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The objectives of these experiments were to determine weed control and sugarbeet injury from the micro-rate system with various adjuvants and to compare the micro-rate to full and reduced rates. Previous results with the micro-rate have been published in the 1995 Sugarbeet Research and Extension Reports, pp 77-82; the 1996 Sugarbeet Research and Extension Reports, pp 62-66 and the 1997 Sugarbeet Research and Extension Reports, pp 103-108 (<http://www.sbreb.org>). Previous results indicated a) oil adjuvant increased the risk of sugarbeet injury from the herbicides but the risk of injury was minimal with the micro-rate plus oil adjuvant; b) the micro-rate applied three times gave better weed control than normal rates applied twice; c) the micro-rate applied three or four times generally gave weed control similar to normal rates applied the same number of times but the micro-rate sometimes gave 5 to 6% less control than normal rates; and d) Select, Poast or Assure II at 33 to 50% of the normal rate gave excellent grass control when combined with the micro-rate.

Precipitation and nozzle plugging have been a problem with commercial use of the micro-rate. Nozzle plugging can be reduced by the following:

- a) Pre-slurry the UpBeet in hot water or in water with a pH 8 to 9. Add the UpBeet to the tank first and make sure it is thoroughly dissolved before adding other herbicides.
- b) Allow the spray-tank water to warm before adding herbicides.
- c) Increase the pH of the spray tank water by adding household ammonia (2% concentration) at 1 gallon per 100 gallons of water. Add ammonia slowly as the tank fills to avoid raising the pH too high.
- d) As an alternative to ammonia, add a basic blend adjuvant at 1% v/v to increase the pH of the spray tank water.
- e) Spray out the tank load immediately after mixing since more precipitate forms as time passes. Spray until the tank is dry and flush frequently. A thorough cleaning may be needed every three or four tank loads.
- f) Add a grass herbicide to the micro-rate.
- g) Use the minimum amount of agitation necessary to keep the solution mixed.
- h) Increase screen size or use slotted screens rather than mesh screens.

Treatments in this experiment were applied four times at four locations and three times at four locations (Table 1). Planting dates, treatment dates, soil temperatures and sugarbeet size at treatment are given in Table 1. Sugarbeet was seeded 1.25 inches deep in 22-inch rows and treatments were applied to the center four rows of six-row plots. Herbicides were applied in 8.5 gpa of water through 8001 nozzles at 40 psi and 3 mph. 'Hilleshog Horizon' was seeded at St. Thomas, Angus, Crookston and Hillsboro. 'Maribo 9581' was seeded at Fargo and 'Hilleshog Viking' at Maynard.

The rates of the components of the 18 treatments applied at each location are given in product per acre and in active ingredient per acre (Table 2). The product rates of Betanex, Betamix, Betamix Progress, Stinger, Select and Assure II are in pt/A while the UpBeet rate is in oz/A and the adjuvants are expressed as % v/v.

Table 1. Dates and sugarbeet growth stages when postemergence herbicides were applied in 1998.

