Update on 2019 Weed Science Research in the IR-4 Environmental Horticulture Program and 2020/2021 Priorities.

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2019 Research Activities

In 2019, the IR-4 Environmental Horticulture Research Program sponsored research on several weed science projects: pre- and postemergent herbicide crop safety with over-the-top in-season applications, efficacy of post-emergent herbicides, and Christmas tree crop safety with herbicides used to manage cover crops. For the over-the-top herbicide crop safety screening the goal was to develop lists of crops where applications would not harm woody and herbaceous perennials grown in container nurseries. Products tested included Basagran (bentazon), Biathlon (oxyfluorfen + prodiamine), Dimension 2EW (dithiopyr), Dismiss 4F (sulfentrazone), F6875 4SC (sulfentrazone + prodiamine), Fiesta Herbicide (FeHDTA), Fortress (isoxaben + dithiopyr), Freehand G (pendimethalin + dimethenamid-p), Gallery SC (isoxaben), Gemini Granular (prodiamine + isoxaben), Marengo 74SC (indazaflam), Pendulum G (pendimethalin), Ronstar G (oxadiazon), SP1770, and Tower EC (dimethenamid-p). Applications were made at dormancy (preemergents) or when leaves were fully expanded (postemergents) and then approximately 6 weeks later for all products. Basagran was screened on 19 crops, Biathlon on 7; Dimension EW on 6; Dismiss on 3; Fiesta on 30; Fortress on 13; Freehand on 2; Gallery on 1; Gemini Granular on 4; Marengo on 8; Pendulum G on 6; SP1770 on 8; Ronstar G on 3; and Tower was screened on 4 crops. The results from this research will aid in the development of product labels and will help growers and landscape care professionals make more informed product choices.

In Season Preemergent Herbicide Crop Safety

Goals: Broaden current preemergent herbicide labels for typical field container and in ground production and for production of stonecrops (*Sedum*, *Hylotelephium*, *Rhodiola*, etc) for use in greenroof systems.

Products: Biathlon, Ronstar, Dimension, Fortress, Freehand, Gallery, Gemini Granular, Marengo SC, Pendulum G, Tower

Preliminary Results: Combined with results from previous research activities, each herbicide has the potential for additional crops to be added. Gemini G, Pendulum G and Ronstar G did not cause injury on some of the stone crop species tested, but none can be broadly recommended for all species.

