CALIBRATION OF NUTRIENT PRESCRIPTIONS FOR BARE-ROOT NURSERIES

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INTRODUCTION

Nursery production of bare-root stock, like agricultural production of food and fibre crops, depends on the input of nutrients to the soil (mostly as fertilizers) to sustain successive crop growth. As in agronomy, soil samples are chemically tested and, based on the results, prescriptions are made for the application of fertilizer nutrients, mostly nitrogen (N), phosphorus (P), and potassium (K). How are the prescriptions derived? They are based on prior knowledge of the effect of known amounts of fertilizer on plant growth, and the expression of such a relationship in graphical or other forms is known as calibration. This paper shows, with examples, how to determine nutrient requirements of a crop and how fertilizer prescriptions are derived.

CALIBRATION

As soon as a nursery is developed, one of the first questions asked by the nurseryman concerns what types and amounts of fertilizers should be applied in order to obtain a desired crop quality. To answer these questions, it is necessary to proceed systematically, as follows:

1. Draw up specifications for morphological characteristics such as height, root-collar diameter, seedling dry weight, and shoot: root ratio.

2. To determine nutrient requirements of a crop (in terms of N, P, and K), lay out a fertilizer experiment that is well replicated.

3. Apply a series of dosages of each nutrient, singly or in combination, to plots in which the seedlings are grown. During the cropping period, water and weed according to the routine used for the rest of the nursery.

4. At the end of the cropping period, measure the growth characteristics, e.g., height, root-collar diameter, and seedling dry weight.

5. Determine the optimum level of fertilization or nutrient requirement by plotting the response of a specific characteristic to various levels of nutrients.

6. Verify the optimum level of fertilization in subsequent crops by applying levels that are more and less than the optimum and noting the response in growth. Confirmation of the optimum level indicates that the seedbed is calibrated for requirement of a particular nutrient.

7. In succeeding crops, it is necessary only to develop a fertilizer prescription or recommendation. The prescription is the difference between the nutrient requirement and the amount of plant-available nutrients already in the soil. This is determined by soil testing.

CALCULATIONS

To determine the amount of nutrients to be added to each plot during the field experiment, assume that the size of each plot is 1 × 1 m or 1 m^2. As 1 ha = 10 000 m^2, each plot is

0.0001 ha. Assume that we would like to add nutrients at the following rates: 0, 28, 56, 112, 168, and, 224 kg/ha. Then each plot would require 0, 2.8, 5.6, 11.2, 16.8, and 22.4 g/plot.

Nitrogen

If N is supplied by ammonium nitrate (34-0-0), for example, the amount of fertilizer required per plot is determined by multiplying g/plot of N by the factor 100/34, or 2.94. Therefore, 0, 2.8, 5.6, 11.2, 16.8, and 22.4 g/plot of N equals 0, 8.2, 16.5, 33.0, 49.5, and 66.0 g/plot of N fertilizer.

Phosphorus

If P is supplied by concentrated superphosphate (0-45-0), the amount of P fertilizer required per plot is determined by multiplying g/plot of P by the factor 100/19.8, or 5.05. Therefore, 0, 2.8, 5.6, 11.2, 16.8, and 22.4 g/plot of P equals 0, 14.1, 28.3, 56.6, 84.9, and 113.2 g/plot of P fertilizer.

NOTE: Fertilizer with the formulation 0-45-0 indicates the presence of 45% P_2O_5 and is equivalent to 45 × 0.44 or 19.8% P.

Potassium

If K is supplied by potassium sulfate (0-0-50), the amount of K fertilizer required per plot is determined by multiplying g/plot of K by the factor 100/41.5, or 2.41. Therefore, 0, 2.8, 5.6, 11.2, 16.8, and 22.4 g/plot of K equals 0, 6.7, 13.5, 27.0, 40.5, and 54.0 g/plot of K fertilizer.

