FACTORS INFLUENCING DEPTH OF SEEDING [1]

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Introduction

The success of direct seeding of woody plants along roadsides depends, in large measure, on the germinability of seed and environmental conditions in which the seed is planted. Knowledge of seed germinability and the range of optimum environmental conditions for seed germination and emergence will assist in selecting species and times of planting for specific conditions that may be encountered.

Moisture, temperature, light, and oxygen influence germination. Seed size, as well as the genetic makeup of seeds, also affect germination (1). When each environmental factor affecting germination is within a favorable range, a viable seed will germinate providing no seed dormancy is present (4). The optimum seeding depth is the one at which each of these factors is favorable for germination and emergence.

This paper discusses the influence of soil temperature, soil texture, and depth of seed placement on the emergence of three woody-plant species having different sized seeds. How seed size, soil temperature, and soil texture affected depth of seeding were evaluated.

1 The research reported is funded by the Calif. Div. of Highways HPR-1 (4) F 0502, RTA 13945-13069 UCD.

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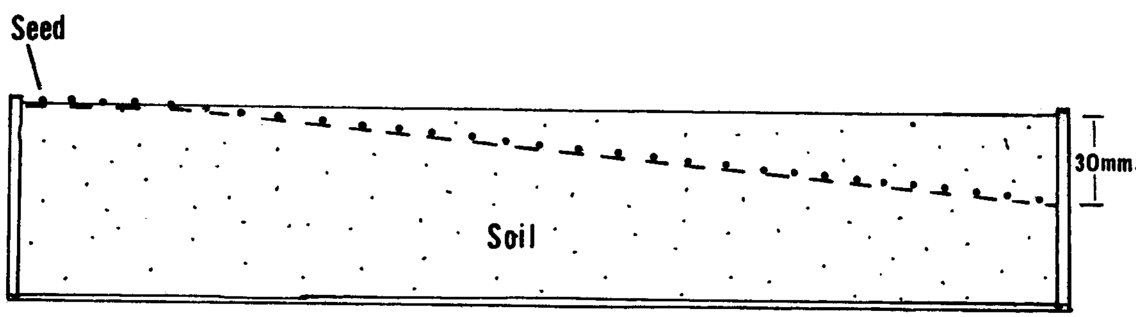
Method

Three species representative of a range of seed sizes were planted at various depths in fine- (clay) , medium- (yolo loam), and coarse-(washed river sand) textured soils in 3 inch-deep flats. The sizes were small-0.21 x 0.23 x 1.10 mm *(Eucalyptus viminalis,* 500,000 seeds per 454 grams) ; medium1.9 x 2.4 x 3.5 mm *(Prosopis tamarugo,* 20,000 seeds per 454 grams) ; and large-2.6 x 4.8 x 8.5 mm *(Pinus radiata,* 13,000 seeds per 454 grams). The quantities of seed for the respective species were 7,000, 200 and 120 seeds per flat. The seeds of each species were evenly distributed in four rows in which the depth of the planted seed varied from the surface of the soil to 30 millimeters (fig. 1) . The rows were divided into seven sections according to depth with approximately the same number of seeds per section for each species: *Eucalyptus*250 seeds, *Prosopis-7* seeds, and *Pinus-4* seeds per section.

The seeded flats were placed in a growth cham ber in which temperature, light, and moisture were controlled. Three flats (replicates) of each of the three soils were placed on a bench without heat and three flats placed on a bench with bottom heat. Heat was provided by electric coils in a moist bed of sand. The soils were heated from 1 to 6 p.m. daily. The heated soil reached temperatures of 80-



Depth (mm)	0	1-5	6-10	11-15	16-20	21-25	26-30
Section	1	2	3	4	5	6	7

Figure 1.—Cross-section view of a seeded flat.

85° F for about 3 hours each day. The soil temperature of the nonheated treatment was essentially the air temperature of the growth chamber that fluctuated from 65-75° F during a 24-hour period. Lights were on from 6 a.m. to 8 p.m. The light intensity at the surface of the flats was 1,800 to 1,900 foot candles provided by fluorescent lights supplemented by incandescent lights.

