Report Type: Final

Title: Breaking bindweed: Can plant growth regulators disrupt apical dominance, deplete a persistent bud bank, and improve the control of perennial weed species in specialty crops?

Principal Investigator(s) and Cooperator(s):
Sosnoskie, Lynn M., Burke, Ian C., and Granatstein, David

Abstract:
Field bindweed (Convolvulus arvensis) is notoriously difficult to manage in specialty crop systems, particularly those under organic production. The difficulty is primarily due to perennial species utilizing abundant nutrient reserves to facilitate plant regrowth from underground dormant buds following physical or chemical control measures. Research, primarily conducted using leafy spurge (Euphorbia esula) as a model, has identified the signature genes involved in regulating perennial weed bud dormancy and described how this state fluctuates in response to endogenous phytohormones. Studies with reed canary grass (*Phalaris arundinacea*) and Japanese knotweed (*Fallopia japonica*) have demonstrated that exogenous applications of plant growth regulators can induce the release rhizomatous buds from dormancy. Results also showed that weed control can be significantly improved when dormancy breaking treatments precede management activities. This proposal, the results of which will be used to leverage USDA SCBG and OREI programs for future research and extension funds, will determine how foliar-applied phytohormones/plant growth regulators can be used to disrupt apical dominance, elicit simultaneous bud break, and make perennial weed pests more susceptible to subsequent control measures. This proposal supports the BIOAg program by providing Washington's specialty crop growers with a novel weed management tool (altering physiological processes to induce to improve perennial pest control). Increased sensitivity to control measures will also enhance the sustainability of crop production by reducing the need for repeated disturbance, which can come with significant environmental and/or economic costs.

Outputs:

Overview of Work Completed

Starting in the fall of 2017, a greenhouse trial was initiated in Pullman, WA to determine the time it takes for field bindweed seedlings perennialize after emergence. Thirty 3 quart pots were filled with Sungro Horticulture Sunshine mix #2 potting soil then two field bindweed seeds were planted at a depth of ½" per pot in a 16 hour photoperiod. At emergence pots were thinned to contain only one seedling. Beginning two weeks after emergence and 5 pots were destructively harvested and both the above ground and root fresh weights were recorded along with the number of adventitious root buds and unique crowns, this process was repeated every two weeks through 12 weeks after emergence. The rational for the perennialization study was to determine how long the field bindweed plants should be grown in a greenhouse setting prior to applying exogenous growth regulators in future experiments. We have determined that field bindweed should be grown a minimum of 10 weeks after emergence in order to develop enough adventitious root buds to elicit a response in future studies (Figure 1).

A root imaging system was designed to assess bud break in real time in response to effective inputs. The rhizotrons were built around a standard root imaging system. A 100 cm length of clear plastic tube was mounted inside a slightly larger pvc tube. Soil (a 2:1 ratio by weight mixture of sunshine mix #6 and horticultural sand) was used as a growth media (Figure 2). The system was intended to be used to observe perennialization in field bindweed without destructive harvests. However, optimization of the approach was necessary as the roots of the field bindweed did not follow the imaging tube in sufficient rhizotrons to be useful in a study. The proof of concept will be utilized in the now funded OREI project entitled CREEP-STOP to continue the investigation of below ground bud development.

