storing to prevent insect attack. Morais *et al.* (1981) confirmed the presence of Bruchidae.

Sowing

Sowing depth used for this species is 1.0 cm, enough to cover the seeds, and is performed directly in plastic bags, cans or other containers, in a 2:1 soil-manure mix. One or two seeds are placed in each container. Should both seeds germinate, the least vigorous seedling is culled, placing the remaining seedling at the center of the container.

This region's most widely used method for breaking seed dormancy is to submerge seeds in hot water for 3 to 5 minutes. This low-cost treatment provides over 90% germination and does not pose

any handling hazards as compared to methods using chemicals such as sulphuric acid.

P. juliflora seedlings are raised without shading, during the period preceding the rainy season. The plants remain in the nursery for 45-60 days, until they reach 20-25 cm height.

In order to prevent the appearance of fungi or other pathogenic agents, the soil mix to be used must be previously fumigated.

At time of sowing, it is advisable to inoculate with *Rhizobium.* Research carried out by Franco (1982) permitted to select strains Br 4001, Br 4002, Br 4003, and Br 4007 as highly efficient for nodulation and nitrogen fixation in *P. juliflora.* In this region, seedlings of this species have been observed with nodules although no prior specific *Rhizobium* inoculation had been performed at time of sowing.

During the seedling raising stage, an average of three waterings per day is carried out, so as to keep moist the soil used as substratum and to facilitate seedling development. As seedlings grow, both amount and frequency of watering are decreased, in order to acclimatize the plants to the region's drought conditions.

Seedling quality

The root system is one of the factors with bears upon seedling quality, and which can depend on type of container. As soon as they germinate, *P. juliflora* seeds issue a fast-growing tap root which, depending on type of container, reaches the bottom of the container in a matter of days. Upon the impossibility of growing farther, it starts to curl upon itself.

Seedlings with wrapping roots entail subsequent plant strangling or root malformation in the field, with likely upturning of the plant.

Fallen adult *P. juliflora* have been observed in the Northeast. CPATSA is investigating the precise reasons behind these falls. Seedling quality is one of the hypotheses being considered, for these falls have occurred at man-made plantations. Two other factors could be soil depth, grounds here being generally flat, and water availability.

P. juliflora possesses a root system with a deep tap root which seeks the phreatic layer and anchors the plant to the ground, and fasciculate roots extending below the canopy area at a depth of some 40 cm. Most of the fallen *P. juliflora* did not have a well formed tap root, and the soils had an excess of water.

In more humid regions, *P. juliflora* tends to develop more its vegetative system, producing more wood. Planted in flat ground, with an underdeveloped root system, sizable height and heavy branches, *P. juliflora* tends to fall when hit by strong winds. Figures 1 and 2 show *P. juliflora* root system after 12 months of out planting. In both cases a main root can be observed with over one meter in length. The extension of the fasciculate roots corresponds approximately to crown diameter.

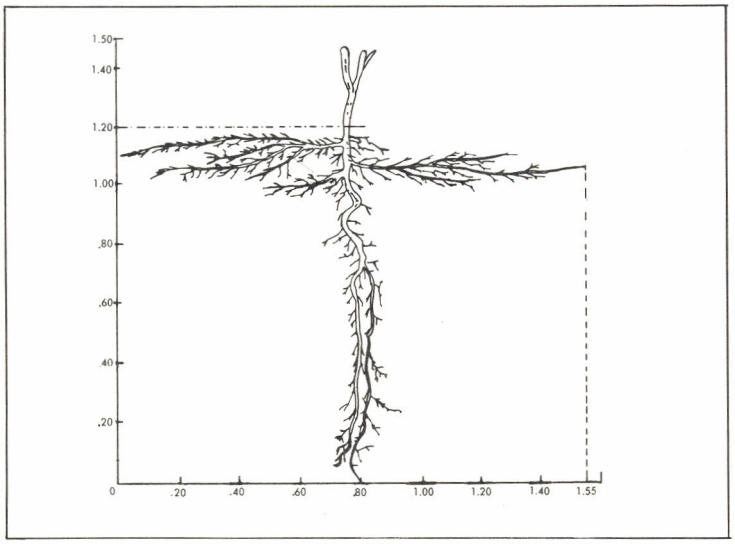

Figure 1. *P. juliflora* root at 12 months of age.
(Seedlings raised in styroblock)

