# LARGE PLOT PERFORMANCE OF SEEDLING DISEASE SEED TREATMENT FUNGICIDES

**H. Kaufman and T. Wheeler**
**Texas A&M Research and Extension Center**
**Lubbock, TX**
**R. Graves**
**Extension Agent-IPM**
**Crosbyton, TX**
**G. Schuster**
**Extension Agent - IPM**
**Dimmitt, TX**
**P. Kidd**
**Extension Agent - IPM**
**Brownfield, TX**
**K. Siders**
**Extension Agent - IPM**
**Levelland, TX**

## Abstract

The value of cotton seed treatment fungicides in the low input production system of the High Plains of Texas was evaluated at five sites in both 1996 and 1997. Four superior seed treatments which included a broad spectrum fungicide (either Captan or Thiram), a material active against *Pythium* (Apron Fl, Apron TL, or Apron XL), and a material active against *Rhizoctonia solani* and *Thielaviopsis basicola* (Baytan 30 or Nuflow M) were compared each year with Captan alone. Plot size ranged from 0.4 to 0.8 acres with 3-4 replications in a RCBD. Disease pressure was low in 1996, due to very warm, dry conditions after planting. Plant stand and root necrosis were significantly improved by the use of superior seed treatments compared with Captan alone at 1 of the 5 sites (*R. solani* was present). Yields were not significantly impacted by seed treatments at any sites in 1996. In 1997, black root rot (*T. basicola*) was a problem at 2 of 5 sites. The use of superior seed treatments reduced root necrosis by an average of 49 % and increased yields by an average of 11 % in a field where root necrosis in Captan alone treated seed was 30 %. In another field where the average root necrosis with Captan alone was 46 %, root necrosis was reduced by 35 % and yield was increased by 12 % with a high rate of Baytan 30 (1 oz/100 lb seed). The 1 oz rate of Baytan 30 had significantly higher yields in this field with high pressure from *T. basicola*, than the 0.5 oz rate. Yield increases were found in fields with moderate or high levels of black root rot when using superior seed treatments which included Baytan 30 or Nuflow M. Superior seed treatments positively impacted plant stand, root health and yield when seedling disease occurred as compared to a minimal seed treatment.

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## Introduction

The benefits of superior seed treatments which contain both broad spectrum activity, plus specific activity on *Pythium*, *Rhizoctonia solani*, and *Thielaviopsis basicola*, on seedling emergence, root necrosis, and yield have been investigated for many years in small plots at various sites in the High Plains of Texas (Gannaway et al., 1994, 1995, 1996; Wheeler et al., 1997). Small plot experiments are well suited for evaluation of fungicide seed treatments in terms of stand establishment and root health. However, economic benefits of fungicide seed treatments require a larger test area. Planting farmer-caught cotton seed is a common practice in the High Plains of Texas. Application of fungicides beyond Captan on farmer-caught seed is only by request. As a result, much farmer-caught seed is not treated beyond Captan. An application of two additional fungicides, like Apron and either Nuflow M or Baytan 30, costs approximately $7 per bag of seed. If 15-20 lbs of seed are planted/acre then the yield response to the use of superior seed treatments must be worth more than $0.36 - $0.48/acre. The objectives for this study were to compare seedling stand, root health, plant development, and yield on: minimal versus superior cotton seed treatments in large plot field tests; and within different superior cotton seed treatments.