NOTE: Fertilizer with the formulation 0-0-50 indicates 50% K_2O and is equivalent to 50 × 0.83 or 41.5% K.

OPTIMUM LEVEL OF FERTILIZATION

Determine the mean height, root-collar diameter, and seedling dry weight associated with each level of fertilization.

Construct a curve to show the relationship between fertilization and each characteristic. The graph for seedling dry weight, for example, may look like that in Figure 1.

The graph shows that the growth associated with the application of N at 112 kg/ha is significantly greater than that at 56 kg/ha, but it is not inferior to growth obtained with the application of 168 kg/ha. Growth began to decline at 224 kg/ha, probably indicating some level of toxicity. In this example, fertilization at 112 kg/ha is optimum.

In cases where the differences in response to fertilization are not as clear, a statistical analysis of the data is made to gain some inference about the significance of the differences between means. The aim is to identify the minimum input that produces acceptable stock, morphologically and physiologically.

Repeated experiments may be conducted to either confirm the relationship or to test intermediate levels of fertilizers.

Having established the optimum level of fertilization, it is necessary in subsequent years to determine only the level of available nutrients in the soil (through chemical soil testing), and to make up, through fertilization, the difference between the amount that is present and the amount that is required. It is on this basis that fertilizer recommendations are developed. Let us see how the calculations for this are done.

FERTILIZER RECOMMENDATIONS

Assume that the optimum level for a nutrient is 112 kg/ha. If soil testing indicates that the amount of available nutrient is only 30 kg/ha,

