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Fertilization-at-Time-of-Planting Spring Plant Interior Spruce Trial – Tahtsa Reach Third Season Progress Report – January 2000

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Treatments

Interior spruce PSB 410 1+0 seedlings (SL 6583) from Fraser Lake's operational spring plant program grown at PRT Summit Nursery (Telkwa, B.C.) were utilized. The three treatments were: 1) Control; 2) Nutri-Plug™ NT; and 3) Tea Bag. The Control consisted of standard operationally grown seedlings. Nutri-Plug's™ are seedlings to which a long term controlled release fertilizer (e.g.Nutricote™ 16-10-10 Type 360) has been incorporated into the plug, often at time of sowing. It is recognized that some of this fertilizer was released while in the nursery, which presently can not be avoided with the fertilizer products available to us. Due to the extra fertilizer in the nursery, the Nutri-Plug™ seedlings were taller than the Control seedlings at time of lifting prior to freezer storage. The Tea Bag (SILVA<>PAK) treatment consisted of polyurethane coated slow release 26-12-6 N-P-K fertilizer contained in a "tea bag like" package, which was placed at mid-plug depth approximately 2 cm from Control seedling plugs at time of planting.

Site

The trial was established on two cutblocks approximately 100 km SW of Houston, B.C. (Latitude 53-43, Longitude 127-58). Both sites are in the Moist Cold Subzone of the Sub-Boreal Spruce (SBSmc2) biogeoclimatic zone, although further classification by the site series rate Site 2 as being more productive. On the appropriate edatopic grid, the site's nutrient and moisture regime are rated as medium and mesic respectively. The elevation of Site 1 is 870 m and Site 2's elevation is 900 m. Site 1 has a slight easterly aspect, while Site 2 is generally flat. The trial area in Site 1 was not mechanically site prepared, thus is referred to as a raw plant. Site 2 was clear-cut in the winter of 1996, and portions were both disc trenched and excavator mounded later that year.

Two tree planters working in the area were used per site, instructed to plant operationally. For the raw ground, this consisted of a light screefing to remove the forest floor or duff, placing the top of the seedling plug approximately 2 cm below the remaining surface layer, and gently closing the planting hole. On the disc trenched site, the seedlings were planted 2-5 cm deep on the hinge. On the mounded site, the stock was planted 2-5 cm deep on the top of the mound.

On Site 1, each treatment is represented by a row of 50 seedlings, of which the first 40 seedlings per treatment row were measured. Rows are 2.5 m apart and seedling spacing in rows is 2.5 m, although planters were told to choose the best seedling microsite, rather than the exact spot dictated by spacing. On Site 2 (disc trench), each treatment is represented by a row of 25 seedlings running across the trenches, replicated randomly, spaced and planted as above. Single tree plots were used on Site 2 (mound), where 100 seedlings of each treatment were randomly planted on the prepared mounds within the trial area.

Height and diameter at ground level (DGL) were measured on all seedlings at time of planting (June 16/17, 1997), and in the fall at the end of the first, second and third summer (September 1997, 1998, and October 1999). During the first fall measurement, current seasons growth from five seedlings per replicate (i.e. 20 seedlings total per treatment) on Site 1 (raw plant) was collected and bulked for foliar nutrient analysis.

Survival

At the end of the first growing season, survival was 100% among all treatments. The raw plant site had some mortality in year two, with survival decreasing from Tea Bag (89%), to Control (86%), to Nutri-Plug™ (77%) seedlings. Fertilization did not effect the high (i.e. ≥ 99%) seedling survival on the disc trench and mounded sites. As mortality was similar between the Control and Tea Bag on the raw plant site, the mortality may have been caused by other factors besides fertilization, such as the cold wet soil. The slightly greater mortality of the Nutri-Plugs™ on the raw plant ground may also have been due to the greater variation in individual seedling microsites, which may have exacerbated the potential for fertilizer salt damage on drier planting spots.

