Auburn University Southern Forest Nursery Management Cooperative

RESEARCH REPORT 98-4

PLANT GROWTH PROMOTING RHIZOBACTERIA AS AN ALTERNATIVE TREATMENT FOR METHYL BROMIDE

by
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INTRODUCTION

The use of plant growth-promoting rhizobacteria (PGPR) as a seed treatment prior to sowing is a novel disease control treatment that may be effective in increasing the growth and survival of seedlings. PGPR research on agricultural crops has been ongoing for nearly 15 years and has resulted in a number of commercially available PGPR products for peanut and cotton. However, research into their ability to promote growth or control disease on forestry species such as conifers has not be done. Preliminary evidence has shown that the treatment of conifer seeds with PGPR strains prior to sowing has a number of beneficial applications in the production of conifer seedlings. The use of beneficial PGPR strains would be an important part of IPM in the southern United States and be a positive step in increasing the productivity of forest lands without a concurrent reduction in disease-free seedlings. Also, because of the intensively managed nature of forest-tree nurseries, the use of PGPR as an alternative to methyl bromide could easily be transferred to current production schedules. This research examined if strains of PGPR can promote the growth and produce high quality loblolly pine seedlings for reforestation programs throughout the southeastern United States.

METHODOLOGY

Three conifer bare-root nurseries, all members of Auburn University Southern Forest Nursery Management Cooperative, agreed to participate with the PGPR research trials and provided the equipment, nursery space, pine seed and maintenance of the plots. The nurseries were located in Swansea, South Carolina, Glennville, Georgia and Camden, Alabama In each nursery, one section was designated for the study of which half was recently treated with 375 lbs/acre of methyl bromide and served as the fumigated soil while the other half was recently non-treated and served as the non-fumigated soil. One day prior to sowing, loblolly and slash pine seed was treated with *Burkerholderia cepecia* at 0.1 mL bacteria per gram of seed, which has been shown to be effective

on other plant species to promote growth and control soil-borne diseases. The seed was sown in April and maintained under current operating practices which included weed, insect and rust control, top and root pruning to maintain seedling out-planting characteristics, and applications of fertilizer to maintain seedling vigor over the growing season. The four treatments were; 1) "recently" fumigated & non-treated seed, 2) "recently" fumigated & treated seed, 3) non-fumigated & treated seed, and 4) non-fumigated & non-treated seed. Emergence of seedlings within treatments were assessed at 1, 2, 3, 4, 5, 15 and 28 weeks after sowing. Seedling information gathered within each permanent 4 ft^2 plot included germination rate, survival, damping-off, cut-worm damage and weeds. At the end of the growing season, 25 seedlings within each of the permanent plots were removed from the beds and seedling characteristics such as grade, stem caliper, height, biomass, and root area were determined.

RESULTS

The treatment of the seed with the bacterial agents did not interfere with either the process of seed sowing or the maintenance of the crop during the season. However, there was some wash-off or removal of the Bayleton, thiram & sticker formula that did occur. Thus, the use of bacteria as a seed treatment does not appear to affect the current procedures used in bare root nurseries as long as the seed was treated with the bacteria prior to treating with the fungicides. Because of the large amount of seedling data, soil characteristics and the number of treatments, only end-of-year seedling data is presented for each nursery for loblolly pine as production managers are more concerned about a treatment's affect on the number of seedlings, root collar diameters and seedling grades.

One reason that differences were not observed with this particular PGPR strain may be due to the lack of disease pressure. Without soil-borne fungi present in the fumigated and non-fumigated soil, the effectiveness of the rhizobacteria on the seedling roots can not be measured. Future plans for the upcoming growing season will move away from this particular strain of bacteria and test some other strains that have shown more promising results with respect to affecting seedling growth.

Champion International Nursery - Swansea, South Carolina: At the nursery operated by Champion International treatment of seed with the bacteria had no effect on the number of seedlings produced in both soil treatments for both tree species (Table 1). The lack of differences between the bacterial-treated and non-treated seed produced in both the "recently" fumigated and non-fumigated soils is most likely due to the carry-over affect of the soil fumigation. While half of the section did not receive any methyl bromide this growing season, the area had been fumigated in March 1996. Previous research by the Auburn University Southern Forest Nursery Management Cooperative has shown that the benefits of fumigation can also be observed during the second and even the third growing season after fumigation. Such benefits include root collar diameter and seedling grade (No 1's, No 2's and culls). These three seedling parameters were also non-significant within a soil treatment for all four treatments in the nursery (Tables 2 & 3). There was, however, a significant reduction in the production of No. 1's with slash pine when comparing treated seed to non-treated seed. This also shows up as a significant increase in No. 2's when comparing treated seed to non-treated seed (Table 3). No explanation for the apparent deleterious affect of using the bacteria on slash pine is available, although, similar trends were noted at Glennville nursery last season with a particular family. Similar family affects have been noted with other plant growth-promoting

