

Spot Sowing of Mediterranean Pines Under Shelter¹

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Direct seeding under inverted plastic cups on raised, prepared spots was demonstrated to be a successful and cost-effective forestation method in Israel. Tests were conducted with three pine species on two common soil types. The procedures may be useful in Mediterranean climates elsewhere.

Direct seeding of conifers as a cheap forestation technique has long attracted foresters (1, 2, 3, 10). However, most forestation work is presently done by planting naked-rooted or balled stock. Planting is preferred to sowing because biotic factors and vegetative competition have less effect on seedling survival. It is, therefore, assumed to result in more uniform survival and growth. One of the rare exceptions in the Mediterranean basin is Cyprus, where direct seeding is the main forestation technique (8).

In the early 1970's, a new approach to direct seeding was developed in Finland (6, 7) and Sweden (4, 9). The new method consists of spot sowing under the shelter of plastic cups. Trials along

this line have been carried out elsewhere (5).

Spot sowing success is strongly affected by climatic conditions. Thus, Mediterranean conditions require certain modifications of the original Scandinavian technique. In northern latitudes, growth occurs mainly during summer, but in the Mediterranean region much growth can occur during the mild winter and spring when water is most available. Therefore, while spot sowing under shelter is done in spring (May) in Finland (7), in Israel the suitable season is early winter (December to January). In Finland, the plastic cups are left in the field to disintegrate. This takes at least two growing seasons. In Israel removal of the cups is necessary after 2 to 4 months to avoid overheating and excess drying of

seedlings during "sharav" conditions (hot easterly winds), which occur during March and April.

Materials and Methods

Experiments were carried out at four plots representing two types of Mediterranean climate—the accentuated thermomediterranean Galilee mountains and the xerothermomediterranean Judean foothills (11)—and two soil types—terra rossa and rendzina (table 1 and fig. 1).

The soil was prepared by destroying the natural vegetation by burning or plowing, loosening the soil to a depth of 20 to 30 centimeters by plowing or by pick-axe and hoe, and applying herbicide (Simanex 50 W.P., Agan Ltd., Ashdod, Israel). At the time of sowing

Table 1.—Site conditions of the experimental plots

| Site description | Galilee site | | Judea site | |
|------------------------|---------------------|------------------|--------------------|------------------|
| | Brown rendzina soil | Terra rossa soil | Pale rendzina soil | Terra rossa soil |
| Longitude E. | 35°26' | 35°27' | 34°59' | 35°02' |
| Latitude N. | 33°03' | 33°04' | 31°49' | 31°49' |
| Elevation (m) | 725 | 675 | 260 | 475 |
| Exposure | Level | South | South | Level |
| Rainfall (mm) | | | | |
| Mean annual | 646 | 702 | 479 | 582 |
| 1980-81 | 994 | 934 | 491 | 591 |
| 1981-82 | — ¹ | 560 | 465 | 545 |
| Daily temperature (°C) | | | | |
| Mean maximum | | | | |
| Warmest month | | 27.7 | | 32.4 |
| Mean minimum | | | | |
| Coldest month | | 4.5 | | 7.7 |

¹—data not available or not applicable.

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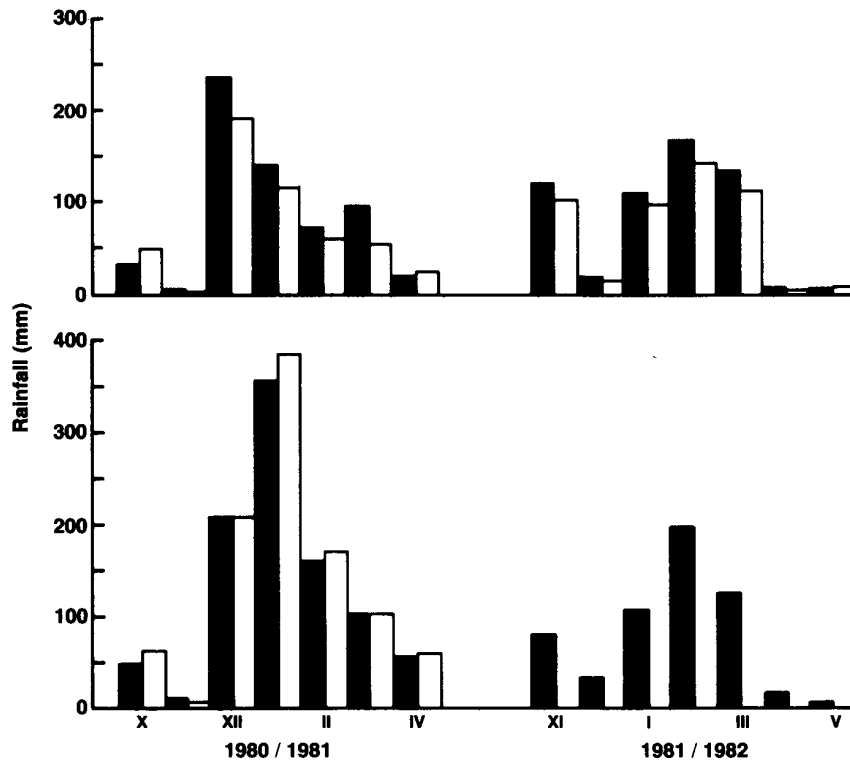


