PIGMENTS FOR USE ON CONIFER SEEDS SOWN IN FOREST NURSERIES

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Cover: Seeds of Douglas-fir treated with WATCHUNG RED (upper left), BRILLIANT YELLOW (upper right), BRILLIANT BLUE (lower left), and untreated (bottom right). Seeds are approximately 2X.

Abstract

Growth room and nursery experiments were conducted to determine the possible phytotoxic effects of three seed-applied pigments [Reeves' Brilliant Yellow (Ost) No. 59 Redimix and Brilliant Blue No. 51 Redimix, and DuPont's Watchung Red B RM-417-D] on germination and seedling growth of Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco], Sitka spruce [*Picea sitchensis* (Bong.) Carr.], white spruce [*P. glauca* (Moench) Voss], lodgepole pine (*Pinus contorta* Dougl.) and western hemlock [*Tsuga heterophylla* (Raf.) Sarg.]. In the growth room, none of the three treatments harmed germination of: (i) good or poor quality (based on both germination capacity and germination speed), stratified and unstratified seeds, or (ii) seeds stored for 2 and 4 weeks after treatment. The treatments were not detrimental to seed germination or seedling growth at Koksilah and Surrey forest nurseries.

Résumé

En serre et en pépinière, les auteurs effectuèrent des tests afin de déterminer si des effets phytotoxiques pouvaient être produits par trois teintures appliquées sur des graines de Douglas latifolié [*Pseudotsuga menziesii* (Mirbel) Franco], Épinette de Sitka [*Picea sitchensis* (Bong.) Carrière], Épinette blanche [*P. glauca* (Moench) Voss], Pin tordu (*Pinus contorta* Dougl.) et de Pruche occidentale [*Tsuga heterophylla* (Raf.) Sarg.] lors de la germination et de la croissance des semis. Ces teintures sont le jaune vif de Reeves (Ost) n^{o} 59 Redimix, le bleu vif de Reeves n^{o} 51 Redimix et le rouge watchung de DuPont B RM-417-D. En serre, aucune des trois teintures n'affecta la germination (i) de graines de bonne ou mauvaise qualité (fondée sur leur faculté germinative et leur vitesse de germination), stratifiées ou non, ou (ii) de graines emmagasinées durant 2 ou 4 semaines après teinture. Ces teintures n'affectèrent pas la germination des graines ou la croissance des semis en les pépinières forestières de Koksilah et de Surrey.

Introduction

Numerous pre-sowing treatments have been used to prevent losses of forest tree seeds to various pests (6, 10). Recently, our studies (7,9) in the growth room and in field trials in British Columbia Forest Service (BCFS) nurseries on several fungicide seed treatments for pre- and post-emergence damping-off control showed that the fungicides, which effectively controlled damping-off, were phytotoxic to seeds and germinants, i.e., gains in disease control were offset by phytotoxicity losses and none of the treatments increased final seedling numbers. These findings led to the recommendation that fungicides, most of which are colored, not be used on seeds sown locally. However, untreated seeds were difficult to see during sowing. Red lead and lithofar red AS dye have been used to color seeds in British nurseries (1); the former may harm germination while the latter involves a complicated procedure of pre-coating the seeds with oil.

The purpose of the present study was to determine the possible phytotoxic effects of three locally available and easily applied materials for coloring seeds commonly sown in BCFS nurseries.

Materials and Methods

Experiment 1. **Effects of pigments on germination of good and poor quality, stratified and unstratfied seeds.** Germination tests were conducted according to international seed testing rules (3), using modified Jacobsen germinators (5), for five tree species, viz., Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco], coastal form, Sitka spruce [*Picea sitchensis* (Bong.) Carr.], white spruce [*P. glauca* (Moench) Voss], lodgepole pine (*Pinus contorta* Dougl.) and western hemlock [*Tsuga heterophylla* (Raf.) Sarg.]. Germination parameters for high and poor quality seeds, based on capacity and speed of germination, are listed in Appendix I. Stratified (11) and unstratified seeds of both seed qualities were used in the experiments. The treatments (pigments) used, in powder form, were: (i) Reeves' Brilliant Yellow (Ost) No. 59 Redimix, (ii) Reeves' Brilliant Blue No. 51 Redimix, and (iii) DuPont's Watchung[R] Red RM-417-D[1/]. For simplicity, these materials are referred to throughout the remainder of the text as the yellow, blue or red pigments; their chemical composition, prices, etc., are given in Appendix II. Pigments were applied at the rate of 5% of seed weight, after stratification, by shaking the seeds with the powder in a small container for 1 minute. This dosage rate had been determined in preliminary trials to be in excess of the amount of pigment that would cling to the seeds. Seeds were surface dried for 10 to 15 minutes before applying the powder; treated seeds were separated from excess powder before the germination tests began. Control seeds were shaken but received no pigment. Each treatment and control was replicated four times (50 seeds per replicate) in a completely random design in the germinator. Germinants were counted daily for 28 days. At the end of the period, ungerminated seeds were cut longitudinally and biochemically tested, using tetrazolium chloride, for remaining viability; they were also classified as rotted, firm, empty or insect filled. Germination capacities, peak values, germination values (4) and R_{50} values (2) were calculated (see footnote 2 in Appendix I). Data, transformed to correct for heterogeneity of variance, were subjected to analysis of variance; means were compared using the Student-Newman-Keuls' test (8).

