The ISSA System for Production of Container Tree Seedlings

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A new system for producing container seedlings has been developed specifically to produce planting material suitable for degraded soils in semi-arid regions, like most of the afforestation areas in Mediterranean countries. The ISSA system (named for the Istituto Sperimentale per la Selvicoltura, Arezzo) consists of a large-capacity pot (1 liter) and a multipot unit holding 12 pieces. The system was designed to improve the standard quality of nursery stock and to avoid problems of root spiralling typical of seedlings grown in the "phytosack," the most common container in Italian nurseries. Seedlings produced with the ISSA system showed a well-balanced growth ratio (root to aboveground biomass), as well as good structural development of their root systems. The operative use of the ISSA system pointed out the possibilities to improve the mechanization level of present nursery practice. The first results of plantations showed the good development of planted seedlings also in difficult reforestation sites in southern Italy. Tree Planters' Notes 43(4):146-149; 1992.

The production of container-grown seedlings has been continuously increasing since many years (Balmer 1979, Tinus 1983) both in temperate-cold and in hot-arid countries. Improvement and standardization of the nursery stock, extension of the planting season, and mechanization of nursery practices and planting techniques are the general reasons that supported this trend.

In arid regions with a minimum rainfall during the growing season, the use of container-grown seedlings ensures also the reduction of planting failures. In these areas, which include the countries of the Mediterranean Basin, very degraded soils, water stress, and drying of the soil surface are often joint adverse conditions. Container planting creates a microhabitat around the root system, minimizes the external limiting factors, and assists in the establishment of the plant.

Production of container-grown seedlings began in Italy (Magini 1979) for reforestation with pine and oak species (typical tap-rooted trees) in difficult sites where bareroot planting and broadcast seeding had given a bad field performance. This practice was then extended to other species and sites.

The container most commonly used in Mediterranean countries has been, and still is, the "phytosack" a round, nondegradable, polyethylene sack, 50-µm thick, provided with a variable number of small holes on its walls and bottom. Its capacity is variable, but usually about 1 liter (61.02 cubic inches). As a rule, the seedling is pulled out of the sack before planting.

Because this container is cheap and easy to use, it is still largely utilized in nursery practice. However, the phytosack has limited the possibilities of nursery mechanization. Most importantly, the root systems of tap-rooted species spiral and develop a characteristic deformation that becomes irreversible with the lignification of plant tissues (figure 1).

Figure 1—*Irreversible root strangling in a stone pine plant grown in a phytosack, several years after outplanting.*

Negative results of root system deformation appear a few years after planting, when the plant reduces its growth rate and shows stability problems (Ben Salem 1971, Franclet 1978, Owston and Seidel 1978, Riedacker 1976).

This question, common to all container seedlings, has been discussed for a long time and different solutions have been suggested. A wide series of containers different in shape, capacity, and materials, from containers with rigid walls and punched bottoms, to those degradable or bottomless, to containers without walls nor bottom or container-growth mediums, were developed.

Most of them were, however, from North America or northern Europe, which made it difficult to use them under different environmental conditions, such as those found in Mediterranean countries and in hot-arid regions in general. The small capacity of the proposed containers, and the complexity of the nursery techniques were the main elements of the poor adaptability to our requirements and to our current organization.

The purpose of our research project was to develop a containerized system able to

- ??Replace the phytosack and improve seedlings quality, that is, root structure and development.
- ??Maintain the operational simplicity of the previous system.
- ??Increase the nurseries' mechanization level compatible with afforestation projects divided on quite small areas in prevailing mountain sites.

Materials and Methods

Our research was developed according to the following steps:

- ??Review of the different container systems already in use to identify the optimal technical features according to our purpose.
- ??Planning and manufacturing of a prototype pot.
- ??Experimental nursery trials and choice of the final version.
- ??Manufacturing of a multipot unit.

Technical features. *Capacity.* Survival and growth of seedlings on semi-arid afforestation sites requires seedlings of an adequate size and with a good ratio of root to above ground biomass (Cousin and Lanier 1976). Seedlings need to be capable of growing rapidly above competing natural grasses and shrubs. These features directed our choice towards a container of 1-liter capacity. This was also the size of the long-used phytosack in Mediterranean countries.

