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Use of plastic mulch for *Kalmia angustifolia* (Sheep laurel) weed control

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ABSTRACT

Kalmia angustifolia (Sheep laurel) is a shrub that grows in the wooded areas of Newfoundland. It is a commonly found weed in reforestation sites. Kalmia angustifolia effectively suppresses the forest tree seedling growth by sapping nutrients and secreting phytotoxic compounds. In a heavily infested site, tree seedlings cannot compete with Kalmia angustifolia and becomes stunted, which may lead to failure of a reforestation project. A herbicide (Vision Max®) is applied to control Kalmia angustifolia in reforestation sites. Repeated herbicide application may be needed depending on the re-growth of the weed. Herbicide application may have unintended environmental consequences. The aim of this research study is to determine the possibility of using plastic mulch as an environmental-friendly alternative technique for weed control.

A four-treatment field experiment was conducted in an area infested with Kalmia angustifolia to study the effectiveness of plastic mulch as an alternative weed control. Plots of 2 m X 2 m were identified in a location where Kalmia angustifolia was the dominant plant species. The four treatments imposed were clear plastic mulch, black plastic mulch, chemical control, and control. Each treatment was replicated three times. Results indicate that plastic mulch effectively controlled the weed growth. The temperature rise observed in the clear plastic is also reported.

Keywords. Kalmia, black spruce, reforestation, plastic mulch, weed control.

INTRODUCTION

Kalmia angustifolia (hereafter referred to as *Kalmia*) is a semi-shade tolerant dwarf (<1 m height) shrub that is commonly found in eastern Canada. *Kalmia* belongs to the family ericaceae which is comprised mostly of lime-hating (calcifuge) plants that thrive in acid soils. *Kalmia* is the dominant understory vegetation in black spruce forests of Atlantic Canada, particularly in Newfoundland. After forest cover removal by disturbances such as clearcutting, wildfire, and insect infestation, *Kalmia* spreads quickly and interferes with forest regeneration. In central and eastern Newfoundland rapid spread of *Kalmia* after forest clearcutting is associated with natural regeneration failure and it can potentially convert black spruce forests into heathlands following disturbance (Mallik 1995). Survey done by English and Hackett (1994) showed domination of *Kalmia* in majority of new plantations after forest clearing, particularly common in central Newfoundland. Regulations of the provincial government of Newfoundland and Labrador discourage forest harvesting in locations where *Kalmia* is the dominant species.

Kalmia has been reported to interfere severely with conifer regeneration in medium-quality site type, and may turn productive black spruce forests into unproductive *Kalmia* heath (Mallik 1995). *Kalmia* possesses very efficient vegetative regeneration capability by stem base sprouting, below-ground rhizomatous, and layering (Mallik 1993). *Kalmia* maintains a large viable seed bank in soil. The open canopy black spruce forests seem to be the ideal habitat for *Kalmia* because the discontinuous canopy allows for sufficient light at a shrub layer and also provides shelter from wind exposure (Mallik 1994, 1995).

The long-term presence of *Kalmia* on disturbed sites has been linked to the formation of thick forests floors and in extreme cases, the persistence of *Kalmia* results in the formation of unproductive heathlands where productive forests has once stood (Damman 1971). Many mechanisms related to soil resources have been proposed to explain poor spruce growth in the presence of *Kalmia*. Mallik (1987) suggested allelopathic interference of root development in black spruce seedlings from compounds found in *Kalmia* leaf litter and leaf litter leachates. Yamasaki et al. (1998) found that black spruce seedlings growing close to *Kalmia* have lower rates of mycorrhizal colonization, suggesting an allelopathic interference of *Kalmia* on soil microbial communities.

Kalmia is adapted to grow in soils with a wide range of texture, moisture, pH, and nutrient conditions and organic matter content. For example, *Kalmia* can grow in dry to wet soils as well as sandy loams to soils with organic content (Mallik 1994, 995). Mallik (1993) studied the vegetative regeneration strategies of *Kalmia* to understand the fast spread of Kalmia after disturbances. *Kalmia* has three methods of vegetative regeneration namely layering, stem-base sprouting and rhizomatous growth. As branches may be destroyed by fires, layering may not be an important mode of regeneration after disturbances. Considerable portion of *Kalmia* biomass is contained underground and may help *Kalmia* regeneration after aboveground portion is destroyed because of a disturbance. Buds found on stem bases and underground rhizomes may be protected by the soil's insulation although the stems may be destroyed by fire. Therefore, stem base sprouting and rhizomatous growth are more important for *Kalmia* regeneration on disturbed sites. A five-year-old *Kalmia* plant may be capable of producing up to 36 secondary rhizomes with a combined length of 7.5 m (Mallik 1993).