## Materials and Methods

Five sites were chosen in 1996 and 1997 based on a previous history of seedling disease, or confirmation of disease potential with a soil bioassay. Plots ranged from four to six rows wide and ran the length of the field, a length of ¼ to ½ mile. This resulted in plots of approximately 0.4 to 0.8 acres in size. The five treatments were planted in a randomized, complete block design and replicated three to four times. The variety Paymaster 'HS26' was used for all sites in 1996 and four of the five sites in 1997. One site, (McClure) was planted with Paymaster 'HS200' in 1997. Untreated seed was obtained from Paymaster Seed Co. and treated in 1996 with a Hege seed treater and in 1997 with a modified cement mixer. In 1996, seed treatments included: Captan 4000 at 2.5 oz/100 lb seed; Captan 4000 + Apron TL + Nuflow M (2.5 + 2.0 + 1.25 oz/100 lb seed); Captan 4000 + Apron TL + Nuflow M (2.5 + 2.0 + 1.75 oz/100 lb seed); Thiram 42S + Apron FL + Baytan 30 (3 + 0.75 + 0.5 oz/100 lb seed); Thiram 42S + Apron FL + Baytan 30 (3 + 0.75 + 1 oz/100 lb seed); and the addition of Kodiak-Epic to Baytan 30 (at both rates) at a rate of 0.25 oz/100 lb seed. At sites which were identified as potential *R. solani* sites, then Baytan 30 treatments were used at the 0.5 oz rate, +/- Kodiak-Epic. At sites that were identified primarily as black root rot sites, then Baytan 30 was used at the 1 oz rate, +/- Kodiak-Epic. In 1997, in the Nuflow M treatments, Apron XL was used instead of Apron TL at 0.32 oz/100 lb seed, and the treatments with Kodiak-Epic were eliminated. Fungicide concentration on samples of seed was assayed by Dr. Dan Krieg at Texas Tech University.

Seedling disease data was collected in three, 20 ft. long areas within each plot. These were used to evaluate stand, root health, and various plant mapping parameters. Stand counts were taken at weekly intervals from 7 to 42 days in 1996 and 7 to 28 days in 1997. A skip index was applied at 28 days after planting to the rating areas. Root health was rated at 21 days after planting by removing 10 plants in 1996 and 6 plants in 1997 from each of the three evaluation areas/plot. A visual estimation of root necrosis was taken and then a rating for severity of damping off due to *R. solani*, with 0 being healthy, 1= a superficial lesion on the hypocotyl, 2 = a deeper lesion on the hypocotyl, and 3= a lesion which caused post-emergence damping off. In 1996, 10 plants in each rating area were then tagged and at 35-42 days after planting, those plants were plant mapped, including height, number of nodes, and leaf area. Plants (10/rating area) in both years were rated for percent open boll before a defoliant was applied. Yields were taken with boll weigh wagons or electronic scales. Four sites were taken to harvest in 1996 (one was loss to hail) and all five sites were harvested in 1997.

## Results

Concentration of fungicides was reduced in almost all cases from the target concentration. Captan 4000 in 1996 was reduced by an average of 19 % when applied alone, and 7-22% when applied in combination with Nuflow M (Table 1). Apron TL was reduced by 14 % in 1996 and Apron Fl was reduced by 8-15 %. The low rate of Nuflow M was down by an average of 15 % and the high rate of Nuflow M was down by an average of 3 % in 1996. The low rate of Baytan 30 was down by an average of 31 % in 1996, and the high rate was higher than the target rate by 5 %. In 1997, the rate of Captan 4000 was reduced by 31-44 % (Table 1). Apron XL, in 1997, was reduced from the target rate by 21-28 %, and Apron Fl was reduced from the target rate by 25-39 % (Table 1). Nuflow M at a low rate in 1997 was higher than the target rate by 9 % and at the higher rate was reduced from the target rate by 12 %. Baytan 30, in 1997, was reduced from the low target rate by 19 % and from the high target rate by 8 % (Table 1).

