

DEVELOPMENT OF COTTONSEED COATING TREATMENT IN CHINA

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Abstract

In Southern China the three way combinations of Nusan-Myclobutanil-Anchor, Nusan-Rhizolex-Anchor, Nusan-MBC-Anchor applied as a cottonseed treatment provided good seedling emergence and disease control. These treatments have higher effectiveness than each individual product. The seed cotton yields were increased from 9.9% to 18.7%. In Northern China the three way combinations of Anchor-Rhizolex-Furadan, Anchor-Nusan-Furada and Nusan-Myclobutanil-Furadan gave successful integrated pest management of soilborne and seedborne diseases and insect pests. Seed cotton yields were increased by 11.7% to 26.7%.

Introduction

Cotton seedling diseases and insects continue to be major threats in establishment of cotton stands. It is estimated that the loss of cotton production is about 10-30% due to seedborne and soilborne diseases and insects. Seed treatment is one of the most economical, effective and simple measures for controlling seed and seedling pests. However, in the past, control measures taken in most regions were not integrated but applied separately for individual disease and insect. In this case, they were laborious, inefficient, and uneconomical. Since 1980, nine cotton seed treatment formulations containing fungicide, insecticide, plant growth regulator, minor elements have been developed and manufactured for commercial use in China, Total extension acreages of coated cotton seeds was about 400,000ha in China. The Government pays more and more attention to a seed treatment program to fund this program in order to promote cottonseed treatment development in China. A new technology co-operation project is established between Wilbur-Ellis Company U.S.A. and Beijing Seed Treatment Technology Center (BSTTC), CAU, 1995. They provided technical chemicals, such as myclobutanil, TCMTB (Nusan) and oxadixyl (Anchor). More than 30 new combined cotton treatment formulations have been prepared and physical, chemical and biological tests have been carried out in laboratory and greenhouse trials. Field trials of 16 promising formulations were conducted in eight selected sites in four provinces to evaluate the performances of single and most multiple

combinations of cotton seed treatments against seed and seedling diseases and insect pests.

Materials and Methods

I. Distribution of field trials.

Southern China: Dongtai (Jiangsu Province) Wangjiang, Wuhu, Huayang (Anhui province)

Northern China: Liaochen, Donying (Shandong Province) Yunchen (Shanxi Province), Guo yang (Anhui Province)

II. Cultivars of cotton:

Different commercial cultivars were used.

III. Field trial design and determination methods.

Heavy naturally infested and infected sites are used in field trials containing the following targets: seedborne and soilborne *Fusarium vasinfectum*, *Verticillium dahliae*, *Colletotricum gossypii*, *Rhizoctonia solani*, *Phytophthora boehmeriae*, *Pythium ultimum* *Fusarium moniliforme* and *aphis gossypii* etc. Treatments were replicated from three to eight times in a randomized complete block design. One week after planting the treated cottonseed, rot, emergence, diseased seedling, survival and aphid data were counted and tabulated.

IV. Samples of seed coating Treatment Formulations

All the combined cotton seed formulation for field trial were prepared by BSITC, CAU and other standard chemicals provided by CAU (see table 1 and 2).

Table 1 New Combined formulations for Southern China

No. of Chemicals	Ingredients	% of AI total	Application rate FL, OZ AI/CWT
T1	Nusan	30%	1.2
T2	Anchor	31%	0.23
T3	Myclobutanil	24%	0.42
T4	Nusan Anchor	30.2%	1.2 0.23
T5	Nusan Myclobutanil	28.2%	1.26 0.44
T6	Nusan Myclobutanil Anchor	28.5%	1.08 0.36 0.20
T7	Nusan Rhizolex Anchor	33.2%	1.13 2.73 0.22
T8	Nusan MBC Anchor	33.2%	1.13 2.73 0.22
T9	Nusan TMTD Anchor	33.2%	1.13 2.73 0.22
T10	Nusan TMTD TMTD	33.2%	1.17 2.73 2.82
CL6	Rhizolex TMTD MBC Pix	26%	0.92 2.76 1.10 0.04
MBC(FL)	Carbondazim	35%	3.50

Table 2 New combined formulations for Northern China

No. of Chemicals	Ingredients	% of AI total	Application rate FL, OZ AI/CWT
T12	Nusan		2.12
	MBC	34%	5.12
	Fusadan		6.36
T13	Nusan		2.12
	TMTD	34%	5.12
	Furadan		6.86
T14	Anchor		0.86
	Rhizolex	34.6%	6.41
	Furadan		6.73
T15	Anchor		0.86
	TMTD	34.6%	5.41
	Furadan		6.73
T16	Anchor		0.86
	MBC	34.6%	8.41
	Furadan		6.73
T17	Anchor		0.88
	Nusan	33.4%	2.13
	Puradan		6.38
T18	Nusan		2.10
	Myclobutanil	32.5%	0.77
	Furadan		6.40
CL24	MBC		4.40
	Rhisolex	30%	2.10
	Corbofuran		3.10

