

Project Title: Ethofumesate applied Postemergence at Greater than 12 fl oz/acre

Project Number/Description: 2018-2, this project is a continuation from the 2017 probe

Project Leader: Thomas J. Peters, Extension Sugarbeet Agronomist, NDSU and Univ. of Minnesota

Other Personnel Involved: Alex Lystad, NDSU; Mike Metzger, Research Agronomist, Minn-Dak Farmers' Cooperative; Mark Bloomquist, Research Director, Southern Minnesota Beet Sugar Cooperative, and David Mettler, Research Agronomist, Southern Minnesota Beet Sugar Cooperative.

Project Location: Crookston, MN, Foxhome, MN, Lake Lillian, MN, Minto, ND, Moorhead, MN, and Oslo, MN, Prosper, ND,

Justification for Research: (For new projects only)

Summary of Literature Review: (For new projects only)

Ethofumesate is an established herbicide for grass and small-seeded broadleaf weed control in sugarbeet. Literature from research in Kansas and Colorado in 1970 indicated 'NC 8438' (ethofumesate) provided greater than 90% green foxtail, foxtail millet, and barnyardgrass control and near 90% redroot pigweed control. Ethofumesate is soil-applied at field use rates ranging from 6 to 7.5 pt/A or applied postemergence at 12 fl oz/A. Ethofumesate is sold in the United States using the trade names 'Nortron' by Bayer CropScience, 'Ethotron SC' by UPI, and 'Ethofumesate 4SC' by Willowood USA. Willowood USA in collaboration with the Beet Sugar Development Foundation is developing a new label to expand Ethofumesate 4SC postemergence use rates from 12 to 128 fl oz/A to sugarbeet with greater than two true leaves. Ethofumesate applied in combination with glyphosate may provide a second mode of action, especially for difficult to control broadleaf weeds in sugarbeet including lambsquarters, kochia, waterhemp, and common ragweed. However, little is known about postemergence broadleaf weed control from ethofumesate, especially at rates greater than 12 fl oz/A.

Experiments were conducted at multiple field locations to evaluate broadleaf control from repeat applications (two) of PowerMax at 28 fl oz/A, ethofumesate at 6, 12, 18, 24, 32, and 64 fl oz/A and PowerMax at 28 fl oz/A plus ethofumesate at 6, 12, 18, 24, 32, and 64 fl oz/A. Assessment was visual 10 to 21 days after the second application by noting control. 2018 Objectives: Expand research program including: a) determining sugarbeet safety from tank-mixtures; b) kochia, lambsquarters, pigweed, and waterhemp control; c) wheat, corn, and soybean rotational crop safety following ethofumesate application at various rates and calendar dates in 2017; and determining if ethofumesate applied postemergence may reduce size of waterhemp and lambsquarters flowering structure and reduce weed seed production.

Materials and Methods: 2017 greenhouse and 2018 greenhouse and field experiments conducted at multiple locations.

- a. Sugarbeet safety. Sugarbeet visual safety evaluation and yield, and quality assessment following ethofumesate alone at 0, 16, 32, 64, and 128 fl oz/A or tank-mixes. Field experiment shall be a randomized complete block design and six replications conducted at Prosper, ND and Ada and Crookston, MN. Greenhouse experiment shall be a randomized complete block design and three replications and repeated in time. Tank-mixtures with ethofumesate shall include PowerMax, Spin-Aid (phenmedipham), and Warrant or Outlook.
- b. Common lambsquarters, redroot pigweed, waterhemp, and kochia control from ethofumesate alone at 16, 32, 64, and 128 fl oz/A and with glyphosate at 32 fl oz/A. Experiment shall be a randomized

complete block design and four replications. Data collection shall include a visual assessment of weed control and weed counts per square meter where appropriate. Visual kochia control and fresh weight reduction from ethofumesate at 16, 32, 64, and 128 fl oz/A. Experiment shall be a randomized complete block design and three replications and repeated in time in the NDSU greenhouses.

- c. Rotational crop safety focusing on crops planted in sequence with sugarbeet. Experiments were conducted at Prosper, ND, Crookston and Lake Lillian, MN and in Michigan in sugarbeet in 2017 to evaluate sugarbeet safety. In 2018, corn, soybean, and wheat stand assessment, grain yield, and grain moisture shall be measured in plots treated with ethofumesate in 2017 at different rates and calendar dates. 2017 experiment entries were:

Treatment	Rate (fl oz/A)	Timing of application
Untreated control		
Etho/etho/etho/etho	32/32/32/32	2-If stage (A) / A+14 days (B) / B+ 14 days (C) / C+14 days (D)
Ethofumesate	128	June 15
Ethofumesate	128	July 15
Ethofumesate	128	August 15

2018 experiments shall be a randomized complete block design and six replications. RR Corn, RR Soybean and a locally sourced wheat cultivar shall be planted on approximately May 15 to evaluate rotational crop safety 11, 10, and 9 months following ethofumesate application. Weeds, insects, and diseases shall be control so that yield estimate shall not be confounded by pest pressure.

- d. Reduce flowering structure formation. Ethofumesate at 32, 64 and 128 fl oz/A shall be applied over eight to 12-inch waterhemp and lambsquarters to determine if a rescue application may reduce size of waterhemp or lambsquarters flowering structure (flower decapitation) and seed production. Reduction of size of the flowering structure will be evaluated visually and the number of affected flowering structures will be counted per unit area. Seed heads shall be harvested and waterhemp or lambsquarters weed seed number will be estimated per unit area. Experiment shall be a randomized complete block design and four replications. Experiment shall be conducted at Moorhead, MN.

Time Line of Anticipated Accomplishments: We anticipate updated and expanded ethofumesate label before the 2018 season. It is business critical that we have a comprehensive understanding of sugarbeet safety, weed control from ethofumesate applied POST and confidence in rotational crop safety, ASAP. Recommendations for use of ethofumesate POST at rates greater than 12 fl oz/A will be discussed with Agriculturalists and Research Staff and at winter grower meetings in preparation for the 2018 field season. Ms. Alexa Lystad will be researching ethofumesate as part of her MS degree in 2018 and 2019. Results shall be summarized and written in the Sugarbeet Research and Extension Report and presented during grower meetings. Experiments and will be repeated and summarized for submission to a referee journal in 2019/2020.

Progress Toward Objectives of On-going Projects: Sugarbeet injury across ethofumesate rates was negligible at most locations. Exception was Moorhead, MN where ethofumesate alone at 32 and 64 fl oz/A and in combination with PowerMax caused between 16 and 30% visual sugarbeet growth reduction. Eleven of 16 plot/evaluation-day combinations at Moorhead exhibited greater than 30% sugarbeet injury from ethofumesate alone or with PowerMax. Injury may have been confounded by 2,4-D application in a neighboring field as ethofumesate has been reported to decrease epicuticular waxes.

Ethofumesate applied at various rates and calendar dates did not injure sugarbeet or cause yield loss or reduce percent sugar (and resultant recoverable sugar per acre) in 2017. However, ethofumesate may have

decreased amount of wax or changed the structure of waxes as sugarbeet was a very deep green color, especially at Lake Lillian, MN.

Ethofumesate across rates provided lambsquarters control ranging from 15 to 78% and redroot pigweed control ranging from 15 to 75 %. Waterhemp control was 95 to 100%. Waterhemp germinates and emerges later than lambsquarters or redroot pigweed, usually in mid-May in North Dakota and Minnesota.

Budget Requested: \$31,153 (see the attached Budget Summary for details). Note graduate student stipend is supported by NDSU.