In early summer of 2018, a dose response study was initiated in Pullman, WA. Sungro Horticulture Sunshine mix #6 was mixed with horticultural sand at a 2:1 ratio for ease of separating roots from soil at harvest. Two hundred 3 quart pots were filled with the growing media mix then two field bindweed seeds were planted at a depth of ½" per pot in a 16 hour photoperiod. October 3, 2018 plants were treated with increasing rates 6 different products; cytokinin as Seacrop 16 (0, 2, 4, 8, 16, 32, 64, 128,fl oz/acre), gibberellic acid as Pro Gibb LV (0, 1.5625, 3.125, 6.25, 12.5, 25, 50, 100 fl oz/acre), brassenosteriod as Organic Vitazyme (0, 1.625, 3.25, 6.5, 13, 26, 52, 104 fl oz/acre), 2,4-D as Weedone LV4 (0, 0.016, 0.16, 1.6, 4, 8, 16, 32 fl oz/acre), dicamba as Clarity (0, 0.024, 0.24, 2.4, 6, 12, 24, 48 fl oz/acre), and aminocyclopyrachlor as Method 280 SL (0, 0.004, 0.04, 0.4, 1, 2, 4, 8 fl oz/acre). Cytokinin as Seacrop 16 was also applied as a soil drench (0, 0.25, 0.5, 1, 2, 4, 8, 16% v/v). Foliar treatments were applied using an air calibrated spray chamber calibrated to deliver 15 gallons per acre. Soil drench treatments were applied by pouring 213 ml solution directly onto the soil. October 15, 2018 shoot counts were recorded. October 25, 2018 shoot counts were recorded and above ground biomass was harvested dried and recorded. November 16, 2018 destructive harvest of the gibberellic acid and nontreated controls were completed, and the number of emerged shoots, activated and dormant root buds was recorded, roots were then dried and the dry biomass was recorded.

Increasing rates of hormones caused an increase in field bindweed aboveground biomass (Figure 3). Of the hormones, ProGibb LV promoted greater amounts of biomass development, especially at the highest rates. Similar responses were observed for shoot numbers, with ProGibb LV stimulating an increase in shoot number greater than the other growth regulators (data not shown). Overall, ProGibb LV, an organic gibberellic acid product, promoted the greatest amount of total bud development and bud release. At harvest, gibberellic acid stimulated more aboveground biomass than belowground biomass (Figure 4a). However, belowground response also included an increase in the total number of buds compared to the nontreated control (Figure 4b). Overall, gibberellic acid was the most effective at stimulating root bud development, rood bud break resulting in bud release, and therefore biomass accumulation. Gibberellic acid may be an important tool for stimulating germination of perennial buds below ground, potentially giving weed managers the opportunity to manage cohorts of buds prior to crop establishment or perennial crop growth cycles. The ability to manage bud growth before crop growth resumes, and diminishing the number of buds that do release during the cropping season may reduce the damage caused by field bindweed, and also reduce additional bud growth during the season. Future research should focus on in situ assessment of buds in rhizotrons and field installations to understand real time bud release in response to growth regulators, and the outcome of any control input.

Figure 1 Seedling Perennialization. Root bud in seedling field bindweed over time. The rate and amount of biomass accumulation and root/rhizome bud formation was a function of temperature, however, in both instances, bud formation was observed by 4 weeks after emergence.

