ESTABLISHMENT AND SEED PRODUCTION OF NATIVE FORBS USED IN RESTORATION

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INTRODUCTION

Although native wildflowers are components of most native communities, their use in re-vegetation projects has been limited largely due to inadequate seed supplies (Shock et al. 2006). A critical component in the production of many native wildflower seeds is to identify the factors that determine successful establishment. The problem of many native wildflower species is slow germination, emergence, and establishment, the threat of weed competition for water(Vargas-Mendoza 1998), sunlight, and nutrients and the lack of herbicides labeled specifically for dicot weed control in these dicot crops. Therefore, testing wildflower species tolerance to pre- and post-emergence herbicides represents a necessary step to facilitate the successful establishment and seed production of native wildflowers (Norcini 2003).

METHODS

Greenhouse studies:

Pre- and post- emergence herbicide screening trials were conducted in the Montana State University Plant Growth Center. The experimental design for the two pre-emergence screening trials were randomized split-plots with four replications conducted at two different times. The five herbicides and an untreated control (Table 1) were the whole-plot treatments and the seven wildflower species were the sub-plot treatments. A pasteurized mixture of 50% Farland silt loam (fine-silty mixed Typic Argiboroll) and 50% sand was used and the soil was watered to capacity. Each tray was assigned at random to be one of four replications and one of six herbicide treatments. Herbicide treatments were applied and incorporated on 22 March 2005 for run 1 and 6 June 2005 for run 2. The post emergence screenings were a completely randomized design conducted twice using seven herbicides (Table 1) and five wildflower species (Table 2). Two soil types were used, the first a pasteurized mixture of 50% Farland silt loam (fine-silty mixed Typic Argiboroll) and 50% sand seeded at 25 PLS per pot, and the second a mix of loam soil, washed concrete sand, and peat seeded at 50 PLS per pot.

The two experimental runs were sprayed 7 Mar 2007. The pre and post emergence spraying was conducted using a spray table fitted with a TeeJet® Flat Fan 8002E nozzle. Prior to application, the spray table was calibrated based on a 35 L/ha volume applied at 3 mph with 40-psi pressure. The nozzle height was 0.3 m above the soil surface. After 15-20 days plant density and damage related to leaf injury were estimated. Leaf injury was recorded as percent damaged relative to the control. Plant density in each pot was recorded prior to spraying and then 3 weeks after to obtain change in density. Plants were harvested 30 days after spraying and fresh weights and dry weights were recorded.

Field Studies:

Three studies are currently being conducted to test the pre and post emergence herbicides in seed production fields. Two studies were established at the Plant Materials Center in Bridger, Montana. These studies have been previously established and are being monitored for herbicide injury to wildflowers and weed control with separate fields for pre- and post-emergence testing. The third study is replicated in Bozeman, Montana at the Post Agronomy Research Farm, and in Bridger, Montana at the Plant Materials Center.
For each site in the third study, the experiment comprises a 35 m by 36.6 m (0.128 ha) area using a split-split-plot randomized block design with three replications (Fig.1). At each site, the emergence and growth of 5 native wildflower species (Table 2) is being evaluated under 12 herbicide treatments (Table 1). Wildflower species are the main plot factor and herbicide treatments are split-plot factors. Each split-plot is further subdivided into hand weeded and non-weeded split-split plots. The control plots are not treated with herbicide or weeding and there is a treatment that is only hand weeded, with no herbicide application. The weeding component will help determine the desired weed density for wildflower establishment and herbicide efficacy.

The number of plants per row (density data) was analyzed using a repeated measure, randomized-block split-plot analysis of variance model (Fig. 2) (Proc GLM, SAS institute 1990). The wet weight, dry weight, density, and % injury were analyzed using an analysis of variance model. (The R Foundation for Statistical Computing 2006)
Results for the field experiments are currently being analyzed.

RESULTS and CONCLUSIONS

The pre emergence greenhouse study showed trifluralin and DCPA least injurious to all species. Wildflower densities (data not shown), leaf number, average plant height, and average biomass per plant were greatest in these treatments (Fig. 2). While using crop rotation, tillage, and herbicide management to reduce weeds in fields prior to planting is critical to wildflower seed production, application of trifluralin or DCPA to target specific troublesome weed species may not injure establishing wildflowers and provide acceptable weed control.

