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DOES NATIVE FLORA INHIBIT THE GERMINATION OF INVASIVE SPECIES?

Minu Adhikari
Nepal Academy Of Science And Technology (Nast), Khumaltar, Lalitpur, Nepal

ABSTRACT

Predominance of invasive weeds in new habitat may be due to their chemical secretion and contamination of soil. Changing the chemical compositions of soil by allelochemical secretion, they alter the native flora and form the mono-species stands. This study was done to know about the allelopathic interference of native species Artemisia dubia Besser. (one of which congener A. vulgaris Linnaeus is invasive to Americas) on invasive weeds Ageratum houstonianum Mill, Chromolaena odorata (L) King and Rob. and Mikania micrantha HBK. (native to Americas). For this seed germination of selected invasive weeds was carried out in the leaf mulching of A. dubia on soil and seedling lengths were measured. There was significant decrease in seed germination of invasive weeds under study which indicates the adverse effect on germination. Germination was dose dependent. Seedling germination was stimulating in M. micrantha for lower concentration of leaf mulching while adverse effect had been recorded in case of A. houstonianum and C. odorata.

Keywords: Invasive weeds, Allelochemicals, Congener

1. INTRODUCTION

Invasive weeds are being great threats to biodiversity and ecosystem (Gurevitch & Padilla, 2004). It affects the native species by changing microhabitat through modifying soil structure and composition initially and finally to whole ecosystem (Stinson, 2006). Number of invasive species in any region is increasing temporally (Dukes & Mooney, 1999). This is because of least studies in flora, their ecology and increase in globalization. Concerning invasive species, Nepal is highly vulnerable to them due to diverse climatic regions with open political boundaries and no effective quarantine laws (Tiwari et al., 2005). Globally, different methods have been used to control or check the invasive species expansion, but the least has been effective. To control the invasive species, we should be clear on their life history traits and their strategies to adapt in the new habitat. Among many of them allelochemical secretion is considered as one of the potent traits for plant to become invasive (Orr et al., 2005). Allelopathic effect of the plants may increase or decrease the plant growth of species growing nearby them (Jabeen & Ahmed, 2009).

The species under study: Artemisia dubia is native to Asia (Hayat et al., 2009). It has been found that the species has allelopathic effect on other species (Mallik et al., 2014). One of its congeners, A. vulgaris is invasive to Americas (Barney & DiTommaso, 2003; Barney et al., 2005) and becoming threats to local plant diversity. Since these two species are congener these may have similar allelopathic effect on other species. Another study species: Ageratum

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houstonianum, Chromolaena odorata and Mikania micrantha are native to Americas and become noxious to most of the countries in Asia including Nepal (Tiwari et al., 2005; Shrestha, 2016). The study was done to find out the allelopathic interference of A. dubia on seed germination of the weed species. It was presumed that there is adverse effect of leaf mulching of A. dubia on seed germination and seedling length of weed species under species. The finding could help for management strategies of invasive weeds in Nepal. If the species can check the seed germination of invasive species, then we can use the native biota (Gulzar, 2017) to control the growth of invasive species without introduction of exotic species as biocontrol which will reduce the risk of introduction of exotic species. Different methods have been using for allelopathic study like leaf leachates, extract solution of plants, leaf mulching, composting etc. Among them leaf mulching method has been incorporated in this study to simulate the nature since leaf mulching occurs more significantly than other forms to release the allelochemicals from plants.

2. MATERIALS AND METHODS

Collection of seeds and leaves

Ripen seeds of invasive weeds under study (A. houstonianum, C. odorata and M. micrantha) were collected on the first week of April 2016 from Gitanagar (27.57330°N and 84.49522°E) of Chitwan district at an altitude of 170 m which is in the buffer zone of Chitwan National Park. Seeds collected were sun dried for a week. For each test species altogether 3600 seeds were counted and packed in plastic zip-lock bags. For leaf mulching study about 6 kg of fresh leaves of A. dubia were collected from Tikauli, Chitwan (27.659°N and 84.457°E) which also lies in the buffer zone of Chitwan National Park. Since leaf has higher allelopathic effect on seed germination than root and stem (Mallik et al., 2014), only leaves were collected. The test species were abundant in that area coexisting with A. dubia. The collected leaves were air dried in shade for one week and chopped into small pieces with the help of knife and chopping board. Allelochemicals are volatile chemical substances and can evaporate easily. So, the chopped materials were stored in zip-locked plastic bags.

