STUDIES REGARDING THE ACTIVITY OF WESTSOL AND OTHER SOIL AMENDMENTS ON SOIL COMPACTION, CRUSTING/SURFACE COMPACTION, AND SOIL SALINITY, 2007-2008.

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Wetsol application experiments were established at three locations in 2007 to investigate its activity on three soils, each with a different problem. The Fargo site has a high clay soil (Fargo silty clay loam; fine smectitic, frigid, Typic, Epiaquerts). This site was investigated for compaction during the growing season. The Prosper site is a location with a heavy soil (Perella, fine-silty, mixed, frigid Typic Haplaquolls) with a reputation by area growers for crusting problems early in the season. The Grand Forks site has a problem with salts (Bearden silty clay loam; fine-silty, frigid Aeric Calciaquolls), and is a more medium-textured soil. Four treatments were imposed at each of the three sites as follows-

Treatment number	Treatment description
1	Check- no additives
2	Wetsol, 1 pt/a
3	Wetsol Gro, 1 gal/a
4	Gypsum, 250 lb/a

Each experiment was designed as a randomized complete block, with four treatments and five replications. This design provides twelve degrees of freedom for the analysis of variance error term. Wetsol and Wetsol Gro treatments were applied with a bicycle spray boom fitted with nozzles suitable for application with water at a 20 gal/a total spray volume rate. Treatments were applied to the surface and were not incorporated. Individual plots were 8 feet wide and 10 feet long. The plots at Prosper and Fargo were fallow, with weeds controlled except at the 8/29 sampling date at Fargo. The plot at Grand Forks was cropped to soybean. Treatments were applied at Fargo 6/05; Prosper 6/11; Grand Forks 6/13. Soybeans were in the third trifoliate stage when treatments were applied. Precipitation following treatment is provided below.

Rainfall Fargo, 6/5-6/10	0.9 inches
Rainfall Prosper, 6/11-6/18	2.5 inches
Rainfall Grand Forks 6/20-7/10	0.9 inches

Penetrometer readings were obtained using a Spectrum SC500 Field Scout® digital cone penetrometer that records pressures every inch in soil depth. The unit has a radar depth sensor and saves values to an internal chip that can be downloaded to a remote computer following field measurements. The values recorded are pounds per square inch (psi). Penetrometer readings were obtained at the date of application at Fargo and Prosper. Addition readings at Fargo were taken on 6/25 and 8/29. Additional readings were obtained at Prosper 6/27 and 7/27.
Soil EC data was obtained at Grand Forks from twin 0-6 inch soil cores taken and composited from each plot on the application date (6/20) and repeated 7/20.

2007 Results

There were no differences in soil density readings at Fargo due to treatment between the 6/05 and 6/25 sampling date (Table 1). There were also no differences in soil density readings between the 6/05 and 8/29 sampling dates due to treatment (Table 2).

Table 1. Penetrometer readings, Fargo, difference between readings on 6/05 and 6/25 (6/25 – 6/05).

Depth inches	Treatment				F*	P<**
	1	2	3	4		
	psi					
0	24.6	-6.0	15.4	9.4	1.24	0.34
1	59.0	33.6	46.0	34.6	0.25	0.86
2	65.2	71.6	64.2	6.0	0.06	0.98
3	24.2	33.8	14.0	22.4	0.37	0.77
4	9.0	12.2	-5.2	16.6	1.31	0.32
5	7.0	3.2	-8.0	7.0	0.69	0.58
6	2.8	-3.0	-7.0	14.8	1.27	0.33
7	3.8	-15.4	-4.0	8.0	1.26	0.33
8	6.0	-20.2	-8.0	-3.2	2.26	0.13
9	-2.0	-25.2	-16.2	7.2	0.91	0.46
10	8.0	-23.4	9.4	0.2	0.56	0.65
11	5.0	-31.4	2.2	1.0	0.64	0.60
12	6.0	-29.4	3.0	5.0	0.72	0.56

* F values are the result of division of treatment sum of squares by ANOVA mean squares.

