VEGETATIVE PROPAGATION OF KURA CLOVER ON MINE SPOILS

by

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Abstract. Kura clover has an extensive root and rhizome system that makes it well adapted to grazing. However, kura clover is difficult to establish because of low seedling vigor and initial partitioning of photosynthate to rhizome production. A split plot design was used to evaluate kura clover establishment by vegetative propagation. Whole plots were mulched or not mulched with straw and subplots consisted of sprigs incorporated by disking, cultipacking, disking plus cultipacking, or conventional seeding. A water conserving-mycorrhizal coating treatment of sprigs incorporated by disking plus cultipacking was added in 1998. Stand counts were taken during establishment and plots were harvested for yield the year following establishment. Mulching increased plant density in the sprigged treatments in both years ($P<0.02$). At the last stand count, mulched and unmulched plots had 9 and 2 plants m^{-2} in Trial 1 and 42 and 18 plants m^{-2} in Trial 2. In the spring following the seeding year the conventionally seeded plots had a plant density of 69 plants m^{-2} compared to 5 plants m^{-2} for the sprigged treatments. The conventionally-seeded treatment always had higher plant densities ($P<0.01$). Separate analysis of the sprigged treatments indicated that treatments involving disking had greater stand densities ($P<0.03$) than those achieved by cultipacking alone. In Trial 1 only the mulched, conventionally-seeded treatment had satisfactory stands one year after seeding.

Additional Key Words: kura clover, establishment, vegetative propagation, reclamation, mulch

Introduction

Red clover (*Trifolium pratense* L.), white clover (*Trifolium repens* L.), and *alfalfa (Medicago sativa* L.) do not persist well in Kentucky pastures. Kura clover (*Trifolium ambiguum* M. Bieb.), a relatively recent introduction originating in the European region of the former USSR, possesses the potential to persist under continuous grazing (Taylor and Smith, 1998). Kura clover has also shown the ability to grow on infertile and acidic soils (Speer and Allinson, 1984), making it a logical choice for reclaimed mined land pastures in Appalachia. However, establishment of kura clover is slow due to its low seedling vigor and initial partitioning of photosynthate into root and rhizome production (Taylor and Smith, 1998). The prolific rhizome production of kura clover suggests that vegetative propagation may be a viable method of stand establishment. The objectives of this study were to compare vegetative propagation and conventional seeding methods for establishment of kura clover, to evaluate the effect of mulch on the establishment of kura clover, and to evaluate the usefulness of a water-conserving mycorrhizal root coating in the vegetative propagation of kura clover.

Materials and Methods

Plots were established in mid-March 1997 and 1998 on reclaimed mine spoil in Breathitt County, KY. Initial spoil conditions are summarized in Table 1. "Rhizo" kura clover sprigs were harvested with a mechanical sprig digger and refrigerated overnight. Sprigs are defined as segments of rhizome, which may or may not contain a crown. Sprig characteristics are presented in Table 2. Plots were rototilled and disked prior to application of the treatments.

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Table 1. Initial spoil characteristics for 1997 and 1998 trials.

Trial	pH	P	K	Ca	Mg
		----------kg ha^{-1}----------			
1997	5.5	36	161	1371	649
1998	6.2	83	231	2759	1673

Table 2. Sprig length, number of nodes, and presence of crown.

Trial	Length	Nodes	Crown
	---------cm---------	-----no. $sprig^{-1}$-----	---% with crown---
1997	18	6	58
1998	18	6	55

The experimental design was a split plot. Whole plot treatments were either mulched with 6.8 Mg ha^{-1} of wheat straw or left unmulched. Split plot treatments were 880 kg ha^{-1} of sprigs incorporated by disking only, disking plus cultipacking, and cultipacking only or conventional seeding using a cultipacker type seeder at 13.5 kg ha^{-1} of seed (Table 3). In 1998, a fifth treatment consisting of a water-conserving mycorrhizal coating of sprigs incorporated by disking plus cultipacking was added. This coating was designed to reduce desiccation and inoculate the sprigs with vesicular arbuscular mycorrhizae (VAM) (RTI, Monterey, CA 93940).

Table 3. Establishment methods.

Treatment	Method
1	Sprigs (880 kg ha^{-1}) incorporated by disking
2	Sprigs incorporated by disking + cultipacking
3	Sprigs incorporated by cultipacking
4	Conventional seeding (13.5 kg ha^{-1})
5	Sprigs + Myco-Dip incorporated by disking + cultipacking (1998 only)

Stand density was determined for the sprigged plots by counting plants in 0.4 m^2 of plot area or by counting 2.4 m of row in the seeded plots. Above-ground biomass was measured approximately one year after seeding by clipping a 7.4 m^2 area above a 5 cm stubble height. A subsample of the harvested vegetation was separated into kura clover and weeds. Weed-free yields of kura clover are expressed on a dry matter basis.

Stand counts were made on nine dates for Trial 1 and on ten dates for Trial 2. Data were transformed using a square root transformation before being analyzed as repeated measures. Trials were analyzed separately due to significant trial x treatment interactions. Since densities of conventionally-seeded plots were substantially higher, data for the sprigged treatments were also analyzed separately using repeated measures.