As a result of *Kalmia's* dominance, many other species are displaced. While regeneration of forest cover in general is a concern, poor regeneration of black spruce has been a particular economic concern. The negative relationship between *Kalmia* abundance and conifer regeneration in Atlantic has been studied. Competition for limiting nutrients and allelopathic mechanisms are thought to be the cause of this negative relationship. Black spruce growth has been shown to be significantly delayed in the presence of Kalmia. Yamasaki et al. (1998) found that black spruce seedlings when grown closer to *Kalmia* (<1m) had significantly lower dry biomass of various plant parts such as stems, twigs, and foliage. In another study black spruce height and stem density was consistently lower in sites that contained *Kalmia* in a 15 year old plantation in Newfoundland (Mallik 2001). Black spruce height and basal diameter were reduced by 65% and 51%, respectively. At the site dominated by *Kalmia*, there was 85% less black spruce volume as compared to the site which did not contain *Kalmia* (Mallik 2001).

Kalmia has proven to be a very difficult forest weed to control. Commonly practiced methods of site preparation, including herbicide treatments, prescribed burning, ploughing, and scarification have been unsuccessful at reducing the presence of *Kalmia* on sites (Mallik 1995). Applications of fertilizer which have inhibitory effects on other ericaceous shrubs have not shown to reduce *Kalmia* growth but such applications of nutrients to soil have increased *Kalmia* growth (Mallik 1996). To protect forest resources, the government of Newfoundland and Labrador has implemented guideleins whereby forest harvesting is discouraged in areas which contain dense *Kalmia* cover (Mallik 2001).

Chemical control of *Kalmia* is the common practice to control *Kalmia* weed in reforestation sites. A herbicide (Vision Max®) is applied to control *Kalmia* weed. Repeated herbicide application may be needed depending on the re-growth of the weed. Herbicide application may have unintended environmental consequences.

Plastic mulch has been used in the agriculture industry for various purposes. Vegetable growers have employed plastic films for mulching to reduce weed growth, soil erosion from wind or water, leaching of fertilizers, and development of soil plant diseases (Brault et al. 2002; Espí et al. 2006; Green et al. 2003; Lamont 1993). Plastic mulches can affect the microclimate of the soil around the plant by modifying the radiation budget of the surface and decreasing the soil water loss (Liakatas et al. 1986). Chaar et al. (2008) found that tree shelters and plastic mulches enhance the growth of cork oak seedlings. The objective of this research study is to determine the possibility of using plastic mulch as an environmental-friendly alternative technique for weed control.

METHODS AND MATERIALS

This project was conducted in the fen area of the Sir Wilfred Grenfell College, Corner Brook, Newfoundland. The area had a range of vegetation present. Locations that predominantly had *Kalmia* species were selected to conduct the experiment. A four-treatment field experiment was conducted. Plots of 2 m X 2 m were identified in areas where *Kalmia* was the dominant plant species. The four treatments imposed were clear plastic mulch, black plastic mulch, chemical control, and control. Each treatment was replicated three times.

The treatment plots were prepared as follows. Firstly 16 plots of 2 m X 2 m were delineated in places where *Kalmia* weeds were the dominant species. An initial survey of the plant species found in the plots was conducted. Except in the herbicide treatment plot, all the plants in the plots were removed by cutting at the base of the stem and the dry matter of each plot was determined before treatment application. Before the removal of plants from plots, the initial dry mass of the plants from the plots were determined by sampling within the plots over an area of 0.5 m X 0.5 m. In the case of the herbicide treatment, the herbicide Vision Max was applied at the commercial application rate to the three chemical treatment plots to kill the weeds without cutting and removing the plants from the plots. Water content, N P K nutrient content, and soil texture were also determined to find any variation among treatment plots. On different days, soil temperature at 0.05 m depth was measured at one hour intervals to find the relative temperature rise under clear plastic mulch cover. At the end of the season, aerial parts of the plants were harvested from each plot and the dry matters were determined. Statistical analyses were conducted to determine treatment effectiveness in weed control.

