University Research Forests Extension Note Series

Quicksheet #26

Alternative Establishment Prescription For Control Of Spruce Weevil Damage: 15-Year Analysis Of Growth And Performance

Research Project 93-03

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Key Words:

Pissodes strobi

clump & mixed-bag planting

weevil reduction

Introduction

This note summarizes the 15-year growth and performance of interior spruce planted with lodgepole pine at both standard spacing as well as in clumps to test for planting prescription effectiveness at reducing damage from white pine (a.k.a. "spruce") weevil (*Pissodes strobi*).

Background on the project can be found in Quicksheet # 2[1], which details the planting prescription and rationale. Quicksheet #7 [2] provides a summary of the management history of the plantation sites as well as spruce growth and performance five years after establishment. Quicksheet #16 [3] summarizes growth and performance after eight years.

Methods

Two planting prescriptions were tested: clump planting and mixed bag. Both treatments were planted in 1993 on two replicates (cutblocks 358 and 361) on the Gavin Lake Block at the Alex Fraser Research Forest. The biogeoclimatic classification is ICHmk3.

Each clump consisted of 4 lodgepole pine and 3 interior spruce. The pine were planted mostly on the south side of the clumps to provide shade to the spruce. Clumps were spaced 5.7 meters apart and the target within-clump inter-tree distance was one meter. Manual brushing was prescribed only within the clumps and deciduous tree and brush species were retained between clumps. They were planted at 300 clumps per hectare and 2100 stems per hectare.

Mixed bag planting consisted of an even mixture of spruce and lodgepole pine at a density of 1800 stems per hectare, with a target inter-tree distance of 2.5 meters. One hundred interior spruce trees from each treatment and replicate were systematically selected along a random transect, tagged and measured at years 1, 3, 5, 8, 12 and 15. At year 15, weevil damage was assessed.

All sample trees were graphed according to basal diameter class over time, as well as mortality. Variability between and among treatments with regard to growth and survival over the duration of the project suggest that mean basal diameter and height as descriptors of population characteristic are being influenced by factors other than just the treatments (e.g. site differences and competition on sample trees from shrubs and other trees). As such, a subset of 40 sample trees from each replicate that exhibited the greatest diameter and height increment at year 15 was selected for statistical analysis. ANOVA and Tukey tests were performed on sub-sample trees at each measurement year to test for treatment effects on

[1] Day, K. 1995. Control of spruce weevil damage by introduction of alternate commercial species. Quick Sheet #2. UBC/Alex Fraser Research Forest.

[2] Hayward, J. and C. Trethewey. 1999. Alternative establishment prescription for control of spruce weevil damage: Five year growth and performance. Quick Sheet #7. UBC/Alex Fraser Research Forest.

[3] Trethewey, 2000. Alternative establishment prescription for control of spruce weevil damage: Year 8 growth and performance. Quick Sheet #16. UBC/Alex Fraser Research Forest.

diameter and height increment. A two-tailed z-test using the sample standard error of the proportion was also used to assess treatment effect on incidence of spruce terminal weevil.

Results and Discussion

Figure 1 depicts diametric distributions of all sample spruce from each measurement year. The occurrence of increasingly larger basal diameter classes indicates tree growth over time. There is much variability among diameter classes between and within treatments. Mortality ("dead" in figure) differs markedly within the clump treatment with 15% and 39 % in blocks 358 and 361, respectively.

