Phenotypic differentiation of invasive and non-invasive species pairs

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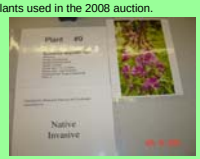
ABSTRACT

An invasive species is a plant that can establish self-sustaining populations outside of cultivation. There are several ways invasive species create problems in plant communities: they absorb nutrients, occupy niches, out-compete native species, and use light for photosynthesis. The purpose of the experiment was to use several quantitative plant characteristics in order to determine if there is a difference between invasive and non-invasive species pairs that belong to the same family and genus. An auction was held in the spring of 2008 to determine whether a plant being Invasive or non-invasive would influence whether consumers would change their purchasing behavior. The same five pairs of plants used in the auction are also used in this experiment. Plants were grown in replicated blocks in a field study; the study will continue for 3-5 years to determine whether the invasive species overtake the non-invasives. Characteristics measured were branching, number of leaves, leaf surface area, plant height, internode lengths, nutrient analyses, and pollen stain ability (male fertility). All of the Invasive plants except *Oxalis vulcanicola* had higher % pollen stainability than their non-invasive counterparts. This experiment proved that there is not a single characteristic only that can differentiate between invasive and non-invasive.

Examples of invasive/non-invasive plants used in the 2008 auction.



INTRODUCTION

An invasive species is a plant that can establish a self-sustaining colony in the wild without cultivation. Weeds are an example of invasive species although they are technically in cultivation. Invasive species have a negative effect on native species because they absorb nutrients, occupy space, and use the available light for photosynthesis which is essential for native species. The purpose of the experiment was to use several quantitative plant characteristics in order to determine if there is a difference between invasive and non-invasive species pairs that belong to the same family and genus. In the spring of 2008, Chengyan Yue organized an auction in which invasive and non-invasive plants were sold. The purpose of the auction was to see if people's decision on buying certain plants would be influenced on whether they are invasive or non-invasive. People were paid to participate and also given money to bid on plants. There were two auctions held. Participants had limited information about the plants during the first auction. The plant name tags only had the family name and perennial. There were five plant pairs. During the second auction plants were paired up again, and this time their name tags indicated whether they were invasive/non-invasive or native/non-native. Some people wanted the invasive plants more because they would grow healthy and wont require much attention. Others absolutely despised the invasive plants.

This experiment is a continuation of the auction experiment because the same ten invasive/non-invasive plants are being used. The characteristics measured were branching, number of leaves, leaf surface area, plant height, early flowering, flowering duration, internode lengths, and pollen stainability. Nutrient analysis was also taken.

METHODS

First, three new plots were measured (in terms of length and width) and selected to use for planting the invasive and non-invasive specie pairs. Each of the plots (blocks) were at least 12 feet 2 inches in width and 15 feet 5 inches in length. Plant species included in this study were: *Dianthus armeria* (DA; invasive), *Dianthus repens* (DR; non-invasive), *Daucus pusillus* (DP; non-invasive), *Daucus carota* (DC; invasive), *Oxalis crassipes* (OC; non-invasive), *Oxalis Vulcanicola* (OV; invasive), *Epilobium angustifolium* (EAMN; invasive), *Epilobium angustifolium* (EAAL; non-invasive), *Gaura coccinea* (GC; non-invasive), *Gaura lindheimeri* (GL; invasive). The plants were all planted and randomized exactly one foot away from one another. The plots were then named randomized complete block (RCB) 1,2, and 3. There were 50 plants in every plot because there were 10 different species with each species represented 5 times in every plot. After the plot locations were established, every plant was given its own special code. The codes were then drawn out of a hat and used to randomly assign plot location. Any weeds that appeared were pulled, then compost was added to the plots. Now the invasive/ non-invasive species pairs were ready to be planted. Pollen stainability was taken to measure the fertility or sterility of the plant. In order to do pollen stainability, a couple flowers were removed from the plant, then the pollen would be taken out. Next, set the pollen on a slide and add a couple drops of dye (0.1% aniline blue in 80% propionic acid). Then a light microscope was used to determine the viable/inviable pollen. Plant height and leaf surface area were measured with a tape measure. Early flowering and flowering duration were measured in terms of days. Early flowering was considered any plant that flowered within the first 14 days of being planted. For nutrient analysis, a small sample of soil from each plot was placed in a zip lock bag and sent to the U of M Soil Testing Laboratory for analysis of pH and nutrient levels.

FIGURE 1

Leaf Surface Area (inches²) of 5 invasive/non-invasive species pairs (see text for abbreviations).

