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# LIVING MULCH SYSTEMS

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## INTRODUCTION

Increasing fertilizer costs, ground water quality, pesticide safety concerns, and a growing interest in organically grown fruit are a few reasons causing researchers to re-examine the age old practice of growing cover crops, or green manures. Though sporting new names such as conservation tillage, living mulch or mulch farming, the practice of green manuring or using cover crops has been practiced for centuries. Early Romans and Greeks used green manures and cover crops to build the soil, prevent erosion and enhance crop growth.

With the introduction of inorganic fertilizers and chemical herbicides, the practice of green manuring declined. The ease of applying fertilizers, less intensive management requirements and the low cost of inorganic fertilizers made the use of green manures nearly obsolete. With rising petroleum costs and increased environmental awareness, cover crops or green manures are becoming cost effective and a viable alternative to inorganic chemical fertilizers.

The benefits of cover crops are many. They reduce erosion by binding the soil to their roots; vegetative top growth slows surface runoff as well. Erosion is further reduced by the leaves of the cover crop which intercept raindrops and dramatically reduce raindrop impact to the soil. Additional benefits include the suppression of weeds due to shading, as well as by competition for nutrients and moisture. Some cover crops such as pearl millet and Elbon rye further suppress weeds by a mechanism known as allelopathy. This is the releasing of a chemical exudate from the roots of these cover crops that inhibits seed germination. A cover crop can aerate the soil with its root system, sometimes even breaking up hardpans with deep rooted cover crops such as alfalfa. As these roots decompose, they slowly release nutrients and, unlike chemical fertilizers, they don't volatilize or leach as quickly. Legumes, due to their ability to fix nitrogen from the atmosphere, are more widely recognized as being green manures; however, even a non-legume can add nutrients to the soil. A properly grown non-legume will contain on a dry weight basis, approximately 2 percent nitrogen, 0.5 to 0.8 percent phosphorus and 0.5 to 3 percent potassium.

A further benefit to the cover crop grower is the aesthetically pleasing inflorescence of some cover crops, such as crimson clover, which produces a thick, solid red carpet between perennials' rows that also attracts bees as pollinators. Several studies were initiated to determine the optimum mulch system to incorporate into blueberry production. Areas of investigation included yields, ease of establishment and weed control. The possibility of growing forage between the blueberry rows, then windrowing it for mulch was also explored.

## MATERIAL AND METHODS

Seeding rates used for cover crop production were, necessarily, higher than normal recommended rates for the same crop used as a forage or pasture. Higher seeding rates helped stand establishment and enhanced weed suppression. Appropriate inoculant was used with all legumes (Table 1). All studies were conducted at Texas A&M University Agricultural Research & Extension Center, Overton unless otherwise noted.

Experiment 1 assessed the performance of different cover crops for summer and winter mulch production. For winter mulch systems, three legumes were chosen: crimson clover, hairy vetch and subterranean clover. Six non-legumes were also selected: Triticale 'B858' and 'T20', wheat 'FLA 302', and TX '182-85', 'Marshall' ryegrass and Elbon rye. These were planted at five locations: Overton, Nacogdoches, Huntsville, Winnsboro and Tyler. Summer mulches chosen for the same locations were two legumes, 'Iron and Clay' cowpeas and 'Sunn Hemp' crotalaria, and three non-legumes, 'Headless Wonder' sorghum, 'Green Graze' sorghum-sudan hybrid and 'Tifleaf' pearl millet.

Experiment 2 was a fertilization response experiment. Three rates of nitrogen, 0, 100, and 200 lbs N/ac were used on production of pearl millet on the Nacogdoches site.

Experiment 3 was to determine response of living mulch to overhead irrigation, using crotalaria, sorghum and cowpeas as summer living mulches.

Experiment 4, was done to compare living mulch production of fertilized (50 lbs N/ac) sorghum to sorghum grown following a previous legume cover crop using no fertilization. A check, using no cover crop or fertilizer was also included.

Experiment 5 was conducted to determine percent leaf nitrogen in seven cover crops: Elbon rye, crimson clover, pearl millet, sorghum, sorghum-sudan, crotalaria and cowpeas. By establishing percent N of total biomass produced, an estimate of total N returned to the soil was determined.

Experiment 6 was conducted to evaluate weed control affected by cover crops. Part one was a field study where five cover crops (pearl millet, sorghum, sorghum-sudan, cowpeas and crotalaria) were planted at four locations and evaluated for weed suppression by determining percent ground covered by weeds. A control using no cover crop was also included. Part two was a greenhouse study to determine allelopathy of four cover crops (cowpeas, crimson clover, pearl millet and Elbon rye) on three species of weeds (crabgrass, redroot pigweed and common bermudagrass) with three concentrations of mulch (20, 40, 80 mg/cm2). Samples of cover crops were air dried, sifted through a 40 mesh screen, placed on weed-inoculated soil, and misted daily. Weed seed germination was evaluated at 20 days and 40 days.

