# Cucurbit crop tolerance to fomesafen, 2009

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## Summary

- Golden Delicious winter squash was more tolerant to fomesafen herbicide (Reflex) than butternut and Dickinson. Zucchini was least tolerant to fomesafen.
- A significant shower caused soil to splash onto squash seedlings shortly after emergence, but did not significantly increase injury or reduce yield. Seedlings that were submerged were significantly damaged.
- Summer annual broadleaf control was exceptional with fomesafen herbicide.

## Methods

The experiment was located at the OSU Vegetable Research farm on a silt loam soil with organic matter of 2.4%, CEC of 20.7meq/100 g soil, and pH of 6.0. The experimental design was a split plot with main effect of herbicide treatment and squash variety as the split plot. Each main plot was replicated 4 times. Rows were made on May 25, 2009 with a John Deere Max emerge planter that banded fertilizer (12-29-10) next to the rows at 540 kg/ha. Plots were 2.8 m wide by 6.4 m long with two rows of one cucurbit variety (Table below) planted 76 cm apart in the center of each plot. Cucurbit seeds were planted on May 26 with a belt planter at 1 seed per 30 cm and 3.2 cm deep. Herbicides were applied on May 27 with a backpack sprayer at 172 kPa delivering 187 L/Ha. Herbicides were incorporated with 1.2 cm of water on May 28.

**Table 1.** Cucurbit varieties planted.

| | |
|---|---|
| Butternut winter squash var. Ultra | *Cucurbita moschata* |
| Hubbard winter squash var. Golden Delicious | *Cucurbita maxima* |
| Pumpkin var. Dickinson | *Cucurbita moschata* |
| Zucchini var. elite | *Cucurbita pepo* |

Weed control was evaluated on June 11 and July 1. Predominant weeds present were hairy nightshade, lambsquarters, and common purslane (43, 25, and 22 percent of total respectively) and averaged 107 seedlings/$m^2$ (SE 12/$m^2$) in unweeded check plots on July 2. Plots were cultivated after each weed control evaluation (2 times), leaving a 30 cm uncultivated band over each crop row. Plots were shortened to 6 m in length after the last weed evaluation and cultivation. Zucchini was harvested 4 times and graded (#1: 2.5-5.1 cm; #2: 5.1-5.7 cm; #3: 5.7-6.4 cm; anything over 6.4 rejected). Winter squash were harvested on October 27. Maturity of winter squash was rated by counting fruit that had reached full color.

## Results and Discussion

A severe thunderstorm delivered 1.9 cm inches of water on June 13 in 20 minutes that flooded several plots in Block 1. The storm caused splashing that coated many seedlings with soil just as they were emerging from the soil and exacerbated injury in plots that were flooded. Crop injury in Table 4 is presented with and without the plots affected by flooding.

Despite the heavy rainfall and damage to some plots, fomesafen (Reflex herbicide) provided exceptional weed control of the broadleaf species present (Table 3). Crop injury was evident for all crops early in the season but was greater for butternut, Dickinson, and zucchini than Golden Delicious. Injury was much greater in plots that were covered by water after the thunderstorm and was as high as 80% for zucchini with fomesafen applied at 0.28 kg ai/ha.

Golden Delicious was the most tolerant of the cucurbits. Dickinson and butternut were injured early in the season, but yield was not reduced significantly. All crops except zucchini produced as much or more fruit at the 0.56 kg fomesafen ai/ha rate than at 0.28 kg fomesafen ai/ha, indicating that the additional weed control provided by fomesafen at 0.56 kg ai/ha reduced weed competition. S-metolachlor (Dual Magnum) at all rates produced high yields of butternut and Dickinson squash even though weed control was not as good as other treatments, probably because the two cultivations applied to the plots sufficiently reduced weed competition. The tankmix of fomesafen and dimethenamid-p (Outlook) at 0.28 and 0.74 kg ai/ha controlled all weeds, caused slight injury to the squash, but produced one of the highest yields of Golden Delicious. This outcome indicates that fomesafen and dimethenamid-p could be applied together at lower rates, reducing potential crop injury yet providing exceptional control of many troublesome weeds in squash production.

