USE OF THE GROWTH RETARDANT "MAINTAIN" BY GEORGIA KRAFT COMPANY

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Abstract.--The growth retardant MAINTAIN(TM) at the concentration of 300 PPM was beneficial in preparing loblolly pine for extended season planting. When applied soon after bud break, the terminals died, new buds formed and remained quiescent until August, stems and roots continued to develop. The planting season was extended by "storing" seedlings in the nursery bed and lifting them fresh as needed.

Additional keywords: Growth retardant, extended season planting, Pinus taeda.

A problem which has plagued Georgia Kraft Company is too many timberland acres to regenerate in too short of a time. In 1967 consideration was given to extending the four-month planting season, December 1 to March 31, which is acceptable if holidays and weather are not considered. During this season, pine seedlings are normally dormant which is the optimum condition for outplanting.

In addition to the large acreage to regenerate, there were idle men and machines in the off-season. Tree planters and tractors are expensive, making it difficult to justify the need for machines that are used a third of the year. Also, labor is an important factor with increasing wages and Company benefits. By extending the planting season, it was considered possible to plant more acres with fewer men and machines.

At this same time, there was research being conducted in Florida to plant slash pine (Pinus elliottii Engelm. var. elliottii) during the summer rainy season. The idea to use MAINTAIN (MAINTAIN-CF125 - U.S. Borax Co.) originated with Dr. Walter Beers of Buckeye Cellulose.

MAINTAIN-CF125 is manufactured by U.S. Borax and is available as an emulsifiable concentrate containing 12.5% a.i. This active ingredient interferes with the development of early growth stages in both monocotyledonous and dicotyledonous plants. MAINTAIN acts systemically being translocated from the leaves (or needles) to the meristematic tissue.

In the first tests, MAINTAIN was selected as the growth retardant and it was compared to sheared and cold storage loblolly pine (Pinus taeda L.) seedlings. In 1975 this research was expanded to other growth retardants. This report is a summary of this research and it is not an endorsement of a specific product.

PROCEDURE

During the evaluation of the use of MAINTAIN, several tests were carried out which overlapped in time which will be described separately in this report.

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The first study was initiated in the early winter of 1971 with the assistance of Dr. Mervin Reines, University of Georgia. A portion of a nursery bed at Georgia Forestry Commission's Morgan Nursery was reserved for the study involving 12,000 seedlings. These seedlings received the following treatments:

1. Portions of the bed were sheared at various times throughout the growing season to keep seedlings 8-10 inches and 12-14 inches in height.

2. Approximately 2,000 seedlings were sprayed with MAINTAIN, 300 PPM aqueous solution to which was added a spreader sticker (Reines, 1972). This application was made shortly after the beginning of terminal elongation.

3. Two bags of seedlings were lifted and placed in cold storage in the company's seed stratification room (35°-48°F) on the last day of operational seedling lifting. Roots were kept moist during storage (Newland, 1972).

Beginning on April 22 and continuing bi-weekly until November 19, 1971, seedlings were removed from the nursery beds and cold storage and hand planted using a replicated, randomized, split plot design. Two more chemicals were added to the test - "WILTPRUF," a top dip antitranspirant and a root dip of an alginate to prevent drying, tradename "AGRICOL" (Kennesaw Chemical Company). Survival by planting dates for the first 14 plantings is shown on Table 1.

Seedlings were lifted by hand or removed from cold storage on the day of planting. Upon counting, the sheared and cold storage seedlings were treated with AGRICOL or WILTPRUF and placed in buckets. The MAINTAIN-treated seedlings did not receive the root or top dip. The AGRICOL-treated seedlings received no further protection. All other treatments had the roots packed in wet peat moss. Seedlings were then transported to the planting site in Greene County, Georgia. Special precautions were taken at all times from lifting to planting to reduce root exposure.

Results of the above treatments were quite satisfactory as the summer of 1971 experienced well-distributed rainfall. Only three planting dates were classified as dry (May 7, June 4 and October 6), causing difficulty in hand planting. The treatments were analyzed and MAINTAIN was found to be a dependable treatment for extended season planting.

Many implications can be made from the data, but the big result was that fresh, quiescent seedlings were suitable for summer planting. While giving good results, shearing required four applications to maintain the desired seedling height.