Environmental conditions in 1996 during May and June were warm and dry, resulting in minimal to no seedling disease at all five sites. Soil temperatures at planting ranged from less than 59º F to 68º F or higher, and then increased rapidly. In 1996, seed treatments at three sites affected emergence at 7 days after planting. At the Bearden and Craft sites, seed treated with Baytan 30 had slower emergence than seed treated with Captan alone or with a 1.75 oz rate of NuFlow M (Table 2). Emergence was poorer at the Craft site for seed treated with the 1.25 oz rate of NuFlow M than the 1.75 oz rate. Cotton at the Higgins site had poorer emergence for seed treated with Baytan 30 than with NuFlow M at 1.25 oz/100 lb seed. There were no differences in plant emergence at the Payne and Phipps sites at 7 days after planting. At 28 days after planting, emergence was significantly higher for cotton with superior seed treatments than treated with Captan alone at the Phipps site (Table 3). At the Payne site, cotton seedlings were damaged by hail around 21 days after planting, and at 28 days after planting, seed treated with Baytan 30 (at 0.5 oz rate) had better emergence than seed treated with Captan alone or with Nuflow M. Root necrosis was less than 5 % for Bearden, Higgins and Craft locations (data not shown). At the Payne location, root necrosis ranged from 12 to 15 %. At the Phipps location, root necrosis was significantly higher from seed treated with Captan alone (38 %) than seed treated with Baytan 30 (29-30%) or Nuflow M at the 1.25 oz rate (31 %) (Table 4). There were no significant differences in any of the fields in 1996 between seed treatments with respect to skip indices, plant height, number of nodes/plant, average leaf area, earliness as measured by the percent of green bolls to open bolls, yield, or lint quality (data not shown). The only field with some disease pressure (as measured by stand and root necrosis) in 1996 was the Phipps location. Though stand was decreased in plots with Captan treated seed by 31 % compared with superior seed treatments, yields were not significantly different in the Captan alone seed treatment (1269 lbs of lint/acre) than those with Nuflow M (1374 and 1255 lbs of lint/acre) or Baytan 30 (1344 and 1284 lbs of lint/acre).

The 1997 season provided environmental conditions more favorable to disease, but some sites were planted too late to take advantage of these conditions. Early stand counts were negatively impacted by Baytan 30 at the 1 oz rate in one site (Marble)(Table 5). However emergence was positively impacted by Baytan 30 treated seed at 14 days after planting in the Welch site (Table 5). By 28 days after planting, stand differences associated with seed treatments were seen in only 1 of 5 locations. In the Welch site, Baytan 30 treated seed at the 1 oz rate had significantly better stands than seed treated with Baytan 30 at the 0.5 oz rate or Captan alone (Table 6). The Nuflow M treatments appeared to be damaged by a late application of Roundup as seedlings were cracking the ground. Therefore, this data has been excluded.

Black root rot, caused by *T. basicola*, was a problem at 2 of the 5 sites (McClure and Welch). At the McClure site, all superior seed treatments except Nuflow M at the 1.75 oz rate had significantly less root necrosis than seed treated with Captan alone (Table 7). The Captan seed treatment averaged 30 % root necrosis, which is considered a moderate level of disease. At the Welch site, seed treated with Baytan 30 had significantly less root necrosis than seed with just Captan (Table 7). The Captan seed treatment averaged 46 % root necrosis at this site which is considered a high level of disease. *Pythium* was also isolated from a number of plants at the Welch site. There were no significant differences between seed treatments at any of the five sites in skip indices or earliness (data not shown).

Yield was improved by all superior seed treatments at the McClure site (moderate black root rot) in 1997 (Table 8). Yields increased an average of 11 % by the application of Nuflow M or Baytan 30 at this site. At the Welch site (high level of black root rot), yields were improved only by the use of a high rate of Baytan 30 (1.0 oz/100 lb seed) (Table 8). There was a significant decrease in yield when seed was treated with a lower rate of Baytan 30 (0.5 oz/100 lb seed) compared with the 1 oz rate of Baytan 30. Yield increased by an average of 12 % when seed was treated with Baytan 30 at the 1 oz rate over the Captan seed treatment. At the Davis site, there was no indication of seedling disease, however, yields were highest when seed was treated with Nuflow M at 1.25 oz rate (Table 8). All superior seed treatments except Nuflow M at the 1.75 oz rate had significantly higher yields than seed treated with Captan (Table 8).

