A BETTER ESTIMATION OF NURSERY SURVIVAL USED IN THE SOWING FORMULA

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An annual question to nurserymen is, "How much seed do I sow to produce a certain number of seedlings?" The answer can be determined for each seed lot by a sowing formula similar to that noted by Wakeley (1954), Eide (1962), Wilson (1964), and Stoeckeler and Slabaugh (1965):

$$T = \frac{D}{(S)\ (P)\ (G)\ (N)}$$

Where:

T = Total pounds of seed to sow
D = Number of seedlings desired
S = Seeds per pound
P = Seed purity in percent
G = Seed germination in percent
N = Estimated Nursery Survival in percent

The factors S, P, and G are specific to each particular seed lot and are determined by seed testing. The seedlings desired (D) is chosen as the number needed.

The estimated Nursery Survival (N) has historically been a figure developed by nurserymen for their particular operation. Nursery Survival represents the percent of the viable seeds sown that the nurseryman expects will produce a plantable seedling. This Nursery Survival, however, is an average figure applicable to the nursery as a whole. Seed germination, seeds per pound, and to a lesser extent seed purity are known to vary greatly from lot to lot. It seems logical then that each seed lot may have its own Nursery Survival, perhaps unrelated to the above three sowing components, S, P, and G.

How Nursery Survival (N), which is the least precise component of the sowing formula, can be more accurately determined is the purpose of this paper.

A preliminary study at the L. T. "Mike" Webster Forest Nursery, located near Olympia, Wash., determined the Nursery Survival (N) for a number of lots, based on the number of seedlings produced. The objective was to determine if the Nursery Survival (N) used by the nursery (85 percent), based on data compiled several years previous to the study, was still valid. The results of this investigation demonstrated that Nursery Survival (N) varied greatly from lot to lot and suggested that the Nursery Survival serves only as a guide to total production. Some lots were under the sowing estimate and others had extra trees. The average production was close to that predicted.

Other information suggests use of specific Nursery Survival estimates for each seed lot. Eide (1962) states that although he assumed a Nursery Survival of 70 percent for all Douglas-fir lots sown in 1959, the actual Nursery Survival varied from 33 to 95 percent. His sowing formula varied slightly from that stated here since seed purity was not taken into account. The important point is the difference between the Nursery Survival he used to take losses into account and that which actually occurred. The average losses may have been close to the predicted, but the number of actual surviving trees for individual lots varied greatly.

Long (1962) suggested a single basic factor (N) for all seed lots. However, he then states that this should probably be modified for different species or with evidence of lack of seed vigor or when adverse cultural conditions might be encountered. In addition, he notes that field losses can vary because of soil type, weather, sowing techniques, etc., e.g., the same lots sown in different nurseries or the same nursery have different survival ratios.

The evidence suggests that a more precise sowing will result if a characteristic Nursery Survival is used for each seed lot. Unfortunately this Nursery Survival is not known until the trees are grown. What can be done to improve its estimation prior to sowing?

Nursery Survival (N) can be improved by keeping accurate records and calculating the actual Nursery Survival of seedlings grown in the nursery.

The Nursery Survival for individual lots can be calculated by:

$$N = \frac{D^1}{(T)\ (S)\ (P)\ (G)}$$

Where:

N = percent Nursery Survival

D^1 = The actual number of plantable seedlings lifted and packed from that lot.

(T) (S) (P) (G) = Number of viable seed sown.

Another and perhaps shorter way to determine (N) is shown in figure 1. The regression lines illustrate the relationship between the percent over/ under-run (based on the sowing) and the actual Nursery Survival. The regression coefficient of these lines is identical to the estimated Nursery Survival used in the sowing formula for that particular lot.

The percent over or under-run (o/u run) of seedlings for a lot can be calculated:

$$\text{percent o/u run} = \frac{D^1 - D}{D} \times 100$$

D^1 = Actual seedling production

D = Number of seedlings desired

To locate the regression line for a seedling lot draw a straight line from - 100-percent under-run through the appropriate Nursery Survival on the vertical axis. As an example, the lines in figure 1 represent a Nursery Survival in the sowing formula of 85, 70, and 50 percent. Note that an over-run of more than 100 percent is possible, but that an under-run of less than -100 percent is not.

By using regression lines similar to those in figure 1, directly determining Nursery Survival from the