Main Results

I. Southern Provinces

1. Effect of new seed treatment formulation on seedling emergence and diseases.

Most data from four sites of field trials in two Southern Provinces (Jiangsu, Anhui) showed that, three-way T6 (Nusan+ Myclobutanil+ Anchor), T7 (Nusan+ Rhizolex+ Anchor), T8(Nusan+ MBC+ Anchor) T9 (Nusan +TMTD+ Anchor) gave good seedling emergence and excellent control of seed rot and seedling disease complex (see table 3,4,5,6). Results indicated the four combinations provided more than 60% seedling emergence which are much better than three untreated control (31.2 - 40%). Good control of seedling disease complex resulted in percentages of seedling survival ranging from 57.6% to 82.75% which was significantly better than untreated control and similar to Chinese local seed treatment formulation no. 6 (Rhizolex+ TMTD +MBC +Pix). Based on successful results from pot tests of T6 and T7, field demonstration was carried out in Dongtai in the same season. They offered good disease control. Pot and plot tests showed that single compounds, such as Nusan or Anchor, did not give very good control of seedborne and soilborne diseases, but single Myclobutanil (FL) gave better control than Nusan and Anchor. Two-way combination (myclobutanil+Nusan) enhances more effectiveness than single treatment. Furthermore, the most effective combinations were formulated with three-way combinations which gave better control than single compounds.

Table 3 Results against diseases in field trial, 1995

(Wangjiang, Anhui)					
Treatment	# Seedling Emergence	% Seedling Emergence	# of Death	% of Death	% Seedling Survival
T1	226	53.8	68	16.4	21.5
T2	227	54.0	58	13.8	34.0
T3	252	60.0	45	10.4	48.8
T4	210	50.0	59	14.0	33.0
T5	381	66.9	36	8.6	58.9
T6	292	69.5	15	8.6	82.8
T7	273	65.0	18	4.25	79.9
T8	277	66.0	20	4.7	77.5
T9	190	45.2	45	10.7	48.8
T10	201	47.9	48	11.4	45.5
CLNO6	306	72.8	19	4.5	78.5
MBC	189	45.0	68	16.2	22.4
Untreated	155	36.9	88	20.9	-

- Note: 1) Number of cotton seeds sown in Nutrition pots in seedlings beds, 420.
 2) Sowing date: April 19, 1995.
 3) Inspection date: April 23-June 24, 1995.
 4) Here is Transplanting cotton.

Table 4 Results against diseases in field trial, 1995

Wuhu, Anhui					
Treatment	# Seedling Emergence	% Seedling Emergence	# of Death	% of Death	% Seedling Survival
T1	98	46.7	38	18.1	19.2
T2	109	51.9	24	11.4	50.1
T3	123	58.6	19	9.0	59.8
T4	99	47.1	29	13.8	38.4
T5	127	60.5	19	9.0	59.8
T6	149	70.9	9	4.9	78.1
T7	141	67.1	8	4.8	78.6
T8	130	61.9	11	5.2	76.8
T9	87	41.4	20	9.5	57.6
T10	103	49.0	21	10.0	55.4
CLNO6	139	66.2	10	4.5	79.9
MBC	94	44.8	32	15.2	32.1
Untreated	72	84.3	47	22.4	-

- Note: 1) Number of cotton seeds sown in Nutrition pots in seedlings beds, 210.
 2) Sowing date: April 21, 1995.
 3) Inspection date: April 25 - June 27, 1995.
 4) Here is Transplanting cotton.

Table 5 Results against diseases in field trial, 1995

Huayang, Anhui					
Treatment	# Seedling Emergence	% Seedling Emergence	# of Death	% of Death	% Seedling Survival
T1	181	43.15	101	24.04	4.0
T2	201	47.9	95	22.0	12.0
T3	220	52.4	51	12.0	52.0
T4	190	45.2	102	24.3	2.8
T5	264	62.3	49	11.7	63.2
T6	250	59.5	28	6.6	73.0
T7	284	67.6	18	4.3	82.0
T8	267	63.6	25	5.9	76.0
T9	277	66.9	20	4.8	80.0
T10	289	68.8	16	3.8	84.0
CLNO6	278	66.2	80	4.8	80.0
MBC	170	40.4	90	16.7	33.0
Untreated	147	-	105	25.0	-

- Note: 1) 420 cotton seed sown in Nutrition pots in seedling beds.
 2) Sowing date: April 21, 1995.
 3) Inspection date: April 25 - June 24, 1995.
 4) Here is Transplanting cotton.