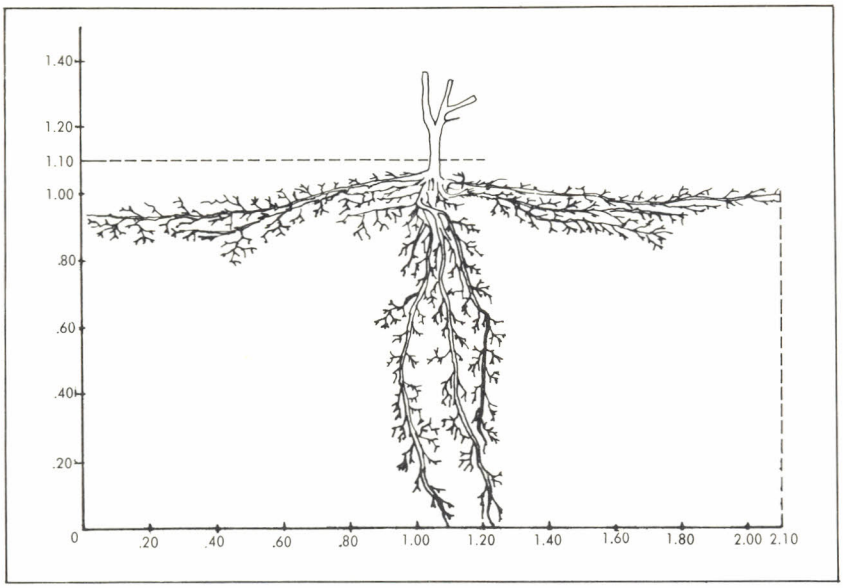

Figure 2. *P. juliflora* root at 12 months of age.
(Seedlings raised in plastic containers)

Silva and Lima (1985), analyzing the quality of *P. juliflora* seedlings produced in different types of container, found differences in growth of plants in the nursery, without bearing on survival rates. No significant differences in height or root length were found 12 months after out-planting, as shown in Table 1. Another factor observed is that the seedlings produced in bottomless containers and in paraffin-treated paper tubes show higher biomass production.

TABLE 1

Height, Root Length, Canopy Size and Biomass Obtained from *P. juliflora* Seedlings Raised in Different Containers

	Nursery (2 months)		Field (12 months)			
Treatment	**Height (cm)**	**Root (cm)**	**Height (m)**	**Root Size (m)**	**Cdiam (m)**	**Biomass (kg/ha)**
Fertile pot	20.9 a	23	1.38	1.2	2.06 a	1,048
Plastic bag	21.8 a	30	1.58	1.3	2.32 a	2,644
Layered strata	16.7 ab	24	1.73	1.3	2.55 a	3,830
Styroblock	8.0 b	13	1.32	1.3	1.57 b	955
Laminated paper	12.7 b	26	1.53	1.4	2.30 a	4,350

Figures followed by the same letter do not differ from each other as per Duncan test at 5% probability level.
Source: Silva & Lima (1985).

Seedlings produced by vegetative propagation

P. juliflora cuttings, once they grow shoots and roots, are placed in containers with a soil-manure mix. The method for inducing rooting in *P. juliflora* cuttings was described by Souza and Nascimento (1984) and by Nascimento *et al.* (1985). Once the seedlings become established, they are removed from greenhouse (35° C temperature and 80% relative humidity) and placed in the nursery, where the only controlled factor is soil moisture, through irrigation.

For final outplanting, seedlings raised from cuttings undergo the same process as seedlings raised from seeds.

Planting Techniques

The planting system with *P. juliflora* is related to the size of the undertaking. Afforestation operations carried out by forest companies generally include land clearing, either manually or mechanically, followed by plowing and levelling, with seedlings planted at regular spacing in square stands. Plantings made by small farmers normally involve placing the seedlings in straight lines around plots, pastures, alongside roads and in small stands, where only the spot itself where the plant will be located is cleared, normally some 2 m around the pit, which is 30 cm × 30 cm.

Planting is carried out at the onset of the rainy season, so that the seedlings find freshly moist soils and can count on all the water from the coming rainfall. Pit planting involves placing the seedling some 15 cm below ground level, so that runoff water accumulates in the depression and improves seepage and water takeup.