When applied at bud break, MAINTAIN prevented terminal growth until early August; thereafter, growth was rapid until fall. This rapid late growth did not occur in the other treatments. MAINTAIN-treated seedlings respond with the death of the terminal bud or fresh shoot - the old needles were retained and diameter growth continued. The diameter growth produced stout, somewhat stiff seedlings which have been found difficult to plant (Newland, September, 1973).

Table 1.--Percent survival by planting date and treatments - October, 1971

Treatment	PLANTING DATE 4/27	5/7	5/21	6/4	6/18	7/2	7/14	7/29	8/12	8/26	9/8	9/22	10/6	10/20	Avg.
Sheared to 8"	87	90	93	43	93	93	93	83	80	80	83	63	43	100	80
Sheared to 8" + WILTPRUF	87	87	87	40	87	66	43	0	1	53	17	13	40	97	51
Sheared to 8" + AGRICOL	100	97	90	63	97	97	90	67	60	83	77	67	50	97	81
Sheared to 12"	80	80	87	60	93	80	80	77	57	77	83	63	53	100	76
Sheared to 12" + WILTPRUF	80	83	37	43	90	60	30	13	0	37	47	53	60	100	52
Sheared to 12" + AGRICOL	87	87	97	57	90	77	80	70	43	70	63	67	40	100	73
MAINTAIN	83	83	93	63	97	90	90	90	53	90	77	67	60	90	80
Cold Storage	67	77	63	30	87	83	70	93	73	NA	NA	NA	NA	NA	71[1/]
Cold Storage + WILTPRUF	87	67	63	50	90	77	83	63	50	NA	NA	NA	NA	NA	72[1/]
Cold Storage + AGRICOL	NA	NA	NA	NA	73	77	63	80	NA	NA	NA	NA	NA	NA	73[2/]
Cold Storage + AGRICOL + WILTPRUF	NA	NA	NA	NA	83	83	67	57	NA	NA	NA	NA	NA	NA	72[2/]

1/ Average applies to first nine periods only.

2/ Average applies to periods 5, 6, 7, and 8 only.

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Table 2.--Percent survival on February 1, 1973, percent soil moisture on day of planting and rainfall for the following two-week period

Planting Date	Treatment[1/] 1	2	3	4	5	6	7	8	9	Soil Moisture % of Wet Wt.	Rainfall Between Dates
5/3/72	72	86	69	51	70	56	55	81	68		
5/17/72	75	81	77	71	76	79	74	86	86	13.3	1.67
5/31/72	75	84	61	43	45	36	67	58	31	13.4	0.43
6/14/72	67	81	78	51	62	38	44	70	41	8.0	6.38
6/28/72	77	76	78	48	77	52	52	81	55	12.2	3.10
7/12/72	40	34	30	14	13	09	12	40	06	22.4	0.70
7/26/72	80	71	64	45	69	17	39	58	46	9.9	3.16
8/9/72	15	35	15	06	16	00	08	37	06	5.5	1.79
8/23/72	00	04	01	00	00	00	00	01	00	3.4	1.59
9/6/72	01	00	00	00	01	00	00	00	00	5.6	0.40
9/20/72	00	00	00	00	00	00	00	00	00	3.3	0.75
10/4/72	02	06	00	23	15	27	09	34	05	6.0	0.15
10/18/72	00	01	06	24	38	21	27	42	27	5.6	0.00
11/1/72	00	00	00	96	92	82	94	90	96	8.3	2.11
Overall	36	40	34	25	41	30	34	53	33		

1/ Treatment description

No.	Description
1	Cold stored
2	Cold stored and water
3	Cold stored and AGRICOL
4	Sheared
5	Sheared and water
6	Sheared and AGRICOL
7	MAINTAIN
8	MAINTAIN and water
9	MAINTAIN and AGRICOL

After the 1972 growing season, the tests were checked for survival, height growth and forking habit (Newland, April, 1973) which indicated no statistical difference for seedlings treated by shearing or MAINTAIN. Seedlings treated by either shearing method or MAINTAIN survived better and forked at approximately the same rate as cold storage seedlings.