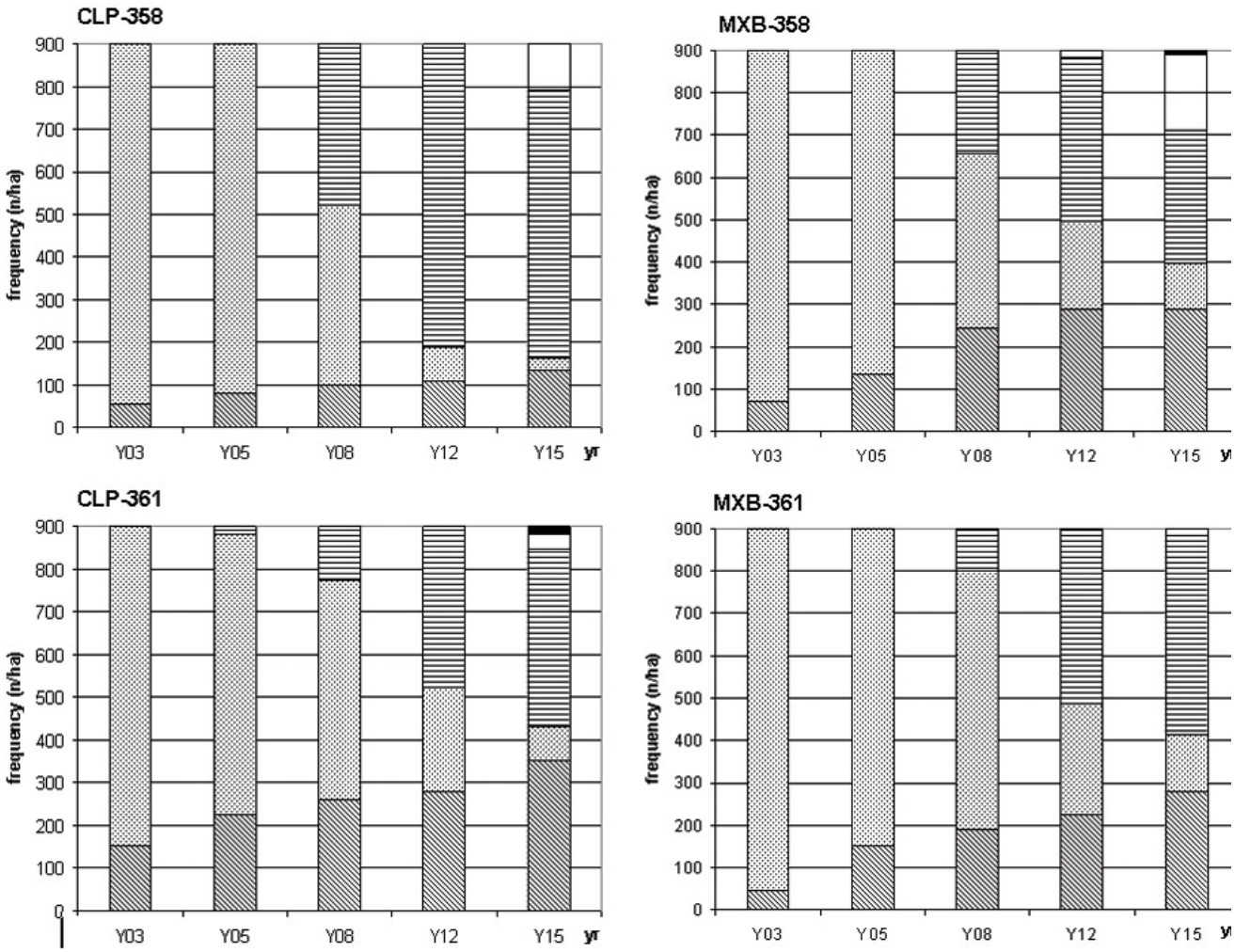

Figure 1: *Diametric distributions by years, treatments and blocks. CLP: Clumped plantation, MXB: Mixed bag plantation, 358 and 361: replicates. Diagonal dashed bars: dead trees, dotted bars: basal diameter (bd) <2.5cm, horizontal dashed bars: 2.5≤bd<7.5cm, white bars: 7.5≤bd<12.5cm, black bars: bd≥12.5cm.*

Mean heights and diameters among treatments and replicates across measurement years for the sub-sample trees are shown in Figures 2 and 3. Spruce planted in clumps have been exhibiting greater mean height than those in the mixed bag treatment (Fig. 2). These differences are statistically significant for years 8 and 12 in both replicates at a significance level of 0.05, with better performance in block 358 (in both treatments). This trend is stronger in block 358 at year 15, where the difference becomes significant at α=0.01. However, in block 361, there was no significant difference in mean height between clump and mixed bag planting at year 15.