Shape. Among the possible different combinations of cross (circular and polyhedric) and longitudinal (cylindrical and conical) section, the circular truncated-conical one, with a high diameter to height ratio, was chosen (Marien and Drouin 1977, Riedacker 1978). The sloping walls make easy the descent of root tips towards the bottom of the container, reducing lateral spiraling. Ribs on the inner walls prevent root spiraling. The tray system holds multiple pots and enables efficient stacking.

Bottom. The large capacity and the need for simple growth media requires that the container have a bottom. The bottom is provided with guides and openings so that the root tips are guided outside. Air pruning then causes the roots to stop growth and stimulates the proliferation of secondary roots inside the container.

Manufacturing material. The container was manufactured in polypropylene. It has rigid walls and can be reused for several nursery cycles.

Testing the prototype. A prototype manufactured in accordance with these characteristics was tested during 4 nursery cycles with the following species: stone pine *(Pinus pinea* L.), European turkey oak *(Quercus cerris* L.), evergreen oak *(Quercus ilex* L.), and cork oak *(Quercus suber* L.). A standard growth medium (50% leaf mould, 30% peat, 20% inert material + Osmocote 8/9-4/5 months as a chemical fertilizer), was used. A morphometric description of seedlings and a detailed classification of deformations still existing at different branching levels in the root system at the end of each yearly cultivation cycle were made.

A series of modifications was carried out during the experimental stage. On the whole, 4 different versions of the pot were manufactured; the bottom was the most-modified detail. The achievement of root systems of the required quality (absence of lateral and lower spiraling and good structure) and development of root biomass well-balanced with the aerial part of the seedling concluded the experimental tests (figure 2).

The final version-named ISSA-pot (figure 3)has a circular-conical section; ribs 2 mm thick (.079 in.) are inserted along the inner side for the overall length of the walls. The convex, conical bottom is provided with V-shaped wedges leading to the rectangular drainage holes along the perimeter of the bottom. The open area is about 9% of the whole bottom area.

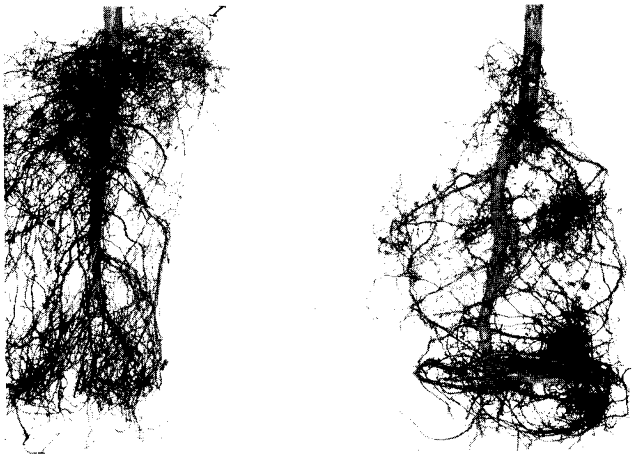

Figure 2—*Comparison of root systems of 1-year-old seedlings grown in an ISSA pot* **(left)** *and phytosack* **(right).**

