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# Effect of Cover Crops on Soil Erosion in Nursery Aisles[1]

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## Abstract

The effectiveness of soil erosion control of various vegetative aisle covers was evaluated using Universal Soil Loss Equation (USLE) type plots. 'Appalow' sericea lespedeza (*Lespedeza cuneata* (Dumont) G. Don 'Appalow'), crimson clover (*Trifolium incarnatum* L.), and perennial ryegrass (*Lolium perenne* L.) aisle treatments and a clean till plot were established on a 5% slope Typic Paleudult soil. Previously established 'Indian Magic' crabapple (*Malus* 'indian magic') and silver maple (*Acer saccharium* L.) were grown parallel to the slope in the center of each plot. Runoff from the clean till aisle resulted in the greatest sediment concentration, runoff volume, and sediment runoff. Crimson clover and perennial ryegrass runoff was similar. The 'Appalow' lespedeza aisle cover had the highest runoff volume of any vegetative aisle cover. However, runoff sediment concentration and sediment runoff were least from 'Appalow' lespedeza covered aisles.

**Index words:** Runoff, living mulch, soil conservation

**Species used in this study:** 'Appalow' sericea lespedeza (*Lespedeza cuneata* (Dumont) G. Don 'Appalow'); crimson clover (*Trifolium incarnatum* L.); perennial ryegrass (*Lolium perenne* L.); 'Indian Magic' crabapple (*Malus* 'Indian Magic'); and silver maple (*Acer saccharinum* L.)

## Significance to the Industry

Increasing consideration of offsite effects of soil erosion might require nurserymen to increase the use of soil conservation practices. Use of winter cover crops such as ryegrass or crimson clover can be easily incorporated into nurserymen's production systems and significantly reduce soil erosion without reducing plant growth or quality. Increased study is needed to develop year round cover crops that can be used as aisle covers without effecting profitability. Low growing crops such as 'Appalow' lespedeza present such a possibility.

## Introduction

Nurserymen commonly plant trees with aisles more than 48 inches wide. The aisles require weed control, accomplished by periodic tilling and herbicide application, which result in sediment and chemical runoff. Because many nurseries are located adjacent to streams for easy access to water for irrigation, delivery ratios of sediments and associated pollutants to receiving bodies of water are potentially high.

Use of living mulch in horticulture crops has many benefits including reduced weed competition, soil stabilization, decreased fertilizer and pesticide needs, and increased soil moisture retention (7 and 11). In addition, living mulches increase soil organic matter and reduce leaching (10). Bregger and Brown (3) suggests certain standards in selecting ground covers (living mulch) for orchards that include; adaption to local climatic conditions; capable of growing under the particular environment, shade, and soil; having roots that stay near the upper soil layer and compete minimally with trees for soil moisture; withstand traffic and recover quickly; growing close to the ground; propagate by seeding; grow best when the nursery crop is relatively inactive; and, be commercially available and affordable.

In comparison of mulches as a conservation tool, Hall et al. (5) reported that living mulches reduced erosion better than corn stover residues. The loss of chemicals and sediment in runoff can also be greatly reduced by contour planting and other conservation practices (1, 3, 5, and 6).

## Methods and Materials

Universal Soil Loss Equation (USLE) type runoff plots were established on a Mountview silt loam (fine, silty, siliceous, thermic, Typic Paleudult). Plot dimensions were 3.0 m wide by 15.2 m long (10 × 50 ft) and were established parallel to slope. Each plot had 3.0 m (10 ft) × 15.2 (50 ft) cm × 16 gauge galvanized steel strips placed 5–8 cm (2–3 in) deep on the north, south, and west edges to prevent runoff water from crossing into adjacent plots. Runoff was collected in a 3.0 m (10 ft) long trough constructed of 15.3 cm (6 in) diameter, 40 gauge pvc pipe located at the base of the plots. The trough guided the water through a H-flume and across a Coshocton wheel subsampler that allowed 1% aliquots to enter 9.0 l (2.38 gal) glass jars (2).

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Connected to the flume was a stilling well which contained a float and counterweight attached to a Stevens Type F flow recorder. Recorders were set on a 24-hour return period.

