Effect of Allelopathy (Ligularia Virgaurea) on Corm Germination of Saffron

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ABSTRACT: Allelopathy is an important process in plant communities, but the role of seed allelopathy in natural ecosystems remains poorly understood. Allelopathy is a new pathway for weed controls, the most important chemical material released by leaf, flower, seeds, steam and roots includes Fensols, alkaloids, felavenoids have allelopathic characters. This material can effect on others plant with different methods. They also can damage or delay in growth and germination. This study was conducted as a factorial experiment based on completely randomized design with three replications. Effect of four concentrations (0, 33, 66 and 100%) Ligularia Virgaurea seeds leachate, and seed density (0, 50g, 100g and 200g) of Ligularia Virgaurea on final percent germination and root length of saffron corms. The results showed that germination percentage and root length decreased by Allelopathy property of Ligularia Virgaurea and then we can employ it as herbicide for controlling all plant and in the time that the lands are fallow.

Key Word: Allelopath, Seed Germination, Saffron, Corm.

INTRODUCTION

Allelopathic interactions are mediated by secondary metabolites (allelochemicals) released from donor plants to the environment, and have an influence on growth and development in both natural and agroecosystems (Inderjit & Duke 2003). These allelochemicals belong to a diverse chemical group and have different sites and modes of biochemical action. In general, when the effect of these allelochemicals decreases growth on the receiver plant, it is considered as a biotic stress called ‘allelochemicals stress’ (Cruz-Ortega, Ayala-ordero & Anaya 2002; Reigosa et al. 2002; Romero-Romero, Anaya & Cruz-Ortega 2002).

In particular, recent studies suggest that Allelopathy may mediate some biological invasions, because the allelochemicals produced by exotic plants are novel in the invaded range and more effective against naïve native species than against the species with which the exotic plants naturally co-occur (Callaway & Aschehoug 2000; Bais et al. 2003; Callaway & Ridenour 2004; Vivanco et al. 2004).

Alternatively, seeds and seedlings can improve their chances of success by releasing germination inhibitors that prevent recruitment of their siblings (e.g. Dyer 2004). In addition, some species use germination inhibitors from other species as cues to postpone germination in areas with intense interspecific competition (e.g. Preston & Baldwin 1999). Sukhada & Jayachandra (1980) demonstrated that pollen extract from the anemophilous Partheniutn hysteroph) rus¹⁴, (Asteraceae) resulted in the in vitro and in vivo inhibition of pollen germination in several sympatric species.

Both Centaurea species and their allelochemicals have much stronger effects on species native to invaded regions in North America than related species in their communities of origin. Alliaria petiolata, a devastating invader of North American temperate forests, also has stronger chemical effects on Geum lacinatum, a new North American neighbor, than on Geum urbanum, its natural European neighbor (Prati & Bosdorf 2004). In a related experiment, although not using invasive species, Malik & Pellissier (2000) found that the Eurasian Vaccinium myrtillus generally had stronger biochemical affects on the North American Picea mariana than on the Eurasian Picea abies. Recently, interest has developed in the allelopathic effects of seeds on the seeds and seedlings of other species (Suman et al. 2002; Qaderi et al. 2003; Rashid et al 2005). However, the majority of seed allelopathy studies have focused on agroecosystems. The role of allelopathic seeds on natural vegetation process remains largely unknown.

Recent research has focused on the reproductive strategies and potential Allelopathy of L. virgaurea as explanations for that species’ dominance. L. virgaurea exhibits aggressive sexual (Ma et al. 2006a) and asexual
(Wang et al. 2008) reproduction, but there is also evidence for allelopathic effects from volatile and aqueous leaf and root extracts on the germination and growth of native for species (Ma et al. 2005, 2006b). In the present study, we examine the potential of L. virgaurea for seed Allelopathy L. virgaurea germinates between mid- to late May, similar to the timing of most native grass species in Tibetan grasslands (Jia, unpublished data). Thus an allelopathic effect of L. virgaurea seeds on seed germination and seedling growth rates of other species may place L. virgaurea seedlings at a significant advantage. In this study we test whether the presence of L. virgaurea seeds or seed leachate negatively influence seed germination and root growth rates of common Tibetan native grass species.

**MATERIALS AND METHODS**

This study was conducted as a factorial experiment based on completely randomized design with three replications. The effects of four concentrations (0, 33, 66 and 100%) of Ligularia Virgaurea seeds leachate, and seed density (0, 50g, 100g and 200g) of Ligularia Virgaurea on final percent germination and root length of saffron corms by Michel and Kaufman. Five corms per dish were used for each treatment. Corms were incubated in the dark at 20°C in a growth chamber. After 20 days seedling dry weight was obtained after oven drying at 70°C. The weight of utilized (mobilized) seed reserve was calculated as the dry weight of the original seed minus the dry weight of the seed remnant. Data from both experiments were separately analyzed by Statistical Analysis System 18. Mean comparisons were performed by a protected least significant difference (LSD) test at 5, 1 and 0.01% levels of probability.

**RESULTS**

In this study we demonstrate that L. virgaurea seeds can have allelopathic effects on both the germination and root growth rates of saffron corms in a laboratory setting. We further demonstrate that this effect is likely driven by a water-soluble seed leachate. These allelopathic effects are potentially an important mechanism increasing L. virgaurea seedling survival and establishment rates in degraded grasslands. This allelopathic mechanism may also contribute to the dominance of L. virgaurea in degraded grasslands because the large numbers of seeds produced by this species may reduce the competition experienced by adult L. virgaurea plants (Ma et al. 2006a) (table 1 and 2).