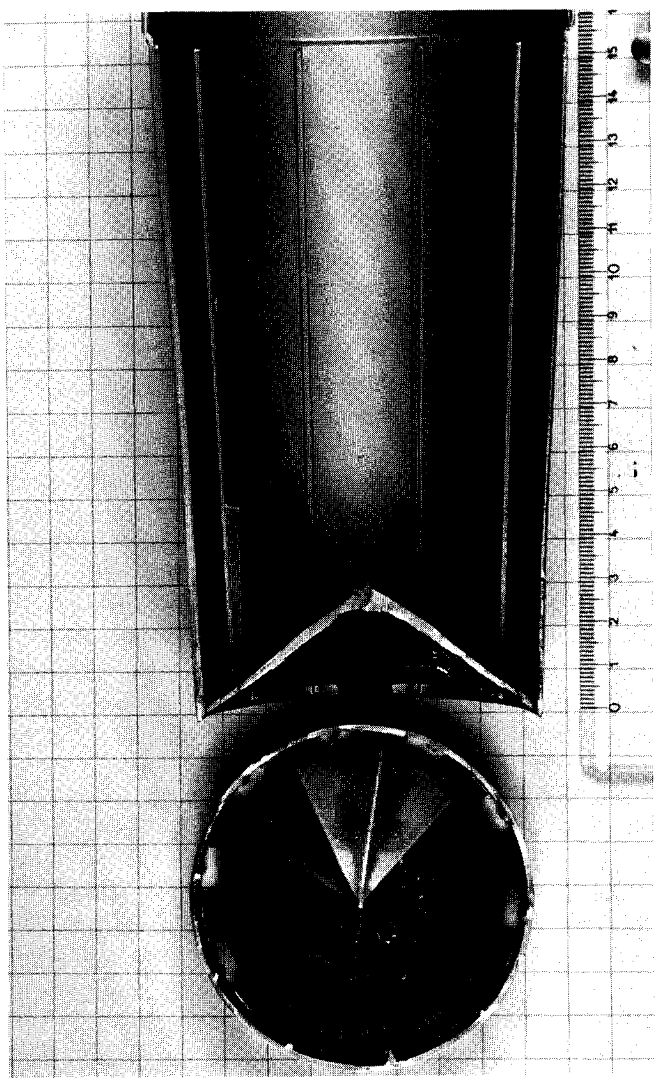

Figure 3—*Inside view of the ISSA pot showing walls and bottom.*

The pot has the following specifications: capacity, 930 cm^3 (56.75 cubic inches); weight, 67 g (2.36 ounces avoir.); height, 17 cm (6.69 inches); and diameter at the top, 9.7 cm (3.82 inches).

The multipot. The last stage of the project consisted of producing a multipot unit that enables nurseries to achieve a higher level of mechanization in filling up, sowing, and handling all the way to the planting site. The multipot unit had several requirements:

?? to hold a number of pots but still be an overall size and total weight that can be handled easily at planting, even on mountain sites.
?? to allow the overlapping of empty and full units.
?? to hold the bottom of the pots a few centimeters raised above the ground level to get the air pruning effect.

The box, named ISSA-box, is manufactured in Moplen, and measures 430 *x* 330 X 165 mm (16.9 *x* 13 *x* 6.5 inches). Its total weight is 720 g (25.39 ounces avoir.) and it holds 12 pots.

The modular structure of the multipot unit (figure 4) was achieved by manufacturing it in two elements, the tray and the frame. The two parts are connectable by pressure and become integral to assure solidity and resistance. The insertion of a frame allows full boxes to be stacked on top of each other.

Preliminary outplantings of seedlings grown in the ISSA container are very promising and will be the subject of a subsequent paper.

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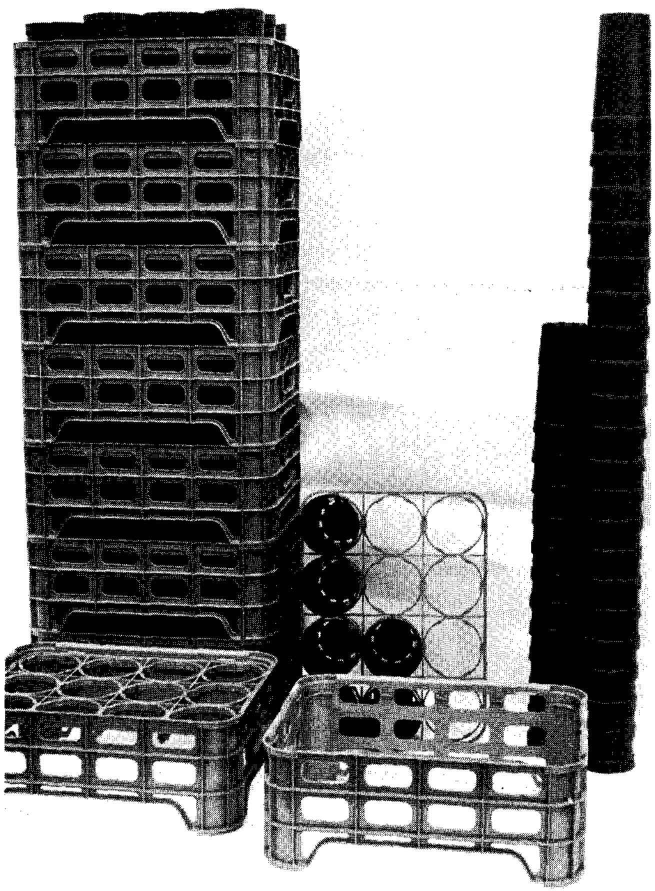

Figure 4—*The ISSA system.*

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