| Location                  | Planting date | First POST |                   |            | Second POST |                   |            | Third POST |                   |            | Fourth POST |                   |            |
|---------------------------|---------------|------------|-------------------|------------|-------------|-------------------|------------|------------|-------------------|------------|-------------|-------------------|------------|
|                           |               | Date       | 6-inch soil temp. | Sugb. Size | Date        | 6-inch soil temp. | Sugb. Size | Date       | 6-inch soil temp. | Sugb. Size | Date        | 6-inch soil temp. | Sugb. Size |
| St. Thomas, ND            | 4/27          | 5/13       | F                 | V          | 5/20        | F                 | V          | 5/27       | F                 | V          | 6/3         | F                 | V          |
| Angus, MN                 | 4/24          | 5/8        | 57                | 1.0        | 5/15        | 63                | 2.0        | 5/22       | 70                | 5.2-6.5    | 5/29        | 66                | 5.2-8.1    |
| Crookston, MN             | 4/24          | 5/8        | 53                | 1.0        | 5/18        | 62                | 1.0-2.0    | 5/22       | 64                | 1.0-4.0    | 5/29        | 66                | 2.3-8.5    |
| Hillsboro, ND             | 4/28          | 5/14       | 58                | 1.0        | 5/20        | 65                | 1.0-3.5    | 5/27       | 65                | 4.0        | 6/3         | 47                | 2.3-8.7    |
| Fargo, ND                 | 4/28          | 5/26       | 68                | 1.0        | 6/2         | 62                | 1.0-2.1    | 6/9        | 68                | 2.7-4.7    | 6/3         | 47                | 4.0-8.0    |
| Wahpeton, ND (weeds only) | 4/28          | 5/19       | 68                | -          | 5/25        | 61                | 4.0-5.2    | 6/1        | 66                | 4.0-6.5    | -           | -                 | -          |
| Maynard, MN               | 4/23          | 5/6        | -                 | 1.0        | 5/13        | -                 | 2.0        | 5/20       | -                 | 4.0        | -           | -                 | -          |
| Clara City, MN            | 4/25          | 5/6        | -                 | 1.0        | 5/13        | -                 | 2.0-2.5    | 5/20       | -                 | 4.0-6.0    | -           | -                 | -          |

V1.0 = cotyledonary stage, V2.0 = two unrolled leaves, V2.5 = two unrolled leaves with third leaf 50% unrolled. See 1996 Sugarbeet Research and Extension Reports, pp 152-157.

Table 2. Herbicide treatments applied at eight locations, 1998.

| Treatment                                      | Product rate applied 3 or 4 times | Active ingredient rate applied 3 or 4 times | Rate name used in Tables 3 & 4 |
|------------------------------------------------|-----------------------------------|---------------------------------------------|--------------------------------|
|                                                | pt or oz/A                        | lb ai/A                                     |                                |
| Betanex                                        | 1.5                               | 0.25                                        | Full                           |
| Betanex+UpBeet                                 | 1.5+0.5                           | 0.25+0.0156                                 | Full                           |
| Bnex+UpB+Stinger                               | 1.5+0.5+0.25                      | 0.25+0.0156+0.09                            | Full                           |
| Bnex+UpB+Stinger                               | 1.0+0.25+0.16                     | 0.16+0.008+0.06                             | Reduced                        |
| Bnex+UpB+MethOil <sup>1</sup>                  | 0.5+0.125+1.5%                    | 0.08+0.004+1.5%                             | Micro                          |
| Bnex+UpB+Sting+MO <sup>1</sup>                 | 0.5+0.125+0.08+1.5%               | 0.08+0.004+0.03+1.5%                        | Micro                          |
| Bnex+UpB+Sting+MO                              | 0.5+0.125+0.08+3.0%               | 0.08+0.004+0.03+3%                          | Micro                          |
| Bnex+UpB+Sting+MO+NH <sub>4</sub> <sup>2</sup> | 0.5+0.125+0.08+1.5%+0.02%         | 0.08+0.004+0.03+1.5%+0.02%                  | Micro                          |
| Bnex+UpB+Sting+Quad7 <sup>3</sup>              | 0.5+0.125+0.08+1.0%               | 0.08+0.004+0.03+1.0%                        | Micro                          |
| Bnex+UpB+Sting+Q7 <sup>3</sup> +MO             | 0.5+0.125+0.08+1.0%+1.5%          | 0.08+0.004+0.03+1.0%+1.5%                   | Micro                          |
| Bnex+UpB+Sting+Quad7                           | 0.5+0.125+0.08+2%                 | 0.08+0.004+0.03+2%                          | Micro                          |
| Bnex+UpB+Sting+Q7+NH <sub>4</sub> <sup>2</sup> | 0.5+0.125+0.08+1%+0.02%           | 0.08+0.004+0.03+1%+0.02%                    | Micro                          |
| Bnex+UpB+Sting+Select+MO                       | 0.5+0.125+0.08+0.12+1.5%          | 0.08+0.004+0.03+0.03+1.5%                   | Micro                          |
| Bex+Up+St+Sel+MO+NH <sub>4</sub> <sup>2</sup>  | 0.5+0.125+0.08+0.12+1.5%+0.02%    | 0.08+0.004+0.03+0.03+1.5%+0.02%             | Micro                          |
| Bnex+UpB+Sting+Sel+Q7                          | 0.5+0.125+0.08+0.12+1%            | 0.08+0.004+0.03+0.03+1%                     | Micro                          |
| Betamix+UpB+Sting+MO                           | 0.5+0.125+0.08+1.5%               | 0.08+0.004+0.03+1.5%                        | Micro                          |
| B.Progress+UpB+Sting+MO                        | 0.4+0.125+0.08+1.5%               | 0.08+0.004+0.03+1.5%                        | Micro                          |
| Bnex+UpB+Sting+Assure+MO                       | 0.5+0.125+0.08+0.25+1.5%          | 0.08+0.004+0.03+0.028+1.5%                  | Micro                          |