**P is the probability of an incorrect finding that treatments are different (5%).

Table 2. Penetrometer readings, Fargo, difference between readings on 6/05 and 8/29 (8/29 – 6/05).

Depth inches	Treatment 1	2	3	4	F	P<
	psi					
0	1.8	16.4	20.6	9.4	0.85	0.49
1	13.4	52.2	61.2	35.8	1.10	0.39
2	99.6	91.6	128.2	101.6	0.36	0.78
3	151.6	92.8	136.2	132.2	0.54	0.67
4	171.8	129.2	179.8	170.0	0.37	0.78
5	186.4	173.2	209.6	145.6	0.23	0.88
6	160.6	154.6	195.4	161.6	0.10	0.96
7	145.4.	145.4	202.4	148.6	0.25	0.86
8	127.2	116.8	167.8	155.2	0.26	0.85
9	115.0	95.8	153.6	171.8	0.54	0.67
10	110.8	78.2	164.0	145.4	0.80	0.52
11	100.8	73.2	142.6	119.8	0.63	0.61
12	98.6	82.2	133.4	135.4	0.70	0.57

At Prosper, the penetrometer readings were lower for the Wetsol, Wetsol green and gypsum treatments than the check (Table 3). This suggests that perhaps these additives might help surface crusting at least for a couple weeks during seedling emergence. At the 7/27 date, the gypsum treatment was superior to the other treatments at the 2-inch depth in reducing penetrometer readings (Table 4).

Table 3. Penetrometer readings, Prosper, difference between readings on 6/11 and 6/27 (6/27 – 6/05).

Depth inches	Treatment 1	2	3	4	F	P<
	psi					
0	79.4	73.4	57.2	32.0	0.28	0.84
1	**222.0**	**100.0**	**90.0**	**93.0**	**2.88**	**0.08***
2	191.0	112.0	153.0	90.0	1.69	0.22
3	91.0	62.0	92.0	62.0	1.60	0.24
4	59.0	48.0	58.0	42.0	0.25	0.86
5	47.0	26.0	47.0	19.0	1.08	0.39
6	18.4	9.2	46.0	9.2	1.34	0.31
7	20.4	1.4	40.6	10.2	1.06	0.40
8	16.4	12.2	36.4	8.2	1.00	0.42
9	20.4	11.8	20.4	1.0	0.47	0.71
10	19.4	19.2	14.4	-1.2	0.53	0.67
11	29.6	20.4	1.0	-0.2	1.49	0.27
12	34.6	13.2	6.6	-6.2	1.40	0.29

* Treatments 2, 3 and 4 are less than the check at the 10% probability level.

Table 4. Penetrometer readings, Prosper, difference between readings on 6/11 and 7/27 (7/27 – 6/11).

Depth inches	Treatment 1	2	3	4	F	P<
	psi					
0	3.0	43.8	7.4	4.0	1.27	0.33
1	19.4	69.2	36.6	31.8	1.37	0.30
2	**47.0**	**76.0**	**70.0**	**30.0**	**2.99**	**0.07***
3	39.0	78.0	68.0	87.0	0.45	0.72
4	14.0	66.0	50.0	66.0	1.31	0.32
5	11.0	52.0	43.0	50.0	0.72	0.56
6	18.0	32.0	37.0	47.0	0.45	0.72
7	26.0	27.0	38.0	29.0	0.17	0.92
8	21.0	12.0	24.0	19.0	0.12	0.94
9	16.4	3.0	15.2	12.2	0.17	0.91
10	16.6	13.2	3.0	8.2	0.19	0.90
11	16.4	12.2	-13.4	12.4	1.38	0.30
12	3.2	-9.4	-4.8	-24.2	0.52	0.67

*Treatment 4 is lower in penetrometer difference compared with other treatments at the 10% probability level.

At Grand Forks, soil EC analysis at the 0-6 inch depth showed no differences between treatments between the initial soil sampling and the later season sampling (Table 5).