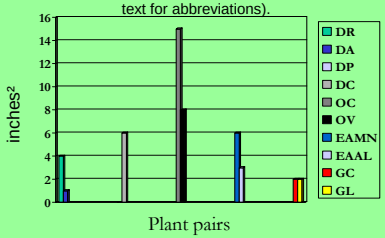


FIGURE 2

Early flowering of 5 invasive/non-invasive species pairs (see text for abbreviations)

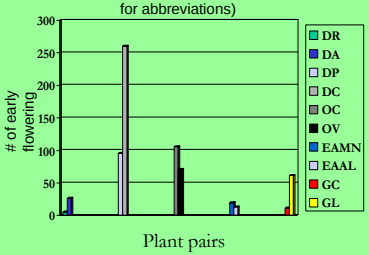
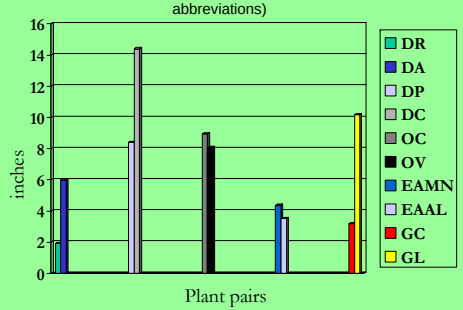


FIGURE 3

Average Plant Height of 5 invasive/ non-invasive species pairs (see text for abbreviations)



RESULTS

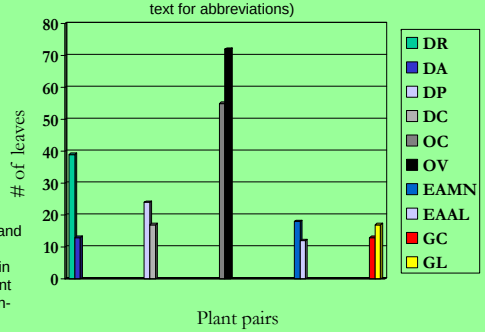
- Analysis of Variance (ANOVA) showed that block 1 and 2 are not significantly different from each other but they are significantly different from block 3 in # of leaves (Table 1).
- Univariate Analysis of Variance and mean separations (refer to Table 1) showed that *Epilobium angustifolium* is the only invasive/non-invasive species pair that is not significantly different for any of the characteristics measured
- All of the invasive/non-invasive species pairs, except *Daucus,* had leaf surface areas that were not significantly different from its invasive/non-invasive counterpart
- The only significant difference for the *Gaura* invasive/non-invasive species pair was plant height
- With the exception of *Oxalis*, all the invasive plants had a higher pollen stainability than the non-invasive counterparts

Table 1. Mean separations within columns (5% LSD, based on ANOVA) for branching, # of leaves, leaf surface area, plant height, and internode. Mean values followed by different letters are significantly different.

specie	branching	# leaves	leaf S.A.	plant height	internode length
1	2.36a	38.86b	5.36a	1.911a	.051479a
2	1.33a	12.8a	26.53abc	5.983bc	1.015773bc
3	14.31cd	23.92ab	95.47d	8.396cd	.399567ab
4	8.57b	16.93a	260.31e	14.393e	1.119064c
5	11.33bc	55.08c	105.61d	8.95d	.177833a
6	17.4d	72d	70.65cd	8.054cd	.117564a
7	.47a	11.6a	13.2ab	3.5ab	.466007ab
8	.93a	17.71a	19.71abc	4.346ab	.278269a
9	.43a	12.64a	11.31ab	3.179a	.261671a
10	.93a	17a	61.63bcd	10.183d	.630700abc

FIGURE 4

Average # of leaves of 5 invasive/ non-invasive species pairs (see text for abbreviations)



CONCLUSIONS

- Pollen stainability showed that invasive species tend to have more viable pollen than non-invasive species, unless they are sterile.
- The characteristics measured cannot be used to distinguish whether an *Epilobium angustifolium* is invasive or non-invasive
- There is not a single characteristic that can differentiate between invasive and non-invasive
- Plant height (Figure 3), internodes length, and # of leaves (figure 4) examined altogether may indicate whether a plant is an invasive or non-invasive species
- Surface area is usually a good indicator of an invasive or non-invasive specie in *Daucus*.

RECOMMENDATIONS

- Collect the seeds of all the plants and analyze (later in 2008).
- Measure the photosynthetic rates in order to see if there is any significant difference between the invasive/non-invasive Species.
- Continue this study for 3-5 years to determine whether the invasive species overtake the non-invasive ones.

REFERENCES/ ACKNOWLEDGMENTS

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