— for the help and hospitality which he extended during my visit.

# INFLUENCE OF SEED WEIGHT ON THE EARLY GROWTH OF *QUERCUS SUBER* L. SEEDLINGS

J.L. GARCÍA VALDECANTOS

*Dpto. de Mejora. Servicio de Investigación Agraria de la Comunidad de Madrid. Apartado 8111, Madrid, Spain*

**Abstract.** The relationship between seed weight, time of maturation, and early growth of Quercus suber seedlings have been studied in order to establish their relative importance. The lengths attained by seedlings obtained from seeds harvested in September, November, and January were recorded during their first year of life. The results show that the main factor is harvest time and not seed weight. Therefore, further integrated research must be done, including as great a number of factors as possible.

## REVIEW OF LITERATURE

Different authors, with different viewpoints, have studied the relationship between seed weight and early growth of seedlings, with not always consistent results.

Wrześniewśki, in a series of papers (8,9,10) establishes the differences in the ratio dry matter in the embryo to dry matter in the megagametophyte, its hydration level, and respiration rate, as well as the imbibition process in seeds of *Pinus sylvestris*, belonging to different weight classes. He concludes that medium-sized seeds are the most favourable and that the growth conditions of seedlings are mainly the result of the conditions of seed development in the mother organism.

Larson (4) did not find an actual influence of the seed weight of *Pinus ponderosa* on either the germination rate, the germination percentage, or seedling growth.

Robinson and van Buijtenen (7) consider there is a correlation between seed weight of *Pinus taeda* and certain morphological characteristics which were related to seedling size at 5, 10, and 15 years.

Working on the same species, Dunlap and Barnett (2) showed that there was a strong influence of seed size on early growth.

Likewise, Keiding (3) points out that the height of one-year-old plants of *Tectona grandis* depends on its seed weight.

Belcher, et al. (1) think that the size of the seed does not show a clear influence on the growth of *Pinus caribaea*.

According to Mikkola (5) the main factor is the provenance of *Pinus sylvestris* and *Picea abies* [*P. excelsa*] seeds, the seed weight being of only secondary importance.

Working on *Quercus suber*, Montoya Oliver (6) found better germination and growth in seedlings produced by heavier seeds.

In our research, we tried to evaluate the influence of seed weight and time of harvest on the growth of *Quercus suber* seedlings during their first year. This idea was suggested by the fact that the cork oak produces three distinct crops each year: the heavier acorns, produced by the end of September, the medium-sized ones — in October-November, which constitute the bulk of the crop, and the smaller acorns, which mature in January.

## MATERIALS AND METHODS

The acorns were gathered in September, November, and January at Constantina (Sevilla) Spain.

After discarding any floating acorns, as well as those showing symptoms of disease, or attacks by insects or rodents, three groups of 70 acorns each were formed (Groups 1, 2, and 3).

The respective weights (W) were recorded, and the acorns previously germinated sown in plastic pots in a mixture of peat-sand 2:1 v/v in a controlled environment greenhouse. While the experiment proceeded, the number of acorns in group 3 was reduced to 51 due to an attack by mice.

The heights of the seedlings were recorded 3, 6, 9, and 12 months after planting, $L_1$, $L_2$, $L_3$, and $L_4$, respectively.

All data were submitted to a covariance analysis and to a mean comparison by means of Duncan's multiple range test.

## RESULTS

Table 1 shows the average values of seed weights and heights of seedlings for the three groups. The plants growing from medium-sized and small seeds are the ones which achieve better lengths, the differences being consistent through the whole period. It should be pointed out that the weight difference between the medium-sized and small seeds is greater than the difference between the large and the medium-sized seeds.

In Table 2 the analysis of covariance of the data is given. The statistical significance of seed weight and time of harvest are easily inferred from the values of the tail probability and the regression coefficients.

