Effectiveness of Plant Diversity on Plant Pests and Disease Control in Managed Landscapes

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Example of typical monoculture landscape.
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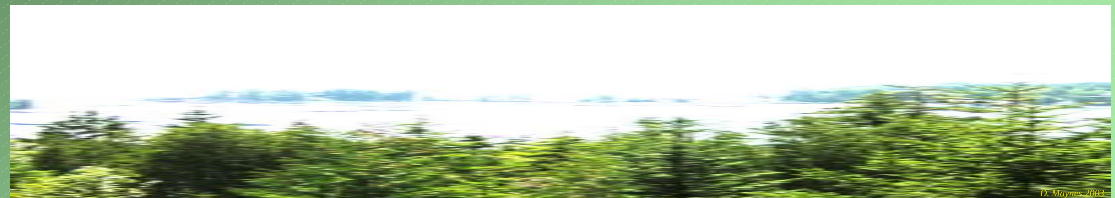

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Introduction

After years of mediocrity and monoculture in landscape design, the need for a sustainable ethic in landscape design and management is an increasing concern in the Green Industry. Insecticides make up 50% of homeowner pesticide use, costing billions of dollars as well as negative environmental impacts. SAS (see&spray) programs have long failed *(Ball and Marsan1991)* and new methodology must be implemented to change current trends and preserve bio-diversity. Selection of diverse pest-resistant plant material is the foundation upon which an Integrated Pest Management program can be implemented. Plant diversity contributes greatly to increasing populations of predatory insects, birds, and small mammals, all of which effect a management program. It is the responsibility of the designer to begin the management component of the design program with the choice, and placement of plant material. Adoption of this design/manage principle as sound practice is critical for environmental restoration and sustainability.

Discussion

Within a landscape with greater plant diversity comes challenges and benefits to an Integrated Pest Management program. Awareness of key plants (plant species that are highly susceptible to pests, diseases, or environmental stress, and plants of high value to the client) is the first method in which to create a bio-palette. Client awareness of this process is key when budgeting for management (i.e. client would like a particularly pest prone plant, needing more care and monitoring).

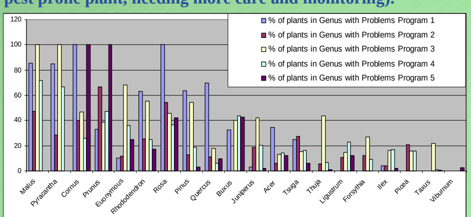


FIG. 1
The frequency of problems caused by insects, diseases, or improper culture associated with 20 common genera of landscape plants monitored by 5 IPM programs. Program 1 was conducted at a university campus and the remaining 4 programs were conducted with suburban home owners(Raupp et al. 1985).

Figure one shows key plants play a critical role in landscape management. Twenty genera of plants accounted for 77-89% of the total material found in any of the five IPM programs. These same twenty common genera of plants in each study accounted for 77-97% of the total problems encountered. (*Raupp et al, 1985*)

After eliminating potentially costly plant choices, a diverse mix of pest/disease resistant plant material can be used. Although plant diversity can increase the total population of insects/disease, overall plant (aesthetic) damage decreases. This is a result of complex landscapes having fewer pest outbreaks than simple less diverse monoculture landscapes(*Shrewsbury & Raupp, 2000).* Predatory insect populations increase in diverse landscapes giving added benefit, as well as saving in scout/monitor time by eliminating small infestations of herbivore insects before they reach a threshold level.

Results

Graph 1. Illustrates the number of beetles per plant over days after planting took place. It tested how beetle populations are influenced by plant diversity and density. Clearly the plants in the plot with dense, diverse plant material were less (if at all) infested by beetles than with plots with low-density/low-diversity.

Graph 2. Illustrates the total number of beetles per plot over days after planting. This clearly shows that beetle populations in plots with high-density polyculture are virtually non-existent. Plots with high-density yet low-diversity showed the highest beetle populations (this explains how monoculture street-tree planting is very unsustainable, i.e. Dutch elm disease leaving neighborhoods bare).

Graph 3. Illustrates how variation in diversity can affect the number of arthropod pests present. Although pest presence increases with plant diversity, it does so at a gradual rate. This gradual increase can most likely be attributed to increasing predatory populations.

Graph 1.

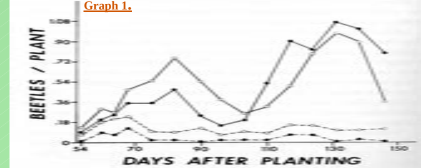


FIG. 3. Mean number of *Acalymma vittata* over the entire season per plant in the four types of experimental plots (low-density monoculture, ○—○; low-density polyculture, ○—○; high-density monoculture, ●—●; and high-density polyculture, ●—●). Points are means for all plants in the three replicate plots (total of 592 plants for the first five sampling days, 587 for the last 10 sampling days). (Bach 1980)

Graph 2.