## RESULTS AND DISCUSSION

Experiment 1: Elbon rye was the highest yielding winter grass at all locations. Crimson clover had good stands and good yields, and both Crimson and Elbon were easily established. Both also provided good suppression of weeds. Although hairy vetch outyielded Crimson at Overton, it was difficult to establish and was invasive quickly covering blueberry plants.

Pearl millet consistently out yielded other summer forages except at Overton where crotalaria dry matter yield was highest (Table 2). Yield of all crops at Winnsboro was generally much higher since overhead irrigation was applied. The other sites were not irrigated. Although cowpeas produced adequate yields, it was invasive, viney and difficult to establish due to its palatability to deer. Pearl millet was easiest to establish, had the best suppression of weeds and its prodigious production of biomass returned substantial nitrogen to the soil. Crotalaria performed well, but was difficult to establish at all locations and provided poor weed control.

Experiment 2: As expected, increasing fertilizer rates on pearl millet increased yields (Table 3). A maximum yield response to N was not found.

Experiment 3: Also expected was the increased yield of crotalaria, cowpeas and sorghum when irrigated (Table 4). Yields were approximately doubled when these cover crops were irrigated.

Experiment 4: Sorghum yields grown on land previously cropped with crimson clover were higher than yields of sorghum fertilized with 50 lb N/Ac and significantly greater than the control (Table 5).

Experiment 5: Although crotalaria and cowpeas returned the highest nitrogen back to the soil, in part because they are legumes, pearl millet has the potential to return up to 250 lb N/Ac by producing such large yields (Table 6).

Experiment 6: Evaluation of weed suppression by cover crops in the field demonstrated that pearl millet was best at reducing weeds while cowpeas were least effective (Table 7). The greenhouse study of weed seed germination also reinforced pearl millet's status as best summer mulch in suppressing weeds (Table 8). Elbon rye and crimson clover were nearly equal in suppression of weeds by a winter mulch. Increasing concentrations of mulch decreased weed seed germination by all cover crops by acting as a physical barrier.

## CONCLUSIONS

Our studies indicate that for a summer mulch, pearl millet was most consistent in establishment and production of biomass. Other summer mulches performed well at some locations, but were inconsistent. Establishment of summer mulches was dependent on timely rainfall. Cover crop production was adversely affected by the low pH soils required for blueberry production.

Proper seedbed preparation greatly enhanced cover crop stand establishment. A rotational planting of a legume cover crop followed by a non-legume provided enough nitrogen to grow the non-legume mulch. Nitrogen was available for the blueberry plants, if windrowed under the plants but production of mulch was not enough for both blueberry production and subsequent cover crops.

Other aspects of living mulch systems to be addressed in the future are mulch combinations such as Elbon rye and crimson clover or crotalaria and cowpeas. Cultural practices such as mowing frequencies and mowing heights also need to be evaluated.

Table 1. Cover crop seed rate.

| Cover Crop | Legume | Seeding Rate (lbs/ac) |
|---|---|---|
| Winter | | |
| Elbon rye | no | 100-120 |
| Triticale | no | 90 |
| Ryegrass | no | 100-120 |
| Wheat | no | 90 |
| Crimson clover | yes | 30-50 |
| Subterranean clover | yes | 25-35 |
| Hairy vetch | yes | 35 |
| Summer | | |
| Pearl millet | no | 35-90 |
| Sorghum-sudan | no | 35 |
| Sorghum | no | 35 |
| Cowpeas | yes | 90-130 |
| Crotalaria | yes | 70 |

Table 2. Yield of blueberry living mulches for different locations in Texas.

| Crop | Yield (lb/ac) | | | | |
|---|---|---|---|---|---|
| | Nacogdoches | Tyler | Huntsville | Winnsboro[y] | Overton |
| | | | Winter 1988/89 | | |
| Elbon rye | 2949 a[y] | 0 | 2104 a | -- | 5644 a |
| Triticale | -- [x] | -- | -- | -- | 3801 b |
| Marshall ryegrass | -- | -- | -- | -- | 1964 c |
| Wheat | -- | -- | 2006 a | -- | 3040 bc |
| Crimson clover | 952 b | 0 | 2395 a | -- | 2537 bc |
| Subterrean clover | 586 b | 0 | 0 b | -- | 1992 c |
| Hairy vetch | -- | -- | -- | -- | 3761 b |
| | | | Summer 1989 | | |
| Pearl millet | 17467 a | 11567 a | 4900 a | 26560 a | 8205 b |
| Sorghum sudan | 16948 a | 1410 c | 4268 a | 21903 b | 7717 b |
| Sorghum | 20810 a | -- | -- | 21052 b | 7058 b |
| Cowpeas[w] | 0 b | 5011 b | 6153 a | 12905 c | 7560 b |
| Crotalaria[w] | 0 b | 0 d | 1248 b | 14467 c | 17917 a |

[z]Overhead irrigation used at this location.
[y]Means separation within columns by Duncan's Multiple Range Test @ 0.05 level.
[x]Indicate crop not planted at that location.
[w]Cowpeas and crotalaria were destroyed by deer at several locations.