**Table 2.** ANOVA for effect of herbicide treatments on crop growth and yield.

| Factor | Emergence | | Crop injury 7 days after cracking | | Crop injury 21 days after cracking | | Crop yield | |
|---|---|---|---|---|---|---|---|---|
| | *F* | *P>F* | *F* | *P>F* | *F* | *P>F* | *F* | *P>F* |
| Block | 5.9 | 0.0008 | 6.2 | 0.0006 | 6.7 | 0.0003 | 1.7 | 0.16 |
| Crop | 6.1 | 0.0007 | 2.1 | 0.11 | 2.1 | 0.10 | 380 | <0.0001 |
| Treatment | 4.3 | <0.0001 | 13.1 | <.0001 | 8.6 | <0.0001 | 2.2 | 0.02 |
| Crop x Treatment | 1.1 | 0.32 | 1.5 | 0.06 | 0.9 | 0.56 | 1.3 | 0.14 |

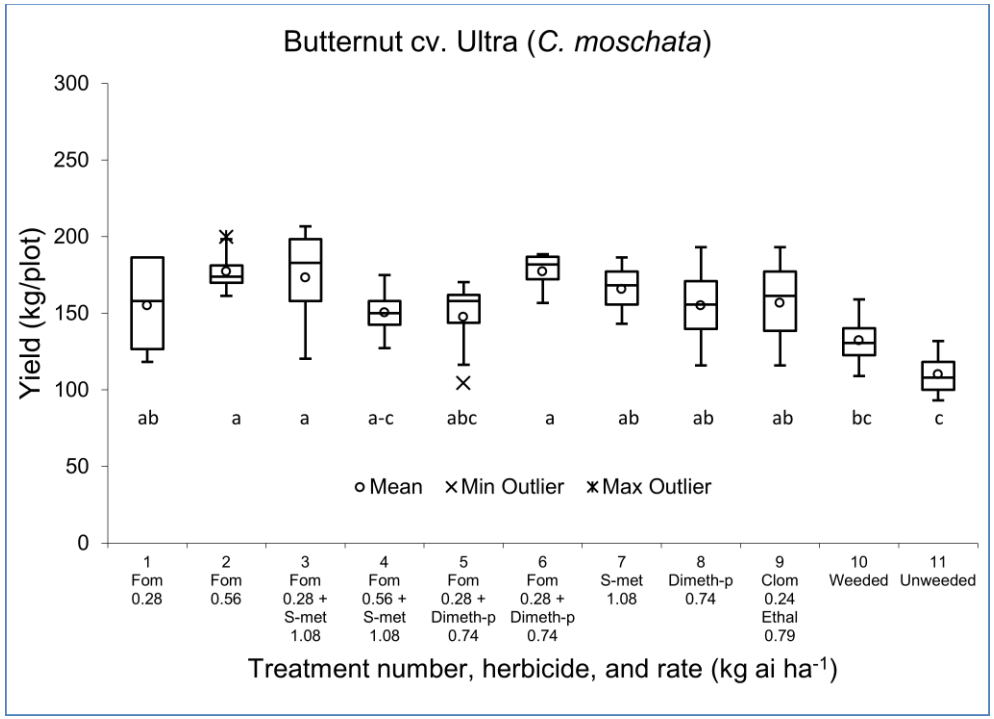
**Table 3.** Effect of fomesafen and other herbicides on weed control in cucurbits on June 11, 2009 (before 1st cultivation) and again on July 1. Observations were pooled across crop in each replication because there was no significant effect of crop on weed control (n=16).