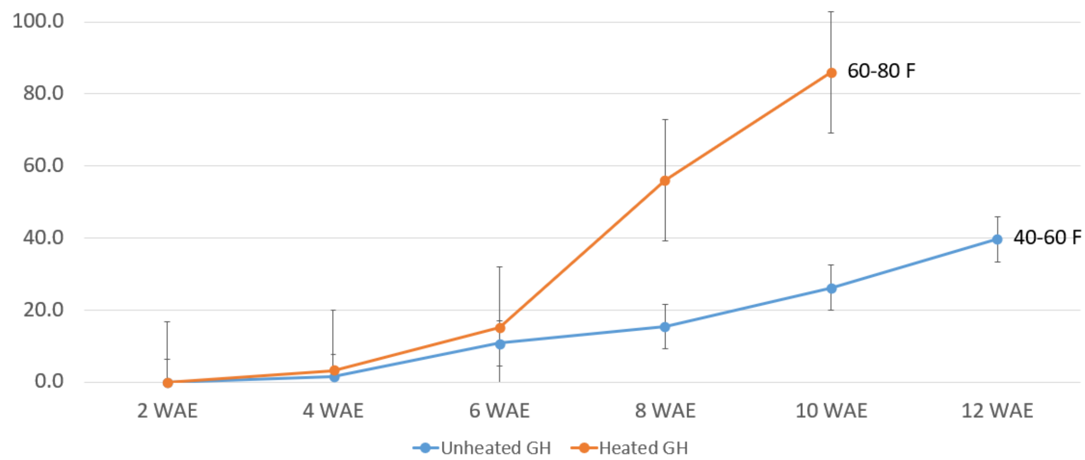


Figure 2. Rhizotrons. Rhizotron apparatus installed in a greenhouse in Pullman, WA. Roots are constrained to a very narrow band of soil around the central scanning tube. Although assessments of bud formation were planned using the rhizotrons, insufficient root scanner tube contact slowed the application. Buds of field bindweed are circled in red.

Figure 3. Field bindweed aboveground biomass at 22 days after treatment in response to organic phytohormones brassinosteroid, gibberellic acid, and cytokinin applied foliarly or as a soil drench.

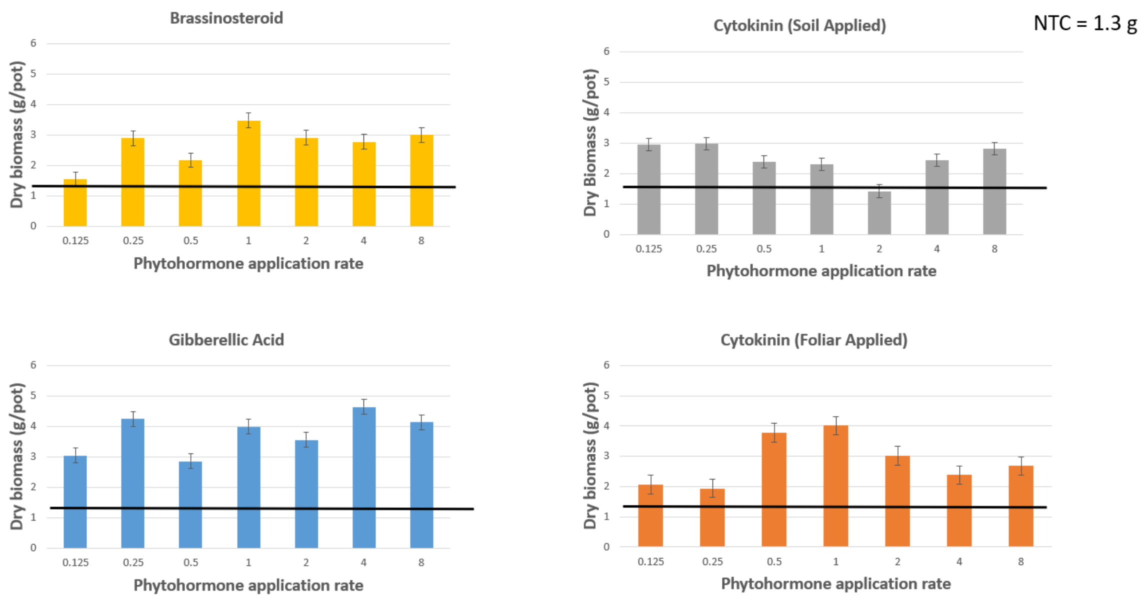
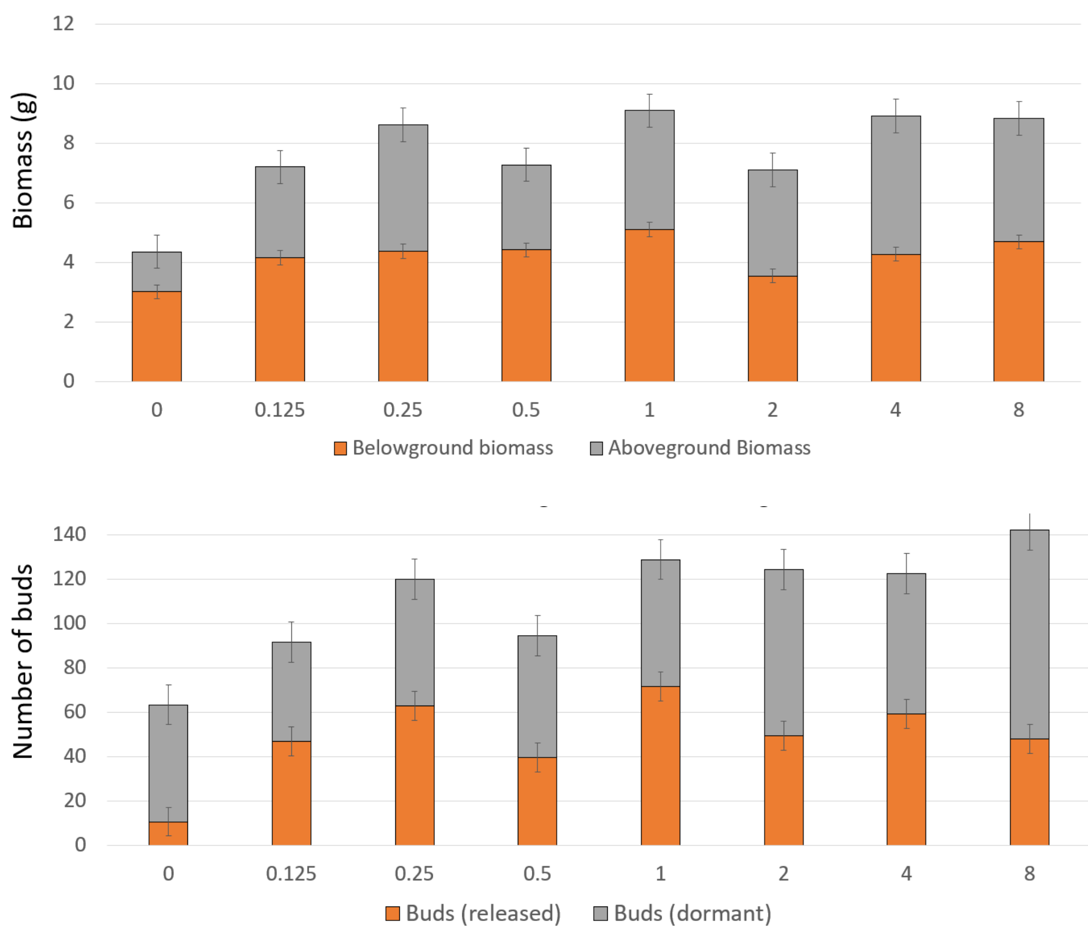