The soils in the flats were maintained at approximately field capacity. Field capacity was determined by taking one-half the percent moisture of a saturated paste for each particular soil. One-half saturation percentage is approximately field capacity (5). Soils in the flats were wetted to field capacity and maintained at this content by weighing and adding water every 2 days.

General Observations

The clay soil was difficult to water uniformly because of cracking. Even with frequent watering, the clay soil cracked. It cracked more in the heated treatment than in the nonheated. The *Eucalyptus* seeds on the surface of the clay soil tended to wash away. These problems were not evident with the loam and sand soils.

The flats were observed daily after the first signs of germination. *Prosopis* seedlings began to emerge in 4 days, *Eucalyptus* in 7, and *Pinus* in 11. The number of seedlings that emerged in each section was recorded. All seedlings were left in place until the termination of the experiment, which lasted 4 weeks.

Results

Optimum seeding depth, the depth at which the greatest number of seedlings emerged, varied with species, soil temperature, and soil texture. Increase in seed size of species and soil temperature and coarseness in soil significantly extended the range of seeding depth (fig. 2).

Influence of seed size of three species on seeding depth.-The optimum seeding depth was greater for the larger size seeds of *Prosopis* and *Pinus* than for *Eucalyptus.* Differences in optimum seeding depth between *Pinus* and *Prosopis* were small (fig. 2) . In the field, seeding the latter two species 15 to 18 millimeters deep probably would not be critical for most soils. However, seeding the fine-seeded *Eucalyptus* at that depth would be a mistake. For example, the *Eucalyptus* seeds emerged poorly when planted 10 millimeters or about two times their optimum seeding depth. But the *Prosopis* and *Pinus* seeds emerged with fair results at 10 to 20 millimeters or two to three times their optimum seeding depth, which would be approximately two to four times the optimum seeding depth of *Eucalyptus,* (fig. 2).

Influence of soil temperature on seeding depth. The optimum seeding depth was almost identical for all nonheated treatments except for *Eucalyptus* in clay soil, and *Pinus* in loam and sand soils. These exceptions were only 5 millimeters deeper than the other treatments. On the other hand, the optimum seeding depth of the heated soils varied considerably (fig. 2). In six cases, the optimum seeding depth was increased two to three times with heat *(Eucalyptus* in clay, *Prosopis* in clay and sand, *Pinus* in all three soils) (fig. 2). In three cases, no difference in optimum seeding depth was observed between the heated and nonheated treatments *(Eucalyptus* in loam and sand, *Prosopis* in loam) (fig. 2).

Higher soil temperature extended the range of seeding depth over that of the nonheated treatments except *Pinus* in sand in which emergence was high at seeding depths to 30 millimeters in both heat and nonheat treatments (fig. 2). Extending the range of seeding depth can be one of the major advantages in planting in warm weather if moisture is available.

Influence of soil texture on seeding depth.-Optimum seeding depth increased from fine to coarse soil texture. This was most apparent with *Pinus* and *Prosopis* seeds from loam to sand in the heated treatments (fig. 2). The optimum seeding depth of *Eucalyptus* was not affected by texture, but the range of seeding depth was extended as texture became coarser. The greatest seeding depth in the clay soil was deeper than the loam soil with all three species. However, this comparison may not be true if the clay did not crack. The cracks in the clay soil allowed germination to occur at deeper depths where seeds were exposed and aeration improved.

Influence of soil temperature and texture on total emergence.-The higher soil temperature and

