AUBURN UNIVERSITY
SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE

RESEARCH NOTE 95-5

DETERMINING LOBLOLLY PINE (*P. taeda* L.) SEEDLING QUALITY BY CHLOROPHYLL FLUORESCENCE

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INTRODUCTION

Plant chloroplasts absorb light energy and transform this energy through photosynthesis into chemical products basic to plant growth and development. Not all of this energy, however, is transformed into the chemical products of photosynthesis. Some light energy absorbed by the chlorophyll pigment is re-emitted in the red portion of the spectrum and is known as chlorophyll fluorescence. Theoretically, chlorophyll fluorescence can be used as an indicator of plant health as changes in fluorescence could indicate damage to the photosynthetic mechanism resulting from environmental stress. Because there is considerable stress to seedlings associated with the lifting, storage, transporting, and planting process, fluorometry has the potential to provide a physiological assessment of seedling quality. Much of the work with fluorescence as an indicator of seedling quality has been done on temperate and boreal species. This work reports on a series of experiments investigating the possibilities of using chlorophyll fluorescence for the assessment of seedling quality in loblolly pine (*Pinus taeda* L.), the principle species planted in the southeastern U.S.

METHODOLOGY

Water Stress Study - Recently lifted loblolly pine seedlings were placed in cold storage (5°C) and water-stressed by exposing the entire seedling to air for a duration of four to 14 days to produce a range in Fv/Fm (quantum yield - an expression of fluorescence) values from 0.37 to 0.66. Water potentials were < -3.5 MPa in all water-stressed seedlings. Fv/Fm ratios were measured on upper and lower needles on a total of 30 seedlings subjected to water stress. After treatment, water-stressed seedlings were planted in pairs with control seedlings in separate pots with a sand medium and placed in a greenhouse. Survival and height growth were measured four weeks following planting.

Freezing Study - Seedlings taken from two weeks in cold storage were subjected to freezing temperatures (-5 to -10 °C) immediately before planting by placing seedlings in a chest freezer for 30 or 60 minutes (n=20 per treatment). Roots were protected by submerging the root system in a bucket of water during the freezing period. Fv/Fm ratios were measured on an upper and lower needle of each seedling after exposure to freezing temperatures and acclimation to room temperature. Stressed seedlings were planted in pairs with control seedlings in separate pots with a sand medium and placed in a greenhouse. Survival and height growth were measured four weeks following planting.

Leaf Photosynthesis or Height growth - The relationship between Fv/Fm and leaf photosynthesis or height growth was measured in 40 seedlings kept in cold storage for one month. Fv/Fm values of upper and lower needles were measured immediately before seedlings were planted into pots with a sand medium and placed in a greenhouse. Net photosynthesis of upper and lower needles was monitored over a four week period until maximum rates were achieved. Height growth was measured at four weeks.

<u>RESULTS</u>

Water Stress Study - The range in Fv/Fm ratios for water stressed seedlings was from .37 to .60 ($\bar{x}$ =.51) while unstressed seedlings ranged from .56 to .65 ($\bar{x}$=.61). Despite the range in Fv/Fm values, all seedlings exposed to water stress died and thus exhibited no height growth (Figure 1). Therefore, no relationship between Fv/Fm ratios and performance was observed. Although the entire plant was water stressed, the roots undoubtedly desiccated more quickly than the shoot resulting in extensive root mortality and disfunction.

Freezing Study - Fv/Fm ratios ranged from .41 to .65 ($\bar{x}$=.58) in seedlings exposed to 30 minutes of freezing, while ratios ranged from .20 to .53 ($\bar{x}$=.34) in seedlings exposed to 60 minutes of freezing. Control seedlings exhibited Fv/Fm values in the range of .47 to .69 ($\bar{x}$=.59)

MANAGEMENT IMPLICATIONS

This first study indicates that Chlorophyll fluorescence (Fv/Fm) may be used to indicate seedling quality when a decline in seedling performance is related to stress induced damage to foliage. For example, seedling mortality caused by freezing was indicated by chlorophyll fluorescence before it became visible on the seedling. On the other hand, environmental stresses negatively affecting the roots will very likely decrease seedling quality but will probably not be effectively detected by fluorescence techniques.

The utility of chlorophyll fluorescence as an indicator of loblolly pine seedling quality deserves further work. It is plausible that decreasing seedling quality associated with long term storage may be measured by Chlorophyll fluorescence. This possibility needs to be investigated.

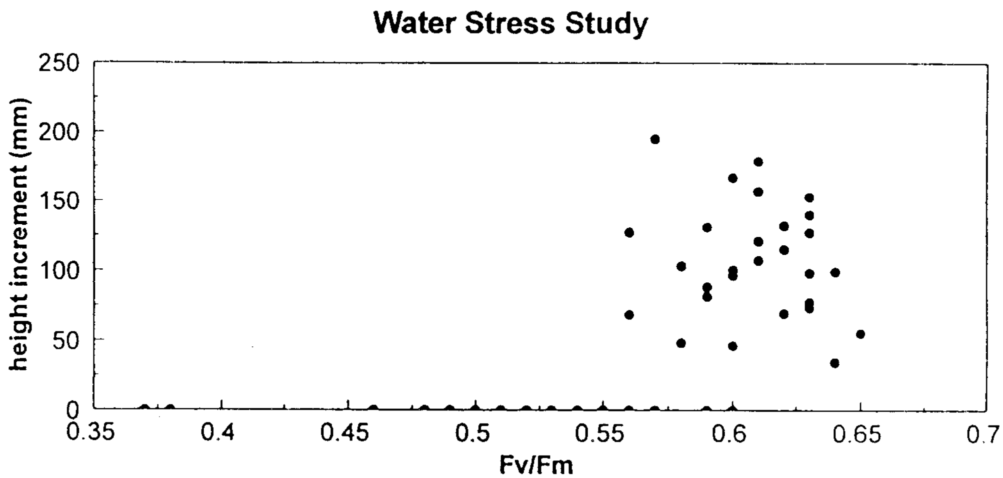

Figure 1. Influence of water stress during cold storage on the Fv/Fm ratio and height increment of the spring flush.