Products	Crops	Preliminary 2019 Outcomes
Biathlon (oxyfluorfen + prodiamine)	Norfolk Island Pine (*Araucaris heterophylla*) Citrus European Olive (*Olea europaea*) Philodendron Portulacaria Leather-leaf Fern (*Rumohra adiantiformis*) Asian Star Jasmine (*Trachelospermum asiaticum*)	No injury with 100, 200 and 400 lb product per acre, but moderate growth reduction at 400 lb rate for *A. heterophylla* and *Portulacaria*.
Dimension EW (dithiopyr)	Black Chokeberry (*Aronia melanocarpa*) Gray Stonecrop (*Rhodiola pachyclados*) Moss Stonecrop (*Sedum acre*) Sedum Hybrids (*Sedum hybridus*) Jenny's Stonecrop (*Sedum rupestre*) Tasteless Stonecrop (*Sedum sexamgulare*)	There was no injury with applications of 2, 4, and 8 pt per acre to *A. melanocarpa*, but all stonecrops were injured with over the top applications at all rates.
Fortress (isoxaben + dithiopyr)	Yarrow (*Achillea sp.*) Garden Chrysanthemum (*Chrysanthemum/Dendranthemum sp.*) Tickseed (*Coreopsis sp.*) Yellow Foxglove (*Digitalis grandiflora*) Bigleaf Hydrangea (*Hydrangea macrophylla*) Panicle Hydrangea (*Hydrangea paniculata*) Oakleaf Hydrangea (*Hydrangea quercifolia*) Big Blue Lilyturf (*Liriope muscari*) Hairyawn Muhly (*Muhlenberggia capillaris*) Finestem Needlegrass (*Nassella tenuissima*) Crimson Fountain Grass (*Pennisetum setaceum*) Russian Sage (*Perovskia atriplicifolia*) Sage (*Salvia sp.*)	No injury or growth reduction was observed with applications of 150, 300, and 600 lb per acre to chrysanthemum, *H. macrophylla*, *M. capillaris*, *N. tenuissima*, *P. setaceum*, and *P. atriplicifolia*. Mixed results were observed with *L. muscari*. Severe injury was observed with *D. grandiflora*.
Freehand (dimethenamid-p + pendimethalin)	Sedge (*Carex sp.*)	n/a
Gallery (isoxaben)	Black Chokeberry (*Aronia melanocarpa*)	No injury observed
Gemini Granular (prodiamine + isoxaben)	Regal Geranium (*Pelargonium x domesticum*) Moss Stonecrop (*Sedum acre*) Sedum Hybrids (*Sedum hybridus*) Jenny's Stonecrop (*Sedum rupestre*)	Variable results were observed with over the top applications of 200, 400 and 800 lb product per acre among stonecrop species ranging from no injury to severe injury and growth reduction.
Marengo SC (indaziflam)	Boxwood (*Buxus sp.*) Atlas Cedar (*Cryptomeria japonica*) Holly (*Ilex sp.*) Juniper (*Juniperus horizontalis*) Norway Spruce (*Picea abies*) Austrian Pine (*Pinus nigra*) Rhododendron	No injury was observed with 9, 18, 36 fl oz per acre on holly, *P. abies*, and rhododendron. Moderate injury occurred on boxwood.
Pendulum G (pendimethalin)	Cherokee Sedge (*Carex cherokeensis*) Stonecrop (*Hylotelephium sieboldii*) Gray Stonecrop (*Rhodiola pachyclados*) Moss Stonecrop (*Sedum acre*) Sedum Hybrids (*Sedum hybridus*) Tasteless Stonecrop (*Sedum sexamgulare*)	No injury or growth reduction was observed with applications of 150, 300, and 600 lb per acre to *C. cherokeensis*, *S. acre*, *S. hybridus*. Minor to moderate injury occurred in *H. sieboldii* and *S. sexamgulare*.
Ronstar G (oxadiazon)	Gray Stonecrop (*Rhodiola pachyclados*) Moss Stonecrop (*Sedum acre*) Sedum Hybrids (*Sedum hybridus*)	With applications of 200, 200, and 400 lb product per acre, *R. pachyclados* exhibited minor phytotoxicity and severe growth, but *S. acre* and *S. hybridus* had no injury or growth reduction.
Tower (dimethenamid-p)	Alder (*Alnus sp.*) Black Chokeberry (*Aronia melanocarpa*) Japanese Rose (*Kerria japonica*) Northern Bayberry (*Myrica pensylvatica*)	No injury or growth reduction occurred with applications of 21, 42, and 84 fl oz per acre to *A. melanocarpa* and *M. pensylvatica*.

Liverwort Efficacy

Goals: Screen for pre- and post- emergent herbicide efficacy to manage *Marchantia* species.

Products: Basagran T/O, Marengo G, Marengo SC, Mosskiller, Ronstar G, Terracyte Pro, Tower

Preliminary Results: In the single preemergent experiment so far, Marengo G (9 fl oz per acre), Marengo SC (200 lb per acre), Ronstar G (200 lb per acre) and Tower (32 fl oz per acre) provided excellent efficacy after two applications (data not shown). In the single postemergent experiment so far, Terracyte (93 and 186 lb ai per acre) provided excellent control while Mosskiller (47 lb ai per acre) exhibited good control. Lower rates of Mosskiller and Basagran T/O were ineffective (*data not shown; for details visit www.ir4project.org/ehc/*).

