Glucosinolate Levels During Seed Development and Maturation of Meadowfoam

Jun Zhang[1], Sabry Elias[1], Ralph Reed[2], and Jennifer Kling[1]

1. Department of Crop & Soil Science, Oregon State University 2. Institute of Linus Pauling, Oregon State University

Introduction

Meadowfoam (*Limnanthes alba* Hartw. ex Benth) is an oilseed crop grown in the Willamette Valley of Oregon. It is a native plant found in Northern California and Southern Oregon. It is a winter annual crop adapted to poorly drained soils and was domesticated in the 1970's at Oregon State University. Seed meal contains a chemical compound that has allelopathic effect called glucosinolate (GSL), which has the potential to be used as a bioherbicide, depending on GSL concentration in seed meal.

Seed quality, including chemical composition, is affected by maturity stage and environment. At physiological maturity, seeds reach maximum dry weight and may attain their greatest potential for germination, however the relationship between seed maturity stages and GSL content in meadowfoam seed is unknown. It is possible that maximum GSL levels in meadowfoam seeds is attained at harvest maturity, when seed moisture content is suitable for direct mechanical harvest. Harvesting too early or too late may affect GSL contents.

No literature is available on the relationship between crop maturity stage and GSL levels in seeds. The objective of this study was to determine the effects of seed development, maturity stage, and environment on the GSL contents of two meadowfoam cultivars grown at two locations in Oregon.

Methods

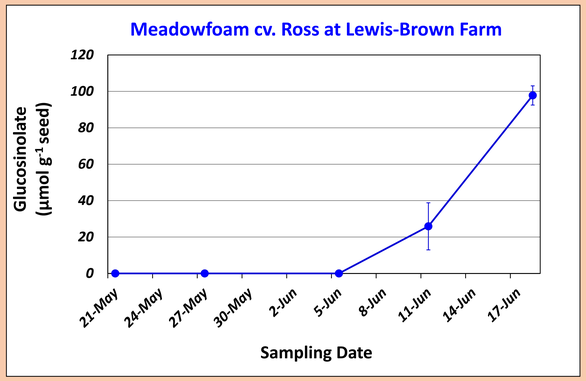
Two meadowfoam cultivars, Ross and MF189 were planted in two separate locations. One at Lewis Brown Farm, and another at Hyslop Farms, both near Corvallis, Oregon. A completely randomized block design with three replications was used. Standard cultural practices were followed. Seed samples were collected from the last four weeks before harvest and were used in the GSL analysis. Seed samples were stored at -80°C until GSL extraction was started.

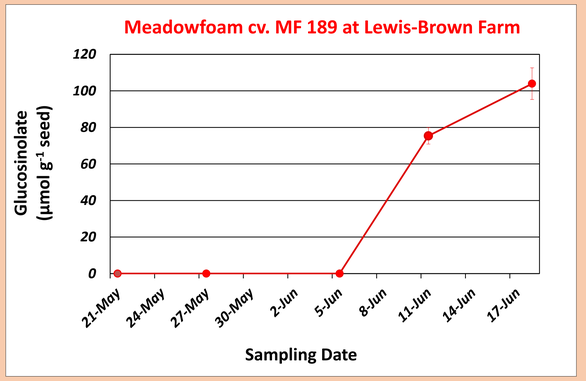
Seeds were removed from the -80°C and placed at room temperature (21°C) for 48 h. The GSL was extracted from seeds by placing a steel bead in the bottom of a 5 ml tube. Three seeds were then placed in the tube and a second steel bead was added. Afterwards, 500 µl of 90% MeOH was added into the tube and placed on a shaker for two minutes at 28 strokes/s. The tube holder was turned upside-down and samples were shaken for additional two minutes. The tubes were then vortex briefly and centrifuged for five minutes at 3,700 rpm. Supernatants were collected and centrifuged for additional ten minutes at 13,000 rpm. The aliquot was collected and diluted at 2:10 with 90% MeOH and analyzed by the HPLC using Meadowfoam JFS4 method.

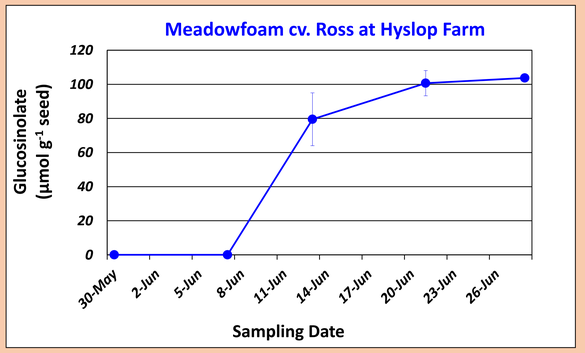
Data were collected and GSL concentration was calculated for each sample. Means of GSL concentration of the three replications and the standard errors were calculated.

Results

Glucosinolate concentration of Ross at Lewis Brown Farm remained 0.0 µmol g^{-1} seed starting from seed formation until two weeks before harvest. At harvest, the mean of the GSL concentration reached 97.8 µmol g^{-1} seed (Fig. 1). A similar trend was observed in MF189 in the same location, but the concentration at harvest was 103.9 µmol g^{-1}seed (Fig. 1). In the same manner, the mean of the GSL concentration of Ross at Hyslop Farm remained 0.0 µmol g^{-1}seed until three weeks before harvest and then increased to 103.7 µmol g^{-1} seed at harvest. Two weeks before harvest, the mean of the GSL concentration for MF189 was 4.5 µmol g^{-1} seed, and reached 85.9 µmol g^{-1} seed at harvest in Hyslop Farm.







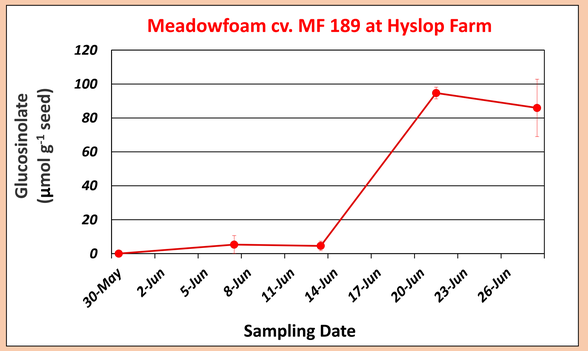


Figure 1. Glucosinolate concentration during seed development and maturation of two meadowfoam cultivars grown at two locations in Oregon. Vertical bars represent standard error of the means.

Conclusions

The GSL concentration reached the highest level at harvest maturity in both cultivars and locations. Therefore, if the objective is to use the meal of meadowfoam seed as bioherbicide, it is recommended not to harvest the crop before reaching harvest maturity.

References

Brown, P.D., and Morra, M.J. 1995. Glucosinolate-containing plant tissues as bioherbicides. J. Agric. Food. Chem. 43:3070-3074.

Elias, S.G. and Copland, L.O. 2001. Physiological and harvest maturity of canola in relation to seed quality. Agron. J. 93:1054-1058.

Stevens, J, Reed, R., Albert, S., Pritchett, L., and Machado, S. 2009. Herbicidal Activity of Glucosinolate Degradation Products in Fermented Meadowfoam (*Linmanthes alba*) seed meal. J. Agric. Food.Chem. 57:1821-1826.

Acknowledgements

Thanks to the Oregon Meadowfoam Growers Association, and Berger Endowment OSU Graduate Fellowship.