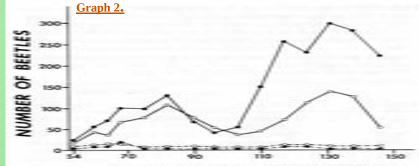


FIG. 2. Total number of beetles per plot over the entire season in the four types of experimental plots (low-density monoculture, ○—○; low-density polyculture, ○—○; high-density monoculture, ●—●; and high-density polyculture, ●—●). Points are means for the three replicate plots. (Bach 1980)

Graph 3.

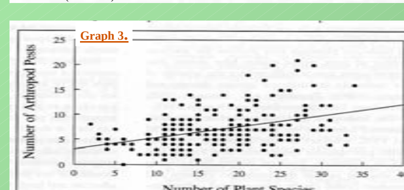
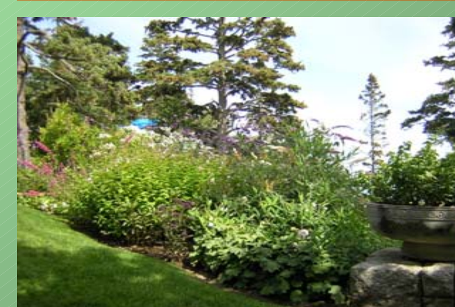


Figure 2. Relationship between the number of plant species in a landscape and the number of arthropod pest species associated with them. The linear regression was significant at $P = 0.001$, and the regression equation was $y = 0.227x + 3.08$, where y = number of pest species and x = number of plant species.
(Raupp et al.2001)

Key plants in the Northeast and associated pests

- **Andromeda**: aphids, lace bug, southern red mite
- **Arborvitae**: arborvitae leafminer, mites
- **Azalea**: azalea lace bug, leafminer
- **Birch**: aphids, birch leafminer, bronze birch borer, fall webworm
- **Cherry**: aphids, borers, Eastern tent caterpillar, Japanese beetle
- **Hawthorn**: aphids, lace bugs, leafminer
- **Hemlock**: hemlock woolly adelgid, spruce spider mite
- **Juniper**: juniper webworm, southern red mites, spider mites
- **Lilac**: lilac borer
- **Pyracantha**: lace bugs
- **Rhododendron**: black vine weevil, lace bugs, rhododendron borer, whitefly
- **Spruce**: Cooley spruce gall adelgid, spruce spider mites, white pine weevil
- **Yew**: black vine weevil, Fletcher scale
- **Viburnum**: viburnum leaf beetle

(Stewart 2003)



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Conclusions

Sustainable landscapes are not a new idea. However, the implementation of how to successfully achieve this ideal is still in it's early stages of development and understanding. Plant diversity, density, and selection are all fundamental components of managing a 'smart' landscape. It is up to not only the designer(scout/monitor), but the Industry as a whole to fulfill these obligations.

- Nursery inventory should be monitored and compared to analysis taken 'in the field'. Trends in plant species behavior and interaction between species subject to biotic and abiotic stresses should be documented and evaluated enabling flexibility within the industry in promoting better plant selection to consumers without a design/manage contract.
- All designers(scout/monitor) should report to a state committee(made up of design professionals, arborists, extension agents) that would oversee the introduction of plant material into the state. The committee would also approve individual design/manage programs before construction could begin of said landscape. This would be similar to getting a building permit for structural construction.
- Following construction, a monitoring program(expedited by designer) would begin for a minimum of two years, in which documentation would be provided to the overseeing committee annually for evaluation and recommendation.

The initial investment in such a program would be far less than current cost trends of present non-sustainable landscapes in the future. As figure 2. reads; cover spray programs over time are a much costlier management practice compared with IPM .

Fig. 2 Pesticide, equipment, and labor costs of the 1996 cover spray and 1997/1998 IPM programs in an IPM Pilot Program for landscape professionals

Site	1996 (Cover spray) Pesticides	Equipment	Labor	Total	1997 (IPM)* Pesticides	Equipment	Labor	Total	1998 (IPM) Pesticides	Equipment	Labor	Total
1	$31	$8	$213	$252	$8	$13	$783	$804	$5	$0.4	$568	$573
2*	$330	$86	$617	$1,033	$333	$88	$1,137	$1,558	$7	$3	$558	$568
3	$9	$7	$242	$258	$2	$2	$535	$539	$5	$0.6	$545	$554
4	$28	$14	$172	$214	$3	$1	$514	$518	$14	$12	$656	$682
5	$354	$173	$1,233	$1,760	$8	$1	$514	$523	$5	$5	$526	$536
Sum	$752	$288	$2,477	$3,517	$354	$105	$3,483	$3,942	$36	$21	$2,856	$2,913

* Cooperator continued cover sprays in 1997.
(Stewart et al.2002)

Plant diversity is a vital component in preserving natural ecosystems and sustaining built environments. It is our job to design landscapes, it is our contribution to do it right.

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