Tissue Analysis

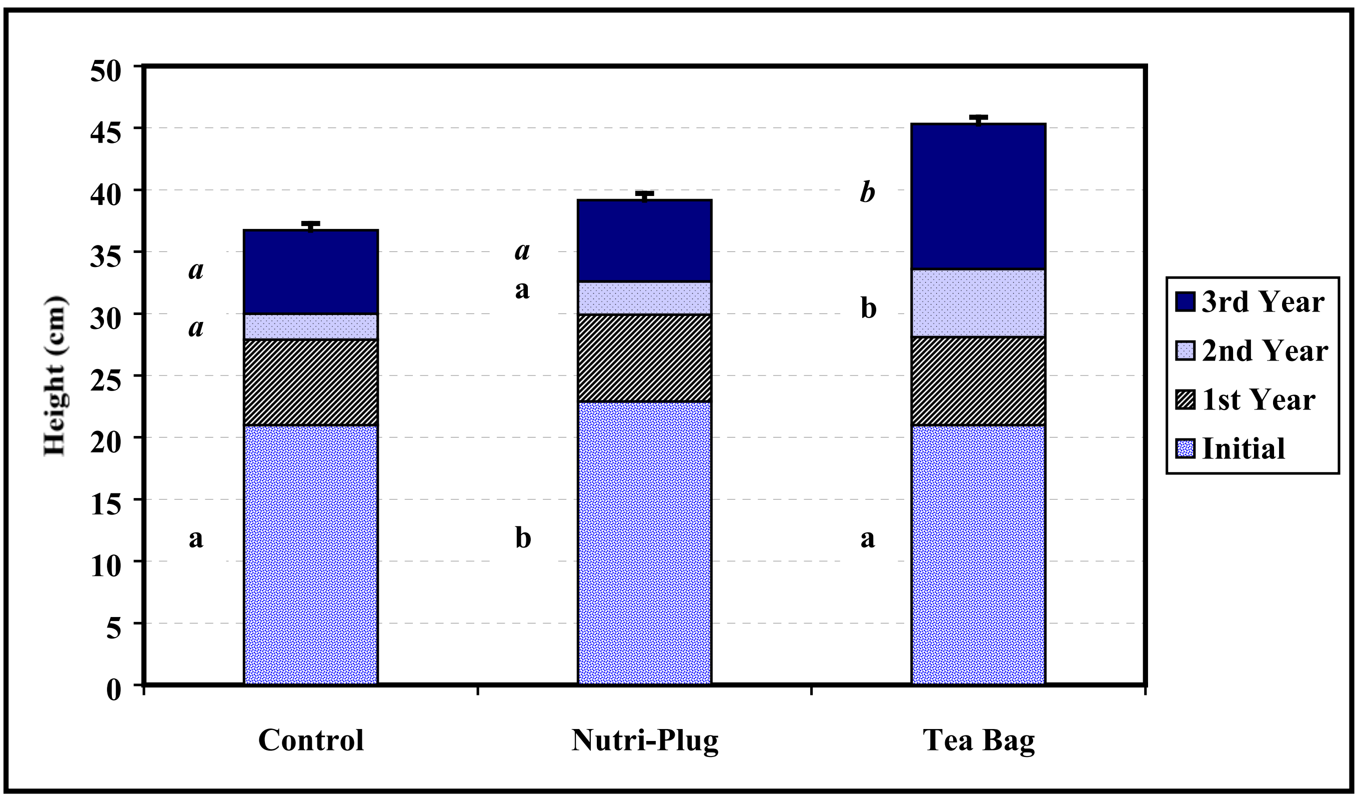
Below are tissue analysis results collected at the end of the first growing season (September 25, 1997), from Site 1 (raw plant) listed in the following order: Control; Nutri-Plug™; and Tea Bag. Values in **bold** are less than adequate.

Macronutrients	**Control**	**Nutri-P**	**Tea Bag**	**Adequate**
Nitrogen:	**0.80**	**0.90**	**1.20**%	> 1.55%
Phosphorus:	0.18	0.16	0.22%	> 0.16%
Potassium:	0.54	0.52	0.72%	> 0.50%
Calcium:	**0.19**	**0.14**	0.27%	> 0.20%
Magnesium:	**0.11**	**0.09**	0.15%	> 0.12%
Sulfur:	**0.06**	**0.06**	0.14%	< 0.12% indicates possible deficiency, 10% of the nitrogen level is adequate (e.g. N 0.8 x 10% = .08)

Micronutrients	**Control**	**Nutri-P**	**Tea Bag**	**Adequate**
Iron:	**54**	**39**	122 ppm	> 50 ppm
Copper:	**2**	**2**	6 ppm	> 3 ppm
Zinc:	14	**10**	53 ppm	> 15 ppm
Manganese:	375	255	49 ppm	> 25 ppm
Boron:	**8**	**7**	28 ppm	> 20 ppm, 5-12 ppm indicates a possible deficiency, depending on the nitrogen levels
Molybdenum:	3	3	59 ppm	> 0.1 ppm

At the end of the first growing season, it can be seen that the majority of nutrient concentrations are low, especially nitrogen. With the exception of nitrogen, the nutrient status of the seedlings increases from Nutri-Plug™ < control < tea bag, thus seedling nutrient status was improved by FAP via Tea Bags. Although not measured, it was observed that the Nutri-Plug™ seedlings had greater foliar biomass, as they appeared more bushy than the nonfertilized Control seedlings. This greater biomass of the Nutri-Plug™ seedlings would explain their low nutrient concentrations, as the nutrients would be more diluted in the larger amount of seedling foliage.