Table 5. Soil EC differences due to treatment, Grand Forks, ND.

Treatment	EC1	EC2	Differences in EC, mmho/cm
1	0.49	0.52	0.03
2	0.48	0.54	0.06
3	0.50	0.57	0.07
4	0.53	0.62	0.09
			F = 0.40
			P< 0.75, non significant

Summary of 2007 experiments-

Three experiments were conducted in 2007 to examine the effect of Wetsol, Wetsol Gro and gypsum on soil compaction, soil crusting and soil salinity in soils where those properties have been suspected of being found. At Fargo, the treatments had no effect on soil density and the resulting soil penetrometer readings. At Prosper, where crusting is often a problem, the Wetsol, Wetsol Gro, and gypsum treatments reduced penetrometer readings at the 1 inch depth, suggesting that the treatments might reduce crusting. At Grand Forks, in an area of a field where salinity can be a problem, there was no reduction in soil EC due to treatment. It is possible that low rainfall following application may have impacted treatments at Grand Forks.

2008 Experiments

In 2008, three additional studies were conducted on Wetsol and Wetsol Gro products. The objective was to repeat the experiments from 2008 to determine if similar results might be obtained with treatment of three problem soils. The first experiment was established at Fargo on a Fargo silty clay loam soil to determine if soil density (compaction) might be impacted by treatments of Wetsol, Wetsol Gro, gypsum and sugar beet spent lime. The treatments imposed were as follows:

Treatment 1- Check (no amendments)
Treatment 2- Wetsol 1 pint/acre
Treatment 3- Wetsol Gro 1 gallon/acre
Treatment 4- Gypsum 250 lb/acre
Treatment 5- Sugarbeet spent lime 1 ton/acre

Sugarbeet spent lime is a waste from sugar beet processing containing calcium hydroxide with significant moisture. The calcium carbonate equivalence is about 70%.

The area of the experiment was chisel-plowed twice in October, 2007. The area was also smoothed in the spring using a field cultivator. No additional tillage was conducted after 5/8.

The experiment was established 6/18/2008 on fallow soil. The experiment was kept weed-free with two glyphosate herbicide applications until 7/14. Penetronometer readings were obtained in the center of each 4-foot by 10-foot plot at the beginning of the experiment and the 7/14 date. An additional reading was obtained 8/6. There were some weeds present in all plots at this last date. Rainfall history from the time the experiment was established is provided in Figure 1.

Significant rain fell at Fargo between May 28 and June 14. This provided an opportunity for settling of the soil from spring tillage. Following the application of treatments, over an inch of rain fell within a week. Any activation of treatments should have occurred following this period.