## Summary

When seedling disease was absent, due primarily to warm soil temperatures, than superior seed treatments generally performed similar to minimal seed treatments on plant stand, root health, plant growth parameters such as height, number of nodes, leaf area, earliness, yield, or lint quality. When seedling disease caused by *R. solani* was present, than superior seed treatments provided a 31 % increase in stand and slight reduction in root necrosis. However, under excellent growing conditions, which resulted in high yields (2.7 bales/acre), this improvement in stand and root health did not translate into any yield increase. When seedling disease caused by *T. basicola* was present at moderate or high levels, then superior seed treatments resulted in a large increase in root health and an 11-12 % increase in yield. At high levels of black root rot, the *Thielaviopsis* recommended rate of Baytan 30 (1 oz/100 lb seed) performed significantly better than the *Rhizoctonia* recommended rate of Baytan 30 (0.5 oz/100 lb seed). Depending on the type and severity of seedling disease, superior seed treatments can be economically justified in the High Plains of Texas.

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Table 1. Assayed concentrations of fungicides applied to cotton seed in 1996 and 1997.

| Products[1] | Assayed dosage (mg/kg) | Target dosage (mg/kg) | Year |
|---|---|---|---|
| C | 630 | 780 | 1996 |
| C+AT+N | 729+131+179 | 780+150+210 | 1996 |
| C+AT+N | 608+127+273 | 780+150+280 | 1996 |
| AF+B | 138+ 81 | 150+117 | 1996 |
| AF+B | 127+246 | 150+234 | 1996 |
| C | 537 | 780 | 1997 |
| C+AX+N | 475+ 54+229 | 780+75+210 | 1997 |
| C+AX+N | 439+ 59+246 | 780+75+280 | 1997 |
| AF+B | 113+ 95 | 150+117 | 1997 |
| AF+B | 91+215 | 150+234 | 1997 |

[1]C is Captan 4000 which was applied at 2.5 oz/100 lb seed; AT is Apron TL which was applied at 2.0 oz/100 lb seed; N is Nuflow M which was applied at a low rate of 1.25 oz and high rate of 1.75 oz/100 lb seed; AF is Apron Fl which was applied at 0.75 oz/100 lb seed; B is Baytan 30 which was applied at a low rate of 0.5 oz/100 lb seed and a high rate of 1 oz/100 lb seed; AX is Apron XL which was applied at 0.32 oz/100 lb seed.

Table 2. Plants/foot at seven days after planting, or application of water in 1996 at five sites.

| | Locations | | | | |
|---|---|---|---|---|---|
| Trt | Bearden | Higgins | Craft | Payne | Phipps |
| 1[1] | 2.6 a[2] | 1.4 ab | 2.9 a | 0.7 | 0.7 |
| 2 | 2.8 a | 1.7 a | 1.6 b | 0.9 | 0.7 |
| 3 | 2.8 a | 1.2 ab | 2.4 a | 0.6 | 1.3 |
| 4 | 2.0 b | 0.9 b | 1.7 b | 0.9 | 1.0 |
| 5 | 1.8 b | 0.9 b | 1.7 b | 1.1 | 0.8 |

[1]Trt 1 =Captan 4000 (C [2.5 oz/100 lbs seed]); Trt 2 = C + Apron TL (AT) + Nuflow M (N) at 2.5 + 2.0 + 1.25 oz/100 lb seed; Trt 3 = C + AT + N at 2.5 + 2 + 1.75 oz/100 lb seed; Trt 4 = Thiram 42 S (T) + Apron Fl (AF) + Baytan 30 (B) at 3 + 0.75 + 1 oz/100 lb seed at the Bearden and Higgins sites and 0.5 oz/100 lbs of seed for Baytan 30 at the Craft, Payne, and Phipps sites; Trt 5 = same as Trt 4 with the addition of Kodiak-Epic at 0.25 oz/100 lb seed.

[2]Significant differences have different letters based on the Waller Duncan k-ratio t-test with $P$=0.05.