Table 6 Results against diseases in field trial, 1995

Dongtai, Jiangsu							
Treatment	# Seedling Emergence	% Seedling Emergence	# of Death	% of Death	% Seedling Survival	Survival	
T1	706	68.8	3	207	17.3	6.35	6
T2	726	60.5	2	182	15.1	17.6	5
T4	707	58.9	3	198	16.5	10.4	4
T5	691	57.6	3	65	5.4	70.6	2
T6	766	63.8	1	42	3.5	81.0	1
T7	815	67.9	1	61	5.1	72.4	2
T8	821	68.4	1	64	5.3	71.1	2
T9	840	70.1	1	54	4.5	75.6	1
T10	732	61.0	2	187	15.6	15.3	3
Untreated	395	31.2	4	221	18.42	-	-

Note: 1) 1200 cotton seeds sown in Nutrition pots in seedlings beds.
2) Sowing date: April 7, 1995.
3) Inspection date: April 14 - June 9, 1995.
4) Here is Transplanting cotton.

2. Effect of new seed treatments on seed cotton yields

The production yields from four sites of field trials in Southern provinces are tabulated in table 7. Results from Table 7 showed that treatments T6, T7, T8 enhanced the production yield substantially ranging from 9.9% to 18.7%. T9 seed treatment could provide better harvest in Wangjiang, Wuhu, Huayang.

Table 7 Cotton Yields from four field trials in Southern China, 1995

Treatment	Wangjiang			Wuhu		
	Harvested 9/2 - 10/7			Harvested 9/4 - 10/5		
	kg/mu	of inc.	% inc.	kg/mu	of inc.	% inc.
T1	109.5	3.9	3.7	92.4	2.6	2.8
T2	110.4	4.8	4.5	94.7	4.9	5.4
T3	113.7	8.1	7.6	98.2	8.9	9.9
T4	107.8	2.2	2.0	95.1	5.3	5.9
T5	118.1	12.5	11.8	99.4	9.6	10.7
T6	120.9	15.3	10.4	105.8	16.0	17.8
T7	121.2	15.6	14.7	104.5	14.8	16.4
T8	125.4	9.8	18.7	101.1	11.3	12.5
T9	121.1	16.5	14.7	104.4	14.6	16.3
T10	120.9	16.3	14.5	95.1	5.3	6.9
CLNO6	127.7	22.1	20.9	106.4	16.6	18.4
MBC	118.0	12.0	11.4	94.5	4.7	5.2
Untreated	105.6	-	-	89.8	-	-

Table 7 Cotton Yields from four field trials in Southern China, 1995 continued

Treatment	Huayang			Dongtai		
	Harvested 9/2-10/16			Harvested 9/4 - 10/16		
	kg/mu	of inc.	% inc.	kg/mu	of inc.	% inc.
T1	101.2	4.6	4.7	118.5	1.9	1.6
T2	102.9	6.8	6.5	119.2	2.6	2.2
T3	109.8	13.2	13.6	125.0	8.4	7.2
T4	102.4	5.8	6.0	118.5	1.9	1.6
T5	108.6	12.0	12.0	124.1	7.5	6.4
T6	109.4	12.8	13.2	130.2	15.6	13.4
T7	108.7	12.1	12.5	130.9	14.3	12.3
T8	106.2	9.6	9.9	129.4	12.8	10.9
T9	102.1	12.5	12.9	121.4	4.8	4.1
T10	98.7	2.1	2.2	120.7	4.1	3.5
CLNO6	110.7	14.6	16.0	114.0	15.4	13.2
MBC(FL)	104.2	7.6	7.8	124.8	8.2	7.0
Untreated	96.6	-	-	116.6	-	-

II. Northern Provinces

1. Effect on seedling emergence and diseases

Three field trials were carried out in the direct planting cotton region of Shandong and Shanxi in which the main diseases are: *Rhizoctonia solani*, *Colletotrichum gossypii*, *Fusarium moniliforme* and *Fusarium oxysporum vasinfectum* and *Verticillium dahliae*. The rot-knot nematode, *Meloidosyne incognita*, was also present. Results of field trials showed that, seed treatments T14, T17 and T18 provided good management of seed and seedling disease complex in three sites of field trials. Emergences of more than 63% were achieved and percentages of seedling survivals ranged from 75.7% to 81.3% (see table 8.9 and 10). Further more, seed treatment T15 could give good disease control in Dongying, Shandong Province.