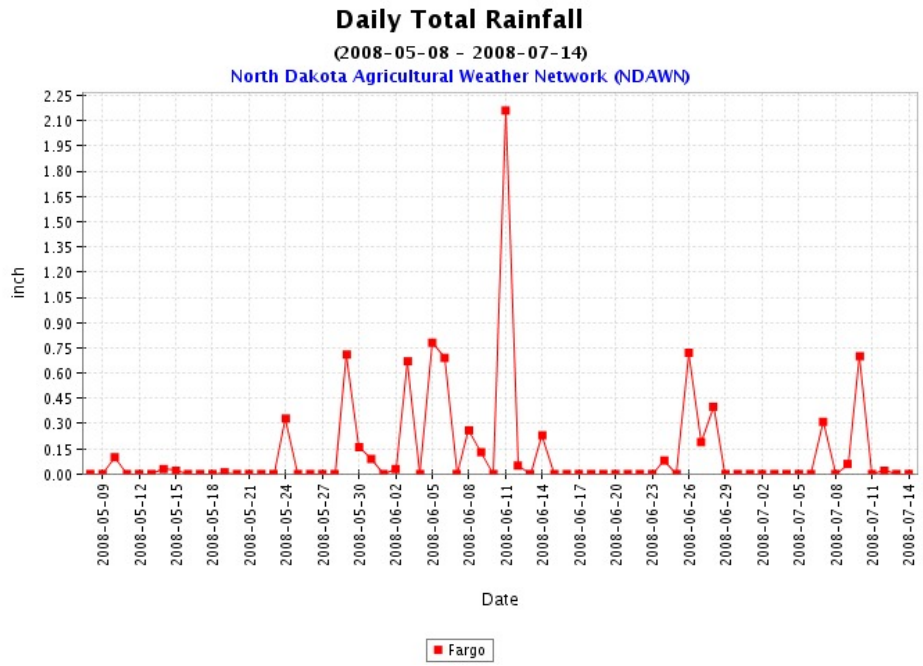

Figure 1. Rainfall at Fargo from May 8 through July 14, 2008. (NDAWN data, 2008)

Table 6. Penetrometer readings, Fargo, 2008. Difference between readings on 6/18 and 7/14 (7/14 – 6/18).

Depth inches	Treatment					F*	LSD
	1	2	3	4	5		
	psi						
0	-12.2	-7.6	6.3	6.0	6.0	1.56	-----
1	32.4	35.0	12.0	59.7	40.2	1.85	------
2	3.8	61.3	11.3	59.8	8.0	1.25	-----
3	52.3	**99.4**	40.9	74.4	68.0	7.59	27.0
4	20.0	42.6	15.9	**56.1**	41.7	4.64	25.5
5	10.0	18.8	-2.8	**32.8**	26.8	4.21	22.0
6	11.3	**22.8**	2.5	**26.3**	**28.0**	3.91	20.0
7	12.5	14.0	7.5	32.8	20.3	1.52	-----
8	11.3	15.3	11.3	32.8	23.8	0.95	-----
9	36.7	41.2	24.2	44.7	48.6	1.62	-----
10	10.0	15.0	5.0	23.8	27.5	1.03	-----
11	11.3	13.8	9.0	17.8	26.3	0.67	-----
12	1.3	10.0	15.0	7.5	21.3	5.48	10.0

* F values are the result of division of treatment sum of squares by ANOVA mean squares.
**LSD is least significant different between means. The level of significance is 5%.

Statistical analysis of the Fargo 2008 penetrometer readings recorded in Table 6 suggest that soil density might increase with Wetsol application at the 3-inch depth, while soil density might also increase with gypsum application at 4-5 inch depths with gypsum. Soil density also increased with Wetsol, gypsum and spent lime compared with Wetsol Gro application at the 6-inch depth. It seems hardly likely that soil density would increase at depths more than 3 inches with the application of any of these products given the relatively low rainfall between the two reading dates. This may be a result of high variability within the plots not resolved by the statistical analysis. The second set of readings obtained August 6 confirms these suspicions, as none of these soil density increases reappear, with only the lime treatment at 2 inches more dense than other treatments (Table 7).

Table 7. Penetrometer readings, Fargo, 2008. Difference between readings on 6/18 and 8/6 (8/6 – 6/16).

Depth inches	Treatment					F*	LSD
	1	2	3	4	5		
	psi						
0	-14.0	-1.3	-1.3	-3.3	7.5	0.59	-----
1	25.5	-1.5	16.5	67.8	110.5	2.02	------
2	100	109	146	120	**238**	2.26	110
3	162	182	127	265	248	1.97	-----
4	131	46	53	164	137	1.63	-----
5	123	27	47	145	109	1.38	-----
6	103	22	50	118	88	1.20	-----
7	94	42	40	92	81	0.75	-----
8	74	21	46	87	71	0.88	-----
9	57	19	38	63	64	0.88	-----
10	68	47	44	60	74	1.17	-----
11	59	46	38	65	72	1.96	-----
12	29	11	26	34	43	1.08	-----

* F values are the result of division of treatment sum of squares by ANOVA mean squares.
**LSD is least significant different between means. The level of significance is 5%.

Prosper soil crust alleviation study, 2008.