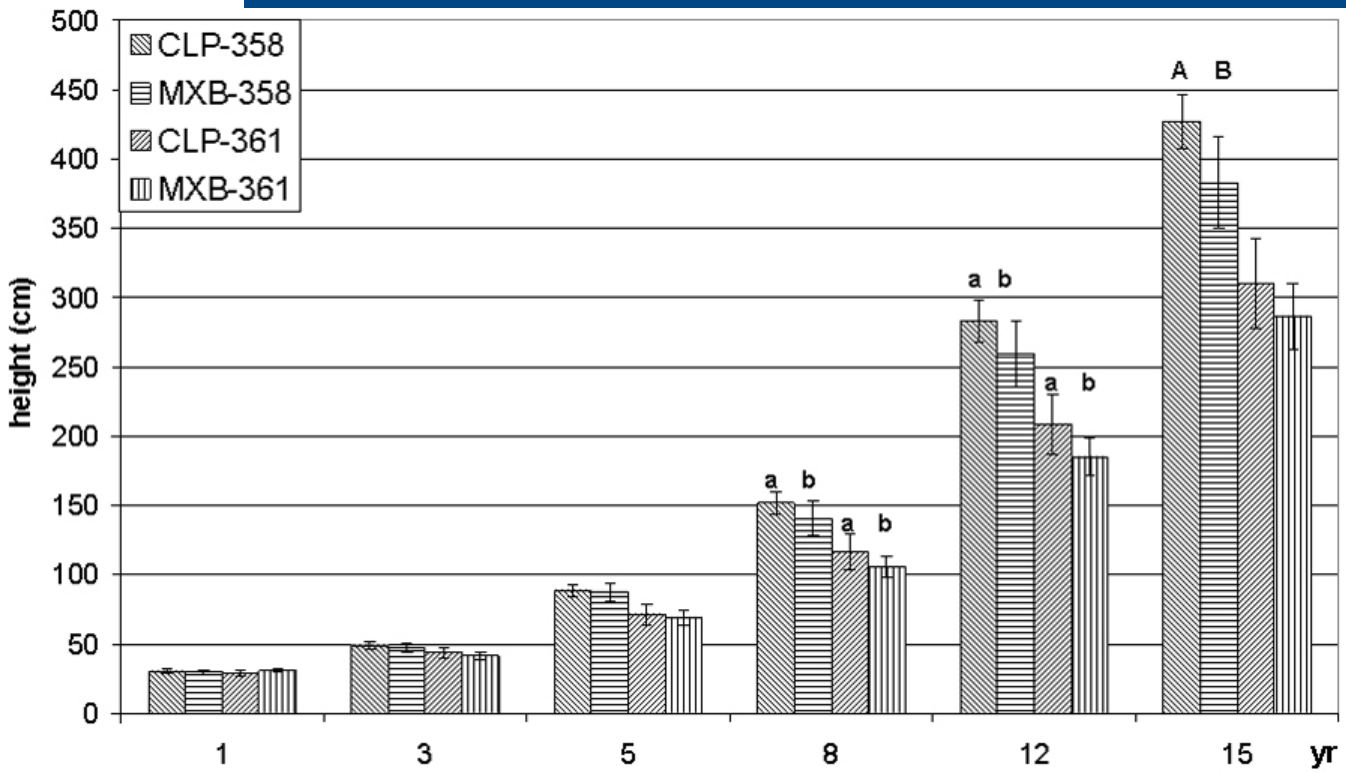

Figure 2: *Mean height for spruce by year, treatment and replicate on a subset of 40 trees in each treatment. CLP: Clumped plantation, MXB: Mixed bag plantation; 358 and 361: replicates. Bars with different letters indicate significant differences between treatments within replicates, in the Tukey test with p <0.05 (lower case letters) and <0.01 (capital letters).The vertical lines at the top of each bar show the standard error (±) of the mean height.*

