Impact of the invasive weed *Ageratum conyzoides* in the Shivalik Ranges of the north-western Himalayas, India

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INTRODUCTION

In India, the north-western Himalayas are well-known for their rich floral diversity. However, during the last two decades a number of exotic weeds have invaded the area, thereby greatly threatening the natural vegetation (Kohli *et al*., 2005), causing irreversible damage to the structure and dynamics of natural communities. The allelopathic interference of these invading weeds also plays an important role in their invasiveness (Callaway & Aschehoug, 2003). Billy goat weed (BGW) (*Ageratum conyzoides*) (Asteraceae) is an aromatic, invasive and exotic weed from tropical America that quickly encroaches upon any given area. BGW possesses a number of ecological strategies, such as fast growth rate, quick regenerative and reproductive potential, and greater tolerance/adaptability, helping it to form monocultural stands in the Shivalik Ranges of the north-western Himalayas. The weed has spread extensively in the Shivaliks, occupying various habitats (forests, plantations, agricultural fields, wastelands, grasslands) and now greatly affects the landscape (Kohli *et al*., 2004). However, a quantitative assessment of the native vegetation following BGW invasion in different habitats have not been done. A study was therefore conducted to assess the status of vegetation in various habitats (such as grasslands, a plantation, riparian regions and wastelands invaded by BGW in the Shivaliks. The studies were further extended to explore the effect of BGW residues on the growth of native species.

MATERIALS AND METHODS

Various habitats invaded by BGW were surveyed for the number of species, plant density and vegetation biomass, using quadrats. Vegetation in nearby areas devoid of BGW was also assessed (as a control). Under natural conditions, large quantities of residues are formed in infested areas and, following decomposition, these become mixed with the soil. To simulate this, residues collected from the BGW-infested areas were mixed into soil (1 g/100 g soil) from BGW-free areas. Soil was also collected from invaded and uninvaded areas. The impact of all these soils was studied on the early seedling growth and biomass accumulation of *Cassia tora* – a sensitive and native species found in association with BGW. Residues were also analyzed for the presence of phenolic allelochemicals, as per Swain & Hillis (1959).

RESULTS AND DISCUSSION

Compared with controls, native vegetation in BGW-infested habitats was significantly reduced, including numbers of species, plant density and biomass (Table 1), especially in wastelands and grassland, indicating that invasion by BGW greatly affects the structure and composition of natural vegetation and also reduces plant diversity.

Table 1. Status of vegetation in different habitats invaded by *Ageratum*.

Habitat	Species types	Density (plants/m^2)	Biomass (g/m^2)
Uninvaded control	45	390.4	978.5
Invaded grasslands	7	137.8	363.9
Invaded plantation of *Dalbergia sissoo* (a native tree)	11	105.7	483.5
Invaded riparian zone	9	115.2	465.6
Invaded wastelands	7	128.7	888.4

All values significantly different from control at $P < 0.01$.

Table 2. Effect of *Ageratum*-infested and amended soil on the growth of *Cassia tora*.

Treatment	Seedling length (cm)	Dry weight (mg/seedling)
Ageratum-free soil	10.94	24.1
Ageratum-infested soil	9.41*	21.9*
Ageratum residue-amended soils	6.68*	19.7*

* Means significantly different from uninfested control at $P < 0.01$

Following invasion by BGW, large quantities of plant residues accumulate, which eventually decompose and become mixed with the soil. It is possible that such residues could affect the growth of sensitive native plants (such as *C. tora*); data presented here (Table 2), indicate that this is so, whether plants are grown in soil from BGW-infested areas or grown in soil amended with BGW residues (including rates as low as 1 g/100 g soil). This suggests that the BGW residues might be contributing biomolecules to the soil that interfere with plant growth. These could possibly be phenolics, which are well-known growth inhibitors (Mizutani, 1999). Upon release, phenolics accumulate in soil and have a growth-retarding effect. Here, the BGW residues were found to contain 470 mg phenolics (per 100 g). It is concluded that BGW invasion drastically affects native vegetation and that residues from the weed, following the release of phenolics, play an important role in this process.

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