Figure 1.—Monthly rainfall amounts (mm) in experimental plots in 1980-81 and 1981-82. Top—Judean foothills (black = terra rossa, Bet Meir; white = pale rendzina, Har'el); bottom—Galilee (black = terra rossa, Yir'on; white = brown rendzina, Bar'am). Data from Bar'am for 1981-82 are not available. (Roman numerals denote month.)

the upper 2 to 3 centimeters of soil were removed to avoid herbicide damage to germinating seedlings.

Sowing was done in the Judean foothills from the end of December 1980 to the beginning of January 1981 and in Galilee at the beginning of February 1981. Three to four weeks before sowing, seeds of three species of pine were soaked in water for 24 hours; floating seeds were removed and the

rest were placed in moist vermiculite for germination. At the time of emergence of the rootlet, the seeds were sown in the field at a depth of 2 to 3 centimeters on so-called "molehills" (fig. 2A), according to current practice. On each molehill (spot), three *Pinus pinea* L. seeds or five *P. brutia* Ten. or *P. halepensis* Mill. seeds were sown, covered with soil, and sheltered by a plastic cup (current price: \$14 per 1,000).

The transparent cup (light transmission 85 to 90 percent) is pierced at its base to form a 1.0- to 1.5-centimeter-wide hole (fig. 2B). The inverted cup is pushed into the soil to a depth of 1.0 to 1.5 centimeters, with its 2-millimeter rim strengthening its hold on the soil. If the surface soil is dry, the seed spot is watered by spraying for a few seconds. Ecogan Gammacide 7 dust (Makhteshim Ltd., Be'er Sheva, Israel) was applied to prevent damage by seed-collecting ants. In each plot, sowing was replicated 5 to 10 times with a total of 100 to 189 sown spots per species. Two to three months after sowing, in the spring, but before the occurrence of "sharav" conditions, the plastic cups were carefully removed and the seedlings thinned to two or three per spot. During the first and second springs, soil around the seedlings was hoed. Seedlings will be thinned to one per spot 2 to 4 years after sowing, depending upon growth rate.

Results

Results of the trials are summarized in figures 3 and 4. Survival of the seedlings in the four plots was quite high (70 to 90 percent). Differences in growth of *P. halepensis* (Aleppo pine-ed.) between the two soil types were pronounced, but not so in *P. brutia* (Calabrian pine-ed.). Survival of *P. pinea* (Italian stone pine-ed.) on pale rendzina was lower than in other plots; this was apparently