None of the herbicides except clopyralid showed significant change in wildflower density or biomass in the post emergence greenhouse study (data not shown). Each species had highly variable growth rates, therefore at time of spraying they were not at uniform heights potentially leading to varied herbicide injury. Preliminary observations indicate that field studies have shown trifluralin and imazapic to be very injurious contrasting to the greenhouse results. Further results are currently being analyzed.

LITERATURE CITED

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Table 1: Herbicides used in greenhouse and field studies

Trade Name	**Chemical Name**	**Mechanism of Action**
Pre emergence		
Dacthal® WP	DCPA	Mitosis inhibitor
Spartan	Sulfentrazone	Photosynthesis inhibitor
Aatrex	Atrazine	Photosynthesis inhibitor
Surflan™	Oryzalin	Microtubule assembly inhibitor
Treflan™	Trifluralin	Microtubule assembly inhibitor
Control		
Post emergence		
Prowl® H2O	pendimethalin 38.7%	Microtubule assembly inhibitor
Treflan™	trifluralin 43%	Microtubule assembly inhibitor
Plateau	Imazapic	ALS inhibitor
Permit®	Halosulfuron	ALS inhibitor
Fusilade	Fluazifop P-butyl	ACCase inhibitor
Stinger	Clopyralid	IAA inhibitor
Envoy	Clethodim	ACCase inhibitor
Lorox	Linuron	Inhibits photosynthesis in photosystem 2
Control	-	-

Table 2: Wildflower species used in greenhouse and field studies
* ACMI and LIPU not used in post emergence screening or experiment 3 in the field

Genus & Species	Common Name	Seed length (mm)	Seed weight (g)	Viability (%)
Achillea millefolium var. *occidentalis*	western yarrow	1.5 to 3 mm	6288	99
Dalea candida	white prairieclover	1.5 to 2.5 mm	613	78
Gaillardia aristata	blanketflower	2 to 4 mm	411	55
Phacelia hastata	silverleaf phacelia	1.5 to 2 mm	337	96
Liatris punctata	dotted gayfeather	6 to 8 mm	139	87
Penstemon eriantherus	fuzzytongue penstemon	2-2.8 mm	NA	63
Ratibida columnifera	prairie coneflower	1.5-3 mm	1625	96

† Pure-Live-Seed

Figure 1: Experimental design to evaluate the effect of pre-and post-emergence herbicides on native wildflower seedling establishment, and wildflower seed production. Each grey area represents one of the five forb species tested.

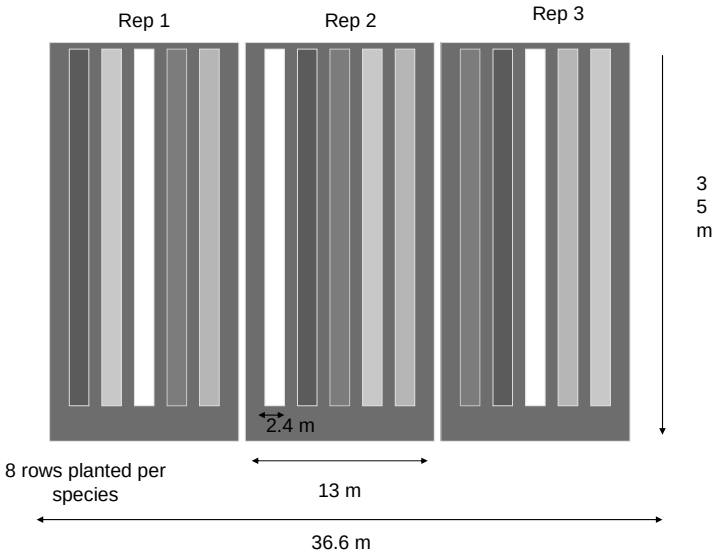

Figure 2: Pre emergence herbicide screening results