<sup>1</sup>MethOil, MO = a methylated seed oil adjuvant from Terra used at 1.5% v/v. <sup>2</sup>NH<sub>4</sub> = household ammonia (2% concentration) used at 1 gallon per 100 gallons of water giving a final NH<sub>4</sub> concentration of 0.02%. <sup>3</sup>Quad 7, Q7 = basic blend surfactant from AGSCO used at 1% v/v.

None of the treatments caused significant sugarbeet injury (Table 3) even when the full rate was applied three or four times starting when sugarbeet plants were in the cotyledon stage.

Betanex alone gave less control of redroot pigweed than the other treatments, all other treatments gave 96% or greater redroot pigweed control. Betanex + UpBeet + MethOil at the micro-rate 0.5 pt/A + 0.125 oz/A + 1.5% v/v gave less control of common lambsquarters than other treatments. Adding Stinger to this treatment increased control of common lambsquarters from 94% to 98%. Stinger is needed as a component of the micro-rate for best control of common lambsquarters. Betanex alone gave no control of common mallow. Betanex + UpBeet + Stinger at the reduced rate 1.0 pt/A + 0.25 oz/A + 0.16 pt/A gave less control of common mallow than the other treatments. For example, Betanex + UpBeet + Stinger + MethOil at the micro-rate 0.5 pt/A + 0.125 oz/A + 0.08 pt/A + 1.5% v/v gave better common mallow control. This indicates that the MethOil adjuvant more than doubled the activity of the herbicides since the reduced rate with

Table 3. Sugarbeet injury and weed control over all locations, 1998.

