

CYTEX[®] AND OTHER CHEMICALS
EFFECTIVELY INHIBIT CONELET ABORTION IN LONGLEAF PINE

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Abstract.--Yields in longleaf pine seed orchards could be much improved by treating foliage and conelets in spring with anti-abortion chemicals. Cytex[®], an extract of marine algae, is an economical source of cytokinin activity. When applied operationally as a 1 percent foliar spray using a mist blower, Cytex increased first-year conelet retention from 33 to 62 percent, 51 to 78 percent, and (with boron) from 33 to 72 percent respectively in three separate annual tests. The anti-abscission chemicals 8-hydroxyquinoline, cobalt chloride, and picloram increased first-year cone retention from 51 percent to 83, 81, and 75 percent, respectively, in 1982.

Premature shedding of conelets (1st year female strobili) is a serious problem in longleaf pine (*Pinus palustris* Mill.) tree improvement programs. In some years 90 percent or more of the conelets are shed prematurely (White et al. 1977), leading to the typically low seed yields in most longleaf pine orchards (Hare 1981). The cause of this "physiological drop" of conelets, which is not due to cone insects or lack of pollination, is unknown but may be related to ethylene production by the foliage or expanding shoots. Foliar sprays with antiethylene compounds or cytokinins have been shown to decrease conelet loss by half and increase seed yield per original conelet up to six-fold (Hare 1981). Boric acid (B) added to the sprays enhanced the effects of some active compounds.

Although several compounds were shown to be effective, none of the antiethylene compounds are available commercially, and purified cytokinins like benzyladenine (BA) are very expensive. A more economical commercial product with cytokinin activity is Cytex^{®2/} (Atlantic and Pacific Research, Inc., North Palm Beach, Florida). Cytex (CX) is an aqueous extract of marine algae with about 100 ppm kinetin equivalents by bioassay (Brain et al. 1973, Ketring and Schubert 1981). Three bioassay methods were used, based on fresh weight increases in carrot explants, radish leaf discs, and callus cultures. It is registered for increasing yield by stimulating growth in a number of agricultural crops (tomato, potato, celery, citrus). In a preliminary 1980 experiment, the effects of 0.1 percent BA and 1, 3, and 5 percent CX on

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conelet abortion were compared in a longleaf pine seed orchard. Conelet-bearing branches on three trees each were sprayed in late April with water, BA, or CX, all containing 0.1 percent Tween-20 surfactant. Conelet survival in October averaged 28 percent for water control, 38 percent for BA, and 53 percent for the 1 percent CX. Higher levels of CX were less effective. CX thus appears to be a practical substitute for BA.

In addition to the six chemicals already reported (Hare 1981), there are a number of chemicals with reported anti-abscission, antiethylene, or cytokinin activity which might be investigated. Aminoxyacetic acid (AOA) inhibited ethylene synthesis in carnation (Broun and Mayak 1981), Tordon (TORD) (picloram) inhibited citrus abscission (Einset et al. 1981), coumarin (COUM) inhibited coleus leaf abscission (Gupta 1970), cobalt (CoC12) inhibited ethylene synthesis in bean and apple (Lau and Yang 1976), 8-hydroxyquinoline (8-HQ) is a powerful ethylene synthesis inhibitor (Parups and Peterson 1973), and 3,5-diiodo-4-hydroxybenzoic acid (DIIIB) inhibits ethylene production by cress roots (Robert et al. 1975). Purines related to BA which might have cytokinin activity include dodecylaminopurine (DDAP) and 6-chloropurine (6-CP), both obtained from Polaroid Corporation.

This study investigates the effects of CX and the above chemicals on conelet abortion in longleaf pine seed orchards. Experiment 1 was a pilot study to see if CX could be used operationally with a mist blower to increase seed yield. Two levels of CX were tested with and without two levels of B, all compared to a surfactant control. Experiment 2 was an exploratory study to compare the effectiveness of nine chemicals and a control using a hand sprayer and bucket truck.

MATERIALS AND METHODS

Experiment 1.--Ninety 19-year-old grafted longleaf pine trees at the Erambert Seed Orchard in south Mississippi were selected on the basis of good seed cone production, ignoring clones. In April 1982, healthy first year conelets were counted on each tree, and 10 trees at random were assigned to each of nine treatments (Table 1). All solutions contained 0.05 percent (v/v) Aromox C/12W[®] surfactant (ArmaK Corp., McCook, Ill.). Solutions were applied on May 4, using a mist blower and thoroughly wetting the crown from opposite sides of each tree. Surviving conelets were counted in October 1982.