Germination of seeds

Germination was carried out in amended soil in plastic pots (6.5 cm diameter) in four different concentration of leaf mulch (0, 2, 4 and 8%; here 0% means no leaf residue in soil, 2% means 1 g of leaf residue in 50 g of soil and so on). Each cup contained 30 seeds of single species and each condition had 30 replicates. To maintain soil moisture, tap water was added to each cup in equal amount (Jha et al., 1996). Number of germinated seeds was recorded in every two days for 20 days. None of the germinated seeds were removed from cups before 20 days. On 20th day, size of the seedlings was measured, and data were analyzed. All the plastic cups with soil, leaf residues and seeds of test species were packed in the plastic bags and discarded in the nature which has already been invaded by test species (i.e. Chitwan) due to invasion issue.

Statistical analysis

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The collected data were analyzed using One Way ANOVA in Microsoft Excel 2013.

3. RESULTS

Effect on seed germination

Seed germination rate of Mikania micrantha (P<0.000; F=18.35), Ageratum houstonianum (P<0.000; F=29.08) and Chromolaena odorata (P<0.000; F=84.97) was significantly decreased with increase in concentration of leaf mulching of Artemisia dubia (Table 1). Germination rate was the highest in 2% leaf mulching and the least in that of 8% in M. micrantha while it was the highest in no leaf mulching and the least in highest concentration of leaf mulching (8%) in A. houstonianum and C. odorata respectively.

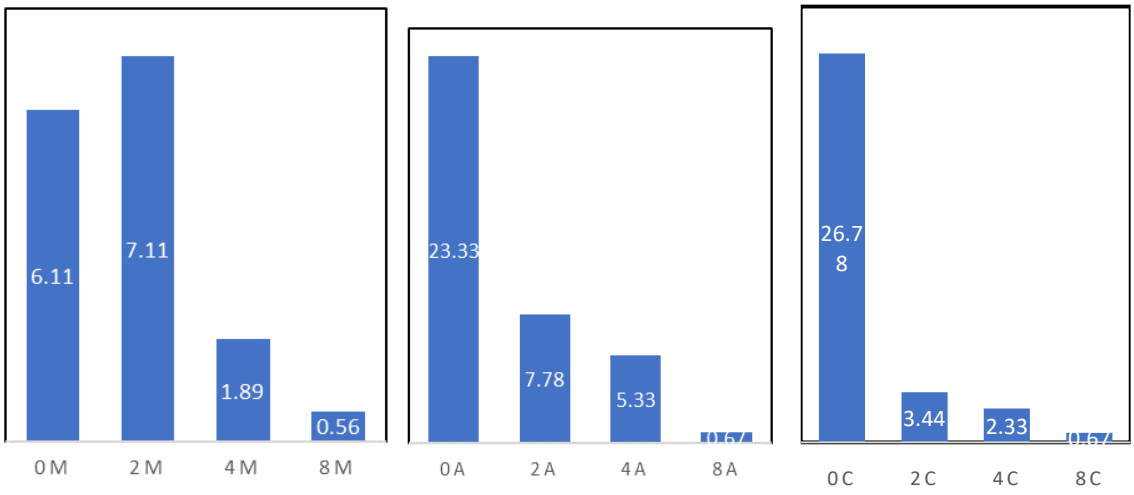

Figure 1: Germination variation among different condition of leaf mulching (Leaf to right: Mikania micrantha, Ageratum houstonianum and Chromolaena odorata)

Following table summarized the statistical data

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Table 1: One-way ANOVA of leaf mulching of Artemisia dubia on germination of the weeds

Species	F value	F critical value	P value
M. micrantha	18.345	2.683	0.000
A. houstonianum	29.081	2.686	0.000
C. odorata	84.965	2.686	0.000

* P<0.05

Effect on seedling growth

Effect of leaf mulching of A. dubia on seedling length of A. houstonianum was insignificant whereas significantly decrease in M. micrantha and C. odorata (Table 2). Seedling length was the highest in the highest leaf mulching (8%) in M. micrantha whereas it was the highest in no leaf mulching in case of A. houstonianum and C. odorata (Figure

