**An Integrated Pilot Project to Ameliorate Herbicide Resistance in Marestail/Horseweed (*Conyza canadensis* (L.) Cronq.)**

Two independent experiments were conducted during the 2018-2019 season in the greenhouse and field conditions. Five cover crops (Rye, Oat, Hairy Vetch (HV), Crimson Clover (CC), and Radish) were planted in monoculture, double, and triple mixture. A total 25 combinations of cover crops were used to suppress the Marestail population and biomass production at UMES Research Farm. Similarly, 20 treatments of different herbicides combinations were used to understand the mechanism of non-targeted site herbicide resistance in Marestail. The maximum biomass was produced by Rye, Rye+CC, and Rye+Oat+CC combinations using mono, double and triple cover crop mixtures respectively. The maximum plant height was observed in HV followed by Rye > Oat >radish> CC. Height of cover crop influences the height of growing Marestail. The maximum leaf area was observed in HV followed by Rye >Oat >CC >Radish>Fellow. Higher leaf area covers more ground (more shade) and suppresses the growth of weeds. The maximum suppression of Marestail population was observed in HV (93.7%) plot followed by the triple (Rye+CC+HV (90.6%) and Oat+CC+HV (90.6%) and double (CC+HV (87.5%) cover crop mixtures. Herbicide treatments at the flowering stage of Marestail showed different responses in terms of reproductive success or seed setting. We classified the responses in three classes. I: Reproductive Success: Seed dispersal, II: Reproductive failure: death of flower inflorescence within 3 to 10 days after herbicide application, and III: Partial Reproductive Success: Inflorescence death after 15 days. Seed formation and dispersal occurred within 15 to 20 Days after flower opening in Marestail. To induce reproductive failure, herbicide must senesce the plant and inflorescence within 10 days or earlier.

T1: Glyphosate (Buccaneer 5 Extra/40 Gallon): Reproductive Success

T2: Glyphosate (Buccaneer 5 Extra/10 gallon): Reproductive Failure

T3: Dicamba (Banvel): Partial Reproductive Success

T4: 2,4D (Defy LV-6): Partial Reproductive Success

T5: Sulfantrazone and Imazethapyr (Authority): Reproductive Success

T6: Paraquat (Parashot): Reproductive Failure

T7: Metribuzin (Tricor DF): Reproductive Failure

T8: Sulfometuron methyl (Alligare SFM 75): Reproductive Success

T9: Glufosinate-ammonium (Interline): Reproductive Failure

T10: T1 (Glyphosate/40 gallon) +T3 (Dicamba): Partial Reproductive Success

T11: T2 (Glyphosate/10 gallon) + T3 (Dicamba): Reproductive Failure

T12: T2 (Glyphosate/10 gallon) + T4 (2,4 D): Reproductive Failure

T13: T3 (Dicamba) + T4 (2,4 D): Reproductive Failure

T14: T2 (Glyphosate/10 gallon) + T3 (Dicamba) + T4 (2,4 D): Reproductive Failure

T15: T6 (Paraquat) + T3 (Dicamba): Reproductive Failure

T16: T6 (Paraquat) +T4 (2,4 D): Reproductive Failure

T17: T6 (Paraquat) + T3 (Dicamba) +T4 (2,4 D): Reproductive Failure

T18: T7 (Metribuzin) + T4 (2,4 D): Partial Reproductive Success

T19: T7 (Metribuzin) + T2 (Glyphosate/10 gallon): Reproductive Failure

T20: T7 (Metribuzin)+ T4 (2,4 D) +T3 (Dicamba): Reproductive Failure

Selected herbicides showed production of H2O2 with subsequent plant death. The highest H2O2 was produced by Paraquat and minimum by T10: T1 (Glyphosate/40 gallon) +T3 (Dicamba), T1: Glyphosate/40gallon/A, T8: Sulfometuron methyl (Alligare SFM 75), and T5: Sulfantrazone and Imazethapyr (Authority). Treatments T10, T1, T8, and T5 failed to manage the Marestail growth and development. Marestail successfully produced seeds in these treatments. Based on Glutathione-S-Transferase (GST) activity, we observed three different strategies for non-targeted herbicide resistance in Marestail. I: Single herbicide application led to continuous increase in GST activity. II: Double herbicide mixture led to first steep increase followed by decline in GST activity. III: A triple mixture of herbicide showed little increase in GST activity. Glutathione Reductase (GR) activity showed a similar trend to GST activity. Correlation between GST and GR showed the dependence of GST on GR as GR generates reduced glutathione, which is used by GST. GR produced reduced glutathione, which can be diverted to scavenge reactive oxygen species such as H2O2 and thus can cause a reduction in GST activity and concomitant decline in herbicide partitioning towards cell vacuole. Herbicides with higher reactive oxygen species (ROS) production can slow non-targeted herbicide resistance in weeds. A combination of single, double and triple herbicide mixture with higher ROS generation capacity can slow down herbicide resistance in Marestail. The triple mixture of Glyphosate+Dicamba+2,4D showed minimum GST and GR activity, which indicates little partitioning of herbicide toward cell vacuole and more H2O2 production.