factors that increase

 the growth and reproduction of *microstegium vimineum*

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Factors that Increase the Growth and Reproduction of *Microstegium Vimineum*

**Introduction**

*Microstegium vimineum* is an exotic plant that invades many forests around the USA (Johnson DJ, 2014). Invasions of non‐native species can have significant ecological and economic effects on ecosystems (Johnson DJ, 2014). *Microstegium vimineum* has negative effects on native plants in the USA. *Microstegium vimineum’s* crucial niche requirements appear to be light (reproductive output), soil moisture (reproductive output, seedling recruitment) and aboveground coverage by leaf-litter and competing species (seedling recruitment and survival) (Warren RJ, 2010). Due to these niche requirements, *Microstegium vimineum* and other invasive speciescontinue to spread throughout US forests*. Microstegium vimineum* resides in disturbed areas of forests, and light, soil moisture, and leaf-litter are factors that increase the growth and reproduction of this invasive species and others as well.

**The Impact of light**

 With more light availability *M. vimineum* grows more rapidly and has higher reproduction rates. *M. vimineum* is a shade tolerant species, but responds positively to increasing light availability (Cole PG, 2004). This invasive species can take up to 20% ambient sunlight, but in some situations, it can be up to 75% ambient sunlight (Cole PG, 2004). These percentages of ambient sunlight are dependent on soil moisture. Light also affects the growth and reproduction of *M. vimineum.* Where there is more light availability there is more growth and reproduction of *M. vimineum* (Cole PG, 2004). Light has also been shown to be mutually substitutable resources for this invasive species. The biomass of *M. vimineum* is also affected by light. Where there is more light, the biomass of this invasive species increases. It has been shown that where there is more light availability, *M. vimineum* height increases (Leicht SA, 2005). Compared to more shaded areas where height decreases with less light availability. Overall, with more light, *M. vimineum’s* growth and reproduction rates increase, and continue to spread more rapidly.

**The Impact of Soil**

 With certain soil factors *M. vimineum’s* growth and reproduction increases. *M. vimineum* has increased growth and reproduction rates at sites with higher soil moisture (Cole PG, 2004). Where the soil had more moisture, *M. vimineum* was more prevalent. Also, soil that had a low amount of organic matter with sandy and silty loams has *M. vimineum* growing on the sites (Cole PG, 2004). When soil moisture is abundant, this invasive species inhabits the area. *M. vimineum* also likes when the soil is disturbed, and the PH is acidic. The soil also contained 1.8%-15.7% carbon and 0.12%-0.55% nitrogen (Cole PG, 2004). Rock content appeared to be in the soil and also litter from surrounding plants and trees. Just like light, soil PH contributed to the overall biomass of *M. vimineum* (Cole PG, 2004). Out of all soil factors, an acidic PH guarantees the occurrence of *M. vimineum.* Soil PH, moisture and contents contribute to *M. vimineum* occurring in various US forests. *M. vimineum’s* reproduction and growth will increase under these specific soil conditions.

**The Impact of Leaf-Litter**

 *M. vimineum* grows and reproduces in areas with leaf-litter. No amount of leaf-litter hinders the growth and reproduction of *M. vimineum* (Schramm JW, 2010). This is because *M. vimineum* is a resilient species that exists in disturbed forests. When *M. vimineum* is present, leaf-litter decomposition decreases (Cole PG, 2004). The survivorship of *M. vimineum* does not decrease when there is leaf-litter, but instead increases. Where there was a deep layer of leaf-litter, *M. vimineum* seedlings grew normally and straight (Schramm JW, 2010). Where there was no leaf-litter, *M. vimineum* didn’t grow well and germination was not successful. This proves that there needs to be some leaf-litter for this invasive species to grow and reproduce. It has been shown that where there is no leaf-litter or little leaf-litter, *M. vimineum* isn’t present. This is mostly in northern states where exotic earthworms decrease leaf-litter (Schramm JW, 2010). As for other places in the United States and southeastern Asia, a closed canopy causes more leaf-litter which ultimately increases *M. vimineum* growth and reproduction (Schramm JW, 2010). Overall, leaf-litter is a needed factor for *M. vimineum* to increase its growth and reproduction.

**Other Invasive Plants whose Growth and Reproduction is Increased by Factors**

 Not only do these factors impact the growth and reproduction of *M. vimineum*, butas well as other invasive plants as well. The other invasive plants include autumn olive, bristlegrass, Japanese honeysuckle, and mimosa (Judge CA, 2008). These plants were all present under the same conditions in Duke Forest, which has a lot of leaf-litter, increased available light, and acidic/ moist soil (Judge CA, 2008). Another invasive species whose growth and reproduction are impacted by these factors is Garlic Mustard. Garlic Mustard was grown under the same conditions as *M. vimineum,* and its growth and reproduction rates increased with more available light, more leaf-litter, and acidic/ moist soil (Redwood ME, 2018). This invasive species also likes to lie dormant in the soil for up to 2 years, which means it likes lots of leaf-litter (Redwood ME, 2018). These invasive species also prefer disturbed areas of forest just like. *M. vimineum.* This means that these invasive species will be most likely seen in a forest disturbed like Duke Forest. All of these invasive species growth and reproduction were greatly impacted by these factors. The growth and reproduction of these invasive species increased along with *M. vimineum.*

**Management Methods for *Microstegium Vimineum***

 *M. vimineum* is an invasive species that negatively impacts the environment and well -being of native species. Limiting leaf-litter will help reduce the spread of *M.* *vimineum.* This is because *M. vimineum* grows in reproduces in forests with large amounts of leaf-litter. *M. vimineum* can also be managed by hand- removing the seeds (Judge CA, 2008). Doing this will stop the spread of this invasive species and limit its seeds from spreading. Also, herbicides stop the growth and reproduction of *M. vimineum* (Judge CA, 2008). When herbicide was used, the above ground biomass of this invasive species significantly reduced (Judge CA, 2008). This was shown to be the most successful method among management methods. For long-term removal of *M. vimineum,* a two-year management plan is needed, and all methods should be considered (Judge CA, 2008). *M. vimineum* needs to be managed and these methods will help native species flourish.

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