Table 3. Plants/foot at 28 days after planting, or application of water in 1996 at five sites.

| | Locations | | | | |
|---|---|---|---|---|---|
| Trt | Bearden | Higgins | Craft | Payne[3] | Phipps |
| 1[1] | 3.5 | 3.9 | 3.9 | 1.7 abc[2] | 2.5 b |
| 2 | 3.7 | 4.6 | 3.8 | 1.6 bc | 3.5 a |
| 3 | 3.7 | 4.0 | 4.0 | 1.5 c | 3.6 a |
| 4 | 3.7 | 4.1 | 3.6 | 2.0 a | 3.9 a |
| 5 | 3.6 | 4.3 | 3.9 | 2.0 ab | 3.5 a |

[1]Trt 1 =Captan 4000 (C [2.5 oz/100 lbs seed]); Trt 2 = C + Apron TL (AT) + Nuflow M (N) at 2.5 + 2 + 1.25 oz/100 lb seed; Trt 3 = C + AT + N at 2.5 + 2 + 1.75 oz/100 lb seed; Trt 4 = Thiram 42 S (T) + Apron Fl (AF) + Baytan 30 (B) at 3 + 0.75 + 1 oz/100 lb seed at the Bearden and Higgins sites and 0.5 oz/100 lbs of seed for Baytan 30 at the Craft, Payne, and Phipps sites; Trt 5 = same as Trt 4 with the addition of Kodiak-Epic at 0.25 oz/100 lb seed.
[2]Significant differences have different letters based on the Waller Duncan k-ratio t-test with *P*=0.05.
[3]Cotton stand at this site was damaged by hail.

Table 4. Root necrosis (%) at 21 days after planting, or application of water in 1996 at two sites.

| | Locations | |
|---|---|---|
| Trt | Payne | Phipps |
| 1[1] | 12 | 38 a[2] |
| 2 | 15 | 31 b |
| 3 | 14 | 33 ab |
| 4 | 12 | 29 b |
| 5 | 15 | 30 b |

[1]Trt 1 =Captan 4000 (C [2.5 oz/100 lbs seed]); Trt 2 = C + Apron TL (AT) + Nuflow M (N) at 2.5 + 2 + 1.25 oz/100 lb seed; Trt 3 = C + AT + N at 2.5 + 2 + 1.75 oz/100 lb seed; Trt 4 = Thiram 42 S (T) + Apron Fl (AF) + Baytan 30 (B) at 3 + 0.75 + 1 oz/100 lb seed at the Bearden and Higgins sites and 0.5 oz/100 lbs of seed for Baytan 30 at the Craft, Payne, and Phipps sites; Trt 5 = same as Trt 4 with the addition of Kodiak-Epic at 0.25 oz/100 lb seed.
[2]Significant differences have different letters based on the Waller Duncan k-ratio t-test with *P*=0.05.

Table 5. Plants/foot at the first evaluation[1] after planting in 1997 at five sites.

| | Locations | | | | |
|---|---|---|---|---|---|
| Trt | McClure | Marble | Davis | Welch | Grisham |
| 1[2] | 1.7 | 2.3 a[3] | 5.6 | 3.2 b | 3.0 |
| 2 | 1.2 | 1.6 b | 4.6 | -[4] | 3.2 |
| 3 | 1.2 | 1.3 bc | 5.5 | - | 2.8 |
| 4 | 1.2 | 1.5 b | 4.8 | 3.6 a | 2.7 |
| 5 | 0.9 | 1.1 c | 5.3 | 4.0 a | 2.6 |

[1]First evaluation was on 14 days after planting (DAP) at McClure's, 7 DAP for Marble, 16 DAP for Davis, 14 DAP for Welch and 8 DAP for Grisham.
[2]Trt 1 =Captan 4000 (C [2.5 oz/100 lbs seed]); Trt 2 = C + Apron TL (AT) + Nuflow M (N) at 2.5 + 2.0 + 1.25 oz/100 lb seed; Trt 3 = C + AT + N at 2.5 + 2 + 1.75 oz/100 lb seed; Trt 4 = Thiram 42 S (T) + Apron Fl (AF) + Baytan 30 (B) at 3 + 0.75 + 0.5 oz/100 lb seed; Trt 5 = T + AF + B at 3 + 0.75 + 1 oz/100 lb seed.
[3]Significant differences have different letters based on the Waller Duncan k-ratio t-test with *P*=0.05.
[4]Treatments with Nuflow M were not reported at this site.