Table 1. Seedlings per sq ft 28 weeks after sowing at Swansea, South Carolina

		Loblolly Pine		Slash Pine	
Nursery	Seed Treatment	Non- Fumigated	Fumigated	Non-Fumigated	Fumigated
Swansea	Bacteria	16.0	17.7	NA†	12.5
	No Bacteria	17.2	17.8	NA	11.4
Glennville	Bacteria	13.9	14.4	13.6	12.3
	No Bacteria	12.6	14.2	13.5	13.5
Camden	Bacteria	18.9	20.0	NA‡	NA
	No Bacteria	18.0	17.3	NA	NA

†There were no "non-fumigated" soil plots for slash pine
‡Slash pine was not tested at this nursery

Table 2. Loblolly pine seedling characteristics 28 weeks after sowing at Swansea, South Carolina

	Seed	RCD (mm)		Fumigated Soil			Non-Fumigated Soil		
Nursery	Treatment	Fum	Non-Fum	No. 1's	No. 2's	Culls	No. 1's	No. 2's	Culls
Swansea	Bacteria	4.6	4.5	10.3	13.2	1.4	8.1	15.2	1.7
	No Bacteria	4.5	4.4	9.6	14.6	1.5	8.2	15.6	1.2
Glennville	Bacteria	4.3	4.2	6.9	14.7	3.4	7.8	15.0	2.1
	No Bacteria	4.6	4.3	10.1	12.6	1.5	6.3	16.3	2.3
Camden	Bacteria	4.5	4.1	9.2†	15.0	0.8	3.1	20.4	1.5
	No Bacteria	4.7	4.1	9.7	14.3	1.0	4.5	19.2	1.3

† Numbers are an average of 25 seedlings collected from each of the 12 plots representing each of the four treatments.

Table 3. Slash pine seedling characteristics 28 weeks after sowing at Swansea, South Carolina

	Seed	RCD (mm)		Fumigated Soil			Non-Fumigated Soil		
Nursery	Treatment	Fum	Non-Fum	No. 1's	No. 2's	Culls	No. 1's	No. 2's	Culls
Swansea	Bacteria	5.5	NA	12.6	10.4*	1.9	NA	NA	NA
	No Bacteria	5.2	NA	15.9*	7.0	2.0	NA	NA	NA
Glennville	Bacteria	5.9	5.4	18.7	5.3	0.9	17.3	6.3	1.3
	No Bacteria	5.7	5.4	18.3	5.5	1.1	18.6	4.6	1.6

* = Significant increase over corresponding treatment

rhizobacteria. Seedling biomass, a measure of increased seedling growth between treatments, was also determined using dry weights of the seedlings collected from the permanent plots. Treating seed with PGPR prior to sowing did not either increase or decrease seedling growth as measured by dry weights of shoots and roots at the end of the growing season for either loblolly or slash pine .

Rayonier Regeneration Center - Glennville, Georgia: Similar seedling densities and characteristics were noted at the nursery operated by Rayonier, Inc. The increase in the number of seedlings when treated with bacteria prior to sowing was less than 1 seedling per sq ft of nursery bed. However, the increase in those plots was not significant from those plots that did not receive bacteria (Table 4). In the section that was not fumigated, there was no difference in the number of seedlings produced between those seeds that had been treated with bacteria prior to sowing and those that did not get treated. There was no difference between the treated and untreated seeds sown in fumigated plots, thus the addition of bacteria to the seed had no affect on the production of seedlings. The benefits of fumigation as far as seedling characteristics were also similar across soil and seed treatments in this trial. These three seedling parameters were also non-significant within a soil treatment for all four treatments (Tables 5 & 6). Overall, seedlings grown in both soil treatments produced seedlings similar in quality for both seed treatments. Seedling biomass, a measure of seedling growth, was also determined using dry weights of the seedlings collected from the permanent plots. Treating seed with PGPR prior to sowing did not either increase or decrease seedling growth as measured by dry weights of roots and shoots at the end of the growing season for either loblolly or slash pine.

Robert Mitchell Nursery - Camden, Alabama: Like that of the other two nurseries the treatment of seed with this particular strain of plant growth-promoting rhizobacteria had no affect on increasing seedling densities and produced seedlings that were similar in size to non-treated seed (Table 7). The root collar diameters were also unaffected and treatments produced similar numbers of 1's, 2's and Culls across the experiment (Table 8). The benefits of fumigation as far as seedling characteristics were also similar across soil and seed treatments in this trial. Seedling biomass, a measure of seedling growth, was also determined using dry weights of the seedlings collected from the permanent plots. Treating seed with PGPR prior to sowing did not either increase or decrease seedling growth as measured by dry weights of roots and shoots at the end of the growing season.

MANAGEMENT IMPLICATIONS

Based on these three trials, as well as trials conducted in 1996 & 1997 on longleaf sown in containers, the extra cost to treat the seed with this PGPR strain is not economically justified when sown into either a fumigated or non-fumigated soil bed.

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