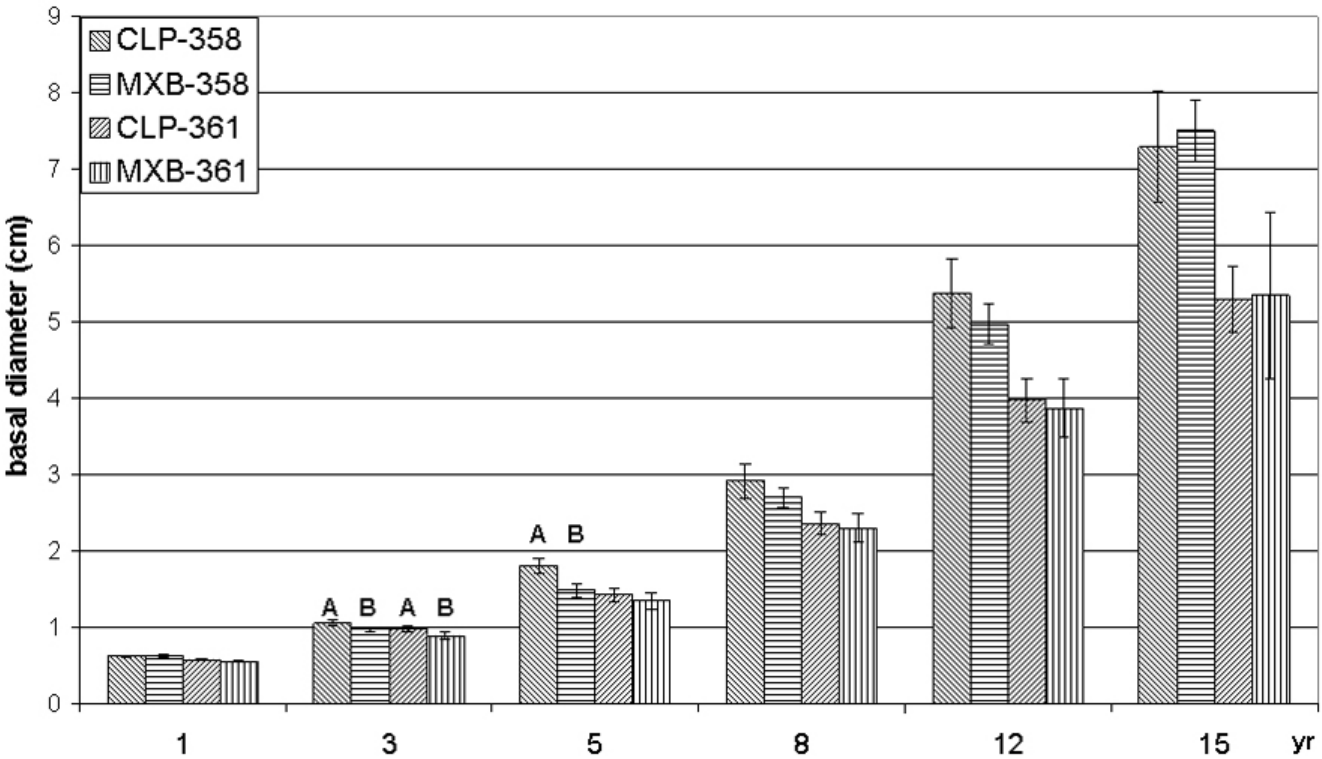

Figure 3: *Basal diameter for spruce by year, treatment and replicate on a subset of 40 trees in each treatment. CLP: Clumped plantation, MXB: Mixed bag plantation; 358 and 361: replicates. Bars with different letters indicate significant differences between treatments within replicates, in the Tukey test with p <0.05 (lower case letters) and <0.01 (capital letters). The vertical lines at the top of each bar show the standard error (±) of the mean basal diameter.*

Clump planted spruce also exhibited significantly greater basal diameter growth than those in the mixed bag treatment in years 3 and 5 (α=0.05) and continued with this general trend through year 12. At year 15, however, the trend changed. While not statistically significant, the mean basal diameter of spruce in both replicates was greater in the mixed bag treatment than those growing in clumps.

A tally of spruce with terminal weevil damage was collected in year 15. To asses if the observed differences were significant for two hypotheses, a two-tailed z-test using the sample standard error of the proportion were carried out at α=0.05. Null hypotheses were: 1) H_0: attack level was 30% for all plots (the expected value on pure spruce plantations in B.C. at year 15[4]), and 2) H_0: the attack level by treatment is equal to the mean percent attacked for all samples combined. Table 1 summarizes the data and results.