Experiment 2.--In April 1982, 50 trees with good seed cone production were selected in the orchard, first-year conelets were counted, and five trees were assigned at random to each of 10 treatments (Table 1). In early May, treatments were applied by spraying conelet-bearing branches to the point of runoff with the appropriate solution from a hand pressure sprayer, using a bucket truck. All solutions contained 0.05 percent Aromox C/12W, Surviving cones were counted in October.

For both experiments, the percentage of spring conelets per tree surviving in October was used as the basis for analyses of variance and Duncan's multiple range test.

Table 1.--Chemicals and concentrations used in two foliar spray experiments^{1/}

Experiment 1			Experiment 2	
Treatment ^{2/}	Chemical Concent.		Treatment ^{2/}	Chemical Concent.
	CX	B ^{2/}		
	%			mg/l
Ck	0	0	Ck	control
CX-1	1	0	AOA	10.0
CX-2	2	0	TORD	0.6
B-1	0	0.13	BA	1000.0
B-2	0	0.26	DDAP	1000.0
CX-1 + B-1	1	0.13	6-CP	1000.0
CX-1 + B-2	1	0.26	COUM	100.0
CX-2 + B-1	2	0.13	CoCl ₂	1000.0
CX-2 + B-2	2	0.26	8-HO	100.0
			DIHB	200.0

^{1/}All solutions contained 0.05 percent Aromox C/12W[®]

^{2/} CX = Cytex, B = boric acid, AOA = Aminoxyacetic acid, TORD = Tordon (picloram), BA = benzyladenine, DDAP = dodecylaminopurine, 6-CP = 6-chloropurine, COUM = coumarin, 8-HO = 8-hydroxyquinoline, and DIHB = 3,5-diiodo-4-hydroxybenzoic acid.

RESULTS AND DISCUSSION

Experiment 1.--The best conelet retention occurred using 1 percent CX with 78 percent survival compared to 51 percent in the control (Fig. 1). The 2 percent CX spray was not significantly better than the control. In the 1980 experiment summarized in Table 2, 1 percent CX was also better than 3 or 5 percent, suggesting that CX may be inhibitory above 1 percent. Boric acid had no significant effect here, but its effects have been inconsistent (Table 2). Conelet retention was excellent with B alone in 1978 but the same concentration in 1979 was ineffective (Hare 1981). The inconsistencies may be related to variabilities in soil B content. The CX experiments summarized in Table 2 indicate that applying a 1 percent CX solution with the mist blower is an effective and economical way to improve longleaf pine orchard seed yields. Addition of 0.3 percent B may help.

The years 1981 and 1982 were exceptionally good conelet retention years in southern Mississippi, with over 50 percent retention from May to October (Table 2). In the previous 3 years controls ranged from 12 to 33 percent retention. High conelet retention levels in control trees reduce treatment effects on a percentage basis.

Experiment 2.--All but three of the nine compounds significantly increased conelet survival (Fig. 2). The best treatments were 8-hydroxyquinoline (83 percent survival), CoCl₂ (81%), and picloram (Tordon) (75%). Coumarin, 6-CP, DIHR, and BA treatments showed about 70 percent survival, compared to 51 percent for the control. Eight-hydroxyquinoline s a

strong ethylene synthetis inhibitor used to preserve cut flowers (Larsen and Frolich 1969). It is available commercially, as are CoCl_2 , Tordon, and coumarin. These compounds and H3B03 in combination with CX will be compared in 1983.