Experiment 2. **Effects of post-treatment storage time on germination.** Stratified (11) seeds of intermediate quality, except western hemlock for which a high quality seedlot was used (see Appendix I), treated with the pigments as in experiment 1, were stored in plastic bags at 2 to 3 C for 0, 2 and 4 weeks

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1/ Trade names included to identify products. No endorsement is implied by the Canadian Forestry Service.

before being germinated; seeds were allowed to remain in contact with excess pigment during storage. Germination conditions, parameters measured and statistical analyses of the data were the same as in our first experiment.

Experiment 3. **Effects of pigments on germination and seedling growth at Koksilah and Surrey nurseries.** Stratified, intermediate quality seeds were treated with the pigments as in experiment 1. At Koksilah, Douglas-fir and Sitka spruce seeds were sown in May 20 and 22, 1975, while Douglas-fir, white spruce and lodgepole pine were sown on May 13 and 14, 1975, at Surrey. A randomized complete block design (8), with six replications of each treatment and control, was used at both nurseries. The plots for each species were laid out along seedbeds considered to have representative nursery soil and environmental conditions. After sowing, the seeds were covered with 0.64 cm (0.25 inch) of washed, coarse sand. Throughout the growing season, fertilizing, irrigation and plot care followed normal nursery practice (11). Counts of live seedlings were made 4 weeks after the seeds were sown and again in mid-August and the end of October 1975. At the time of the last count, seedling height (soil line to base of the terminal bud) was measured for eight randomly selected seedlings from each treatment in each plot. The seedling count and shoot growth data were transformed to correct for heterogeneity of variance and subjected to analysis of variance. The Student-Newman-Keuls' test (8) was used to determine differences between treatment means.

Results and Discussion

In our first experiment, none of the pigments seriously affected any of the germination parameters of either good or poor quality, stratified or unstratified seeds of the five species tested (Table 1)[2]. Some interactions between seed quality, stratification and pigment were noted. For example, the red pigment was associated with increased germination (all parameters) of poor quality Douglas-fir seeds, whether or not stratified, whereas in Sitka spruce, the same pigment tended to increase germination in stratified, poor quality seeds but to reduce germination in unstratified, poor quality seeds. The effects, however, did not reach practical proportions. The failure of those poor quality seeds that did not reach 50% germination after 28 days was not related to seed treatment. In general, stratification did not affect germination capacity of good quality seeds, but it was usually detrimental to poor quality seeds. For example, the germination capacity of stratified, poor quality, untreated seeds was significantly ($P = .05$) reduced by about 14, 6, 4 and 31% for Douglas-fir, Sitka spruce, white spruce and lodgepole pine, respectively. Germination also tended to be slower (lower peak values) in stratified, poor-quality seeds. In contrast, the speed of germination of good-quality seeds (including western hemlock) was usually significantly improved by stratification, as indicated by the lower R_{50} values and increased peak values. The tetrazolium chloride test made at the end of the 28-day germination period revealed that all filled, ungerminated seeds had rotted; apparently none of the pigments affected the responsible microbes. We conclude that the pigments had no detrimental effects on either good or poor quality, stratified or unstratified seeds.

Overall in the second experiment, colored seeds suffered no serious ill-effects after storage for 2 and 4 weeks (Table 2). Neither treated nor untreated western hemlock

[2] Germination values reflected trends identical to those shown by the germination capacities; thus, for conciseness, the germination values have been omitted from Tables 1 and 2 (these data are available from the senior author).

germinated; thus, this species is not included in the table. In Sitka spruce, red and yellow pigments reduced germination capacity by 9 and 15%, respectively, after 4 weeks, following the same germination trend with storage as the control seeds; germination of seeds treated with blue pigment did not deteriorate. In contrast, the germination capacity of blue treated white spruce seeds tended to deteriorate with storage, as did the controls, while yellow and red treated seeds showed no deterioration. Although certain differences between treated and untreated seeds were found to be statistically significant, they did not amount to any practical proportion.