After the 1973 growing season, the 1971 plantings were remeasured to compare the effect of MAINTAIN on height growth with cold storage seedlings (Newbold, May 7, 1974). The data were paired by planting dates and it was concluded that there was no significant statistical difference in height growth which led to the conclusion that there was no residual effect on terminal growth after the first season.

In 1972 a second study was installed to determine if the results from 1971 study were biased by the favorable rainfall pattern in 1971. In this test three main treatments were tested - cold storage, shearing to 8" and treating with MAINTAIN. On these three treatments were imposed two additional treatments - watering in with 0.1 gallon of water in the planting slit and dipping the roots in AGRICOL. The planting dates and survival are presented in Table 2 (Newland, May, 1973).

There were several differences in the two plantings. First, the rainfall in 1971 was slightly above normal and exceptionally well-distributed. In 1972 the rainfall was also slightly above normal, but was unevenly distributed. The normal dry period from late July through October produced almost drought conditions. The 1971 plantings were on a Davidson clay loam and the 1972 plantings were on a Molena sandy loam. The result was poorer overall survival in 1972.

In an attempt to secure better survival, the cold storage seedlings were kept in sealed plastic-lined bags until planting and these seedlings survived better than either the MAINTAIN-treated or sheared seedlings until late July when all treatments failed. In October, survival picked up for the sheared and MAINTAIN-treated seedlings which indicated that cold storage seedlings have a limited life in the bag. After the last of July, the bagged seedlings were not considered usable.

Watering improved the survival of the three basic treatments. Though not operationally feasible, this reinforced the belief that adequate soil moisture was necessary (Newbold, May 1, 1974) which makes upland sites of coarse soils not suitable for summer plantings.

Developmental field tests

Based on the 1971 test, operational tests were initiated on the Georgia Kraft Company Developmental Forest, Greene County, Georgia (Carson and Presnell 1975). Over a period of three years, 600 acres were planted with MAINTAIN-treated loblolly pine seedlings. The area planted was eroded Piedmont land which had been clearcut and site prepared by two chops with rolling drum cutters. The planter was a Reynolds double coulter pulled by a light crawler tractor equipped with a V-blade.

After the start of shoot elongation, MAINTAIN treatment was applied at the standard rate of 300 PPM (active ingredient) in 1972 and 1973. In 1975 the treatment was applied prematurely on dormant buds in February and had to be repeated in early April. The treatment kept the seedlings in a quiescent state until mid-July or early August. The new shoots typically twisted, curled, dried up, and fell off; however, new buds formed and remained dormant. Despite the first flush being lost, the seedlings in the beds continued to grow in diameter and developed a fibrous root mass requiring the trimming of some roots prior to planting.

For the three years reported, procedures varied to consider improvement in techniques as the result of previous observations. Permanent plots were established to monitor survival and growth - five rows of ten well-planted trees each.

1972

On three different dates, trees were lifted by regular nursery techniques starting at 8:00 a.m., placed in tubs, carried to the building for packing, and transported to a 58°F cool cellar. One day's planting was taken from storage at a time, and planting was conducted three days per week from May 15 to August 18, starting at 8:00 a.m. During this period, 150 M seedlings were planted on 275 acres and survival ranged from 93% to 10%.

1973

Lifting of seedlings in the nursery was changed to first light and all packing completed by 10:00 a.m. and the seedlings were placed in cool storage by noon. Seedlings were planted two days per week for six weeks, from June 6 to August 8. The scheduled workday was from 5:30 a.m. to 1:00 p.m. Fifty thousand seedlings were planted on 72 acres with survival between 89% and 48%.

1975

Seedling lifting began at first light, bagged in the field, and the sealed bags were placed in a refrigerated van at 35°-40°F within one-half hour after lifting. Planting was carried on for a full five-day week as weather and soil permitted, starting at 5:30 a.m. Survival was between 91% and 24% over the 293 acres planted.

The review of this work concluded that changes in practices at the nursery helped maintain the viability of the seedlings. Refrigerated vans are now a routine method of transporting seedlings. Storage at 35°-40°F retains seedling vigor better than at 58°F. Survival showed a definite decrease as storage time increased. An attempt was made to schedule planting sites by soil moisture conditions which proved impractical in the highly variable terrain due to loss of control and the crew spending a lot of time moving. The schedule evolved to one of plant the entire tract or do some other activity that day.