**Table 1.** Average values of seed weight (W) and seedling length (L).

| | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| W | 8.06 gr | 7.75 gr | 6.74 gr |
| $L_1$ | 66.96 mm | 163.07 mm | 212.75 mm |
| $L_2$ | 93.90 mm | 306.43 mm | 215.78 mm |
| $L_3$ | 138.11 mm | 308.00 mm | 286.17 mm |
| $L_4$ | 166.61 mm | 333.86 mm | 305.00 mm |

$L_1$, $L_2$, $L_3$, $L_4$ - 3, 6, 9, and 12 months, respectively, after planting.

**Table 2.** Analysis of covariance.

| Dependent variable | Source | Sum of squares | Degrees of freedom | Mean square | F | Tail prob. | Regression coefficients |
|---|---|---|---|---|---|---|---|
| | Time | 847424.06 | 2 | 423712.03 | 73.40 | 0.00 | |
| $L_1$ | Weight | 280500.57 | 1 | 280500.57 | 48.59 | 0.00 | 18.18 |
| | Error | 1079540.63 | 187 | 5772.94 | | | |
| | Time | 1743704.22 | 2 | 871852.11 | 84.47 | 0.00 | |
| $L_2$ | Weight | 487480.97 | 1 | 487480.97 | 47.23 | 0.00 | 23.97 |
| | Error | 1930187.09 | 187 | 10321.86 | | | |
| | Time | 1432038.26 | 2 | 716019.13 | 45.69 | 0.00 | |
| $L_3$ | Weight | 726652.46 | 1 | 726652.46 | 46.37 | 0.00 | 29.27 |
| | Error | 2930236.03 | 187 | 15669.71 | | | |
| | Time | 1369944.10 | 2 | 684972.05 | 36.92 | 0.00 | |
| $L_4$ | Weight | 837774.77 | 1 | 837774.77 | 45.16 | 0.00 | 31.43 |
| | Error | 3469366.39 | 187 | 18552.76 | | | |

However, when we adjust the cell means for the first dependent variable (discarding the influence of seed weight), in Table 3 the trend of Table 1 is stressed. The seedlings developing from the heavier seeds are the slowest growing, contrary to what seemed predictable.

**Table 3.** Adjusted cell means for the first dependent variable (weight).

| *Dependent variable* | *Group 1* | *Group 2* | *Group 3* |
|---|---|---|---|
| $L_1$ | 58.48 mm | 160.20 mm | 228.32 mm |
| $L_2$ | 82.72 | 302.65 | 236.31 |
| $L_3$ | 124.47 | 303.39 | 311.24 |
| $L_4$ | 151.96 | 328.90 | 331.91 |

Finally, in Table 4, the comparison of the adjusted cell means shows no statistical differences between the seedlings belonging to groups 2 and 3 after the sixth month, being in all cases higher than those belonging to group 1.

These results are in accordance with those of Wrześniewski (9,10), according to which medium-sized and small seeds are the better ones.

**Table 4.** Comparison of the adjusted cell means.

| Group | $L_1$ | $L_2$ | $L_3$ | $L_4$ |
|---|---|---|---|---|
| 3 | 228.31 | 236.31 | 311.24 a[1] | 331.90 a[1] |
| 2 | 160.20 | 302.65 | 303.39 a | 328.90 a |
| 1 | 58.48 | 82.72 | 124.47 | 151.96 |

[1] Means in the same column followed by the same letter are not significantly different at the 99 percent probability level.

## DISCUSSION

As stated above, seed weight cannot be regarded as the only or the main factor in every case. Germination and early growth involve a series of complex biological processes that cannot be summed up by saying "the heavier the seed, the better the seedling".

In respect to *Quercus suber*, and for those of the same origin, the quality of the acorns depends much more on their maturation time (physiological conditions of the mother plant) than on their weight.

This could be related to the better hydration level, as well as optimal embryo-megagametophyte ratio recorded for other species.