RESULTS AND DISCUSSION

Table 1 shows the description of plant species and their numbers found in different plots before the treatments were applied. Plots had a range of different plant species despite the fact that plots were located to have a larger presence of Kalmia.

Table 1. Plant species and their counts showing plant abundance in the 2 m X 2 m experimental plots before the treatments were applied. Data presented are values averaged over three replicates.

Common Name	Scientific Name	Control	Chemical	CP	BP
Kalmia/Sheep Laurel	*Kalmia angustifolia* L.	18	30	34	24
Labrador Tea	*Ledum groenlandicum*	13	13	18	11
Leather Leaf	*Chamaedaphne calyculata*	8	12	15	13
Bog Rosemary	*Andromeda polifolia*	2	2	3	3
Rhodora	*Rhododendron canadense*	15	5	4	7
Mountain Fly Honey Suckle	*Lonicera villosa*	0	2	3	2
Sweet Gale	*Myrica gale*	2	8	13	10
North Eastern Rose	*Rosa nitida*	7	6	3	2
Low Sweet Blueberry	*Vaccinium angustifolium*	1	2	0	0
Chuckley Pear	*Amelanchier rosaceae*	0	0	0	1
Mountain Holly	*Nemopanthus mucronata*	0	1	1	1
Pin Cherry	*Prunus pensylvanica* L.	0	0	4	0
Total plant count		**66**	**81**	**98**	**74**

Table 2 shows the changes in plant species counts after the imposition of four months of weed control treatments.

Table 2. Plant counts after four months showing changes in plant species distribution as affected by the treatments. Initial refers to the plant species count before the treatments were imposed and Final refers to plant species count four months after the treatments were imposed. Data presented are the mean values averaged over three replicates.

Treatments		**Control**		**Chemical**		**Clear Plastic**		**Black Plastic**	
Common Name	**Scientific Name**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
Kalmia/Sheep Laurel	*Kalmia angustifolia* L.	18	22	30	0	34	8	24	5
Labrador Tea	*Ledum groenlandicum*	13	13	13	0	18	5	11	1
Leather Leaf	*Chamaedaphne calyculata*	8	6	12	0	15	5	13	5
Bog Rosemary	*Andromeda polifolia*	2	1	2	0	3	0	3	1
Rhodora	*Rhododendron canadense*	15	13	5	0	4	1	7	1
Mountain Fly Honey Suckle	*Lonicera villosa*	0	1	2	0	3	0	2	0
Sweet Gale	*Myrica gale*	2	1	8	0	13	3	10	2
North Eastern Rose	*Rosa nitida*	7	6	6	0	3	1	2	1
Low Sweet Blueberry	*Vaccinium angustifolium*	1	1	2	0	0	0	0	0
Chuckley Pear	*Amelanchier rosaceae*	1	0	0	0	0	0	1	0
Mountain Holly	*Nemopanthus mucronata*	0	0	1	0	1	1	1	0
Pin Cherry	*Prunus pensylvanica* L.	0	0	0	0	4	2	0	0
Total plant count		**66**	**64**	**81**	**0**	**98**	**26**	**74**	**16**

Four months after the treatments were imposed plant species abundance has considerably changed depending on the type of treatment. Control plots show a slight reduction in the total number of plants although the number of *Kalmia* plants slightly increased. This may be due to a decrease in the plant competition. Chemical control had a full control on the plants as it killed all the plants. Clear plastic mulch had a good control over most of the weeds. Only 25% of the *Kalmia* re-grew. Black plastic mulch was more successful in controlling the weeds than the clear plastic mulch. The increased efficiency over clear plastic mulch may be due to the blocking of sunlight to the weeds. Only about 20% of the *Kalmia* re-grew. These results indicate that plastic mulches can be good alternative as non-chemical method of weed control even though they are not as efficient as the herbicide weed control.