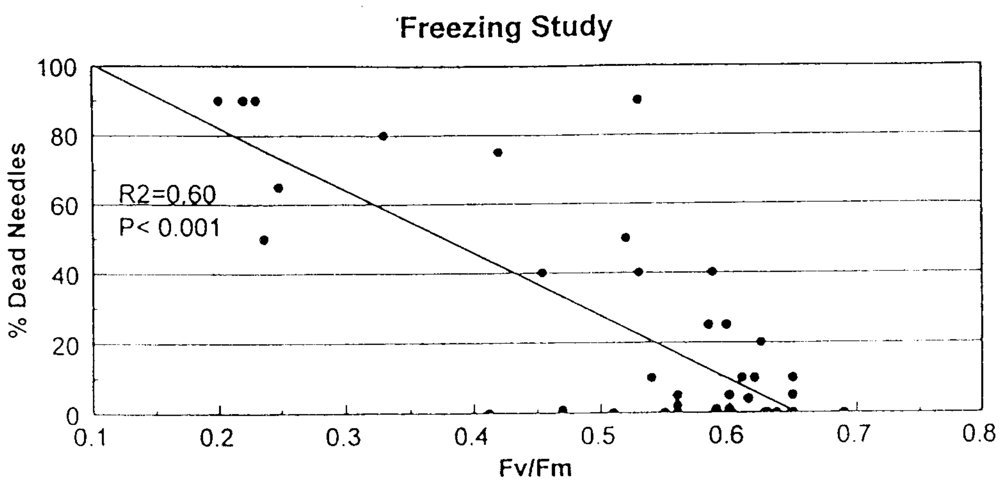

Figure 2. Influence of freezing during storage on the Fv/Fm ratio and percentage of dead needles.

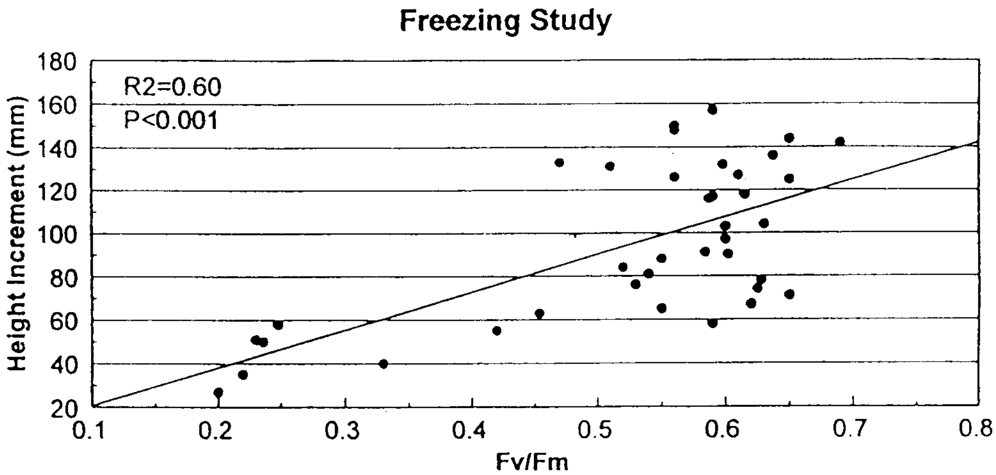

Figure 3. Influence of freezing during cold storage on the Fv/Fm ratio and height increment of the spring flush.

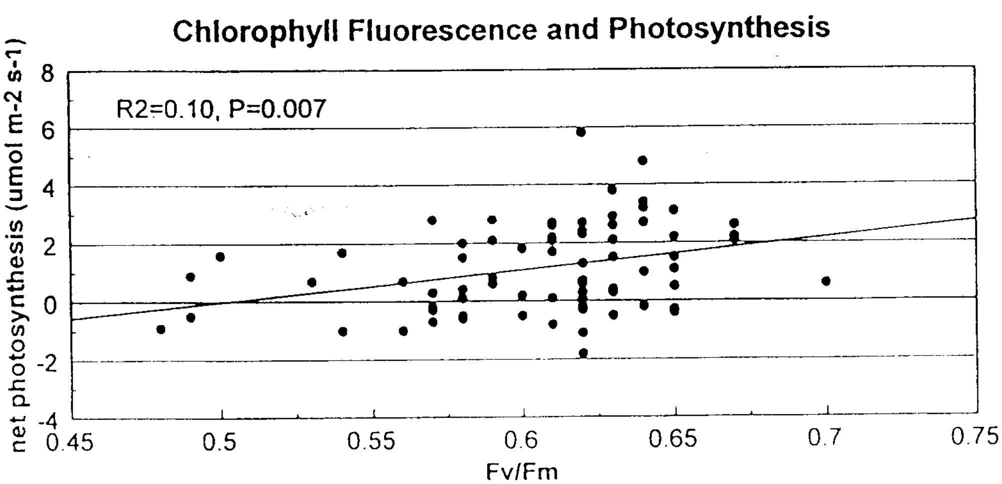

Figure 4. Relationship between net photosynthesis and the Fv/Fm ratio measured at planting.