In Season Postemergent Herbicide Efficacy

Goals: Broaden current postemergent herbicide labels for typical field container and in ground production and screen for non-traditional herbicides.

Products: Basagran T/O, Dismiss 4F, Fiesta, Marengo SC

Preliminary Results: Excellent control of Northern Willowherb (*Epilobium ciliatum*) was achieved by Basagran, Dismiss, Fiesta, and Marengo. Hairy bittercress (*Cardamine hirsuta*) was well managed by Dismiss, Fiesta and Marengo. Excellent control of oxalis (*Oxalis stricta*) occurred with Fiesta and Marengo (*data not shown)*. For results on other weeds or for more details visit *www.ir4project.org/ehc/*.

In Season Postemergent Herbicide Crop Safety

Goals: Broaden current postemergent herbicide labels for typical field container and in ground production and screen for non-traditional herbicides.

Products: Basagran T/O, Dismiss 4F, Fiesta

Preliminary Results: Combined with results from 2018, it is possible to add additional crops to the Basagran and Dismiss registrations. However, Fiesta's label may be limited for over-the-top applications to certain ornamental grass species and specific narrowleaf evergreens such as *Juniper*, *Picea*, *Pinus*, and *Taxus*.

Products	Crops	Preliminary 2019 Outcomes
Basagran T/O (bentazon)	False Goat's Beard (*Astilbe sp.*) Elephant's-Ear, Angel-Wings (*Caladium sp.*) Maiden Pink (*Dianthus deltoides*) Eastern Purple Coneflower (*Echinacea purpurea*) Field Fescue (*Festuca glauca*) Hydrangea (*Hydrangea sp.*) Lily (*Lilium sp.*) Mondo Grass; Lilyturf; Ker-Gawl (*Ophiopogon sp.*) Switch Grass (*Panicum virgatum*) Crimson Fountain Grass (*Pennisetum setaceum*) Black-Eyed Susan (*Rudbeckia hirta*) Stonecrops: Moss (*Sedum acre*), White (*Sedum album*), Kamchatka (*Sedum kamtschaticus*), Jenny's (*Sedum rupestre*), Tasteless (*Sedum sexamgulare*), Two-Row/Caucasian (*Sedum spurium*) Bridal-Wreath (*Spiraea sp.*) Tulip (*Tulipa sp.*)	Applications of 32, 64 and 124 fl oz per acre caused severe injury with *Astilbe*, *Ophiopogon*, *R. hirta*, *S. album*. No to severe injury was observed with *Spirea*, and minor to severe injury occurred on *D. deltoides*, *P. virgatum*, *P. setaceum*, *S. acre*, and *S. rupestre*. Only *F. glauca* exhibited no injury or growth reduction.
Dismiss 4F (sulfentrazone)	Feather Reed Grass (*Calamagrostis acutiflora*) Silver Grass (*Miscanthus sp.*) Muhly, Hairyawn (*Muhlenbergia capillaris*)	No injury was observed with *C. acutiflora*; minor to moderate injury and growth reduction was observed with applications of 8, 16, and 24 fl oz per acre on *M. capillaris*.
Fiesta (FeHDTA)	Big Blue Stem (*Andropogon gerardii*) Boxwood (*Buxus sp.*) Sedge, Cherokee (*Carex cherokeensis*) Sedge (*Carex sp.*) Indian Woodoats (*Chasmanthium latifolium*) Cotoneaster (*Cotoneaster sp.*) Wintercreeper (*Euonymus fortunei*) Spurge (*Euphorbia sp.*) Daylily (*Hemerocallis sp.*) Alumroot (*Heuchera sp.*) Rosemallow (*Hibiscus sp.*) Plantain Lily (*Hosta sp.*) Hydrangea (*Hydrangea sp.*) Holly, Chinese (*Ilex cornuta*) Crape Myrtle (*Lagerstroemia indica*) Privet (*Ligustrum sp.*) Silver Grass (*Miscanthus sp.*) Muhly, Hairyawn (*Muhlenbergia capillaris*) Oleander, Rosebay (*Nerium oleander*) Mondo Grass; Lilyturf; Ker-Gawl (*Ophiopogon sp.*) Japanese Pachysandra (*Pachysandra terminalis*) Switch Grass (*Panicum virgatum*) Fountaingrass (*Pennisetum alopecuroides*) Crimson Fountain Grass (*Pennisetum setaceum*) Pine, Loblolly (*Pinus taeda*) Fir, Douglas (*Pseudotsuga menziesii*) Rhododendron (*Rhododendron sp.*) Rose (*Rosa sp.*) Rosemary (*Rosmarinus officinalis*) Stonecrop, White (*Sedum album*) Stonecrop (*Sedum sp.*) Houseleek (*Sempervivum sp.*) Bridal-Wreath (*Spiraea sp.*)	After applications of 8.5, 17, and 34 gal per acre (25, 50 and 100 oz per 1000 sq ft) no injury or growth reduction was observed on *A. gerardii*, *Buxus*, *E. fortunei*, *M. capillaris* and *P. alopecuroides*. All other crops exhibited minor to severe injury.