Figure 4. Field bindweed total biomass (a) and root bud numbers (b) in response to applications of gibberellic acid. Aboveground biomass was more affected than belowground biomass, and total number of buds and total number of non-dormant buds were greater at all rates of gibberellic acid compared to the nontreated control.



Publications, Handouts, Other Text & Web Products:

Thompson, J.R., L.M. Sosnoskie, and I.C. Burke. 2018. Bindweed Root and Shoot Development and the Potential to Improve Control. WSWS. Mar.14, Garden Grove, CA.

Impacts:

- Short-Term: Identification of organic plant growth regulators that could stimulate bud break in field bindweed.
- Intermediate-Term: Change in practice by organic growers, who can utilize organic gibberlic acid and mechanical weed inputs in an integrated system to deplete root energy reserves in field bindweed.
- Long-Term: Effective reduction of filed bindweed as a pest in organic systems.

Additional funding secured:

USDA-OREI Proposal #2018-02850, $2M. P. Carr, PD. Creep-Stop: Integrating biological, cultural, and mechanical/physical tools for long term suppression of creeping perennial weeds in Northern Great Plains and Pacific Northwest cropping systems.

Graduate students funded:

Thompson, Jeremy R.

Recommendations for future research:

- Using the data generated in the exploratory trials performed we will look further into the use of gibberellic acid treatments coupled with organic herbicides and cultural methods to improve biologically based management outcomes for field bindweed.