Researchers from the Rio Grande do Norte Research Agency (EMPARN) have conducted promising research on planting with *P. juliflora* pseudo-cuttings, obtained from seedlings pruned some 10 to 15 cm above and below the collar, respectively. The main objective of this system is to reduce transportation and labor costs, without negative bearing on plantation development. This process has the further advantage of making possible the use of seedlings which have stayed too long in the nursery, as a result of postponing outplanting due to lack of rains, and normally considered useless on account of the size and extension attained by the root system.

Irrigated planting

When planting is carried out during the dry season, the plants are irrigated from a water truck provided with hoses. The truck moves slowly along the plant rows, so as to enable the operators to control the amount of water being provided to each plant. Two to three liters are supplied per plant every 10 days, as long as considered necessary.

Another alternative being examined by CPATSA is the use of permeable mud pots buried near the plants. They keep the soil moist near the roots. These pots are about 40 cm tall and have around 10-liter capacity, being replenished every 30 days, assuring plant survival and development until the onset of the rainy season. With large-scale plantings, however, this system is impractical due to the high cost involved.

In situ rainwater catchment

The dry season at the Brazilian Northeast lasts about 9 to 10 months, and the rainfall regime is irregular. Soil preparation for plantings should include the use of techniques to improve rainwater retention and infiltration.

CPATSA is presently assessing technically and economically *in situ* rainwater catchment systems for plantings of some evergreen species, including *P. juliflora.* Soil texture, structure and porosity, and depth reached by the plants' root system are essential features to consider when planning such systems.

The system consists of modifying the soil surface, so that the area between plant rows acts as a catchment area. It is necessary to form a slope to increase water runoff and to direct it towards the area containing the roots. Furrows are made following the contour and with a minimum gradient (Silva and Porto, 1982).

This system showed good results in terms of plant survival and development at a CPATSA experimental plot with *P. juliflora.* Furthermore, it permits the establishment of edible or fodder crops at the water catchment furrows, in the space between the plants, during the year of establishment, without affecting *P. juliflora* development negatively.

Spacing

Spacing for *P. juliflora* plantations depends on the product output aimed at (timber or fodder) and on site characteristics. Alves and Campos (1985) have analyzed the various options for intercropping with *P. juliflora,* determining the optimum spacing for each case in terms of good area use and absence of negative interference with *P. juliflora* development.

With 3 × 2 m spacing aimed at fuelwood production, timber volumes produced in Petrolina were 7.2 and 15.5 m^3/ha at 3 and 5 years of age, respectively (Lima, 1985). As from the third year, height growth rate starts to slow down as a result of competition, being suggested therefore to clearcut in the fifth year to obtain fuelwood. Gomes (1961) recommends 5 × 5 m as the smallest spacing for *P. juliflora* plantations in the Northeast.

Wider spacings, in excess of 10 × 10 m, enable greater canopy development and, consequently, higher fruit output. Trees with an average of 100 m^2 vital space at the Bebedouro experimental station, Petrolina, produced pods at a mean rate of 78 kg/tree/year.

Intercropping

A common practice among the region's farmers is to plant *Opuntia ficus* var. *indica* in association with *P. juliflora.* Alves and Campos (1985) report on some alternative options for intercropping with *P. juliflora* tried at the Pendência farm, Paraíba.

For shading of *Opuntia* planted at 1 × 1-m spacing, these authors recommend a 5 × 5-m spacing for *P. juliflora.* In association with edible crops during the plantation establishment stage, they recommend spacings of 10 × 10 m and 2 × 1 m for corn *(Zea mays)* and macassar bean *(Vigna unguiculata)* in alternate rows. With buffel grass *(Cenchrus ciliaris),* they recommend leaving a 2-m-diameter area around *P. juliflora* free of this grass. Ribaski (1986) also recommends a clearing not smaller than 1 meter in diameter around *P. juliflora,* as the competition between both crops is strong, with up to 10% *P. juliflora* mortality when associated with buffel grass if this clearing is not provided.

When planting *P. juliflora* in pastures of *C. ciliaris* with free cattle grazing in the area, a protecting fence must be erected around the tree in addition to the clearing described above. Ribaski (1986) reported 60% mortality of *P. juliflora* associated with buffel grass due to damage caused by cattle. The remaining trees exhibited smaller height and diameter gain than those protected behind fences.

Fertilization

Considering *P. juliflora* rusticity, the Brazilian Forest Development Institute (IDBF) has not encouraged fertilization in projects subsidized by the state. However, institutions and companies participating in afforestation campaigns involving farmers generally recommend the use of fertilizer.