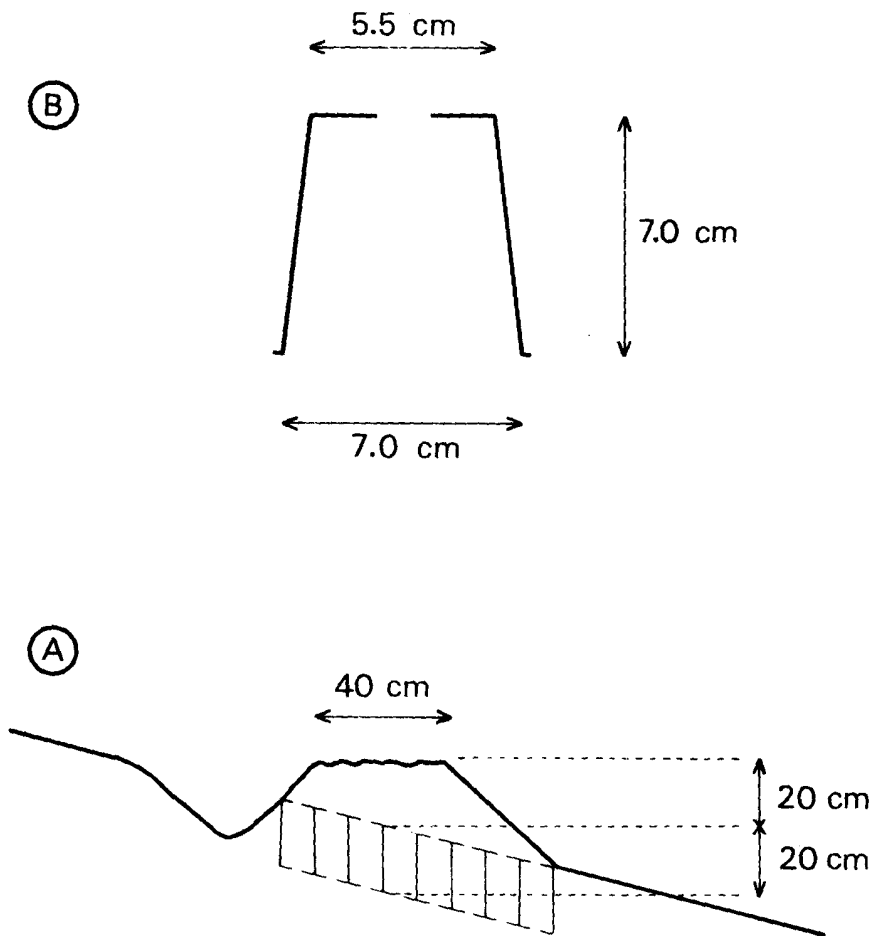


Figure 2.—Cross sections of (A) seedling spot ("molehill") and (B) plastic shelter (cup). Loosened soil beneath the artificially raised "molehill" is indicated by vertical bars.

because some of the cups were not placed exactly on the seed spots, thereby reducing the survival rate during the first winter.

Discussion and Conclusions

The current method of forestation in hilly areas of Israel—hand-planting of naked-rooted, 13- to

15-month-old nursery stock—is an efficient and proven technique. However, it is quite expensive, and seedlings grown in containers (tins) are sometimes crooked at the root collar or have an inadequate top-root ratio. Still, forestation involving large amounts of manual labor may soon come to a standstill because workers are be-

coming scarce and more expensive. Thus, there is a need to mechanize forestry operations. Current expenses for forestation (during the first 2 years) in hilly areas are about \$2,090 per hectare; personnel costs account for two-thirds and materials (mainly seedlings at 2,500 per hectare) for one-third of the expenses. Comparison with Cyprus (8) shows that forestation there is much less expensive (planting—\$900/ha and direct seeding—\$450/ha). Two-thirds of the area forested annually is seeded and one-third is planted.

In conclusion, in hills in the Mediterranean region with a mean annual rainfall of more than 400 millimeters (figs. 3 and 4), under-shelter spot sowing of pine provides 70- to 90-percent survival rates. This technique is suitable for the main forest soils in Israel—terra rossa and rendzina. The technique has both advantages and disadvantages in comparison with the current method of planting naked-rooted stock, but the advantages markedly exceed the disadvantages. Advantages are: (1) Raising the nursery stock for 13 to 15 months is dispensed with; (2) The "shock" caused by the transfer of the seedlings from the nursery to the field and distortion of the root system is avoided; (3) The roots of spot-sown seedlings are better developed than those of planted stock (5); (4) There is no need to plan forestation 1 ½ years ahead, as only a few weeks are required; (5) Since several seedlings