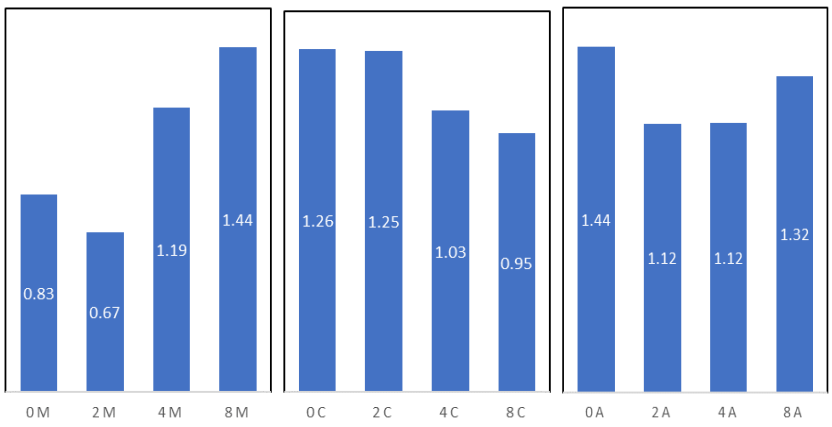

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Figure 2: Seedling length of weed species in different condition of leaf mulching of Artemisia dubia

Statistical data has been summarized below:

Table 2: Statistical value of One-way ANOVA of leaf mulching of Artemisia dubia on seedling length of weed

Species	F value	F critical	P value
M. micrantha	4.736	2.750	0.005
A. houstonianum	2.339	2.733	0.081
C. odorata	3.696	2.852	0.019

4. DISCUSSION AND CONCLUSION

Germination rate was significantly decreased in all weed species. Though there was low germination in high concentration of leaf mulching on Ageratum houstonianum and Chromolaena odorata, Mikania micrantha had the highest germination in 2% leaf mulching. It indicates that low concentration of leaf mulching of Artemisia dubia on seed germination of M. micrantha is favorable. Teasdale and Mohler (2000) also observed that there is the increase in germination of Amaranthus retroflexus in low mulching concentration. The increase in germination may be due to increase in soil nitrate which may enhance the germination (Gallagher & Cardina, 1998). Germination decreases in A. houstonianum and C. odorata with increase in leaf mulching concentration. The reason behind it may be due to allelopathic effect. A. dubia shows allelopathic effect on seed germination of weed species (Mallik et al., 2014). Mannan et al. (2010) has reported that there is presence of allelochemicals in leaf of different species of Artemisia and show allelopathic effects (Stiles et al., 1994). No complete inhibition of germination was accessed in this study. It is contrary to the result found by Mallik et al., (2014) where there was no seed germination of Ageratum conyzoides (congener of A. houstonianum) on leaf extract of A. dubia in ≥5%. This may be due to presence of higher amount of allelochemicals in extracts than residue (Barnes & Putnam, 1986).

Seedling length showed irregular patter with increase in concentration of leaf mulching. In M. micrantha seedling length was firstly decreased and then increased with increase in concentration. In case of C. odorata seedling length was concentration dependent i.e. decreased with increase in concentration of leaf mulch while in A. houstonianum it was decreasing initially

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and slightly increased later. In the germination experiment conducted by Tefera (2002), there was stimulatory effect of flower, root and stem extract of Parthenium hysterophorus on shoot length of Eragrostis tef. Other research also suggested the stimulatory effect of allelochemicals on shoot length (Rejila and Vijayakumar, 2011). This stimulatory effect may be due to presence of phenols, tannins etc. (Compton & Preece, 1988).

Germination rate was the least in highest leaf mulching in general which indicates there is allelopathic effect on seed germination of weed species under study. Higher concentration had adverse effect on seedling length of M. micrantha and C. odorata while in A. houstonianum it was in highest test concentration. Lower concentration of leaf mulch is stimulatory for seedling length in M. micrantha indicating that if there is presence of A. dubia in low density then it will outburst the growth of M. micrantha while A. houstonianum and C. odorata can be control by small population of it. This result may be interesting for the management of the weed species in Nepal.

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