Table 3. Plant ground coverage and plant dry matter as affected by the weed control treatments imposed. Ground coverage values are means averaged over replicates. Dry matter values are means±standard error calculated from three replicates.

	Control	**Chemical**	**Clear plastic**	**Black plastic**
Ground coverage (%) (before treatment)	75	85	79	75
Dry matter (kg) (before treatment)	9.9±1.6	12.6±2.6	10.5±4.3	10.8±5.1
Ground coverage (%) (after four months)	63	0	13	8
Dry matter (g) (after four months)	23.5±2.6	0	4.1±2.8	1.9±0.9

Table 3 shows the effect of different weed control methods on plant ground coverage and plant dry matter production. The ground coverage before the treatment were applied varied in the range of 75 – 85%. Mean of plant dry matter from the experimental plots varied between 9.9 – 12.6 kg. A statistical analysis showed that the dry matter of plots designated for different treatments were not significantly different showing little variation among experiment plots. With the imposition of various treatments live-plant ground coverage and dry mass production decreased depending on the method of weed control applied. Control had about 15% decrease in the ground coverage. Herbicide application removed all the live-plant ground coverage. Clear plastic and black plastic mulches reduced live plant coverage by about two-third of the plant coverage before the treatments were imposed. There are big differences in dry matter harvested before the treatments were imposed and after four months in all the experimental plots including the control. Before the first harvest of plants they have grown in this area without any disturbance for years. Within the four-month period the plant regeneration has been slow and consequently resulted in small dry matter accumulation. Among the treatment plots control had the largest dry matter production. Herbicide application did not allow any re-growth of vegetation at all. Clear plastic and black plastic mulch had about 17% and 8% of the dry matter found in the control, respectively. The results confirm that plastic mulches can be good alternative as non-chemical method of weed control even though they are not as efficient as the herbicide weed control.

The temperature changes with time under different treatment regimes are given in Fig. 1. Temperatures were recorded on a cloudy day afternoon on July 12, 2007. Since the data were recorded in the afternoon, the soil temperatures were higher than the air temperature as soil absorbs solar radiation. The temperatures in the chemical plots were consistently lower than the other three treatments. This may be because the chemical plots, after herbicide treatment, retained dead plant mulch that acted as good ground cover preventing soil temperature rise.

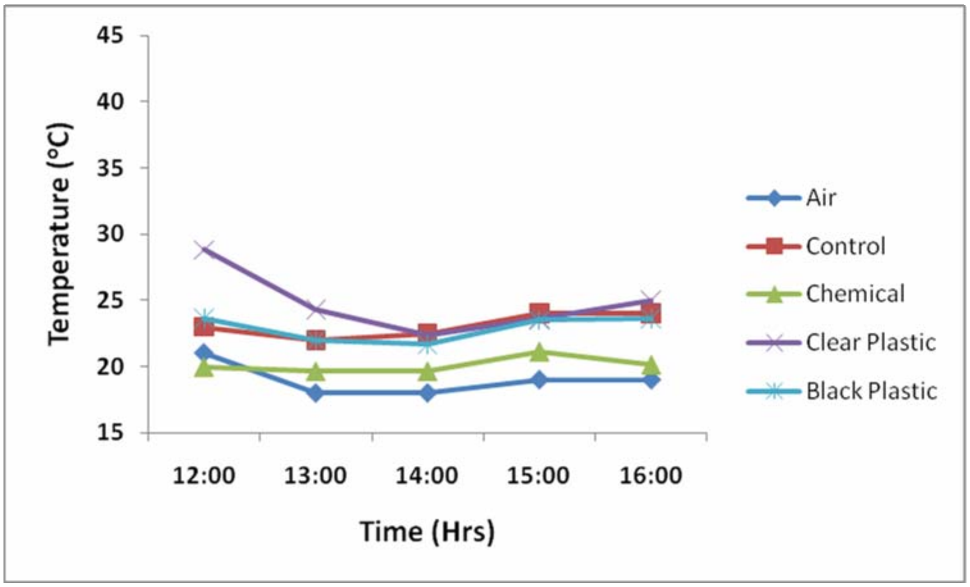

Fig. 1. Soil temperatures at a depth of 0.05 m as affected by weed control treatments showing soil heating under clear plastic mulch (July 12, 2007, Cloudy day). The plotted values are the means averaged over three replicates.