Speed of germination, as indicated by R_{50} values and peak values, also tended to decline with 4 weeks' storage in both Sitka and white spruce seeds, irrespective of treatment with pigment; in most instances, these effects were not significantly different from untreated seeds. In Douglas-fir and lodgepole pine seeds, storage had virtually no effect on capacity or speed of germination. The results indicate that pigmented seeds can be stored up to 1 month without seriously reducing viability. During storage, condensation collected on the walls of the plastic bags in which the seeds were retained; this moisture dissolved some of the blue and yellow pigments. Seeds coated with the water insoluble red pigment were not affected.

In the nursery trials (experiment 3), the only effect on germination occurred at Koksilah nursery, where plots sown with blue-pigmented Douglas-fir seeds contained significantly fewer seedlings than plots sown with other pigmented seeds, 5 and 12 weeks after sowing (Table 3). Treated seeds were readily visible when sown and the Watchung Red adhered to the seedcoats even after the seeds had emerged. Post-emergence losses of pigmented seeds did not differ significantly from the controls after 22 weeks. Seedling heights were unaffected by any of the treatments.

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Table 1. Germination responses of stratified (S) and unstratified (US) seeds treated with pigments.

Species, seed quality and pigments	Germination capacity, % 2/		Peak value		R50 3/	
	S	US	S	US	S	US
DOUGLAS-FIR						
Good quality 1/						
Yellow	X90.0a	Y81.0a	X5.1a	Y2.9a	X10.7a	Y13.7a
Blue	X88.3a	X85.0a	X5.9a	Y3.6a	X10.5a	Y13.9a
Red	X91.0a	X84.0a	X5.4a	X3.5a	X10.7a	Y12.7a
Control	X87.0a	X88.0a	X5.6a	Y3.1a	X10.5a	Y13.9a
Poor quality						
Yellow	X35.5a	Y53.3a	X1.5b	X2.0a	----	*
Blue	X38.5a	Y50.5a	X1.6b	X1.9a	----	*
Red	X45.0a	Y57.3a	X2.5a	X2.2a	----	*
Control	X41.3a	Y55.0a	X2.0ab	X2.0a	----	*
SITKA SPRUCE						
Good quality						
Yellow	X88.5a	X90.3a	X6.2a	Y5.1a	X 9.5a	Y12.1a
Blue	X88.0a	X86.8a	X6.4a	Y5.2a	X 9.3a	Y11.5a
Red	X90.8a	X84.8a	X5.4a	X5.2a	X 9.9a	Y11.5a
Control	X91.5a	X88.3a	X6.6a	Y4.6a	X 9.5a	Y12.2a
Poor quality						
Yellow	X58.8a	Y76.3a	X3.5a	Y4.8a	X13.6a	X12.6a
Blue	X56.3a	Y73.0a	X3.8a	X4.4a	*	12.8a
Red	X71.3a	X68.5a	X4.8a	X4.3a	X12.1a	X13.0a
Control	X64.8a	Y70.8a	X3.9a	X4.2a	X13.1a	X13.5a
WHITE SPRUCE						
Good quality						
Yellow	X91.3a	X91.8a	X8.0a	X7.7a	X 8.2a	X 8.7a
Blue	X87.8a	X90.3ab	X8.4a	X7.5a	X 8.0a	Y 8.8a
Red	X87.0a	X84.3b	X7.9a	X6.5b	X 7.9a	Y 9.0a
Control	X91.0a	X89.3ab	X5.2b	X6.8ab	X 8.4a	Y 9.4a
Poor quality						
Yellow	X46.8a	Y55.3a	X3.1a	X3.6a	----	15.2a
Blue	X48.0a	Y58.0a	X3.4a	X4.0a	----	13.4a
Red	X43.8a	Y57.8a	X3.2a	X3.6a	----	*
Control	X50.8a	Y54.8a	X3.6a	X3.7a	*	13.7a
LODGEPOLE PINE						
Good quality						
Yellow	X90.5a	X85.7a	X10.2a	Y7.1a	X 6.7a	Y 8.6a
Blue	X85.8a	X87.5a	X 9.8a	Y8.1a	X 6.4a	Y 7.9a
Red	X89.8a	X88.5a	X10.3a	Y8.1a	X 6.4a	Y 8.1a
Control	X91.3a	X88.0a	X10.7a	Y8.4a	X 6.3a	Y 7.8a
Poor quality						
Yellow	X35.3b	Y70.3a	X3.4b	Y5.3a	----	9.2a
Blue	X31.0b	Y58.8b	X3.0b	X3.6a	----	10.7a
Red	X46.5a	Y59.8b	X4.6a	X4.7a	----	11.0a
Control	X32.3b	Y63.0ab	X3.0b	Y5.1a	----	10.5a