Runoff was collected from October 17, 1990, through April 29, 1991. Aisle treatments included: 'Appalow' sericea lespedeza (*Lespedeza cuneata* (Dumont) G. Don), crimson clover (*Trifolium incarnatum* L.), perennial ryegrass (*Lolium perenne* L.) and clean till. The crimson clover and perennial ryegrass aisles had been previously planted in tall fescue (*Festuca arundinacea* Shreb.). On June 1, 1990, 978 g (2.15 lb) of 12N-0.43P-1.72K (12-1-4) was banded in each USLE plot. Glyphosate (Isopropylamine salt of N-(phosphonomethyl glycine) at 3.6 kg ai/Ha (3.21 lb ai/A) was applied to the tall fescue aisle plots on September 21, 1990. Perennial ryegrass and crimson clover was broadcast by hand at a rate of 22.5 kg/Ha (20 lb/A) after the plots were roto-tilled on September 27, 1990. Trees were planted parallel to the slope and in the center of the plots, on the west half with crabapple (*Malus* 'Indian magic') and the east half with silver maple (*Acer saccharinum*). Clean tilled plots were roto-tilled each month during the growing season. The tree rows were centered in a 25.4 cm (10 in) wide strips that were weeded monthly. The weeds growing in the cover crops were controlled by spot spraying with sethoxydim (20[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-2-cyclohexen-1-one) at 0.18 kg ai/Ha (0.16 lb ai/a). Glyphosate was applied with a rope wick to weeds using a 33% solution (41% concentrate). A rain gauge was placed in the study area.

Runoff subsamples were collected in 1 liter (0.26 gal) Nalgene plastic bottles after each runoff event and stored at 4°C (39.2°F) until they could be analyzed. All runoff samples were analyzed for total solids. Porcelain crucibles were cleaned, numbered and dried in an oven at 110°C (230°F) for two hours and weighed. The contents of the runoff subsamples were transferred to 1 liter (0.26 gal) beakers and mixed until a thorough suspension was obtained. A 50 ml (16.9 oz) aliquot of each suspension was transferred into individual crucibles. The crucibles were oven dried and weighed until a constant weight was achieved.

Strip charts from the Stevens Flow Recorder containing plot runoff events were photocopied to 141% of the original chart size. The magnification doubled the area and made area tracing easier. A digital planimeter (Tamaya Digital Planimeter, PLANIX 3') with a linear adjustable arm was used to calculate the area under each curve. The planimeter arm was adjusted to read 1:1 metric scale (0.1 $cm^2$ [0.0115 $in^2$] for each registered number). Each area was traced five times; the high and low figures were discarded and the remaining three numbers averaged. The resulting number was multiplied by 0.1 $cm^2$ (0.155 $in^2$) and divided by 2 to obtain the original area recorded on the strip chart. In addition, the length of the recorded area was taken with a ruler. Bernoulli's equation was used to calculate the volume of runoff. Bernoulli's equation: $Q = 1.84\ L\ H^{3/2}$ (9), where Q = cubic meter per second (flow), 1.84 = constant, L = width of weir (.235 m [9.25 in]), and H = head of flowing water. The H under each curve was calculated by dividing the mean area by the length of area. The flow was multiplied by the duration of the runoff event in seconds to obtain volume of runoff. When the Stevens Flow Recorder was set on a 24 hour setting, the pen would cross each strip chart at a rate of 1 cm/hr (0.39 in/hr). The weight of sediment in each runoff event was calculated by multiplying the sediment concentration in each event by the runoff volume and dividing by the area of the plot.

## Results and Discussion

Rainfall events were grouped into rainfall ranges: 0–0.49 cm (0–0.19 in), 0.5–0.99 cm (0.2–0.39 in), 1.0–1.99 (0.4–0.79 in), 2.0–3.99 cm (0.8–1.59 in), and ≥ 4.0 cm (1.6 in). Problems due to equipment malfunction and weather related interferences prevented strip chart recording when runoff occurred for a few of the dates (Table 1).

The runoff sediment concentration was significantly affected by rainfall amount, aisle cover and the rainfall by cover interaction (Table 2). The 'Appalow' lespedeza cover plots produced the lowest runoff sediment concentration for each rainfall amount compared to the other cover treatments (Table 3). Crimson clover and perennial ryegrass produced similar runoff sediment concentration for all rainfall ranges. Compared to runoff sediment concentration produced from the 'Appalow' lespedeza plot during each rainfall, both the crimson clover and perennial ryegrass runoff sediment concentration were approximately 0.10 g/l (0.83 lb/1 × $10^3$ gal) greater. The clean till mean sediment concentration during each rainfall period was 1.9, 3.5, 5.0, 7.25, and 8.8 times greater compared with the highest sediment concentrations of the three vegetated aisle covers during successive rainfall events.