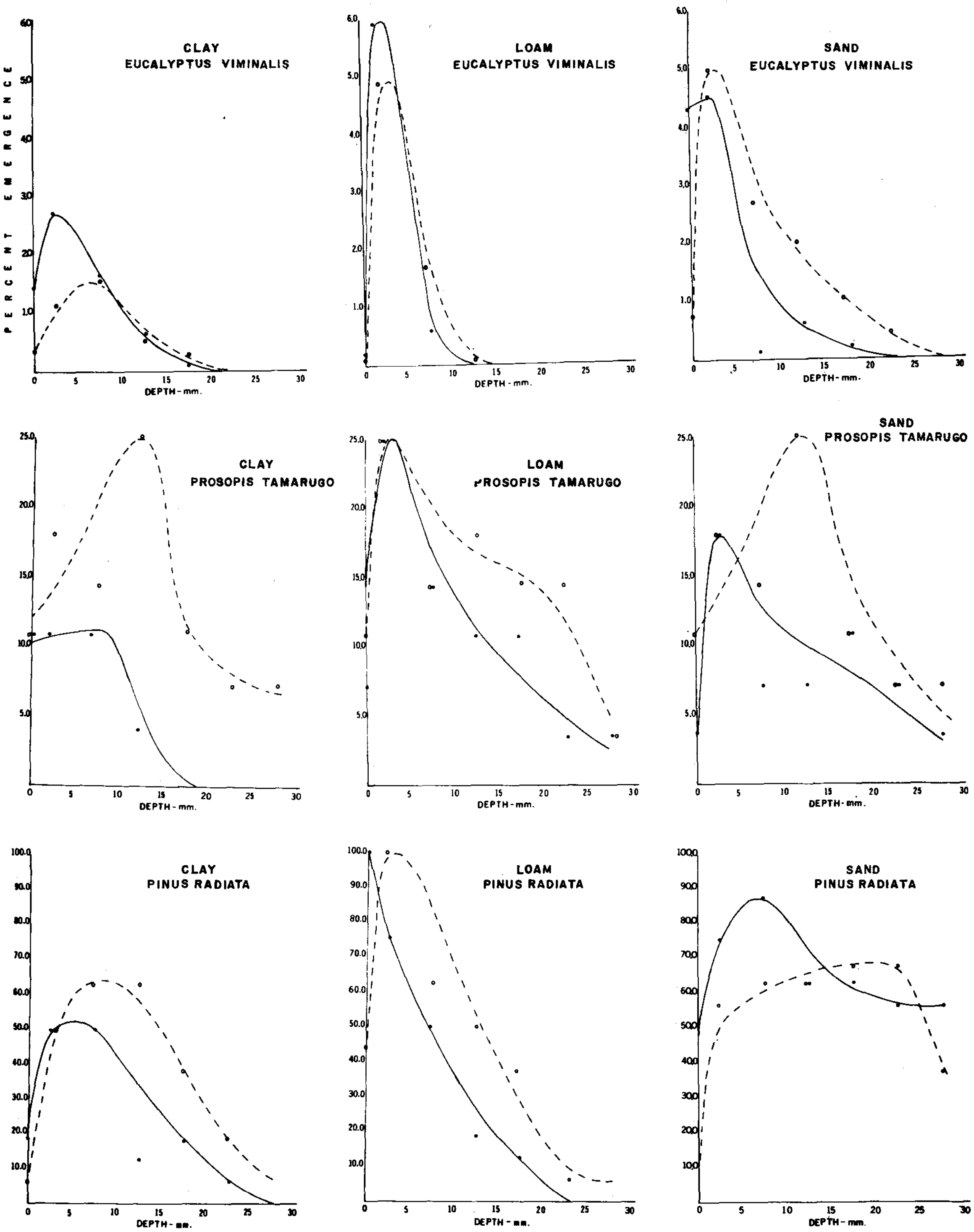


Figure 2.—Emergence of seedlings at various depths of *Eucalyptus viminalis, Prosopis tamarugo,* and *Pinus radiata* in clay, loam, and sand for two sets of soil temperatures (broken-line curve: 65–85°F, solid-line curve: 65–75°F.)