Table 8 Results against disease in field trial, 1995

Liaochen, Shandong							
Treatment	# Seedling Emergence	% Seedling Emergence	Sequence	# of Death	% of Death	% Seedling Survival	Sequence
T12	1010	67.8	1	281	15.4	55.1	AB 3
T13	894	59.6	3	308	20.5	40.2	AB 4
T14	932	62.1	2	107	7.1	79.2	C 1
T15	965	64.8	2	192	12.8	62.7	ABC 2
T16	921	61.4	2	317	21.1	38.5	A 4
T17	957	63.8	2	120	8.0	76.7	C 1
T18	947	63.1	2	125	8.3	75.7	C 1
CL24	352	66.8	3	125	8.3	75.7	C 1
CF(G)	419	27.9	5	527	35.1	-2.3	5
MBC(FL)	800	53.3	4	172	11.5	66.6	BC 2
Untreated	449	29.2	5	515	34.3	-	-

Note: 1) Here is direct planting cotton.
2) 1500 seeds sown and their seedlings for tests.
3) Sowing date: April 16, 1995.
4) Determination date: April 13 - May 13, 1995.
5) Values in columns followed by the same letter are not statistically different at the 0.05 level.

Table 9 Results against disease in field trial, 1995

Yunchen, Shanxi							
Treatment	# Seedling Emergence	% Seedling Emergence	Sequence	# of Death	% of Death	% Seedling Survival	Sequence
T12	579	57.9	3	68	6.8	65.7	4
T13	625	62.5	2	74	7.4	62.6	4
T14	754	75.4	1	37	3.7	81.8	1
T15	717	71.7	2	58	5.8	70.7	3
T16	582	58.2	3	89	8.9	55.1	5
T17	766	76.6	1	39	3.9	80.3	1
T18	728	72.8	1	40	1.0	79.8	2
CL24	741	74.1	1	41	4.1	79.8	2
CF	395	39.5		182	18.2	-	-
MBC	592	59.2	4	72	7.2	68.6	4
Untreated	459	45.9	-	198	19.8	-	-

Note: 1) 10 seeds and seedlings taken 8, 10, 12, 14, 16, 18, 20, 22, 24 days after sowing.
2) Sowing date: April 5, 1995.
3) Inspection date: April 12 - May 12, 1995.
4) Direct planting cotton in this test.

Table 10 Results against disease in field trial, 1995

Treatment	Dongying, Shandong							
	# Seedling Emergence	% Seedling Emergence	Sequence	# of Death	% of Death	% Seedling Survival	Sequence	
T12	432	43.2	3	91	9.1	54.4	3	
T13	475	47.5	3	68	6.8	59.6	2	
T14	703	70.3	1	33	3.3	78.8	1	
T15	668	66.8	2	36	3.6	76.9	1	
T16	492	49.2	3	78	7.8	50.0	4	
T17	686	68.6	1	32	3.2	79.5	1	
T18	684	68.4	1	29	2.9	81.4	1	
CL24	690	69.0	1	31	3.1	80.1	1	
CF(G)	392	39.2	5	148	14.8	-	-	
MBC(FL)	512	51.2	3	68	6.8	56.4	5	
Untreated	407	40.7	4	156	15.6	-	-	

Note: 1) 1000 seeds sown and their seedlings, samples taken 8, 10, 12, 14, 16, 18, 20, 22, 24 days after planting.
 2) Direct planting cotton in this test.
 3) Sowing date: April 24, 1995.
 4) Inspection date: May 2 - June 28, 1995.

2. Effect of new seed treatments on aphids

Results against aphids in three field trials indicated that several combinations containing insecticide carbofuran provided good aphid control with control efficacy over 65% (see table 11, 12, 13). T14 (Anchor + Rhizolex + Furadan), T17 (Anchor + Nusan + Furadan) and T18 (Nusan + Myclobutanil + Furadan) gave excellent aphid control and persisted longer than 45 days after emergence.