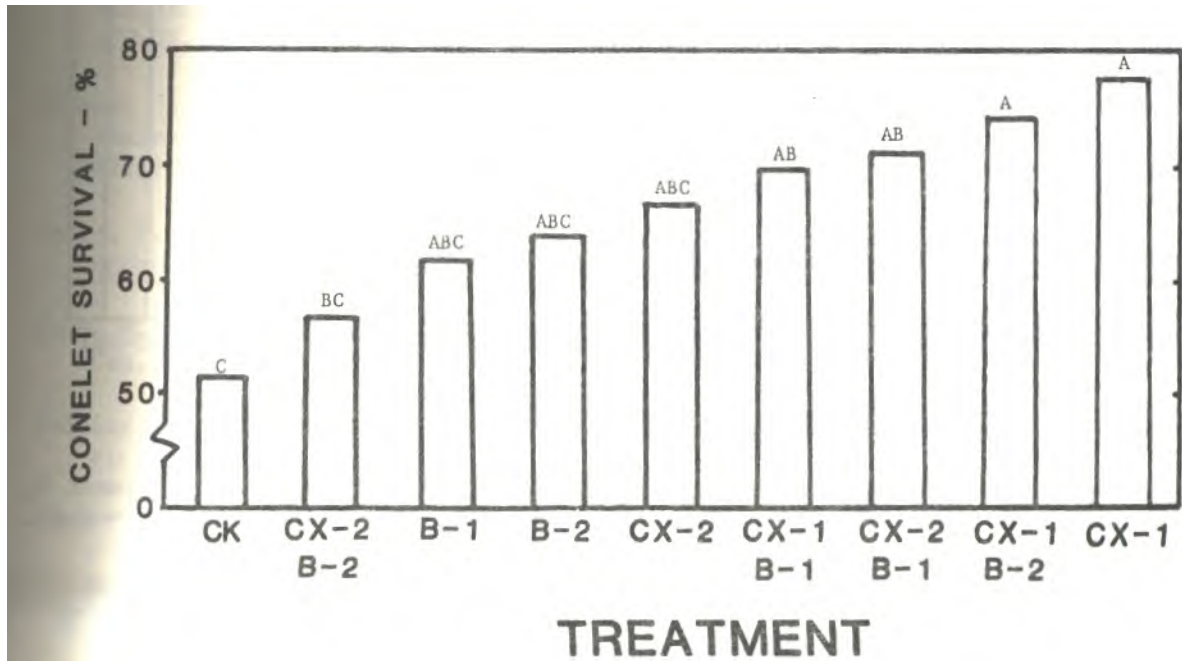


Figure 1.--Percent average survival of conelets in Experiment 1 by treatment, May to October. Bars with same letter do not differ significantly, $P = 0.05$. CK = control, CX-1 = 1 percent Cytex[®], CX-2 = 2 percent Cytex[®], B-1 = 0.13 percent boric acid, B-2 = 0.26 percent boric acid.

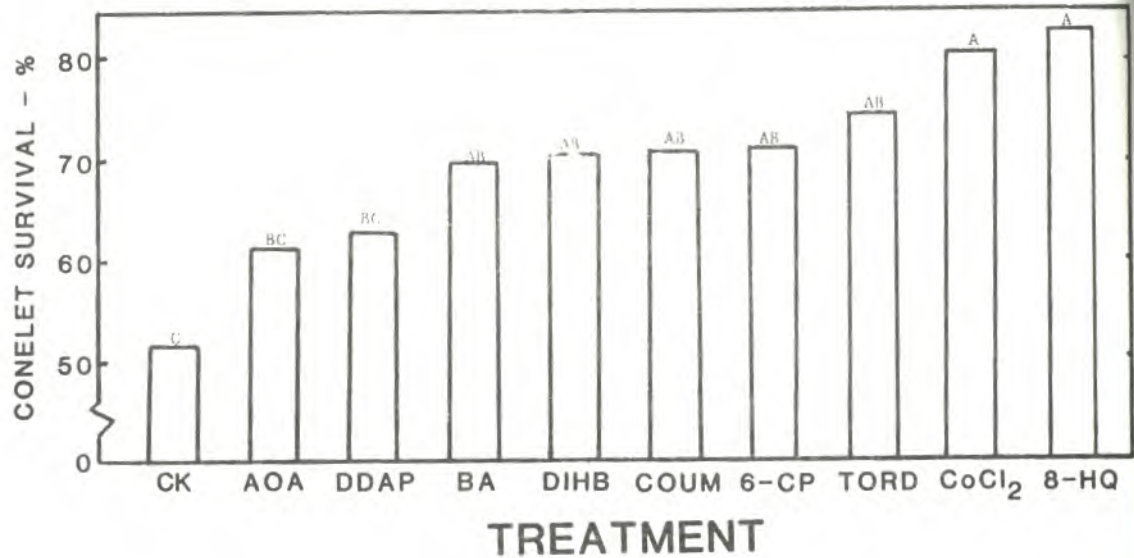


Figure 2.--Percent average survival of conelets by treatment in Experiment 2, May to October. Bars with same letter do not differ significantly, $P = 0.05$. See Table 1 for chemical abbreviations and concentrations.

Table 2.--Summary of six longleaf pine conelet abortion experiments, using boric acid and a cytokinin source.

Exp. Year	Type of Application	Chemicals used as foliar sprays ^{1/}								
		Control	B	PBA or BA	1% CX	2% CX	3% CX	5% CX	BA + B	CX 1% + B
-----Percent ^{2/} -----										
1978	Hand sprayer	19	49	55	--	--	--	--	--	--
1979	Hand sprayer	15	16	35	--	--	--	--	52	--
1980	Mist blower	12	32	25	--	--	--	--	21	--
1980	Hand sprayer	33	--	42	62	--	18	34	--	--
1981	Mist blower	53	64	--	57	--	--	--	--	72
1982	Mist blower	51	64	--	78	66	--	--	--	74

^{1/}PBA = (N-benzyl-9-(tetrahydro-2H-pyran-2yl)-adenine, BA = benzyladenine, B= boric acid, CX = Cytex®

^{2/}Percent of May conelets surviving in October of the treatment year.

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