The mean runoff volume was significantly affected by rainfall amount, and aisle cover, but not by the rainfall by cover interaction (Table 2). Total runoff from vegetated plots was the greatest for 'Appalow' lespedeza. The crimson clover and perennial ryegrass total runoff volume were 67% and 57% of that of 'Appalow' lespedeza (Table 4). The greater total runoff volume from the 'Appalow' lespedeza

**Table 1. Number of rainfall events and respective rainfall accumulation used for calculating total solid, volume, and sediment.**

| Rainfall range (cm) | Perennial ryegrass | | 'Appalow' lespedeza | | Crimson clover | | Clean tilled | |
|---|---|---|---|---|---|---|---|---|
| | No. of events | cm | No. of events | cm | No. of events | cm | No. of events | cm |
| 0.0–0.49 | 15 | 3.75 | 15 | 3.75 | 15 | 3.75 | 15 | 3.75 |
| 0.5–0.99 | 13 | 8.55 | 13 | 8.55 | 13 | 8.55 | 13 | 8.55 |
| 1.0–1.99 | 14 | 19.62 | 13 | 18.32 | 14 | 19.62 | 14 | 19.62 |
| 2.0–3.99 | 06 | 14.55 | 08 | 20.45 | 07 | 16.95 | 06 | 14.55 |
| ≥ 4.0 | 08 | 41.10 | 08 | 41.10 | 07 | 37.10 | 08 | 41.10 |
| Total | 56 | 87.57 | 57 | 92.17 | 56 | 85.97 | 56 | 87.57 |

Table 2. Combined analysis of variance for sediment concentration, runoff volume, and sediment runoff.

| | Runoff solid concentration (mg/1) | Runoff volume ($m^3$/Ha) | Sediment runoff (kg/Ha) |
|---|---|---|---|
| Rainfall[z] | ** | *** | *** |
| Cover | *** | ** | *** |
| Rainfall × Cover | * | NS | *** |

[z]A strip plot experimental design was used to analyze the effect of rainfall range and aisle cover on mean runoff sediment concentration, mean runoff volume, and mean sediment runoff.

*Significant at 0.10 level

**Significant at 0.05 level

***Significant at 0.001 level

NS Not Significant

than from crimson clover and perennial ryegrass plot seems to contradict previous studies about water infiltration in pastures (8). The review by Stewart et al. (8) suggests that dense vegetative cover would provide good infiltration. The 'Appalow' lespedeza plots were established in fall 1988 and maintained continuously through the study period. Only occasional hoeing and other weed control methods in the tree rows were implemented on the 'Appalow' lespedeza plot. Compaction of the ground in the 'Appalow' lespedeza aisles probably hindered infiltration of water. When rainfall was greater than or equal to 0.5 cm (0.2 in), 'Appalow' lespedeza plots produced consistently greater total runoff volumes compared to the other vegetative covers. The clean till plot had the greatest total runoff volume of any plot (46,832 $m^3$/Ha [$4{,}964 \times 10^3$ gal/A]).

The mean sediment runoff was significantly affected by rainfall amount, aisle cover and the rainfall by cover interaction (Table 2). The total sediment runoff was least for 'Appalow' lespedeza (4,854 kg/Ha [4,330 lb/A]) and greatest for clean till (92,164 kg/Ha [82,287 lb/A]) (Table 5). The perennial ryegrass and crimson clover plots eroded 5,889 kg/Ha (5,253 lb/A) and 9,710 kg/Ha (8,661 lb/A) of total sediment. The 0–1.99 cm (0–0.79 in) rainfall contributed 0.52–14.39% of the total sediment load for the four treatments. The 2.0–3.99 cm (0.8–1.59 in) rainfall contributed 30.4–36.9% of the total sediment runoff. The greatest total sediment runoff occurred when rainfall was greater than or equal to 4.0 cm (1.6 in) (55–73%). The combined total sediment runoff from the 'Appalow' lespedeza, crimson clover, and perennial ryegrass (20400 kg/Ha [9.1 ton/A]) was only 22% of that of the clean till sediment runoff (92200 kg/Ha [41.1 ton/A]). The sediment load was a function more of cover type than total volume of runoff. The permanent cover of 'Appalow' lespedeza had the second greatest total runoff volume (34,304 $m^3$/Ha [$3{,}636 \times 10^3$ gal/A]), but the lowest sediment runoff.