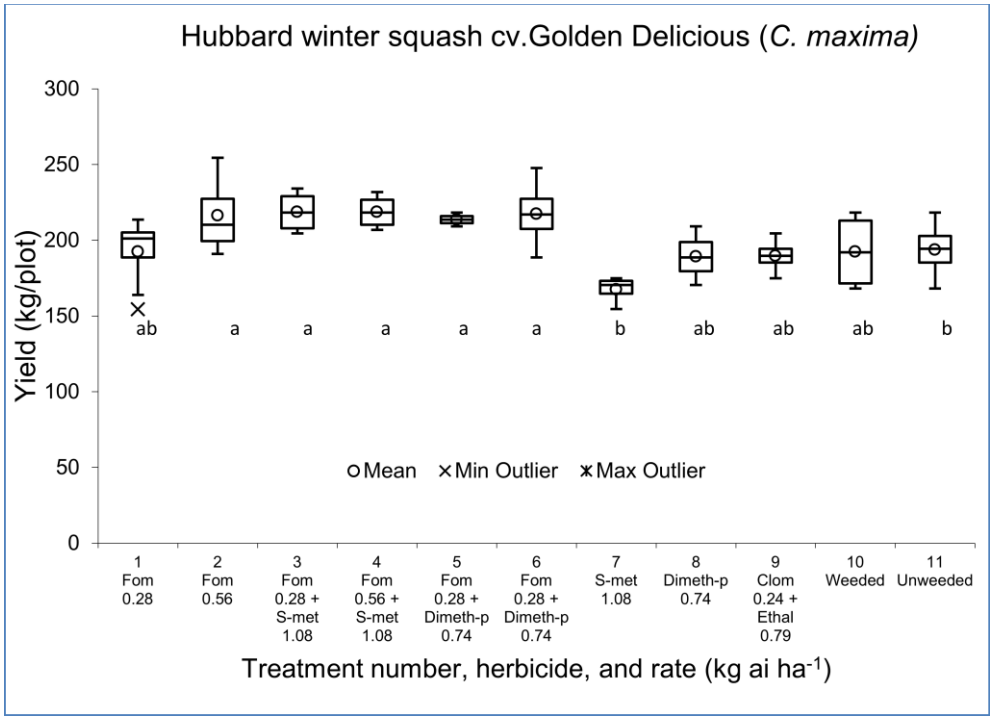
| | Herbicide | Rate | | Hairy nightshade | Pigweed | Lambs-quarters | Smart weed | Purslane | Composite rating |
|---|---|---|---|---|---|---|---|---|---|
| | | *oz/A* | *kg ai/ha* | *----------% control----------* | | | | | |
| | | | | ***June 11, 2009** (before 1st cultivation)* | | | | | |
| 1 | Fomesafen | 16 | 0.28 | 100 | 89 | 99 | 100 | 100 | 99 |
| 2 | Fomesafen | 32 | 0.56 | 100 | 100 | 100 | 100 | 100 | 100 |
| 3 | Fomesafen | 16 | 0.28 | 100 | 100 | 100 | 100 | 100 | 100 |
| | S-metolachlor | 16 | 1.08 | | | | | | |
| 4 | Fomesafen | 32 | 0.56 | 100 | 100 | 100 | 100 | 100 | 100 |
| | S-metolachlor | 16 | 1.08 | | | | | | |
| 5 | Fomesafen | 16 | 0.28 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Dimethenamid-P | 14 | 0.74 | | | | | | |
| 6 | Fomesafen | 32 | 0.56 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Dimethenamid-P | 14 | 0.74 | | | | | | |
| 7 | S-metolachlor | 16 | 1.08 | 78 | 99 | 74 | 89 | 100 | 77 |
| 8 | Dimethenamid-P | 14 | 0.74 | 95 | 100 | 93 | 99 | 100 | 94 |
| 9 | Clomazone | 9 | 0.24 | 80 | 93 | 89 | 83 | 99 | 83 |
| | Ethalfluralin | 30 | 0.79 | | | | | | |
| 10 | Weed-free | | - | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Unweeded | | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | *FPLSD (0.05)* | | | *4* | *7* | *4* | *6* | *0.4* | *4* |
| | | | | | | ***July 1, 2009*** | | | |
| 1 | Fomesafen | 16 | 0.28 | 99 | 100 | 96 | 96 | 99 | 97 |
| 2 | Fomesafen | 32 | 0.56 | 100 | 100 | 99 | 100 | 99 | 99 |
| 3 | Fomesafen | 16 | 0.28 | 100 | 100 | 100 | 99 | 99 | 99 |
| | S-metolachlor | 16 | 1.08 | | | | | | |
| 4 | Fomesafen | 32 | 0.56 | 100 | 100 | 100 | 100 | 100 | 100 |
| | S-metolachlor | 16 | 1.08 | | | | | | |
| 5 | Fomesafen | 16 | 0.28 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Dimethenamid-P | 14 | 0.74 | | | | | | |
| 6 | Fomesafen | 32 | 0.56 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Dimethenamid-P | 14 | 0.74 | | | | | | |
| 7 | S-metolachlor | 16 | 1.08 | 82 | 100 | 68 | 95 | 98 | 78 |
| 8 | Dimethenamid-P | 14 | 0.74 | 95 | 100 | 88 | 97 | 100 | 92 |
| 9 | Clomazone | 9 | 0.24 | 93 | 92 | 92 | 84 | 99 | 86 |
| | Ethalfluralin | 30 | 0.79 | | | | | | |
| 10 | Weed-free | | - | 100 | 100 | 99 | 100 | 100 | 99 |
| 11 | Unweeded | | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | *FPLSD (0.05)* | | | *3* | *3* | *6* | *8* | *1* | *6* |