It is evident that much more research is needed on this subject, by means of integrated experiences on the many factors involved: provenance of the seed, weight, moisture content, and chemical characteristics of the seed coat, the megagametophyte, and the embryo.

**Acknowledgements.** The author wishes to acknowledge Mrs. Rosa Calvo, from the Departamento de Cálculo del INIA (Madrid) for her skillful help in the statistical treatment of data.

## LITERATURE CITED

1. Belcher, E.W., G.N. Leach, and H.H. Gresham. 1984. Sizing slash pine seeds as a nursery procedure. *Tree Planter's Notes*, 35:2,5-10.
2. Dunlap, J.R., and J.P. Barnett. 1983. Influence of seed size on germination and early development of loblolly pine (*Pinus taeda* L.) germinants. *Can. Jour. For. Res.* 13:40-44.
3. Keiding, H. 1985. Teak, *Tectona grandis*, Linn. f., Danida Forest Seed Centre, Seed Leaflet No. 4.
4. Larson, M.M., 1963. Initial root development of ponderosa pine seedlings as related to germination date and size of seed. *Forest Sci.*, 9:4,456-460.
5. Mikkola, J. 1980. The effect of seed size and duration of growth on the height of Scots Pine (*Pinus sylvestris* L.) and Norway Spruce (*Picea abies* (L.) Karst) provenances and progenies at the nursery stage. *Silva fennica* 14:1,84-95.
6. Montoya Oliver, J.M. 1982. Efectos de la profundidad de siembra y del tamaño de la bellota en el repoblado de Quercus suber L. *INIA-Anales Serie Forestal*, 6:9-16.

7. Robinson, J.F., and J.P. van Buijtenen. 1979. Correlation of seed weight and nurserybed traits with 5-, 10-, and 15-year volumes in a Loblolly pine progeny test. *Forest Sci.*, 25:4,591-596.

8. Wrześniewski, W. 1982. Physiology of Scots pine seedlings grown from seed of different weight. I. Differentiation of seed characteristics. *Acta. Physiol. Plant.*, 4:1-2,31-42.

9. Wrześniewski, W., 1982. II. Imbibition, germination, respiration and early growth. *Acta. Physiol. Plant.*, 4:1-2,43-51.

10. Wrześniewski, W., 1982. III. Differentiation of seedling growth during the first growing season. *Acta. Physiol. Plant.*, 4:3-4,139-151.

# PLANT PROPAGATION OBSERVATIONS IN NORTH AMERICA

DANIEL P. ELLIOTT

*E.R. Johnson Nurseries, Limited*
*Whixley, York*

I travelled in North America for a two-month period from June to August, 1985, on a Nuffield Farming Scholarship study of nursery management. I visited nurseries in the Virginia, Maryland, Delaware area, Lake County Ohio, and the West Coast from Los Angeles to Vancouver, B.C., Canada.

Propagation, per se, comprised a relatively minor part of my study, but I did have an opportunity to view a wide range of propagation practices.

Climate is an important consideration in choosing a propagation system and almost, without exception, summer temperatures were higher than in the U.K. Spring frosts finished earlier and autumn frosts were later. Mist, both outside and under protection, was the most widely used system and seemed ideally suited to the climatic conditions.

Mist units were controlled by time clocks with a few exceptions, where solar controls were used. The majority of nozzle types were large and applied high volumes of water by comparison with conventional U.K. types. Rooting composts needed to be more open and less water retentive. Various mixtures of perlite, peat, bark, vermiculite, and sand were used in the rooting composts — with perlite being the most widely used ingredient. Combined with high temperatures, the above factors provided excellent humid rooting conditions.

Cuttings were gathered from growing crops. Early potting, continous liquid feeding, and production in large (1, 3, and 5 gal.) containers necessitated frequent trimming to produce strong, bushy plants, thus yielding large quantities of cutting material. Stock beds were used in some cases, i.e. with culti-