The second experiment was conducted near Prosper, ND on Perella soils similar to those described in 2007. These soils are subject to surface crusting in some years. The experiment consisted of six treatments, replicated four times. The treatments were:

Treatment 1- Check
Treatment 2- Wetsol 1 pint/acre
Treatment 3- Wetsol Gro 1 gallon/acre
Treatment 4- Gypsum 250 lb/acre
Treatment 5- Sugarbeet spent lime 1 ton/acre
Treatment 6- Sugarbeet spent lime 2 ton/acre

The study area was treated 5/8, and seeded to sugarbeets shortly afterwards. The plots were 11 feet wide by 30 feet long. Sugar beet seed was planted at a 200 seed/100 foot seeding rate in 22-inch rows. Penetrometer readings were made on the date of establishment (May 8) and June 18. Stand emergence readings were obtained by counting plants in rows 3 and 4 of the 6-row plots (the two center rows), and converting the results to plants/100-foot of row. Statistical analysis was conducted in SAS 9.1, using either the GLM (general linear model) for a randomized complete block, or PROC MIXED if the data from each property was found spatially variable using GS+ 7 for windows. In the PROC MIXED routine, the spatial variability structure of the experimental data was included in the analysis and removed during the process. Precipitation during the experiment is shown in Figure 2.

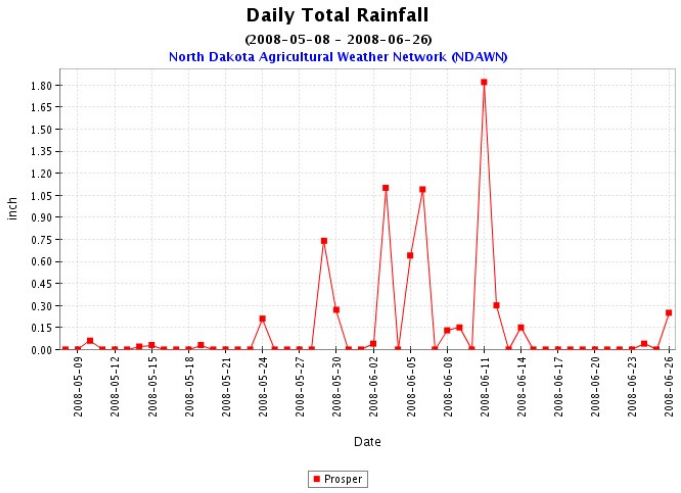

Figure 2. Rainfall at Prosper between 5/8 and 6/26. (NDAWN data, 2008).

Table 8. Penetrometer readings, Prosper, 2008. Difference between readings on 5/8 and 6/18 (6/18 – 5/8).

Depth inches	Treatment						F*	LSD
	1	2	3	4	5	6		
	psi							
0	1.5	9.0	5.0	-16.8	-25.8	-6.8	0.73	-----
1	-4.8	-24.6	-29.2	-41.7	-37.6	-22.0	0.73	-----
2	-26.5	-24.3	-45.8	-27.8	-25.8	-14.0	0.39	-----
3	-81.8	-70.5	-75.5	-83.5	-65.5	-92.1	0.33	-----
4	-61.9	-87.2	-58.1	-83.3	-64.5	-101.2	0.94	-----
5	-38.6	-66.4	-27.8	-56.6	-45.6	-68.8	0.85	-----
6	-24.2	**-65.9**	-37.0	**-67.7**	-44.7	-63.6	2.09	40.0
7	-19.5	-41.3	-11.4	-43.9	-28.7	-48.7	1.93	-----
8	-11.3	-15.0	-7.5	-30.5	-12.8	-27.8	1.16	-----
9	-1.3	-25.3	-25.3	-29.5	-5.0	-24.0	1.81	-----
10	-1.0	-38.3	-36.0	-26.5	-11.8	-26.5	0.60	-----

* F values are the result of division of treatment sum of squares by ANOVA mean squares.
**LSD is least significant different between means. The level of significance is 5%.