Table 1. (Continued)

Species, seed quality and pigments	Germination capacity, % 2/		Peak value		R_{50} 3/	
	S	US	S	US	S	US
WESTERN HEMLOCK						
Good quality						
Yellow	X96.3a	X96.3ab	X4.7a	Y3.4a	X15.2a	Y20.4a
Blue	X97.5a	X97.8a	X4.7a	Y3.6a	X14.2a	Y20.9a
Red	X97.8a	X97.0ab	X4.4a	Y3.5a	X14.9a	Y22.7a
Control	X96.0a	X94.8b	X4.8a	Y3.4a	X14.4a	Y20.5a
Poor quality						
Yellow	X33.3a	X33.5a	X1.3a	X1.2a	----	----
Blue	X28.3a	X30.8a	X1.1a	X1.1a	----	----
Red	X30.3a	X28.8a	X1.1a	X1.0a	----	----
Control	X29.5a	X31.3a	X1.1a	X1.1a	----	----

1/ Seed quality based on germination capacity and speed (see Appendix I for the parameters used to assign seed quality); the dosage levels for the seed pigments are given in the materials and methods section; the various germination responses are defined in Appendix I.

2/ Values are means of four replicates of 50 seeds each. Reading across, valid comparisons can only be made for means of stratified vs. unstratified seeds within each treatment for each germination parameter; when these means are preceded by a different letter (either X or Y) they differ significantly (P=.05). For example, under good quality Douglas-fir we see that germination capacity of yellow-treated, stratified (X90.0%) seeds differs from that of similarly treated, unstratified (Y81.0%) seeds. Valid comparisons of stratified vs. unstratified seeds can not be made among the different germination responses or among the pigment treatments within a germination parameter. Reading down, valid comparisons can only be made for those four means within each seed quality for a specific germination response such as germination capacity and only under either stratified or unstratified seeds. For example, none of the treatments significantly affected the germination capacity of good quality, stratified Douglas-fir seeds since each mean is followed by the same letter (90.0a, 88.3a, 91.0a, 87.0a). Similarly, none of the treatments affected germination capacity of unstratified, good quality Douglas-fir seeds since, once again, each mean is followed by the same letter (81.0a, 85.0a, 84.0a, 88.0a).

3/ Dash indicates that germination failed to reach 50% during the test period; * indicates that although germination averaged more than 50% it did not reach this level in all four replicates, thus an R_{50} value was not calculated.

Table 2. Effects of post-treatment storage (0, 2 and 4 weeks) of pigmented seeds on germination .

Species and pigments[1]	Germination capacity, %			Peak value			R_{50}		
	storage			storage			storage		
	0 wk.	2 wk.	4 wk.	0 wk.	2 wk.	4 wk.	0 wk.	2 wk.	4 wk.
DOUGLAS-FIR									
Yellow	67.0a	59.7a	59.7a	4.4a	4.1a	3.9a	11.8a	12.4a	13.1a
Blue	64.7a	63.3a	61.7a	3.8a	4.2a	4.1a	13.1a	12.3a	12.6a
Red	66.7a	65.0a	63.7a	5.1a	5.1a	5.3a	10.4a	10.6a	9.8a
Control	51.7a	55.0a	57.0a	3.0a	3.6a	3.0a	12.7a	18.3a	9.6a
SITKA SPRUCE									
Yellow	80.0a	73.7a	64.7ab	6.1a	5.8b	4.2c	9.6a	9.4a	8.9a
Blue	70.3b	74.7a	75.7a	5.5b	5.8b	6.0a	9.8a	9.8a	9.4a
Red	80.3a	72.0b	71.3ab	6.3a	5.9b	5.6a	9.5a	9.9a	9.6a
Control	75.3a	78.3a	57.7b	5.5b	6.8a	4.9b	9.6a	8.6a	6.4a
WHITE SPRUCE									
Yellow	63.7a	64.0a	63.3a	6.7a	6.1a	5.6a	8.2a	8.8a	9.2a
Blue	67.3a	58.0a	55.0a	6.5a	5.5a	4.9a	8.3a	9.2a	6.6a
Red	62.3a	62.0a	65.0a	6.1a	6.2a	5.9a	5.5a	8.7a	9.0a
Control	66.3a	56.3a	59.0a	6.9a	5.2a	5.3a	7.5a	6.0a	9.7a
LODGEPOLE PINE									
Yellow	79.3a	78.3a	78.4ab	10.3a	10.3a	9.9a	5.9a	5.7a	6.3a
Blue	75.7a	79.7a	78.0ab	10.2a	10.5a	10.5a	6.0a	5.5a	6.0a
Red	83.7a	84.3a	81.7a	10.7a	11.5a	9.4a	5.9a	5.6a	6.3a
Control	84.0a	73.0b	74.0b	11.0a	9.7a	10.0a	5.5a	5.9a	6.3a