**Table 1. Effects of Ligularia Virgaurea seeds leachate on final percent germination and root length in saffron.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Percent germination</th>
<th>Root length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>SS</td>
</tr>
<tr>
<td>extract</td>
<td>3</td>
<td>2.1</td>
</tr>
<tr>
<td>Leachate</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>extract × Leachate</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Error</td>
<td>24</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>5.7</td>
</tr>
</tbody>
</table>

*p ≤0.05, ***p≤0.001

**Table 2. Effects of seed density of Ligularia Virgaurea on final percent germination and root length in saffron.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Percent germination</th>
<th>Root length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>SS</td>
</tr>
<tr>
<td>extract</td>
<td>3</td>
<td>3.14</td>
</tr>
<tr>
<td>Seed density</td>
<td>4</td>
<td>1.68</td>
</tr>
<tr>
<td>extract × Seed density</td>
<td>12</td>
<td>1.63</td>
</tr>
<tr>
<td>Error</td>
<td>60</td>
<td>3.03</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>9.48</td>
</tr>
</tbody>
</table>

**p ≤0.01, ***p≤0.001**

Our observations indicated that percent of germination of saffron is highly enhanced during senescence of seeds (table 1, 2), suggesting that when allelopathic potential of seeds is evaluated the presence of both young and old seeds should be considered. In many plants seeds are liberated close to the parent plant, the zone where seed-induced Allelopathy may occur. Large numbers of seeds are usually produced in order to ensure establishment; greater number and mass of seeds may also increase allelopathic inhibition of competing vegetation.

The Allelopathy of Ligularia Virgaurea on other plants, the effects of different extracts on the growth of several plants was studied by bioassay. Results showed that the water extracts inhibited the growth of corn (Zea mays L.), wheat (Triticum aestivum L.), cotton (Gassypium Hirsutum L.), soybean (Glycine hispida L.),...
peanut (Arachi shypogaea L.), rice (Oryza sativa L.), crabgrass (Digitaria sanguinalis L.) and rigweed (Amaranthus retroflexus L.). The results of other studies showed that the water extracts of Ligularia Virgaurea inhibited the growth of corn (Zea mays L.), wheat (Triticum aestivum L.), cotton (Gassypium Hirsutum L.), soybean (Glycine hispida L.), peanut (Arachi shypogaea L.), rice (Oryza sativa L.), crabgrass (Digitaria sanguinalis L.) and rigweed (Amaranthus retroflexus L.).

Pollen extracts from Ligularia Virgaurea in eastern Ontario, Canada were tested for allelopathic effect on the pollen germination. 17 sympatric target species the test and target species were recorded to determine if any phonologically in 1987. The How-ering phenologies of divergent species showed evidence of n vitro pollen-allelopathic interactions. Ligularia Virgaurea demonstrated pollen-allelopathic effects on all targets except Linaria vulgaris Hill. It also exhibited significant phenological divergence with seven of the target species. Pollen extracts from Agrt>stis stoltnifera L, Melilotus alba Desr and Vicia craeca L. inhibited pollen germination in some of the target species, but the results suggest that these effects were pH-mediated. The pollen extract of Ligularia Virgaurea did not cause inhibition of pollen germination in any of the target species. Further tests with pollen extract of Ligularia Virgaurea and another 23 sympatric target species were performed in 1988. Pollen germination was significantly inhibited in all but two of these species: A. stolonifera and P. pratense. Hence, the pollen of Ligularia Virgaurea was not auto-allelopathic. The breeding system, relatively tall growth habit and relatively large quantity of pollen produced all support the in vitro evidence of P. pratense as a pollen-allelopathic species. Germination percentage and root length decreased by Allelopathy property of Ligularia Virgaurea and then we can employ it as herbicide for controlling all plant and in the time that the lands are fallow (figs 1, 2).

\[\text{Figure 1. Effect of Ligularia Virgaurea seeds leachate on final A) percent germination and B) Root length of saffron.}\]

\[\text{Figure 2. Effect of Ligularia Virgaurea Seed density on final A) percent germination and B) Root length of saffron.}\]

DISCUSSION

In this study we showed effective allelopathic Ligularia Virgaurea on germination and growing at saffron. Density of seeds, rate of emanation of inhibitors, their amount and effectiveness, all determine allelopathic potential of seeds. Our observations in Ligularia Virgaurea indicated that rate of germination of the
inhibitor is highly enhanced during senescence of corms, suggesting that when allelopathic potential of seeds is evaluated the presence of both young and old seeds should be considered. Inhibitors of germination or of growth, highly diversified chemicals are commonly found in higher plants. They occur in vegetative organs as well as in seeds or other dispersal units. Non protein amino acids, when present, are mainly found in seeds where they can occur in extremely high concentrations. In many plants seeds are liberated close to the parent plant, the zone where seed-induced Allelopathy may occur.

Large numbers of seeds are usually produced in order to ensure establishment; greater number and mass of seeds may also increase allelopathic inhibition of competing vegetation and in saffron Leaves and corms produce active component to effect of other plant Saffron alkaloid can be affected on other plants highest effect is on germination and seed growth) datorea sp · Hyoscyamus nigra Colchicine material there is in saffron like. Aqueous leachate of Ligularia Virgaurea showed germination and root growing of saffron is decreased. Also this extract has a poisonous effect Ligularia Virgaurea growth. The results showed that L. virgaurea seeds can have potential allelopathic effects on seed germination, mean time to germination and root. Germination percentage and root length decreased by Allelopathy property of Ligularia Virgaurea and then we can employ it as herbicide for controlling all plant and in the time that the lands are fallow.

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