|                                                | Rate applied<br>3 or 4 times | 7 loc.<br>Sugb <sup>4</sup><br>inj | 5 loc.<br>Rrpw <sup>4</sup><br>cntl | 3 loc.<br>Colq <sup>4</sup><br>cntl | Crook.<br>Coma <sup>4</sup><br>cntl |
|------------------------------------------------|------------------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
|                                                | (See T.2)                    | %                                  | %                                   | %                                   | %                                   |
| Betanex                                        | Full                         | 1                                  | 92                                  | 99                                  | 0                                   |
| Betanex+UpBeet                                 | Full                         | 2                                  | 99                                  | 100                                 | 90                                  |
| Bnex+UpB+Stinger                               | Full                         | 2                                  | 100                                 | 100                                 | 98                                  |
| Bnex+UpB+Stinger                               | Reduced                      | 2                                  | 99                                  | 100                                 | 84                                  |
| Bnex+UpB+MethOil <sup>1</sup>                  | Micro                        | 1                                  | 96                                  | 94                                  | 95                                  |
| Bnex+UpB+Sting+MO <sup>1</sup>                 | Micro+1.5%                   | 2                                  | 98                                  | 98                                  | 97                                  |
| Bnex+UpB+Sting+MO                              | Micro+3%                     | 2                                  | 97                                  | 99                                  | 96                                  |
| Bnex+UpB+Sting+MO+NH <sub>4</sub> <sup>2</sup> | Micro                        | 2                                  | 99                                  | 99                                  | 96                                  |
| Bnex+UpB+Sting+Quad7 <sup>3</sup>              | Micro+1%                     | 1                                  | 99                                  | 99                                  | 94                                  |
| Bnex+UpB+Sting+Q7 <sup>3</sup> +MO             | Micro                        | 1                                  | 99                                  | 99                                  | 98                                  |
| Bnex+UpB+Sting+Quad7                           | Micro+2%                     | 2                                  | 98                                  | 99                                  | 93                                  |
| Bnex+UpB+Sting+Q7+NH <sub>4</sub> <sup>2</sup> | Micro                        | 1                                  | 98                                  | 98                                  | 94                                  |
| Bnex+UpB+Sting+Select+MO                       | Micro                        | 1                                  | 99                                  | 98                                  | 94                                  |
| Bex+Up+St+Sel+MO+NH <sub>4</sub>               | Micro                        | 2                                  | 98                                  | 98                                  | 94                                  |
| Bnex+UpB+Sting+Sel+Q7                          | Micro                        | 2                                  | 98                                  | 98                                  | 91                                  |
| Betamix+UpB+Sting+MO                           | Micro                        | 2                                  | 96                                  | 100                                 | 96                                  |
| B.Progress+UpB+Sting+MO                        | Micro                        | 2                                  | 97                                  | 100                                 | 97                                  |
| Bnex+UpB+Sting+Assure+MO                       | Micro                        | 1                                  | 98                                  | 98                                  | 94                                  |
| LSD (0.05)                                     |                              | NS                                 | 2                                   | 3                                   | 8                                   |

<sup>1</sup>MethOil, MO = a methylated seed oil adjuvant from Terra used at 1.5% v/v. <sup>2</sup>NH<sub>4</sub> = household ammonia (2% concentration) used at 1 gallon per 100 gallons of water giving a final NH<sub>4</sub> concentration of 0.02%. <sup>3</sup>Quad 7, Q7 = basic blend surfactant from AGSCO used at 1% v/v. <sup>4</sup>Sugb = sugarbeet, Rrpw = redroot pigweed, Colq = common lambsquarters, Coma = common mallow.

twice as much herbicide but no oil adjuvant gave less control than the micro-rate with oil adjuvant. The micro-rate gave common mallow control similar to the full rate.

Doubling the rate of MethOil from 1.5% to 3% or doubling the rate of Quad 7 from 1% to 2% had no significant effect on weed control or sugarbeet injury (Table 3). Weed control with Quad 7 adjuvant was similar to weed control with MethOil adjuvant. Adding ammonia had no effect on weed control or sugarbeet injury. Weed control was similar with Betanex, Betamix or Betamix Progress in the micro-rate.

Table 4. Weed control over all locations, 1998.