[1] Intermediate quality (see Appendix I) stratified seeds were used for this experiment. Values are means of four replicates (50 seeds each) for each storage period. Reading down, within any one species, means followed by a different letter differ significantly ($P = .05$). For example, the germination capacity of untreated (control) lodgepole pine seeds, after 2 weeks of storage, was significantly lower than treated seeds (78.3a, 79.7a, 84.3a, 73.0b). Comparisons between germination parameters, storage periods and species are not valid.

Table 3. Numbers of seedlings and seedling heights during the first growing season in plots sown with pigment-treated seeds at Koksilah and Surrey nurseries.

Nurseries, species and pigments 1/	Numbers of seedlings and counting times (weeks from sowing) 2/			Seedling heights mm
	5 weeks	12 weeks	22 weeks	22 weeks 3/
KOKSILAH				
Douglas-fir				
Red	58.3a	57.0a	45.0a	91.3a
Blue	50.2b	47.2b	42.0a	86.1a
Yellow	59.3a	55.8a	46.5a	90.0a
Control	61.3a	59.5a	49.3a	84.9a
Sitka spruce				
Red	51.5a	49.3a	40.8a	37.9a
Blue	57.2a	52.5a	43.2a	37.0a
Yellow	52.2a	51.8a	45.2a	36.8a
Control	48.7a	46.3a	37.8a	36.6a
SURREY				
Douglas-fir				
Red	36.2a	24.5a	15.3a	86.1a
Blue	31.3a	20.5a	13.0a	80.1a
Yellow	40.7a	31.5a	21.2a	82.7a
Control	39.5a	27.0a	15.0a	84.6a
White spruce				
Red	40.2a	35.0a	34.8a	10.6a
Blue	31.8a	26.8a	24.8a	10.3a
Yellow	36.2a	29.5a	27.3a	11.4a
Control	28.0a	28.5a	27.7a	11.6a
Lodgepole pine				
Red	61.3a	52.5a	48.7a	64.3a
Blue	59.8a	55.3a	53.7a	67.3a
Yellow	67.8a	64.3a	59.5a	62.8a
Control	60.2a	51.7a	51.0a	63.9a

1/ See materials and methods for pigment concentrations, etc.; all seeds were of intermediate quality (see Appendix I).

2/ Values are means of six replicates of 100 seeds each. Reading down, valid comparisons can only be made for each group of four treatments (3 pigments plus control) within each species and counting time. Means followed by the same letter are not significantly different (P=.05). For example, after 5 weeks at Koksilah nursery, plots sown with red and yellow pigmented Douglas-fir seeds contained the same number of seedlings as plots sown with untreated (control) seeds; plots sown with blue-pigmented seeds contained significantly fewer seedlings (58.3a, 50.2b, 59.3a, 61.3a).

3/ End of October, 1975; soil line to base of the terminal bud.

Appendix I

Species, qualities, seedlots, and germination parameters of seeds used in the growth room and field experiments.