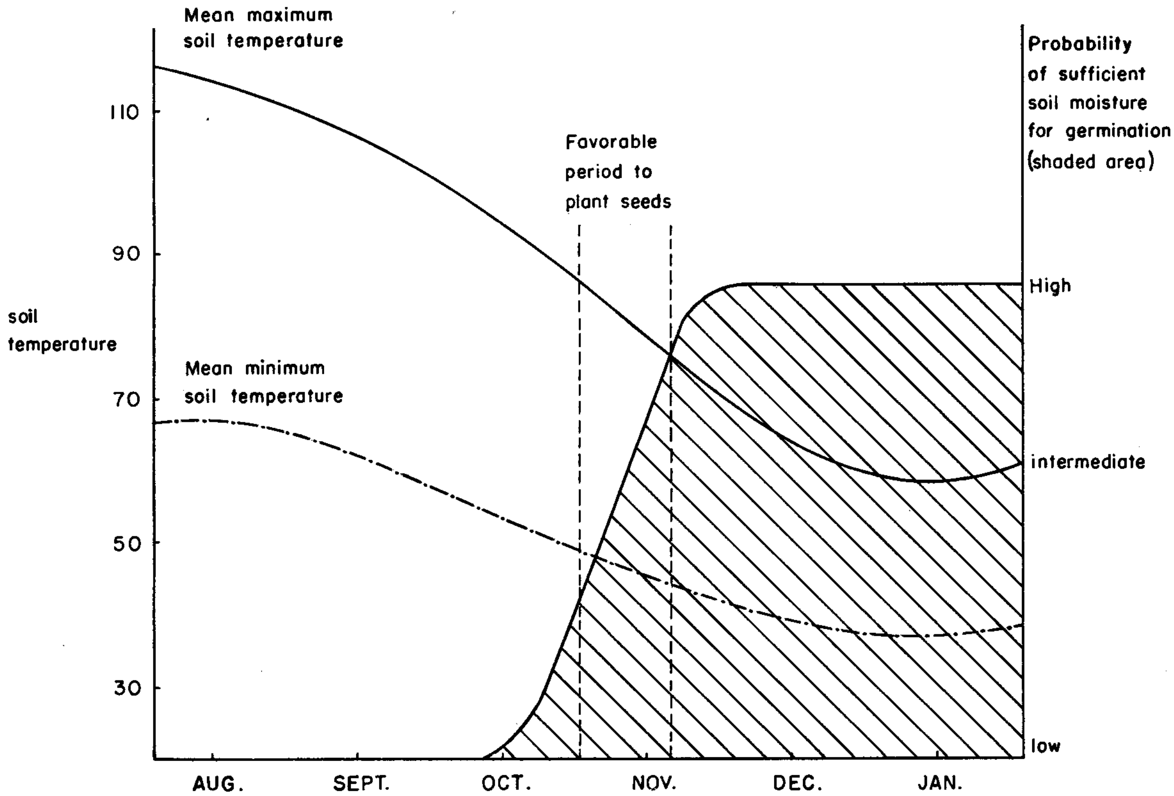


Figure 3.-Relates typical field conditions to information acquired from a seeding depth curve of *Pin us radiata* in clay soil (fig. 2) to determine when seeds should be planted.

coarser soil texture increased total emergence in most cases (fig. 2). But total emergence was lower *for Eucalyptus* in clay with the higher temperature. The probable reason, mentioned earlier, for the lower emergence was the problem of washing away some of the fine seeds and the desiccation of others due to the cracking of the clay.

Although the coarser sand soil showed good results in total emergence, it probably would not be as satisfactory under field conditions. Unless adequate moisture is available, sand would tend to dry rapidly. A finer textured soil would retain moisture for a longer period of time during which germination could occur.

Discussion and Conclusion

A knowledge of the optimum seeding depth of a species for a particular soil temperature and soil texture can be useful in determining a favorable time to plant seeds. By knowing the soil temperature, the texture of the soil, and the soil moisture of a seeding depth curve, one can relate this information to typical conditions. The time to plant seeds would be that period just before soil moisture and soil temperatures in the field best approximate those found to be satisfactory under the test conditions for the particular species concerned (fig. 3). [3]

[3] The seeding depth curves (fig. 2) suggest higher temperatures of 65-85° F. are more favorable than 65° F. and lower for germination and that the optimum depth to plant seeds be 12.5 nim. when sufficient moisture is available.

With time, temperature becomes limiting and moisture not so limiting. To have the seeds in the soil at the beginning of the favorable period would probably be more satisfactory to take advantage of the warmer temperatures that are not likely to increase and less hazardous for germination. Planting at a later date for a species that germinates poorly at lower temperatures could he hazardous.

The need for more research on the effects of soil temperature on germination and emergence is apparent. We must find out what the soil temperatures are in different environmental situations, and how seeds are affected by them.

This study showed that seed size of various species, soil temperature, and soil texture are primary considerations for determining the depth seeds should be planted. For maximum success, care must be taken in placing seeds at a proper depth.