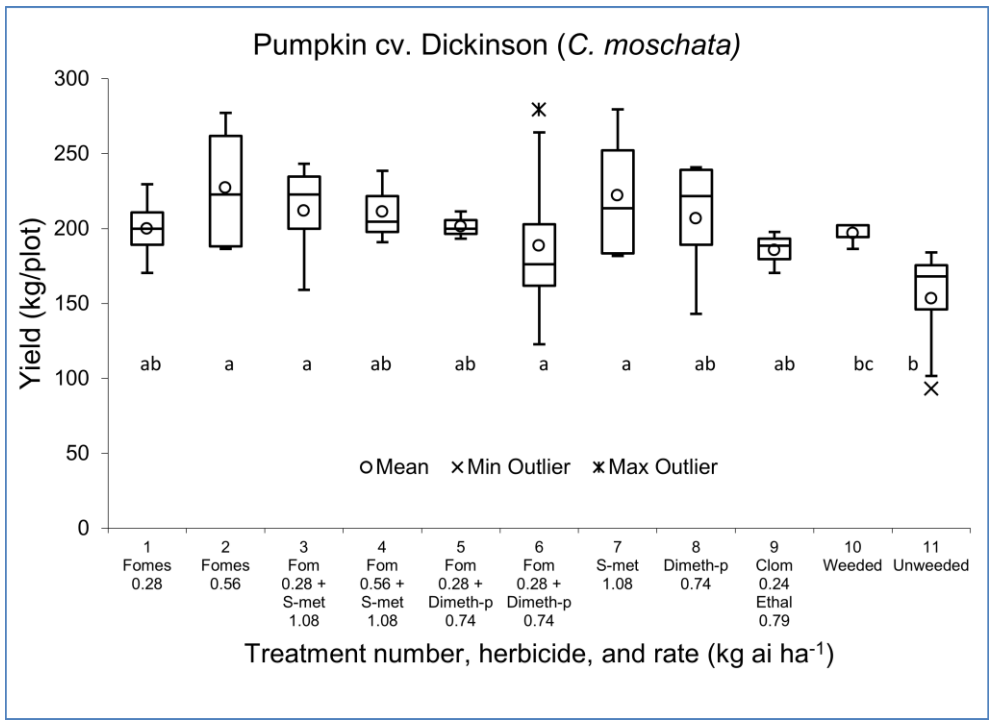
**Table 4.** Effect of fomesafen and other herbicides on crop injury and yield. See Table 3 for herbicide treatment key. BTNUT=Butternut, DKNSS=Dickinson, GD=Golden Delicious, and ZUCC=zucchini.