|                                                | Rate applied<br>3 or 4 times | 6 loc.<br>Gr & Yeft <sup>1</sup><br>cntl | St. Thomas<br>Vowh <sup>1</sup><br>cntl | Angus<br>Hillsboro<br>Wioa <sup>1</sup> cntl | Wahpeton<br>Cocb <sup>1</sup><br>cntl |
|------------------------------------------------|------------------------------|------------------------------------------|-----------------------------------------|----------------------------------------------|---------------------------------------|
|                                                | (See T.2)                    | %                                        | %                                       | %                                            | %                                     |
| Betanex                                        | Full                         | 64                                       | 70                                      | 26                                           | 85                                    |
| Betanex+UpBeet                                 | Full                         | 88                                       | 89                                      | 74                                           | 83                                    |
| Bnex+UpB+Stinger                               | Full                         | 83                                       | 88                                      | 58                                           | 100                                   |
| Bnex+UpB+Stinger                               | Reduced                      | 78                                       | 76                                      | 34                                           | 100                                   |
| Bnex+UpB+MethOil <sup>1</sup>                  | Micro                        | 81                                       | 89                                      | 81                                           | 73                                    |
| Bnex+UpB+Sting+MO <sup>1</sup>                 | Micro+1.5%                   | 84                                       | 92                                      | 76                                           | 100                                   |
| Bnex+UpB+Sting+MO                              | Micro+3%                     | 85                                       | 95                                      | 82                                           | 100                                   |
| Bnex+UpB+Sting+MO+NH <sub>4</sub> <sup>2</sup> | Micro                        | 81                                       | 90                                      | 82                                           | 100                                   |
| Bnex+UpB+Sting+Quad7 <sup>3</sup>              | Micro+1%                     | 82                                       | 88                                      | 64                                           | 100                                   |
| Bnex+UpB+Sting+Q7 <sup>3</sup> +MO             | Micro                        | 84                                       | 91                                      | 74                                           | 99                                    |
| Bnex+UpB+Sting+Quad7                           | Micro+2%                     | 82                                       | 90                                      | 77                                           | 99                                    |
| Bnex+UpB+Sting+Q7+NH <sub>4</sub> <sup>2</sup> | Micro                        | 83                                       | 92                                      | 53                                           | 100                                   |
| Bnex+UpB+Sting+Select+MO                       | Micro                        | 98                                       | 98                                      | 100                                          | 100                                   |
| Bex+Up+St+Sel+MO+NH <sub>4</sub>               | Micro                        | 98                                       | 98                                      | 100                                          | 100                                   |
| Bnex+UpB+Sting+Sel+Q7                          | Micro                        | 98                                       | 98                                      | 400                                          | 100                                   |
| Betamix+UpB+Sting+MO                           | Micro                        | 89                                       | 91                                      | 86                                           | 100                                   |
| B.Progress+UpB+Sting+MO                        | Micro                        | 87                                       | 94                                      | 82                                           | 100                                   |
| Bnex+UpB+Sting+Assure+MO                       | Micro                        | 97                                       | 96                                      | 99                                           | 99                                    |
| LSD (0.05)                                     |                              | 5                                        | 7                                       | 10                                           | 12                                    |

<sup>1</sup>MethOil, MO = a methylated seed oil adjuvant from Terra used at 1.5% v/v. <sup>2</sup>NH<sub>4</sub> = household ammonia (2% concentration) used at 1 gallon per 100 gallons of water giving a final NH<sub>4</sub> concentration of 0.02%. <sup>3</sup>Quad 7, Q7 = basic blend surfactant from AGSCO used at 1% v/v. <sup>4</sup>Gr & Yeft = mixture of green and yellow foxtail, Vowh = volunteer wheat, Wioa = wild oats, Cocb = common cocklebur.

All treatments that included Stinger gave nearly total control of common cocklebur (Table 4). Betanex alone gave less control of grasses than the other treatments. Betanex + UpBeet at the full rate 1.5 pt/A + 0.5 oz/A gave better control of foxtail spp. and wild oat than Betanex + UpBeet + Stinger at the full rate 1.5 pt/A + 0.5 oz/A + 0.25 pt/A indicating that Stinger antagonized grass control from Betanex + UpBeet. However, Betanex + UpBeet + MethOil at the micro-rate 0.5 pt/A + 0.125 oz/A + 1.5% v/v gave grass control similar to Betanex + UpBeet + Stinger + MethOil at the micro-rate indicating that the MethOil prevented the antagonism of grass control by Stinger. Betanex + UpBeet + Stinger + MethOil at the micro-rate gave grass control similar to Betanex + UpBeet at the full rate. Betanex + UpBeet + Stinger + MethOil at the micro-rate sometimes gave better control of wild oat than Betanex + UpBeet + Stinger + Quad 7 at the micro-rate. Treatments that included Select or Assure II generally gave better grass control than other treatments.