Figure 2 shows soil temperature variation with time as recorded on a sunny day morning into the afternoon (July 27, 2007). The air temperature remained at about 30^{o}C during the day and did not vary much. As the soil absorbed solar radiation soil temperatures in all the plots increased with time. The soil temperature of the control plot, being completely exposed, reached a temperature of 40^{o}C. As the clear plastic traps solar radiation, the temperature of the clear plastic-covered plots rose to 45^{o}C. Plots covered with black plastic cover showed a moderate temperature increase to 35^{o}C lower than that in the control plot. Black plastic mulch preventing solar radiation may be responsible for this lower temperature rise. The temperatures in the chemical plots are lower than those from all the other plots. The temperature of the chemical plot rose to the air temperature in the afternoon.

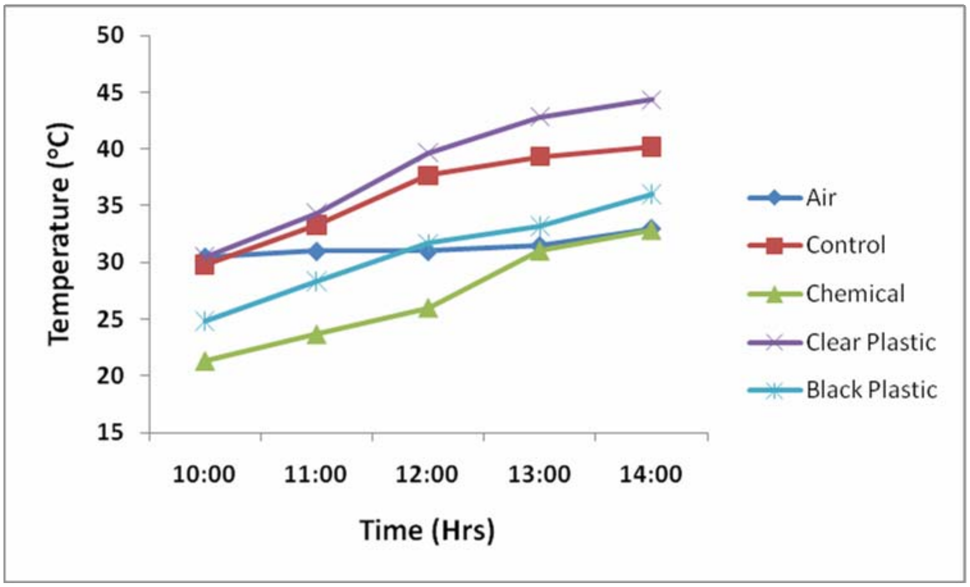

Fig. 2. Soil temperatures at a depth of 0.05 m as affected by weed control treatments showing soil heating under clear plastic mulch (July 27, 2007, Sunny day). The plotted values are the means averaged over three replicates.

CONCLUSIONS

Kalmia is a persistent weed found in Newfoundland. *Kalmia*, if found in reforestation areas, can severely affect the growth of forest seedlings. A herbicide, Vision Max®, is commonly used to control *Kalmia* weed. Because of the inherent environmental concern of repeated chemical applications, this study was conducted to evaluate the effectiveness of non-conventional methods of weed control. The experimentation had four treatments namely control, chemical, clear plastic and black plastic mulches. In terms of eradicating weeds chemical treatment was the best as it killed all the plants. Plastic mulches did significantly control the weeds although the effectiveness was not as much as with the chemical treatment. Black plastic mulch controlled the weeds better than the clear plastic mulch. Although plastic mulches are less effective than the chemical weed control, they can be a considered as a good alternative to chemical treatment which may have unintended environmental consequences.

The weed control treatments invariably have influenced the soil temperature which may have some consequences on nutrient availability in the soil. Clear plastic mulch, by trapping solar radiation, raises the temperature to higher levels than in control. Black plastic mulch and chemical control reduce temperature below that of chemical control. Chemical plots retaining dead-plant mulch kept the soil temperature cooler than the control. While warmer temperatures are expected to raise the level of soil nutrient availability, cooler temperatures may reduce the availability of plant nutrients.

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