As the result of scheduled operational planting, several observations can be made: (1) If lifted weekly, MAINTAIN-treated seedlings will usually do well in May and June and during July and August they may be used on sites with favorable soil and moisture conditions; (2) soil and site seem to exert stronger influence than rainfall on survival; (3) during dry seasons the seedlings continue growing in the nursery beds and are available for the next season's planting; and (4) advance planning is a must for successful extended season planting.

Operational results

Operational planting and planning differ slightly from research or developmental work. During 1972 a wet, mixed-up season resulted in the tree planters being behind schedule. After bud break in the nursery, there remained a large number of seedlings to be planted. MAINTAIN was applied to 500 M seedlings which looked like a disaster when the withering flush was ready to drop. In 1974 conditions again required the operational use of MAINTAIN. Three areas were planted with a D-8 tractor pulling a pair of Taylor heavy-tapered disc tree planters. The following observations were made by operating personnel in each area:

1. Kathleen, Georgia (1972) - April and May, dry weather and medium texture soil, 76 acres, 50% survival, at three years trees looked good.

2. Kathleen, Georgia (1972) - April and May, dry weather, black gumbo soil, 192 acres, failure.

3. Monticello, Georgia (1974) - April, sandy clay loam, full stand survived. Many of the seedlings lost all their needles before a flush emerged in August.

4. Griswoldville, Georgia (1974) - April, sandy to sandy loam (Fall Line hills), 5 acres, survival 70%, planted with Reynolds double coulter and D-4.

SUMMARY

Georgia Kraft Company continues to have a need for an extended planting season. Research has provided several tools which, if used properly, permit successful planting for at least six months; however, pine seedlings are living organisms which have certain requirements that must be met for survival.

Three treatments have proven successful:

1. Shearing - This treatment requires more attention than other methods as survival is effected by the physiological state of the plant at the time of lifting. This method is best used for keeping seedlings in the nursery briefly after the normal planting season which requires planning of nursery space. Also, the treatment is very labor intensive.

2. Cold storage - More nurseries and planting crews are utilizing cold storage to insure the viability of the seedlings after lifting. If lifted before bud elongation, these seedlings have a shelf life of up to three months. The plastic-lined bags, which do not require watering until the seal is broken, store better than "jelly roll" bales. Temperatures of approximately 35°F have been most effective for storage. Cold storage also eliminates some of the problems in the coordinating of nursery and planting operations.

3. MAINTAIN treatment - The beds to be treated need to be remote from normal nursery operations. MAINTAIN should be applied after the buds break. Early application requires a repeat job and late application takes more out of the plant than necessary. Once MAINTAIN is successfully applied, no additional treatment is required until the seedlings are lifted.

With each of these treatments, the longer time extension beyond the normal planting season the more care is required to retain seedling viability. Supervision is the key to success of late season planting in that no treatment will be successful if the material is allowed to go into heat, exposed roots allowed to dry out, or sites are planted after the soil is too dry.

In 1975 a new study was installed at Alabama's Stauffer Nursery to evaluate other growth retardants (Little, 1977). In this study MAINTAIN was the control and four other commercial growth retardants were tested at the manufacturers' prescribed rates. Several retardants gave indications of potential value and one appeared to be the equal of MAINTAIN. Future studies will be implemented as a result of these preliminary evaluations.

The following characteristics were noted when loblolly pine seedlings were treated with MAINTAIN:

1. Seedlings treated before bud break will have to be retreated.

2. Seedlings treated after the bud elongates will have the terminal buds brown and die. The plant will develop new buds but will remain quiescent until about August.

3. With height growth retarded, the seedlings continue to grow in diameter and develop a fibrous root system. Thickening is noticeable on the stem with a layer of wood resembling summer wood being built up. In a short time, these seedlings are growing thicker, stiffer stems which tend to be more brittle than normal as a result of their continuing to store energy. Some treated seedlings tend to grow pear-shaped (similar to one with a basal Cronartium infection).

4. Two to three years after planting, the MAINTAIN treatment is no longer noticeable with normal height growth and average forking. When outplanted during a dry spell, some have lost all their needles, and now these seedlings can only be identified by the planting site.

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