Mortality of Basagran to Astilbe. Left to right: water, 32, 54, 128 fl oz per acre). Andy Senesac, 2019.

Hydrangea bloom damage with Fiesta. Left: water; Right, Fiesta. Marcello Moretti, 2019.

Foliar necrosis and stunting with Fiesta applications to Ophiopogon. Left to right: water, 8.5 gal, 16 gal, 24 gal per acre). Andy Senesac, 2019.

2020/2021 Research Priorities

Entomology – Borer & Beetle Efficacy
Entomology – Mealybug & Scale Efficacy
Entomology – New Pest Management Tool Crop Safety

Pathology – Pythium Efficacy
Pathology – Non-Oomycete Root & Crown Rot Efficacy
Pathology – New Disease Management Tool Crop Safety

Weed Science – Preemergent Herbicide Crop Safety
Weed Science – Nostoc Efficacy on Hard Surfaces

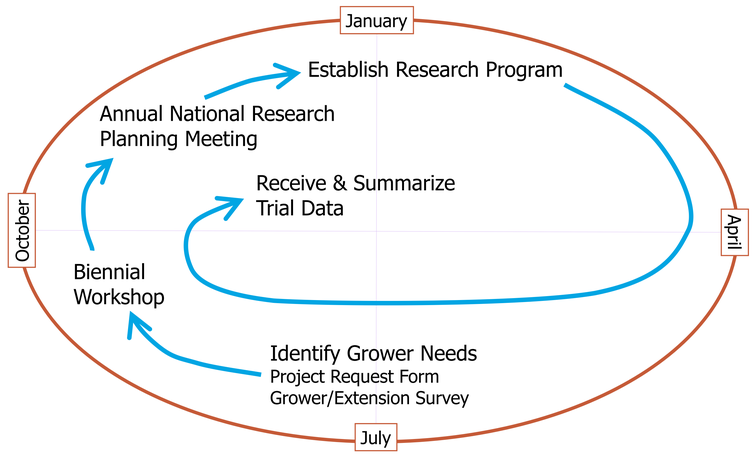
Biopesticide Specific – Powdery Mildew on Greenhouse Potted Plants
Biopesticide Specific – Root Knot Nematode Efficacy

NCR – Ambrosia Beetle Efficacy
NCR – Root Knot Nematode Efficacy

NER – Improving Directions for Use with Fatty Acid Herbicides
NER – Thrips Efficacy for Outdoor Uses

SOR – European Pepper Moth Efficacy
SOR – Bacterial Leaf Spots & Blight
SOR – Post Emergent Crop Safety & Efficacy for Glyphosate Resistant Weeds

WSR – Snail Efficacy
WSR – Liverwort Efficacy
WSR – Botrytis Efficacy on Peony



Acknowledgements

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2019 Weed Scientists

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