Height and Diameter Growth
At time of planting, height of the Nutri-Plug™ seedlings was significantly greater than the Control and Tea Bag seedlings, thus was used a covariant in the statistical analysis to account for this initial difference. At the end of the first growing season, there was no significant difference in height between all treatments. At the end of the second and third growing season, height of the Tea Bag treatment was statistically significantly greater than that of the Control and Nutri-Plug™ seedlings.



Seasonal treatment means followed by the same letter are not significantly different (p=0.05)

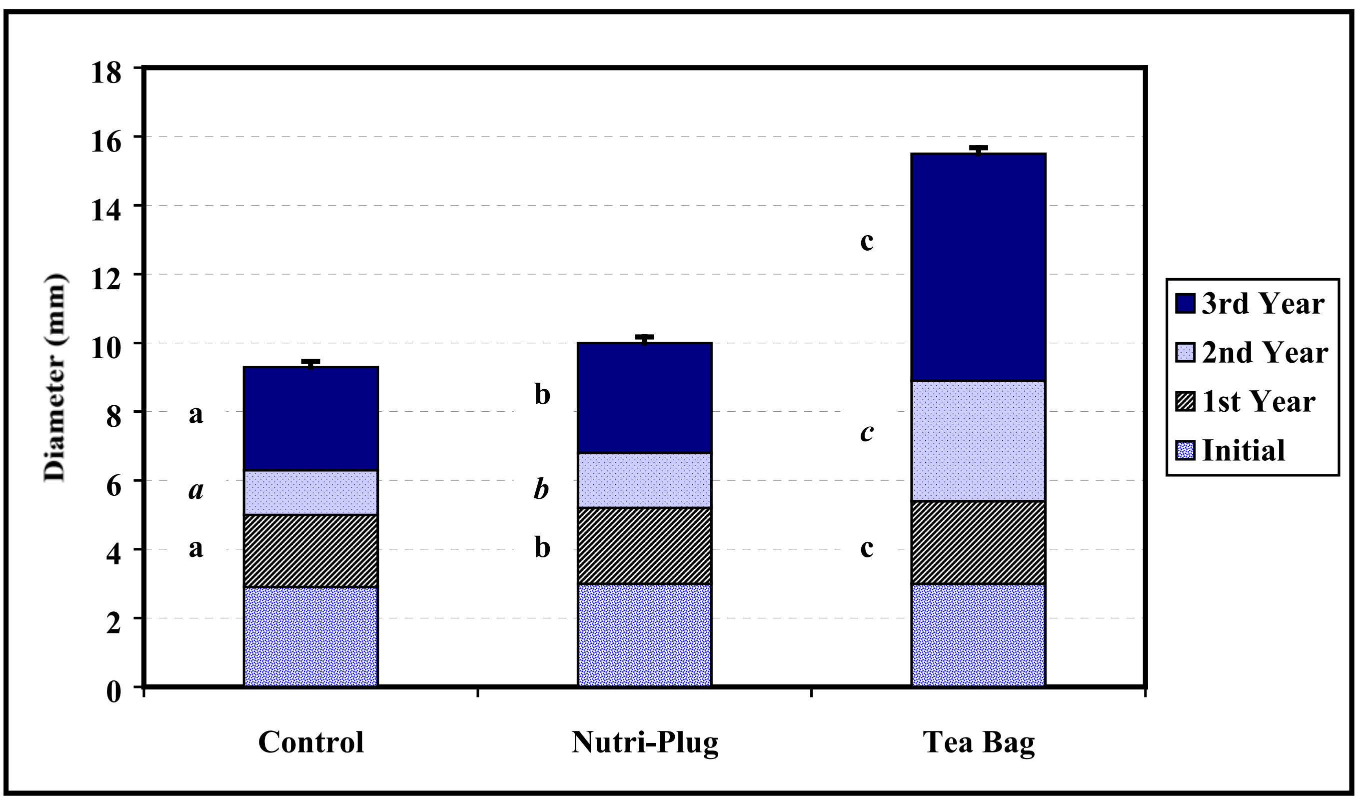
Seedling diameter was measured on the portion of the stem at ground level, that is, diameter at ground level (DGL). At the end of the first, second and third growing season, DGL was statistically different between all treatments, increasing from Control < Nutri-Plug™ < Tea Bag.