There were no differences in soil density between the check, Wetsol Gro and the two lime treatments. Unlike 2007, there were also no differences between the check at depths that would aid in crusting alleviation. There were decreases in soil density between the Wetsol treatment and gypsum treatment and the check at the 6-inch depth. This seems a little deep for the treatments to impact the study; however, five inches of rain fell between treatment establishment and this measurement, so perhaps it is possible the treatments moved that far into the soil.

Table 9. Stand emergence counts (5/21) and final stand counts (6/26) of sugar beets as affected by treatments at Prosper, 2008.

	Treatment						F*	LSD
	1	2	3	4	5	6		
	Plants/100 foot row							
Emergence counts	108	133	136	125	155	118	0.60	-----
Final stand counts	200	204	**217**	198	**212**	193	2.61	16.0

* F values are the result of division of treatment sum of squares by ANOVA mean squares.
**LSD is least significant different between means. The level of significance is 5%.

Early emergence of sugar beets, obtained about 2 weeks after seeding (5/21) showed no differences due to treatments. Stand counts obtained a month later (6/26) were higher with Wetsol Gro and the spent lime treatment at 1 ton/acre. Later stand was not enhanced by Wetsol, gypsum or the spent lime at 2 ton/acre.

Effect of Wetsol in alleviation of salts at Prosper, 2008.

An experiment was established about 2 miles west of the Prosper crusting study on Glyndon soils where sugar beets were seeded into an area affected by high soluble salts. The treatment areas were marked and paired soil cores to a 6-inch depth were obtained. Soil samples and the treatments were applied to the soil surface June 20. A second set of soil samples using the same technique was obtained July 14.
Treatments were:

Treatment 1- Check
Treatment 2- Wetsol 1 pint/acre
Treatment 3- Wetsol Gro 1 gallon/acre
Treatment 4- Gypsum 250 lb/acre
Treatment 5- Sugarbeet spent lime 1 ton/acre

There were no differences in change in soil salinity (EC) between sampling dates. The application of treatments did not influence soil salinity levels (Table 10).

Table 10. Salinity level (EC) change with treatment, Prosper, 2008.

Treatment	Change in soil EC measurement
1	0.03
2	0.10
3	-0.13
4	0.08
5	0.05
F value 0.54	No significance

Summary of 2008 experiments

Three experiments were conducted in 2008 to examine the effect of Wetsol, Wetsol Gro, gypsum and sugarbeet spent lime on soils with high soil density, soil crusting and soil salinity in. At Fargo, the treatments did not reduce soil density and the resulting soil penetrometer readings. At Prosper, where crusting is often a problem, none of the treatments reduced soil density at shallow (3-inches or less) depths. There was a reduction in soil density at the 6-inch depth by Wetsol and gypsum. Sugarbeet stand was improved by both the Wetsol Gro and spent lime at 1 ton/acre treatments. At the Prosper area site with high soluble salts, no reduction in salinity was recorded with any treatment.

Summary of 2007 and 2008 experiments

There were no reasonable effects of Wetsol, Wetsol Gro, gypsum or spent lime on soil density properties of the Fargo soil. This is a soil high in shrinking/swelling clays (smectites). There was also no effect of any treatment on alleviation of soluble salts.

There was inconsistent reduction in soil density by both Wetsol and gypsum at various depths at the Prosper site. The soil at this site is high in smectitic clay, but also has a reputation for crusting. The data showed reduction in soil density in 2007 at a shallow depth with both treatments, and also showed an increase in sugar beet stand with Wetsol Gro in 2008. This suggests that Wetsol-based products may alleviate soil crusting and perhaps improve other surface soil properties to enable better stands in problem soils. Any promotion of the product should stress its use in soils with a history of crusting, and not as a benefit in all soils, which was not observed. Also, any reference to alleviation of compaction in our regional soils (almost all have high smectite clay content) should be avoided. Any reference to the products effect on soil salinity should also be avoided.

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Disclaimer

Use of the products in this study does not constitute an endorsement for their use by the author or NDSU.