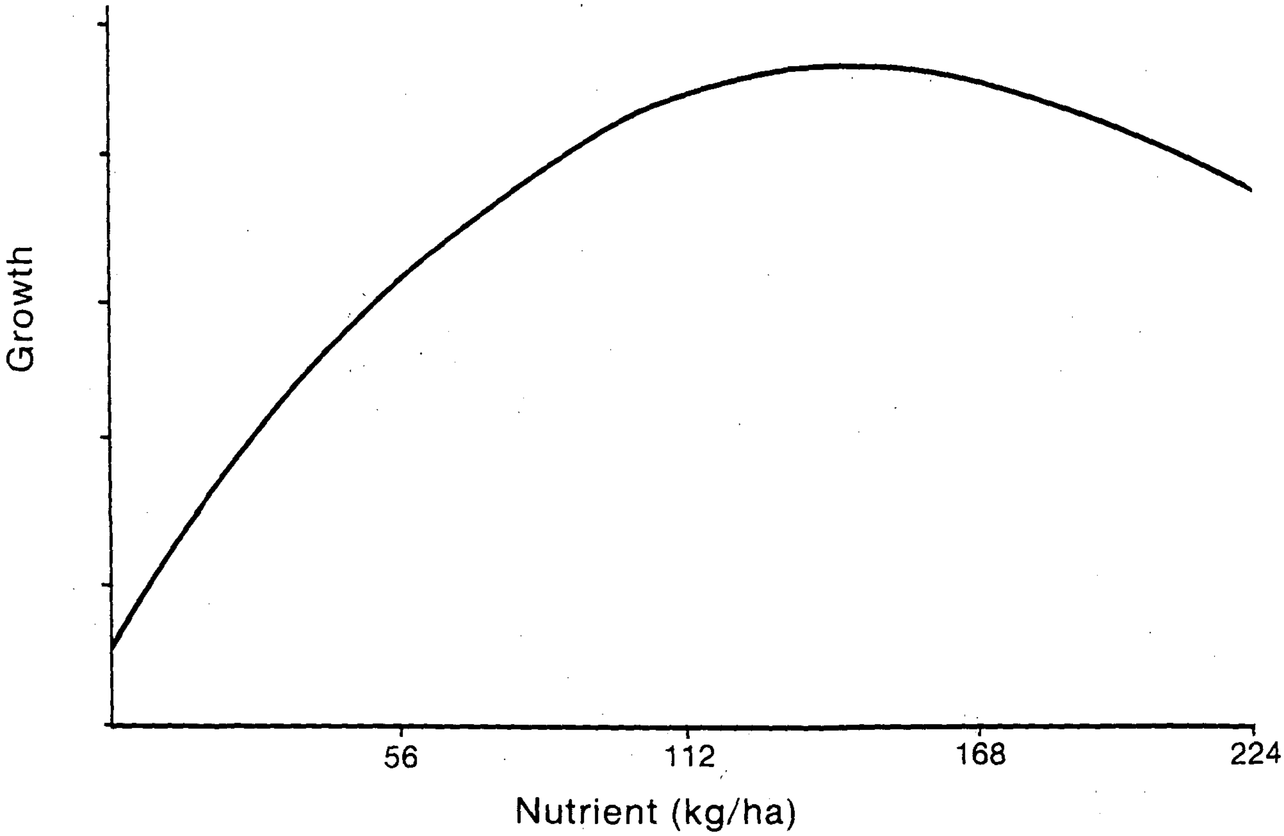

Figure 1. Growth response to nutrient application.

it means that a total of 82 kg/ha is required from fertilization.

If N is the nutrient and ammonium nitrate (34-0-0) is used to supply N, the quantity of fertilizer required is (82 × 100/34) kg/ha, or 241 kg/ha.

If P is the nutrient and concentrated superphosphate (0-45-0) is used to supply P, the quantity of fertilizer required is (82 × 100/19.8) kg/ha, or 414 kg/ha (45% P_2O_5 is equivalent to 19.8% P).

If K is the nutrient and potassium sulfate (0-0-50) is used to supply K, the amount of fertilizer required is (82 × 100/41.5) kg/ha, or 198 kg/ha (50% K_2O is equivalent to 41.5% K).

SOIL TEST RESULTS

There are numerous soil testing procedures for different elements and for different soils. The essential point to bear in mind is that the method used by any laboratory should produce results that are highly correlated with plant growth and nutrient uptake. If this condition is met, the results will be valid for the calculation of fertilizer recommendations as outlined above.

The expression of soil test results should not present a problem. If the unit of expression is kg/ha, no conversion is necessary. If the unit is given in ppm (parts per million), mg/kg, percent, or lb./acre, conversion to kg/ha is required. Conversion factors are as follows:

1%	=	10 000 ppm
mg/kg	=	ppm
ppm × 2	=	lb./acre
lb./acre × 1.12	=	kg/ha

SUMMARY

Calibration of nursery soil is the determination of the level of nutrient that is required to produce a crop with desired specifications. It initially consists of soil testing and a fertilizer trial to develop the nutrient requirement. Checks are subsequently made to confirm the requirement. Fertilizer recommendations are made annually to make up the deficit between the requirement and the available nutrients in the soil.

RECOMMENDATIONS

1. Develop morphological and physiological specifications for the seedlings to be produced.

2. Do soil testing of the nursery beds.

3. Apply different levels of fertilizer in a replicated experiment.

4. Determine the minimum level of a nutrient that produces the most suitable seedlings in terms of the desired specifications.

5. In subsequent crops, add enough fertilizer to bring soil nutrient level to that found in Step 4. The minimum level of soil nutrient that is associated with the most suitable plant growth and nutrient uptake is the plant requirement. Standards for foliar concentration of nutrients should be met.

6. Always perform random checks in successive crops by applying, to selected plots, levels of fertilizers that are either more or less than the plant requirement. If growth performance remains constant or declines with more fertilizer and also declines with less, the plant requirement in Step 5 is confirmed and the soil is calibrated for that species. Soil fertility standards are essential features of any bare-root nursery.

7. If there are no major changes in soil management (e.g., removal of

top soil, pipeline placement) and if the required levels of pH and organic matter are met, soil productivity can be maintained through fine tuning the system, as in Step 6.

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