Manure is the fertilizer recommended, as the semi-arid region soils are poor in organic matter. Generally speaking, 1 kg of manure is used per pit. CPATSA is carrying out trials with both chemical and organic fertilizers for *P. juliflora,* considering plant survival and growth rates. Results show better height growth and crown development in plants receiving 5 kg of manure per planting pit.

Cultural Treatments

As any agricultural crop, *P. juliflora* requires certain minimum care to become established, develop and produce well.

From nursery operations onward, weed eradication is necessary. After final out-planting, weeding three times per year is a must during the first two years to insure firm *P. juliflora* establishment in this region. It is not necessary to perform an in-depth clearing, and a 2-m clear space around the tree is enough to permit unimpeded *P. juliflora* growth, which then has no need to compete for water and nutrients. When weeding is carried out, it is advisable to leave the removed weeds lying on the ground, to check soil moisture loss through evaporation.

Pests and disease

In addition to ants, the appearance of other insects is controlled with chemicals at the nursery stage. In the field, damage caused by *Oncideres* spp. has been reported frequently.

Lima (1982) observed damage in 66% of the trees planted, as from the third year after field

planting. Spread of this insect is controlled by burning all fallen and sawn-off branches, where the eggs have been deposited and larvae start their development.

In the nursery, Santos and Silva (1983) found that *P. juliflora* is a susceptible host to the nematode *Meloidogyne javanica* (Trub 1985) Chitwood 1946, which does not affect seedling survival rates. Nematode-bearing seedlings were planted in the field and exhibited normal development. Nematodes are controlled in the nursery by fumigating the soil.

The presence of the grasshopper *Striphra robusta* Mello-Leitão has been reported in *P. juliflora* plantations. Although it reduces foliar area in the trees, no serious damage has been observed. Recently, bee atacks to *P. juliflora* fruit have been detected at the final ripening stage, consuming the entire fruit pulp prior to its falling to the ground. The attack did not occur on all individuals in the population, suggesting that those attacked had very high sugar concentration in the pods. No form of control has been tested against this insect.

Pruning

P. juliflora must grow unimpeded when the plantation purpose is stake and fuelwood production, without pruning. A *P. juliflora* plant, in regular plantations with 3 × 2-m spacing, has an average of 6 forkings below DBH (Lima, 1982). In commercial plantations whose objective is to produce fuelwood, pruning is expensive and not advisable.

At Brazilian Northeast towns, it is common to plant *P. juliflora* alongside streets and roads. In this case, pruning is recommended. It consists of cutting off secondary branches until the plant reaches about 1.8 m height, at which point three or four branches are left, forming the base of the tree's canopy.

Pruning for canopy shaping is also common, whereby branch tips are cut off until the desired shape is obtained. Pruning is performed at the onset of the rainy season. Drastic pruning cases are not uncommon, where the canopy or the lateral branches are reduced in size to keep them from surrounding or reaching power lines. The tree recovers normally, being fully sprouted by the time the dry season starts again.

No records exist regarding fruit productivity research on *P. juliflora* in which pruning has been performed either to guide the stem or to shape the canopy, in comparison with free-growing individuals. Studies conducted at CPATSA found a correlation between pod production and canopy size, plant nutritive status and flower pollination efficiency. Relative humidity and insects can have bearing on increase or decrease of *P. juliflora* pod output.

Regeneration

P. juliflora regeneration in the Northeast occurs naturally, and plants can be seen growing on river banks, alluvial soils and barren lands where animals graze freely. Animals feed on the fallen pods and then disseminate the seeds encapsulated in their droppings. After the rains, seeds start to germinate and, if conditions are favorable, they become seedlings and, later, trees.

Under adverse fertility and moisture conditions, regeneration will hardly take place as in fertile humid lands. A pod contains an average of 18 seeds and even if all of them manage to emerge intact out of the animal's digestive tract and then germinate, the resulting seedlings will be grazed by the animals themselves when faced with the scantiness of browse or pasture in these areas during the dry season.

To prevent undesired *P. juliflora* propagation in pastures or subsistence farming lands, it is advisable to feed the animals ground pods, either alone or combined with other fodder, so that the seeds are totally destroyed and plants will not proliferate through seeds embedded in animal droppings.

Stumps issue new shoots after clearcut felling, more intensely so in young trees. When firewood production is desired, no pruning of these regrowth is advisable, although ideally no more than two shoots should be left per stump.