| Crop | Treatment | Obs | Emergence | Crop injury (7 day after cracking) | Crop injury (21 day after cracking) | Yield | Avg. fruit wt | Proportion not fully ripe |
|---|---|---|---|---|---|---|---|---|
| | | N | no/plot | % | % | MT/ha | kg | |
| BTNUT | 1 | 4 | 28 | 35(23) [1] | 23(6) | 29.1 | 2.73 | 0.18 |
| BTNUT | 2 | 4 | 23 | 53(43) | 43(30) | 33.2 | 3.05 | 0.12 |
| BTNUT | 3 | 4 | 32 | 28(10) | 25(6) | 32.5 | 2.77 | 0.12 |
| BTNUT | 4 | 4 | 23 | 61(50) | 49(33) | 28.2 | 3.18 | 0.13 |
| BTNUT | 5 | 4 | 29 | 28 | 18 | 27.6 | 2.50 | 0.06 |
| BTNUT | 6 | 4 | 30 | 38 | 20 | 33.2 | 2.86 | 0.13 |
| BTNUT | 7 | 4 | 32 | 1 | 5 | 36.9 | 2.82 | 0.18 |
| BTNUT | 8 | 4 | 31 | 5 | 3 | 29.1 | 2.68 | 0.14 |
| BTNUT | 9 | 4 | 29 | 10 | 13 | 34.5 | 3.00 | 0.13 |
| BTNUT | 10 | 4 | 26 | 0 | 15 | 24.8 | 2.68 | 0.12 |
| BTNUT | 11 | 4 | 31 | 0 | 0 | 20.6 | 2.50 | 0.23 |
| *FPLSD* | | | *11* | *24* | *29* | 9.6 | ns | *ns* |
| DKNSN | 1 | 4 | 27 | 28(27) | 20(13) | 37.5 | 6.18 | 0.40 |
| DKNSN | 2 | 4 | 21 | 45 | 45 | 42.5 | 7.09 | 0.30 |
| DKNSN | 3 | 4 | 29 | 15(7) | 18 (3) | 39.7 | 5.77 | 0.29 |
| DKNSN | 4 | 3 | 19 | 58 | 53 | 39.6 | 7.82 | 0.22 |
| DKNSN | 5 | 4 | 30 | 13 | 18 | 37.7 | 5.55 | 0.26 |
| DKNSN | 6 | 4 | 23 | 28 | 25 | 35.4 | 6.00 | 0.33 |
| DKNSN | 7 | 4 | 31 | 18 | 5 | 41.6 | 5.86 | 0.39 |
| DKNSN | 8 | 4 | 27 | 25 | 20 | 38.7 | 6.36 | 0.30 |
| DKNSN | 9 | 3 | 31 | 10 | 13 | 34.8 | 6.09 | 0.45 |
| DKNSN | 10 | 4 | 30 | 0 | 5 | 41.5 | 6.23 | 0.29 |
| DKNSN | 11 | 4 | 32 | 0 | 0 | 28.7 | 5.59 | 0.46 |
| *FPLSD* | | | *10* | *21* | *22* | ns | 1.09 | *ns* |
| GD | 1 | 4 | 30 | 8 | 10 | 36.1 | 5.14 | 0.01 |
| GD | 2 | 4 | 30 | 38(33) | 33(26) | 40.5 | 5.27 | 0.00 |
| GD | 3 | 4 | 33 | 13 | 8 | 41.0 | 5.09 | 0.00 |
| GD | 4 | 4 | 31 | 20 | 18 | 41.0 | 5.23 | 0.01 |
| GD | 5 | 4 | 32 | 18 | 8 | 37.8 | 5.05 | 0.00 |
| GD | 6 | 4 | 31 | 23 | 20 | 40.7 | 5.59 | 0.00 |
| GD | 7 | 4 | 29 | 20 | 15 | 31.4 | 4.55 | 0.01 |
| GD | 8 | 4 | 33 | 13 | 5 | 38.6 | 4.77 | 0.00 |
| GD | 9 | 4 | 29 | 16 | 15 | 35.5 | 5.27 | 0.09 |
| GD | 10 | 4 | 30 | 5(0) | 8(0) | 36.1 | 5.41 | 0.01 |
| GD | 11 | 4 | 33 | 0 | 0 | 36.3 | 4.68 | 0.01 |
| *FPLSD* | | | *ns* | *18* | *15* | 6.2 | ns | *ns* |
| | | | | | | *sum of 3 harvests* | | *proportion Grade 1* |
| ZUCC | 1 | 4 | 29 | 30(13) | 33(16) | 3.8 | 0.15 | 0.60 |
| ZUCC | 2 | 4 | 25 | 40(27) | 40(30) | 3.1 | 0.14 | 0.51 |
| ZUCC | 3 | 4 | 23 | 20 | 25 | 3.7 | 0.18 | 0.43 |
| ZUCC | 4 | 4 | 26 | 20 | 23 | 3.5 | 0.15 | 0.63 |
| ZUCC | 5 | 4 | 28 | 20 | 10 | 3.5 | 0.15 | 0.56 |
| ZUCC | 6 | 4 | 26 | 38 | 33 | 3.4 | 0.13 | 0.72 |
| ZUCC | 7 | 4 | 27 | 23 | 18 | 3.5 | 0.14 | 0.68 |
| ZUCC | 8 | 4 | 26 | 18 | 23 | 3.3 | 0.12 | 0.79 |
| ZUCC | 9 | 4 | 29 | 13 | 8 | 3.9 | 0.15 | 0.59 |
| ZUCC | 10 | 4 | 31 | 0 | 5 | 3.9 | 0.16 | 0.50 |
| ZUCC | 11 | 4 | 30 | 0 | 0 | 2.5 | 0.15 | 0.63 |
| *FPLSD* | | | *7* | 21.0 | 33 | 0.8 | ns | *ns* |

[1] Numbers in () are mean injury values if excluding plots that were submerged during the rain storm on June 13 (n=3).