Table 11 Result of aphid control in field trial, 1995

Treatment	Dongying, Shandong					
	28 days		31 days		48 days	
	Population 100 Plants	Control Efficacy (%)	Population 100 Plants	Control Efficacy (%)	Population 100 Plants	Control Efficacy (%)
T12	423	34.1	983	28.9	1274	28.9
T13	501	21.0	1011	26.9	2018	16.8
T14	127	80.2	319	76.9	582	76.0
T15	372	42.1	935	32.4	728	70.0
T16	372	42.1	935	32.4	728	70.0
T17	131	79.6	277	80.0	594	75.5
T18	128	80.1	294	78.7	601	75.2
CL24	107	83.3	311	77.1	592	76.0
CF(G)	192	70.1	789	43.0	1448	40.8
MBC(FL)	596	-	1447	-	2572	40.3
Untreated	642	-	1383	-	2426	-

Note: 1) Sowing date: April 24, 1995.
 2) The date for mean from tree replications.
 3) Survey time, early morning without rain and wind.

Table 12 Results of aphid control in field trial, 1995

Treatment	Liaochen, Shandong			
	23 days		45 days	
	Population/ 100 Plants	Control Efficacy	Population/ 100 Plants	Control Efficacy
T12	523	81.2	1037	76.0
T13	411	85.2	948	78.0
T14	97	96.5	781	81.9
T15	255	90.8	1000	81.9
T16	312	88.8	1003	76.8
T17	61	97.8	780	82.0
T18	103	96.0	784	81.7
CL24	121	95.0	781	61.9
CF(G)	808	89.0	1678	61.1
MBC(FL)	2836	-	3773	-
Untreated	2782	-	4319	-

Table 13 Results of aphid control in field trial, 1995

Treatment	Yunchen, Shanxi					
	28 days		31 days		48 days	
	Population 100 Plants	Control Efficacy (%)	Population 100 Plants	Control Efficacy (%)	Population 100 Plants	Control Efficacy (%)
T12	898	36.9	1858	32.4	2071	47.9
T13	973	31.7	1142	58.5	1649	58.5
T14	880	76.8	1027	62.7	1247	68.9
T15	620	56.5	1077	60.8	1385	65.1
T16	598	58.4	1158	58.9	1342	66.2
T17	432	69.7	762	72.1	1107	72.1
T18	345	75.8	804	70.8	1281	67.8
CL24	369	74.1	950	65.5	1495	62.4
CF(G)	602	57.2	1475	46.4	2018	49.2
MBC(FL)	1217	-	2650	-	3740	-
Untreated	1424	-	2750	-	3972	-

Note: 1) These data for mean from tree replications.
 2) Determination time, early morning without rain and wind.
 3) Sowing date: April 5, 1995.

IV Effect of new seed treatments on seed cotton yields in Northern China

Enhancement of production yields are presented in table 14 as the amount of seed cotton harvested from mid October to mid November. The results from Table 14 revealed that seed treatments T14, T17 and T18 increase seed cotton yield by 11.7% - 26.7% which is nearly the same as Chinese local commercial product No. 24. T14 gave higher harvest than local No. 24 in Liaochen and Shanxi province. Some combinations should be improved in the future and yield increases should be possible.

Table 14 Cotton Yields from some field trials in Northern China

Treatment	YUNCHEN			LIAOCHEN		
	Harvested 10/7 - 11/8			Harvested 10/5 - 11/6		
	kg/mu	kg/mu of inc.	% inc.	kg/mu	kg/mu of inc.	% inc.
T12	94.9	3.7	10.4	98.4	3.7	3.9
T13	97.8	6.6	13.8	101.8	7.1	7.5
T14	101.9	10.7	11.7	120.8	26.8	26.7
T15	98.5	7.4	8.1	99.6	4.9	5.2
T16	95.7	4.5	4.9	105.3	10.6	11.2
T17	107.6	16.4	17.9	117.6	22.9	24.2
T18	106.5	15.3	16.8	112.5	17.8	18.8
CL24	101.5	10.1	11.1	149.2	14.5	15.3
MBC(FL)	94.2	8.0	3.2	98.6	3.9	4.1
Untreated	91.2	-	-	94.7	-	-

Conclusion and Discussion

1. In Southern China the three way combination formulations T6, T7, T8, and T9 provided good seedling emergence and disease control. The three-way combinations have higher effectiveness than every single compound. T6, T7, T8 and T9 enhanced seed cotton yields substantially and ranged from 9.9% to 18.7%.

2. In Northern China the three-way combination formulations T14, T17 and T18 gave successful integrated pest management of soilborne and seedborne diseases and insect pests in three field trials in Northern Provinces. The three-way combinations can increase seed cotton yield by 11.7% to 26.7%, which is nearly same as Chinese local commercial product No. 24.

3. There will be big potential in pest control and yield enhance in some new formulations containing Nusan, Myclobatanil and Anchor, if they will be approved in coming years.

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