Table 3. Blueberry living mulch production at Nacogdoches, Texas as affected by nitrogen rate.

| Treatment | Yield (lb/ac) Fresh Weight | Yield (lb/ac) Dry Weight |
| --- | --- | --- |
| N rate (lb/ac) | | |
| 0 | 13752 a | 5914 a |
| 100 | 72618 b | 15234 b |
| 200 | 117543 c | 28896 c |

[z]Mean separation within columns by Duncan's Multiple Range Test @ 0.05 level.

Table 4. Irrigation, fertilizer, and cover crop effect on blueberry living mulch production.

| Treatment | | Yield (dry wt. lb/ac) |
| --- | --- | --- |
| Irrigation | | |
| | Crotalaria | 17917 |
| | Cowpeas | 7561 |
| | Sorghum | 5089 |
| No Irrigation | | |
| | Crotalaria | 5833 |
| | Cowpeas | 4046 |
| | Sorghum | 377 |

Table 5. Yield of sorghum as a blueberry living mulch as affected by a previous legume cover crop and nitrogen fertilization.

| Previous Crimson Clover Cover Crop | Nitrogen[z] | Yield (dry wt. lb/ac) |
|---|---|---|
| + | - | 12470 a[x] |
| - | + | 11097 a |
| - | - | 2675 b |

[z]50 lb/ac.
[x]Mean separation by Duncan's Multiple Range Test @ 0.05% level.

Table 6. Mean leaf N and total N in the above ground portion of various living mulch crops in Texas.

| Crop | % leaf N | lb/ac N in tops |
|---|---|---|
| Elbon | 1.5 - 2.2 | 37 - 46 |
| Crimson clover | 1.2 - 1.7 | 31 - 40 |
| Pearl millet | 0.7 - 2.2 | 53 - 222 |
| Sorghum | 0.4 - 1.8 | 36 - 116 |
| Sorghum sudan | 0.5 - 2.3 | 22 - 196 |
| Crotalaria | 1.7 - 3.3 | 45 - 312 |
| Cowpeas | 0.7 - 2.9 | 80 - 249 |

Table 7. Percentage weeds between blueberry rows in living mulch cover crops.

| | % Ground Covered by Weeds[z] | | | |
|---|---|---|---|---|
| Crop | Nacogdoches plot 1 | Nacogdoches plot 2 | Winnsboro | Overton |
| Pearl millet | 15 a[x] | 20 c | 1 a | 3 a |
| Sorghum sudan | 52 b | 31 bc | 21 ab | 26 b |
| Sorghum | 39 b | 36 c | 9 ab | 22 ab |
| Cowpeas | 100 c | 50 b | 45 bc | -- |
| Crotalaria | 99 c | -- | 66 c | -- |
| Control | 100 c | 94 a | -- | -- |

[z]Weeds mostly crabgrass.
[x]Means separation by Duncan's Multiple Range Test @ 0.05 level.

Table 8. Allelopathic suppression of weed seed germination through the use of mulches of different cover crops[z].

| | % Weed Germination | | | | | |
|---|---|---|---|---|---|---|
| | Crabgrass | | Common Bermudagrass | | Pig Weed | |
| Cover Crop | 20 days | 40 days | 20 days | 40 days | 20 days | 40 days |
| Cowpeas | 13 a[x] | 48 b | 2 a | 52 d | 16 b | 40 b |
| Crimson clover | 15 a | 53 c | 1 a | 36 c | 10 a | 30 ab |
| Pearl millet | 13 a | 37 a | 1 a | 28 ab | 16 b | 25 a |
| Elbon rye | 22 b | 52 c | 2 a | 22 a | 21 c | 34 ab |
| Concentration of mulch ($mg/cm^2$) | | | | | | |
| 0 | 22 c | 50 b | 3 b | 30 ab | 35 d | 43 c |
| 20 | 22 c | 57 b | 3 b | 46 c | 28 c | 45 c |
| 40 | 18 b | 51 b | 1 a | 33 b | 15 b | 32 b |
| 80 | 7 a | 35 a | 1 a | 27 a | 4 a | 21 a |

[z]Tops of cover crops were air dried at 25°C, ground to pass a 40 mesh screen, placed on top of soil that was inoculated with weed seeds and misted with distilled water daily.
[x]Means separation by Duncan's Multiple Range Test @ 0.05 level.