References

ALVES, A. Q. and CAMPOS, S. V., 1984: "A importancia prática do consórcio da algarobeira - *Prosopis juliflora* (Sw) DC com plantas forrageiras e culturas de subsistencia," Silvicultura, 10 (37): 43-6.

CARVALHO, R. F., 1976: "Alguns dados fenológicos de 100 espécies florestais, ornamentais e frutíferas, nativas ou introduzidas na EFLEX de Saltinho," PE. Bras. Flor. 7 (25): 42-4.

FRANCO, A. A., 1982: "Fixação de N atmosférico em *Prosopis juliflora* (Sw) DC," In: *Proceedings,* I. Simpósio Brasileiro sobre Algaroba, Natal, 1982, EMPARN, pp. 319-329. (EMPARN. Documents 7)

GOMES, P., 1961: "A algarobeira," Rio de Janeiro, Ministério da Agricultura, Serviço de Informação Agrícola, 49 p. (Series SIA, 865)

LIMA, P. C. F., 1982: "Comportamento silvicultural da *Leucaena leucocephala* (LAM) de Wit comparado a *Prosopis juliflora* (Sw) DC e *Eucalyptus alba* Reinw ex Blume em Petrolina-PE, região semi-árida do Brasil," Curitiba, Universidade Federal do Paraná, 96 p. (M. Sc. Thesis)

LIMA, P. C. F., 1985: "Tree productivity in the semiarid zone of Brazil," Petrolina-PE, EMBRAPA-CPATSA, 15 p. (Paper presented at the Symposium *Establishment and Productivity of Tree Plantings in Semiarid Regions,* Kingsville, USA).

MORAES, G. J.; RAMALHO, F. S.; SOUZA, S. M. de; SILVA, C. M. M. de S. and LIMA, P. C. F., 1981: "Insetos associados a sementes de forrageiras e essencias florestais no tropico semi-árido do Brasil," Petrolina, EMBRAPA-CPATSA, 2 p.,(EMBRAPA-CPATSA, Research in progress, 11).

NASCIMENTO, C. E. de S.; LIMA, P. C. F. and SILVA, H. D. da, 1985: "Influencia do número de gemas no enraizamento de estacas da algaroba," Petrolina, EMBRAPA-CPATSA, 3 p., (EMBRAPA-CPATSA. Research in progress, 39).

RIBASKI, J., 1986: "Estudo do estabelecimento da algaroba plantada em área cultivada com capim buffel," Petrolina, EMBRAPA-CPATSA, 4 p., (EMBRAPA-CPATSA, Research in progress, 47).

RIBASKI, J., 1986: "Sobrevivencia e desenvolvimento da algaroba, plantada com e sem proteção, em área de capim buffel sob pastejo," Petrolina, EMBRAPA-CPATSA, 4 p., (EMBRAPA-CPATSA, Research in progress, 48).

SANTOS, J. M. dos, and SILVA, H. D. da, 1983: "Susceptibilidade de espécies florestais á *Meloidogyne javanica* na região semi-arida do Nordeste," In: *Simpósio IUFRO em melhoramento genético e produtividade de espécies florestais de rapido crescimento,* Auguas de São Pedro, Silvicultura, 8 (3): 379-9.

SILVA, H. D. da, and LIMA, P. C. F., 1985: "Tipos de maceta para la producción de plantas de algarroba," In: *Proceedings,* Encuentro Regional de CIID, América Latina y el Caribe, 2, Santiago, Chile, "Forestación en zonas aridas y semi-áridas", Santiago, CIID/INFOR, pp. 97-104.

SILVA, A. de S. and PORTO, E. R., 1982: "Utilização e conservação dos recursos hídricos em áreas rurais do trópico semi-árido do Brasil; tecnologias de baixo custo," Petrolina-PE, EMBRAPA-CPATSA, 128 p., illust., (EMBRAPA-CPATSA, Documentos, 14).

SOUZA, S.M. de; LIMA, P. C. F. and ARAUJO, M. de S., 1983: "Sementes de algaroba: métodos e custos de beneficiamento," R. Bras. Sem., Brasília, 5 (3): 51-61.

SOUZA, S. M. de, and NASCIMENTO, C. E. de E., 1984: "Propagação vegetativa de algaroba através de estaquia," Petrolina, EMBRAPA-CPATSA, 3 p., (EMBRAPA-CPATSA, Research in progress, 27).