Table 6. Plants/foot at 28 days after planting in 1997 at five sites.

| | Locations | | | | |
|---|---|---|---|---|---|
| Trt | McClure | Marble[1] | Davis | Welch | Grisham |
| 1[2] | 4.4 | 2.4 | 5.4 | 3.1 b[3] | 5.0 |
| 2 | 4.9 | 1.9 | 4.2 | -[4] | 5.0 |
| 3 | 4.9 | 2.1 | 5.3 | - | 4.8 |
| 4 | 4.4 | 2.2 | 4.5 | 3.1 b | 4.9 |
| 5 | 4.4 | 1.9 | 5.0 | 3.8 a | 5.0 |

[1]High winds reduced stands at this site.
[2]Trt 1 =Captan 4000 (C [2.5 oz/100 lbs seed]); Trt 2 = C + Apron TL (AT) + Nuflow M (N) at 2.5 + 2 + 1.25 oz/100 lb seed; Trt 3 = C + AT + N at 2.5 + 2 + 1.75 oz/100 lb seed; Trt 4 = Thiram 42 S (T) + Apron Fl (AF) + Baytan 30 (B) at 3 + 0.75 + 0.5 oz/100 lb seed; Trt 5 = T + AF + B at 3 + 0.75 + 1 oz/100 lb seed.
[3]Significant differences have different letters based on the Waller Duncan k-ratio t-test with *P*=0.05.
[4]Treatments with Nuflow M were not reported at this site.

Table 7. Root necrosis (%) at five sites in 1997.

| | Loactions | | | | |
|---|---|---|---|---|---|
| Trt | McClure | Marble | Davis | Welch | Grisham |
| 1[1] | 30 a[2] | 4 | 5 | 46 a | 0 |
| 2 | 12 b | 1 | 9 | -[3] | 0 |
| 3 | 21 ab | 1 | 9 | - | 0 |
| 4 | 16 b | 2 | 7 | 31 b | 0 |
| 5 | 12 b | 0 | 5 | 29 b | 0 |

[1]Trt 1 =Captan 4000 (C [2.5 oz/100 lbs seed]); Trt 2 = C + Apron TL (AT) + Nuflow M (N) at 2.5 + 2 + 1.25 oz/100 lb seed; Trt 3 = C + AT + N at 2.5 + 2 + 1.75 oz/100 lb seed; Trt 4 = Thiram 42 S (T) + Apron Fl (AF) + Baytan 30 (B) at 3 + 0.75 + 0.5 oz/100 lb seed; Trt 5 = T + AF + B at 3 + 0.75 + 1 oz/100 lb seed.
[2]Significant differences have different letters based on the Waller Duncan k-ratio t-test with *P*=0.05.
[3]Treatments with Nuflow M were not reported at this site.

Table 8. The affect of seed treatments on yield (lbs of lint/acre) at five sites in 1997.

| | Locations | | | | |
|---|---|---|---|---|---|
| Trt | McClure | Marble | Davis | Welch | Grisham |
| 1[1] | 848 b[2] | 563 | 752 c | 795 ab | 627 |
| 2 | 958 a | 475 | 833 a | -[3] | 635 |
| 3 | 942 a | 473 | 713 d | - | 601 |
| 4 | 977 a | 458 | 787 b | 784 b | 619 |
| 5 | 919 a | 501 | 791 b | 895 a | 627 |

[1]Trt 1 =Captan 4000 (C [2.5 oz/100 lbs seed]); Trt 2 = C + Apron TL (AT) + Nuflow M (N) at 2.5 + 2 + 1.25 oz/100 lb seed; Trt 3 = C + AT + N at 2.5 + 2 + 1.75 oz/100 lb seed; Trt 4 = Thiram 42 S (T) + Apron Fl (AF) + Baytan 30 (B) at 3 + 0.75 + 0.5 oz/100 lb seed; Trt 5 = T + AF + B at 3 + 0.75 + 1 oz/100 lb seed.
[2]Significant differences have different letters based on the Waller Duncan k-ratio t-test with *P*=0.05.
[3]Treatments with Nuflow M were not reported at this site.