The vegetated aisles were clearly beneficial in soil con-

Table 5. Effect of aisle cover and rainfall amount on total sediment runoff.

| Rainfall (cm) | Perennial ryegrass | Appalow lespedeza | Crimson clover | Clean till |
|---|---|---|---|---|
| | kg/Ha | | | |
| 0.0–0.49 | 671.6 | 130.1 | 229.3 | 250.9 |
| 0.5–0.99 | 174.9 | 183.4 | 218.1 | 227.9 |
| 1.0–1.99 | 385.7 | 420.7 | 1015.8 | 22872.9 |
| 2.0–3.99 | 1400.2 | 1149.4 | 1140.3 | 11057.5 |
| ≥ 4.0 | 3247.9 | 2960.2 | 7104.1 | 57655.8 |
| Total | 5880.1 | 4843.8 | 9707.6 | 92065.2 |

Table 3. Effect of aisle cover and rainfall amount on runoff solid concentration.

| Rainfall (cm) | Perennial ryegrass | 'Appalow' lespedeza | Crimson clover | Clean till |
|---|---|---|---|---|
| | g/l | | | |
| 0.0–0.49 | 0.13 | 0.09 | 0.14 | 0.26 |
| 0.5–0.99 | 0.19 | 0.09 | 0.23 | 0.81 |
| 1.0–1.99 | 0.15 | 0.06 | 0.18 | 0.90 |
| 2.0–3.99 | 0.20 | 0.09 | 0.18 | 1.45 |
| ≥ 4.0 | 0.48 | 0.38 | 0.54 | 4.75 |
| LSD (0.10) = 0.28 | | | | |

Table 4. Effect of aisle cover and rainfall amount on total runoff.

| Rainfall (cm) | Perennial ryegrass | 'Appalow' lespedeza | Crimson clover | Clean till |
|---|---|---|---|---|
| | $m^3$/Ha | | | |
| 0.0–0.49 | 928 | 605 | 1597 | 1422 |
| 0.5–0.99 | 1236 | 3789 | 1897 | 2382 |
| 1.0–1.99 | 3621 | 6741 | 5491 | 12167 |
| 2.0–3.99 | 6456 | 13224 | 6126 | 8355 |
| ≥ 4.0 | 7219 | 9945 | 7562 | 22505 |
| Total | 19458 | 34304 | 22674 | 46832 |

servation. Hall et al. (5) found that "living" mulch reduced soil losses by about 100%. In their study the conventional till system had 4400 to 32200 kg/Ha (1.96 to 14.2 ton/A) of soil los while the living mulch systems resulted in 0 to 1100 kg/Ha (0 to 0.49 ton/A). Frere (4) discussed how finer particles transported by water can contain organic matter, phosphorus, and nitrogen in amounts equal to the soil content.

The annual soil loss tolerance for the study site was 11230 kg/Ha (5 ton/A). Based on the experiment, 'Appalow', lespedeza, (2430 kg/Ha [1.31 ton/A]) crimson clover (4850 kg/Ha [2.16 ton/A]), and perennial ryegrass plots (2940 kg/Ha [1.31 ton/A]) were well within the tolerance limit. However, the clean till plot was over four times (46100 kg/Ha [20.6 ton/A]) the tolerance limit during the six-month data collection period.

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# An Economic Inquiry into South Florida's Foliage and Woody Container Nurseries[1]

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## Abstract

South Florida's nursery industry was examined to isolate important factors contributing to a recent loss of market share. Results indicate that a wide range of problems afflict both the foliage and woody industries. Two of the most pressing problems are easy market access and a lack of basic supply and demand information necessary for firm-level decision-making. These factors are detrimental to even the most efficiently run firms.

**Index words:** economic performance, economic coordination, market research, merchandising.

## Significance to the Nursery Industry

Evidence indicates that, in spite of the economic growth in Florida's nursery industry in the 1980's, rate of growth is declining. Although part of this decline can be explained by growing competition from other states, additional problems persist. Easy market access and inadequate information on product supply and demand, are two of the most pressing problems. These factors weaken the decision-making capacity of firms and contribute substantially to business failures. Business failures, in turn, create considerable instability within the industry as new firms constantly replace old. Since new businesses require a "learning" period before they become competitive, inefficiencies arise primarily in the form of below-cost prices and poorer product quality overall.

## Introduction

The nursery industry in the U.S. grew considerably during the 1980's. Between 1982 and 1988 cash receipts rose from $3.4 billion to $6.9 billion, representing a 10 percent average annual increase (12). Nursery crops also accounted for nearly one-tenth of all farm crop cash receipts in 1988,

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