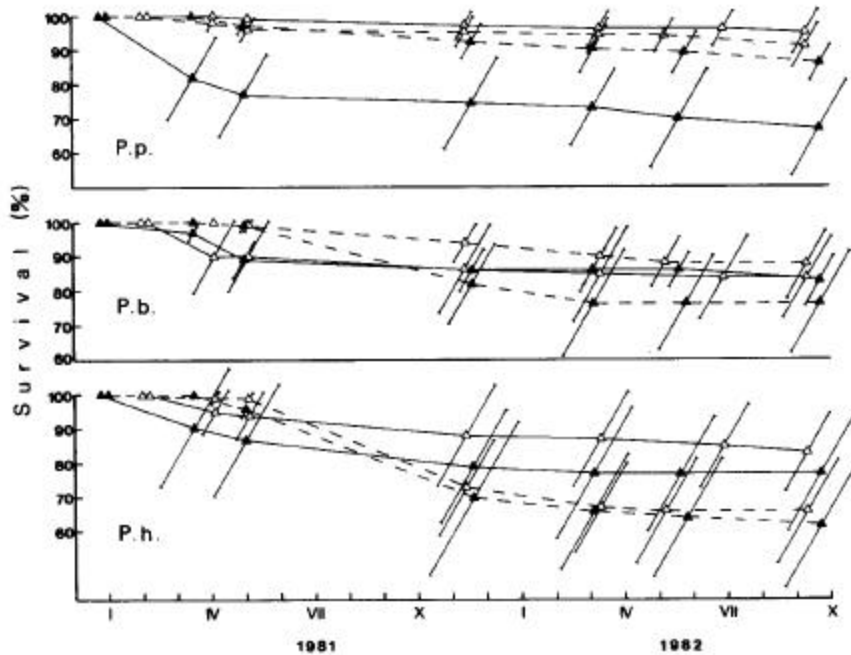


Figure 3.—Survival (%) of seedlings from direct seeding. *P.b.* = *P. halepensis*; *P.p.* = *P. pinea*. ? = Judean foothills; ? = Galilee; broken line = terra rossa; solid line = rendzina.

will germinate in each spot, competition during the first years will hasten their height growth and improve their form (thus, after 2 years, the height of *P. halepensis* from spot sowing nearly equaled that of nursery-raised stock when sowing and planting in the field were done at the same time); (6) Direct seeding is more suitable for mechanization than planting; (7) The use of a sowing dibble developed in Finland (Tyevaline Oy, Espoo) dispenses with the need for the worker to stoop down during seeding; and (8) Spot sowing under shelter will save about 50 percent

of the costs of the current forestation technique.

On the other hand, seedlings in the first 2 years are most often smaller than planted stock; thus, they may need additional protection and cultivation, as well as increased supervision of personnel at all stages of the work.

This application of spot sowing under shelter seems to be suitable for pine forestation under Mediterranean climates in Israel as well as in California, while the original Scandinavian technique applies to cooler climates.

Summary

Field trials were carried out to compare growth and survival of three species of pines in reforestation of Mediterranean hilly areas by an improved technique of direct seeding. The use of spot sowing under plastic shelter is recommended as a reliable forestation technique. The technique could be suitable for forestation of similar areas in the United States.

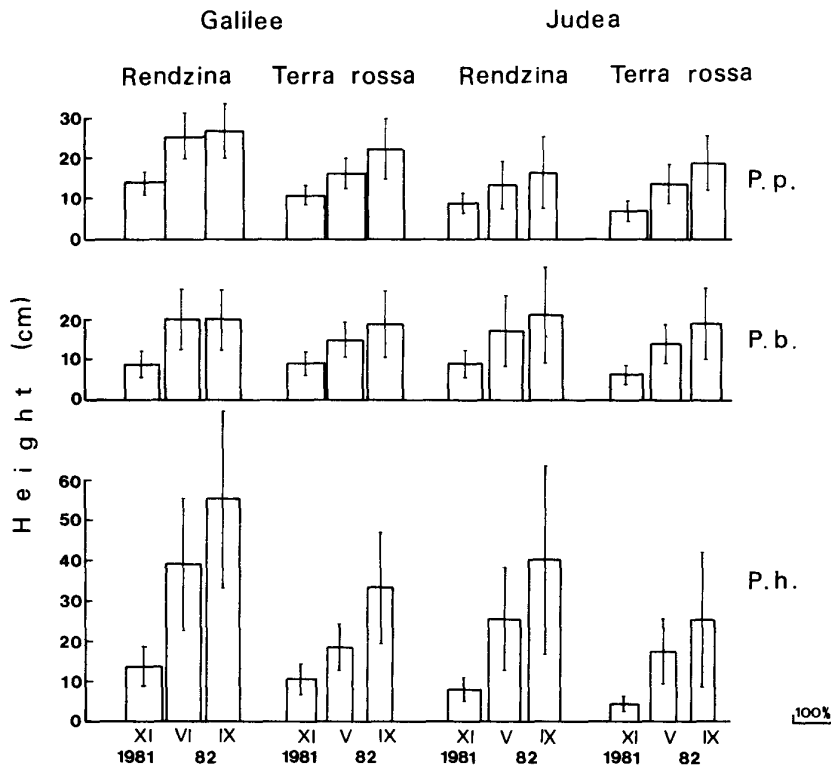


Figure 4.—Height (cm) of seedlings from direct seeding on three dates in 1981 and 1982. P.b. = *Pinus brutia*; P.h. = *P. halepensis*; P.p. = *P. pinea*. Bar width indicates average survival percentage in the treatment at measurement time. The scale to the right indicates 100-percent survival.

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