Volume
Seedling stem volume was calculated by the following formula: (1/3 **x** π **x** ((DGL/2)^2 **x** HT) = cm^3. This

measure takes into account both seedling height and diameter, giving an estimate of total seedling biomass. After one growing season (i.e. approximately four months), seedling volume of the Control and Tea Bag treatments was the same at 2.1 cm^3, both greater than the 1.8 cm^3 volume of the Control. After two growing seasons, seedling volume increased in the following order: Control – 3.1 cm^3; Nutri-Plug™ - 4.0 cm^3; and Tea Bag - 7.0 cm^3. Seedling volume in the fertilized Nutri-Plug™ and Tea Bag treatments was roughly 30 and 225%, respectively, greater than that of nonfertilized Control seedlings. After three growing seasons, seedling volume increased in the following order: Control – 8.2 cm^3; Nutri-Plug™ - 10.3 cm^3; and Tea Bag – 18.8 cm^3. Seedling volume in the Nutri-Plug™ remained at 25% more than the Control seedlings, while the Tea Bag treatment increased further to 230% more than that of the Control seedlings.

Site Preparation x Fertilization Interaction

The disc trenched area was the most productive, while the mounded site had moderate growth. There was a weak but significant site x fertilization interaction for the end of second season DGL, and also for third year height growth. Both are weak interactions as the trends in fertilizer response were similar on all sites. The interactions may have been caused by the differences in seedling microsites resulting from the different site preparation treatments. It appears the mechanically prepared disc trenched and mounded areas created conditions which allowed the seedling to more fully exploit the tea bag nutrients (i.e. removed other site limiting factors such as cold, wet soils).



Seasonal treatment means followed by the same letter are not significantly different (p=0.05)

Silvicultural Implications
Seedling survival was not affected by fertilization-at-time of planting (FAP), as it was high for both fertilized and nonfertilized seedlings on the mechanically prepared mounded and disc trenched planting spots. FAP resulted in statistically significant increases in height and diameter growth after the first, second and third growing seasons. At the end of the first growing season, absolute height of the Nutri-Plug™ seedlings was the greatest (although not statistically significant when the initially greater height at time of planting is taken into account), and DGL increased significantly from Control to Nutri-Plug™ to Tea Bag. At the end of the second growing season, height and DGL of the Nutri-Plug™ seedlings was approximately midway between the nonfertilized Control and the fertilized Tea Bag seedlings, and greater yet for the Tea Bag seedlings. At the end of three growing seasons, the fertilized seedlings were still larger than the nonfertilized Control seedlings, with the Nutri-Plug™ seedlings having statistically significantly greater diameter, and the Tea Bag seedlings having statistically greater height and diameter. Based on the results of three growing seasons, it is still too early to make conclusive statements regarding the use of FAP via Nutri-Plugs™ or Tea Bags on interior spruce on this site. However, if the clearly visible initial height and diameter growth increases observed in this trial aids in prevention of seedling mortality from snow/vegetation press and helps overcome vegetation competition, then FAP is justifiable. Vegetation competition was not a big problem on these trial sites, but with third season volume increases of 230% over the Controls, there is the potential of meeting free to grow sooner through FAP.

In this trial, seedlings fertilized via Tea Bags had the greatest growth increase, while the Nutri-Plug™ seedlings had approximately one fifth the growth response of the Tea Bag seedlings. While we were never trying to achieve the same growth response as the Tea Bag treatment, this is slightly less than what we are currently trying to achieve with the Nutri-Plugs™. On a monetary basis, Nutri-Plug™ seedlings cost on average only one fifth the total cost of installing a Tea Bag seedling. Also, it is worth noting that the growth response of future Nutri-Plug™ seedlings may increase further, as different products, formulations, release rates and application methods of Nutri-Plug™ fertilizers are currently under investigation. Another factor to consider when analyzing costs, is if there are other ways of increasing plantation productivity for the same cost of FAP (e.g. using larger stock without fertilizer, instead of adding Tea Bag fertilizer to smaller seedlings). It is recommended that this trial continue to be measured at periodic intervals to observe the length of the fertilizer treatment effect over time.