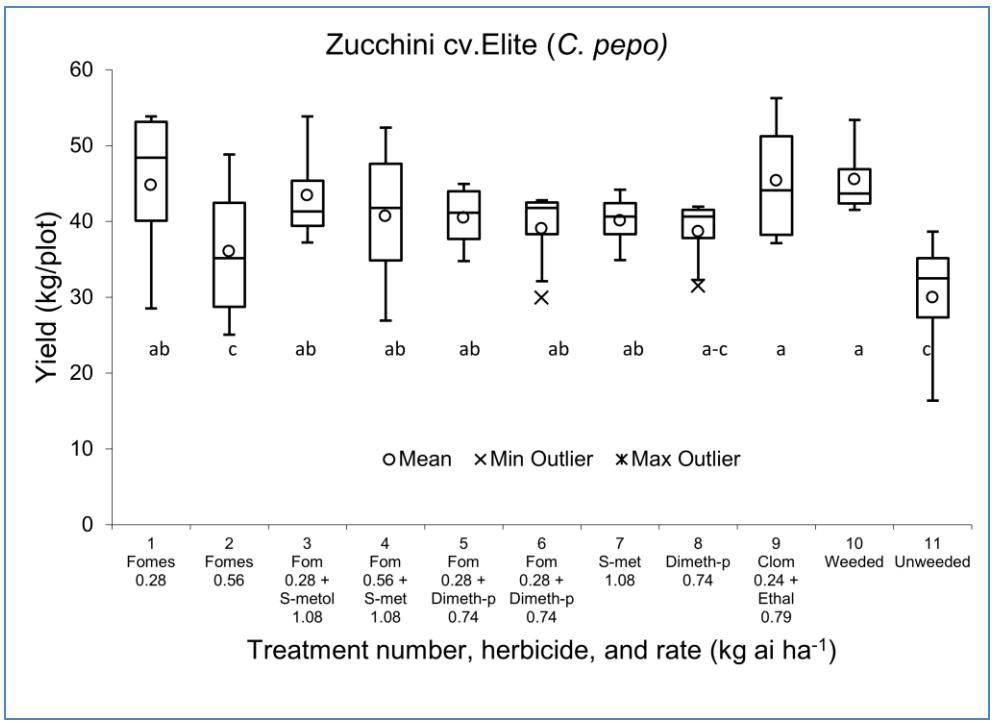




**Figure 1.** Effect of fomesafen and other preemergence herbicides on yield of cucurbits at Corvallis in 2009.The ends of the whisker are set at 1.5*IQR (inner quartile range) above the third quartile (Q3) and 1.5*IQR below the first quartile (Q1). Min or Max values outside this range are shown as outliers. Abbrev: Fom, fomesafen; s-met, s-metolachlor; dimeth-p, dimethenamid-p; clom, clomazone; ethal, ethalfluralin. Means separated with Fishers protected LSD. Means labeled with the same letter do not differ.

**Table 5.** Site characteristics and herbicide application data.

| **Site characteristics** | |
|---|---|
| Plot size/exp. design | 2.0 m by 7.6 m even-spray zone |
| Preceding crop | Fallow |
| Soil test | pH 6.0; %OM (LOI) 2.4; CEC 20.7 meq/100 g |

| **Herbicide application data** | |
|---|---|
| Date | Wednesday, May 27, 2009 |
| Crop stage | Planted 5-26 with belt planters |
| Application timing | PES |
| Start/end time | 7-8:30 AM |
| Air temp/soil temp (5cm)/surface (C) | 21/18/20 (8:45AM) |
| Rel humidity | 60% |
| Wind direction/velocity | N 0-4 |
| Cloud cover | 50% |
| Soil moisture | Dry, moisture at 4 cm inches |
| Sprayer/Pressure | BP 172 kPa |
| Mix size | 7000 mls |
| Delivery rate | 187 L/ha |
| Nozzle type | 4-XR8002 flat fan |
| Nozzle spacing and height | 51/56-60 cm |
| Soil inc. method/implement | 1.25 cm irrigation on May 28 |