Seed species and qualities	Seedlot number 1/	Germination Parameters 2/ Germination capacity, %	Germination value	R_{50}
Douglas-fir				
High	315 (1959)	71.5	9.47	14.2
Intermediate	1255	51.0	4.51	21.5
Poor	544	24.0	0.80	-----
Sitka spruce				
High	1504	77.0	15.03	10.5
Intermediate	1866	60.0	7.72	15.3
Poor	1826	45.5	4.64	-----
White spruce				
High	2211	79.5	16.46	9.8
Intermediate	1862	44.5	5.61	-----
Poor	1863	36.0	3.77	-----
Lodgepole pine				
High	2203	78.5	17.41	9.2
Intermediate	2102	47.0	7.57	-----
Poor	2096	20.5	0.67	-----
Western hemlock				
High	SL1	95.0	16.70	13.9
High	SL2	84.8	12.92	14.5
Poor	980	37.5	?	-----

1/ B.C. Forest Service seedlot numbers except for the high quality western hemlock seeds which were supplied by the junior author. For western hemlock, the SL2 and 980 seedlots were used for the first experiment and SL1 was used for the second experiment.

2/ Germination parameters for stratified (11) seeds; values are means of four replicates of 50 seeds each; the dash indicates that an R_{50} was not reached in the 28-day test period; the question mark indicates that the parameter was not determined.

The formulas used to calculate the above germination parameters and also those used in tables 1 and 2 were:

(1) R_{50} = days to reach 50% germination; 28 day test period.

(2) Germination capacity (percentage) = germination capacity after 28 days.

(3) Germination value = MDG x PV where PV (peak value) of germination is the maximum quotient obtained by dividing daily the accumulated number of germinants by the corresponding number of days. MDG (mean daily germination) is the quotient obtained by dividing the accumulated total number of germinants by the number of days of the test (28 days in our experiments).

See Allen (2) for parameter one and Czabator (4) for the remainder.

Appendix II

Pertinent information on the pigments used in the growth room and in field experiments.[1]

I. The yellow and blue pigments.

A. Trade names, chemical compositions, and technical information:

1. BRILLIANT YELLOW (Ost) No. 59 Redimix. The pigment is Monolite Yellow G-classified as Permanent Yellow No. 3 in the Color Index. 4 Chloro-2 Nitroaline -0-Acetoacetanilide.

2. BRILLIANT BLUE No. 51 Redimix. Ultramarine C.I. Pigment No. 29. A Polysulfide of sodium (or potassium, lithium or silver) alumino-silicate of unknown constitution.

3. These pigments are mixed with natural chalks, dextrin is the adhesive and 0.1% para-chloro-meta-cresol is the preservative. The vehicle is water. These pigments are non-toxic to humans and there are no reports of toxicity to plants.

B. Manufacturer's name, addresses and telephone numbers:

1. Reeves and Sons Ltd., Lincoln Road, Enfield, Middlesex, EN1, 1SX, England. Telephone 01-804-2431.

2. Offices for Canada:
   a. Head Office: 100 Dolomite Drive, Downsview, Ontario, M3J 2N3. Telephone (416) 661-0491.
   b. 491 LeBeau Blvd., Suite 203, St. Laurant, P.Q. Telephone (514) 331-8570.
   c. 175 West Kent Ave., Vancouver 15, B.C. Telephone (604) 324-7396.

C. Quantities available and price:

1. 128 oz packages available; price not quoted.
2. 5 or 45 gallon (powder) containers in 30 to 60 days following notifying the manufacturer. Canadian price would range from $7.50 to $10.00 per gallon (June 1975), depending upon container size and quantity.

II. The red pigment.

A. Trade name, chemical composition and technical information:

1. Watchung Red B RM-417-D is Pigment Red 48 Color Index No. 15865, which is described as Permanent Red 2B pigment. It is an aluminum hydrate and barium sulfate extended coupling of 6-chloro-4-toluidine-3-sulfonic acid with 3-hydroxy-2-naphthoic acid. The composition of the standard product is: Red 2B Toner Pigment 41.7%, barium sulfate 29.2%, alumina hydrate 23.1%, and moisture 6.0%. The material contains no pesticides. It may contain minute quantities of heavy metals as a result of the use of commercial grades of raw materials.

1/ Supplied by the manufacturers.

B. Manufacturer's name, addresses and telephone numbers:

1. E.I. DuPont De Nemours & Co., Inc., Pigments Department, Export Sales, Centre Road Building, Wilmington, Delaware 19898, U.S.A.

2. DuPont of Canada Ltd., Box 26, Toronto-Dominion Centre, Toronto, Ontario, M5K 1B6. Telephone (416) 362-5621.

C. Quantities available and price:

The price of this pigment is $2.18 per pound in 160 pound drums. Quoted price (April 1975) is in U.S. funds, delivered to destination. Duty and applicable sales taxes are extra.

Canadian Forestry Service
Pacific Forest Research Centre
506 West Burnside Road
Victoria, B.C.

BC-X-146
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