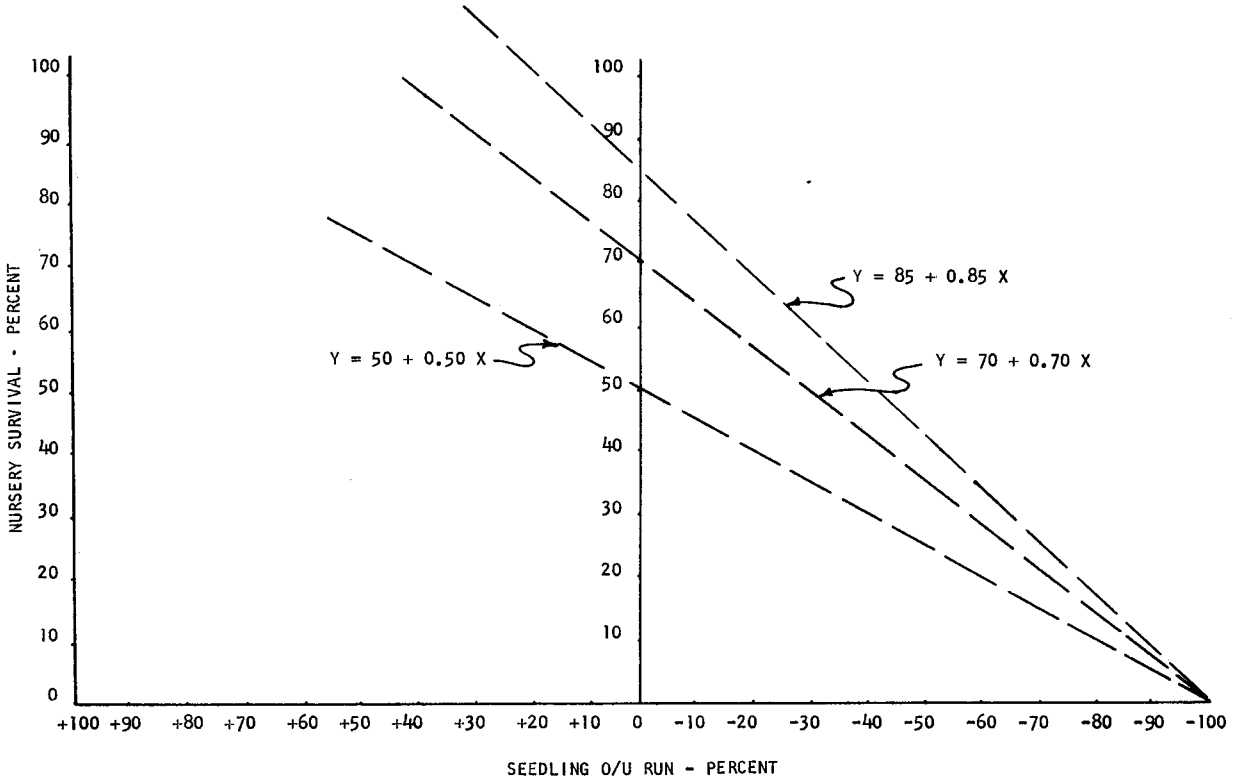

Figure 1.—The relation of actual Nursery Survival to nursery o/u run when the Nursery Survival used in the sowing calculations was 85, 70, or 50 percent.

calculated percent o/u run is possible. However, the regression coefficient and, therefore, the slope of the regression line must be the same as the estimated Nursery Survival (N) used in sowing this lot. In addition, the sowing calculation must be made using the formula illustrated in this paper.

Records of Nursery Survival can be used to improve sowing accuracy. For those lots sown in succeeding years, (N) would be available based on the previous performance of each specific seed lot. It is possible that Nursery Survival may be influenced greatly by nursery growing conditions, which vary from year to year. This is strongly suggested by Allen (1962), but it is not known at this time how much of an influence this is, and only by accumulating and comparing the Nursery Survival over a period of time can this information be obtained.

For seed lots which have never been sown before, the Nursery Survival must still be estimated. A more accurate estimate may be obtained by using the actual Nursery Survival of similar lots. Actual Nursery Survival information can be correlated with any number of seed and nursery characteristics including:

Seed germination
Seed weight
Seed age
Seed collection year
Seed source-range
Seed source-township
Seed source-elevation
Seedling lot size
Year of sowing
Seedbed density
Seedbed location in nursery

These correlations can be used to judge what Nursery Survival should be assigned to new lots of seed being sown.

The discussion up to this point is valid for nurseries essentially applying the same practices to each seed lot. If lots are culled at various intensities, a more precise sowing calculation can be obtained as follows:

$$T = \frac{D}{(S)\ (P)\ (G)\ (F)\ (K)}$$

Where most symbols are as before except:

F = estimated *field survival;* the percent of the of the total viable seeds planted which produce a tree of any quality in the seedbeds.

K = estimated pack (100 - percent cull = percent pack)

and note that:

$$N = (F)\ (K)$$

Under these conditions, the best way to calculate the estimated pack is by counting the trees culled from any known quantity of trees in the packing room. As an alternative, several samples of trees could be lifted from the beds and graded. The resulting cull factor would apply to the whole lot, the total being determined after packing. It is not recommended that actual cull be calculated as the difference between nursery inventory and the number of trees packed and shipped. An inaccurate inventory would cause an unreliable answer.

When the percent pack is known, the Field Survival (F) can be calculated by:

$$F = \frac{D}{(T)\ (S)\ (P)\ (G)\ (K)}$$

or:

$$F = \frac{N}{K}$$

if N has been determined by figure 1.

The Field Survival and the pack can then be used to increase sowing accuracy as illustrated previously for Nursery Survival, i.e.,

1) By providing sowing data for seed lots sown in successive years.
2) By the correlation of F and K to various seed and nursery characteristics providing a better estimate for seed lots not previously sown.

The methods described in this paper can be applied immediately. There is no need to wait until future sowing data is available. Regardless of how the sowing was originally determined, the Nursery Survival for a seed lot can be calculated; provided that the necessary information on T, S, P, G, and D 1 are available in the nurserymen's files.

Forms to record pertinent data on individual seed lots have been developed. These, including instructions on how to use the forms, are available from the author.

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