Table 5. Grass control at Fargo, 1998.

| Treatment                                | Rate applied<br>3 times | Sugb <sup>2</sup><br>inj | Gr & Yeft <sup>2</sup><br>cntl | Barley, Oats<br>cntl | Fomi <sup>2</sup><br>cntl |
|------------------------------------------|-------------------------|--------------------------|--------------------------------|----------------------|---------------------------|
|                                          | fl.oz.                  | %                        | %                              | %                    | %                         |
| Bnex+UpB+Sting+MO>Select                 | Micro <sup>1</sup> + 2  | 0                        | 99                             | 99                   | 98                        |
| Bnex+UpB+Sting+MO+Poast                  | Micro + 5.3             | 0                        | 97                             | 99                   | 96                        |
| Bnex+UpB+Sting+MO+Assure                 | Micro + 4               | 0                        | 95                             | 99                   | 93                        |
| Bnex+UpB+Sting+MO+Assure+AMS             | Micro + 4 + 4           | 0                        | 97                             | 99                   | 96                        |
| Bnex+UpB+Sting+Quad7>Select              | Micro + 2               | 0                        | 98                             | 99                   | 96                        |
| Bnex+UpB+Sting+Quad7+Poast               | Micro + 5.3             | 0                        | 92                             | 99                   | 93                        |
| Bnex+UpB+Sting+Quad7+Assure              | Micro + 4               | 0                        | 99                             | 99                   | 97                        |
| Bnex+UpB+Sting+MO>Select+NH <sub>4</sub> | Micro+2+0.02%           | 0                        | 98                             | 99                   | 98                        |
| Bnex+UpB+Sting+MO+Poast+NH <sub>4</sub>  | Micro+5.3+0.02%         | 0                        | 94                             | 97                   | 95                        |
| Bnex+UpB+Sting+MO+Assure+NH <sub>4</sub> | Micro+4+0.02%           | 0                        | 97                             | 99                   | 95                        |
| Bnex+UpB+Sting+AgPro+Assure              | Micro + 4               | 0                        | 89                             | 99                   | 93                        |
| LSD (0.05)                               |                         | NS                       | 7                              | NS                   | NS                        |

<sup>1</sup>Micro-rate = Betanex at 0.5 pt/A plus UpBeet at 0.125 oz/A plus Stinger at 1.3 fl. oz./A plus MethOil at 1.5% v/v. A basic blend, Quad 7 at 1% v/v, was used in place of MethOil in some treatments. AgPro is a surfactant and was used at 0.25% v/v.

<sup>2</sup>Sugb = sugarbeet, Gr & Yeft = mixture of green and yellow foxtail, Fomi = foxtail millet.

The experiment represented in Table 5 was seeded May 5. Sugarbeet, barley, oat and foxtail millet were seeded across the plots. Green and yellow foxtail was a natural infestation. Herbicides were applied May 26, June 2 and June 10. On May 26, sugarbeet plants were at the cotyledon to two-leaf stage, oats and barley were 2 to 4 inches and foxtail spp. were 0.5 to 1.5 inches tall. Herbicides were applied across the species to the center 7.3 feet of 11-foot wide plots in 8.5 gpa of water through 8001 nozzles at 40 psi and 3 mph.

All treatments in Table 5 included Betanex + UpBeet + Stinger at the micro-rate of 0.5 pt/A + 0.125 oz/A + 0.08 pt/A. The rates of Select, Assure II and Poast were about 33% to 50% of normal rates. Sugarbeet injury, oat and barley control and foxtail millet control were similar among all treatments (Table 5). Betanex + Upbeet + Stinger + AgPro + Assure II gave less control of green and yellow foxtail than Betanex + UpBeet + Stinger + MethOil + Assure II indicating that MethOil was a better adjuvant than AgPro surfactant for Assure II. Substituting Quad 7 for MethOil had no significant effect on grass control.

### Summary

The micro-rate of Betanex + UpBeet + Stinger + MethOil generally gave weed control similar to Betanex + UpBeet + Stinger at the full rate. The micro-rate with oil adjuvant gave better control of wild oat than the full rate without oil adjuvant. Any advantage to the full rate was less than 5% and was not significant. Betanex + UpBeet + Stinger + MethOil at the micro-rate gave better control of common mallow and all grasses than Betanex + UpBeet + Stinger at the reduced rate even though the reduced rate had twice as much herbicide.