Table 1: *Two-tailed z-tests using the sample standard error of the proportion were carried out at α=0.05 to assess treatment effect on incidence of spruce terminal weevil (IWS). 1) Null hypothesis used assumes an equal attack of 30% of living spruce, for all the treatments and replicates. 2) Null hypothesis used assumes an equal attack of the mean attack for the entire project: 14.49%. Shaded cells in Result row indicate the rejection of null hypothesis.*

Observed data					
Plot	CLP-358	MXB-358	CLP-361	MXB-361	ALL
Observed IWS	8	13	10	10	41
Non attacked	77	55	51	59	242
Total	85	68	61	69	283
Proportion IWS	0.0941	0.1912	0.1639	0.1449	0.1449
1) H_0: attack level of 30% for all plots (the expected value on pure spruce plantations in B.C. at year 15)					
H_0: p=	0.30	0.30	0.30	0.30	0.30
z-test statistic	-6.501	-2.281	-2.871	-3.660	-7.412
$Z_{0.05}$	(-1.645;1.645)				
Result	H_0 rejected	H_0 rejected	H_0 rejected	H_0 rejected	H_0 rejected
2) H_0: attack level by treatment is equal to mean percent attacked for all samples combined (41/283=0.1449)					
H_0: p=	0.1449	0.1449	0.1449	0.1449	
z-test statistic	-1.604	0.971	0.4001	0	
$Z_{0.05}$	(-1.645;1.645)				
Result	H_0 Not rejected	H_0 Not rejected	H_0 Not rejected	H_0 Not rejected	

Spruce in both prescriptions combined are experiencing about half the expected levels of attack at year 15 (14.49% vs. 30%). Weevil attack levels are below 30% in all samples. At year 15, no differences in weevil attack can be detected between or within treatments.

Cooley spruce gall adelgid (*Adelges cooleyi*) is occurring in 59.3% of the living spruce trees at year 15, without significant differences between or within treatments.

Discussion

The improved growth in the clump planted spruce over mixed bag planted spruce reported in Trethewey 2000 appears not to be persisting at year 15. While one clumped replicate continues to exhibit significantly greater mean height, the trend does not persist for both replicates. There also appears be a shift occurring whereby mean basal diameter of the clumped trees is, at least anecdotally, becoming smaller than that for the mixed bag.

[4] Terminal Weevils Guidebook. Forest Practices Code. http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/WEEVIL/figure3.htm

The clumped treatment in block 361 ceases to show a significant mean height difference from the mixed bag treatment at year 15. As far back as the year 5 measurements, mean basal areas for both treatments in this block have not been significantly different, though the clump planted trees have tended to be larger. At year 15, the mean basal diameter for the mixed bag spruce is marginally greater than that for the clumped.

The clumped treatment in block 358 has shown significantly greater mean height values at years 8, 12 and 15 over those in the mixed bag treatment. The mean basal diameter, always greater (not significantly) for the clump planted spruce up until and including year 12, is less than that for the mixed bag spruce at year 15 in this block as well.

Spruce in the clumped treatment are apparently becoming tall and skinny. This form is often a function of inter-tree competition for light whereby height increment is favoured over diameter increment. The clump configuration of 3 interior spruce surrounded by 4 lodgepole pine at 1 m inter-tree distances is likely inducing competition effects at this point in time. Pre-commercial thinning of the pine, as originally scheduled in the prescription, should now be considered.

Both the mixed bag and clump planted treatments at year 15 show significantly lower incidences of spruce weevil damage compared to the expected value of 30% attack on 15-year-old pure spruce plantations in the province. There were no significant differences to suggest one treatment is more effective than the other. As the Terminal Weevil Guidebook recommends using stands >15 years old to identify the peak levels of annual attack, continued monitoring of weevil damage in relation to each treatment should be continued.

Conclusions

After 15 years of growth, spruce planted in clumped and mixed bag configurations are showing comparable growth, though the form of the clumped spruce is beginning to be affected by inter-tree competition. There are no apparent differences in spruce weevil occurrence between treatments and both are exhibiting less than half the expected occurrence in pure spruce stands at age 15. Further monitoring through year 20 should clarify treatment effectiveness at reducing weevil occurrence as peak levels of weevil damage is expected in stands older than 15 years.

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