Results and Discussion

Mulch

In both 1997 and 1998, mulching significantly increased plant density of the sprigged plots ($P<0.02$). The positive effect of mulch on the sprigged treatments became apparent 75 days after planting (DAP) in 1997 and 120 DAP in 1998 (Figs. 1 and 2). Ample and well distributed rainfall during the first part of the growing season in 1998 probably delayed expression of the mulch effect. The magnitude of the mulch effect increased with time after planting in both trials ($P<0.02$). The positive effect of the mulch was most likely due to increased spoil moisture in the mulched treatments.

Establishment Method

The conventionally seeded treatment consistently had higher plant densities ($P<0.01$) (Table 4). Sprigs incorporated by disking and disking plus cultipacking had uniformly higher stand counts ($P<0.03$) (Figs. 3 and 4). Treatments involving disking probably resulted in a deeper incorporation of the sprigs into the spoil material than cultipacking alone, thereby creating a more favorable environment in terms of moisture status for sprig growth. Plant densities were generally greater in Trial 2, most likely due to more favorable moisture conditions during establishment and better spoil material, which resulted in a seedbed more conducive to sprig incorporation. A negative aspect of ample and well distributed rainfall in 1998 was the growth of annual lespedeza [*Kummerowia striata* (Thunb. Schindler)] which competed with the kura clover seedlings. This competition resulted in smaller seedlings at the end of the establishment year, and most likely contributed to the more rapid decline in seedling numbers in the 1998 seeding.

In the spring of 1998 for Trial 1 (391 DAP), and in the fall of 1998 for Trial 2 (217 DAP), plant density increased substantially for all sprigged treatments compared with earlier dates (Figs. 3 and 4). This increase in plant density resulted from the production of daughter plants. However, even with this increasing trend in plant density, none of the sprigged treatments had developed acceptable stands in Trial 1. The earlier formation of daughter plants (217 DAP) in the 1998 seeding was most likely due to better growing conditions in 1998 and superior spoil material. A trend of increasing plant density in the sprigged treatments and a slight decrease in the conventionally seeded treatment was observed in Trial 1 ($P<0.01$) (Table 4).

Plots established using Myco-Dip treated sprigs and incorporated with disking plus cultipacking had fewer plants than plots using no Myco-Dip and incorporated with disking plus cultipacking. This suggests that the coating had a negative effect on sprig survival. The basis for this effect needs further investigation. However, one may postulate that the root coating somehow negatively affected water relations of the treated sprig. The highly hygroscopic coating may have drawn water from the sprig tissues or may have restricted movement of soil water to the sprig.

Survival and growth of kura clover sprigs was much better in Trial 2, however a stand count in the spring of 1999 will be necessary to gauge the success of sprigging for Trial 2. Since kura clover has the potential to spread by rhizomes both trials will be followed over two additional years to track stand development.

Yield

The only treatment combination from Trial 1 that resulted in harvestable swards was the mulched and seeded treatment. The total yield for the year following establishment was 1470 kg ha^{-1} (Table 5). Approximately 90% of the total yield came from the first harvest. The yield for the establishment year was approximately 40% that of red clover. This was expected since kura clover generally yields less than red clover on undisturbed soils. Although kura yields less, the potential benefit is from its ability to persist on infertile, acid soil and under a continuous grazing system.

Table 5. Kura clover yields in the year following establishment (1997 trial).

Treatment Combination	Harvest 1	Harvest 2	Total
	-----------------------kg ha^{-1}	-----------------------	
Mulched/seeded†	1440	160	1470
Standard deviation	340	110	450

Conclusion

Mulching increased plant density regardless of establishment method employed. Conventional seeding consistently resulted in higher plant densities than the sprigging treatments. Among the sprigging treatments, disking and disking plus cultipacking resulted in the highest plant densities due to better incorporation of the sprigs into the seedbed. Only the mulched and seeded treatment from Trial 1 resulted in harvestable swards. Myco-Dip root coating did not enhance establishment of kura clover sprigs in mine spoil and may have negatively impacted sprig survival. Although kura clover possesses many desirable characteristics in terms of grazing and stress tolerance, its use in mined land reclamation may be limited by poor stand establishment.

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Table 4. Establishment method effects on plant density.

Establishment Method	Days After Planting									
	----------Plants m^{-2}----------									
1997	**31**	**38**	**53**	**74**	**100**	**124**	**137**	**180**	**391**	
Disk	1.0[†]	2.0	7.1	4.4	3.4	3.4	4.4	2.0	8.1	-
Disk + Cultipack	1.0	1.3	1.7	4.0	2.7	4.0	2.7	3.0	4.4	-
Cultipack	0.7	1.3	1.0	2.7	1.3	1.7	2.0	1.3	2.0	-
Conventional Seeding	40.7	163.8	160.1	111.4	125.5	130.5	83.1	78.7	69.0	-
1998	**31**	**54**	**61**	**77**	**95**	**111**	**119**	**189**	**217**	**245**
Disk	11.4[‡]	18.5	7.7	10.8	24.6	13.5	14.8	13.1	24.2	36.3
Disk + Cutipack	8.1	12.4	10.1	10.8	19.8	12.4	11.4	14.5	36.3	37.0
Cultipack	2.4	7.4	5.0	6.7	10.4	6.1	10.1	9.1	18.8	20.2
Conventional Seeding	245.2	188.4	150.0	204.5	179.0	188.4	208.9	110.7	48.8	70.0
Myco-Dip	8.1	9.8	4.7	3.7	10.4	7.7	10.1	7.4	18.2	25.6

[†]Standard error for time X sprigging treatments for Trial 1 was 0.21

[‡]Standard error for time X sprigging treatments for Trial 2 was 0.22

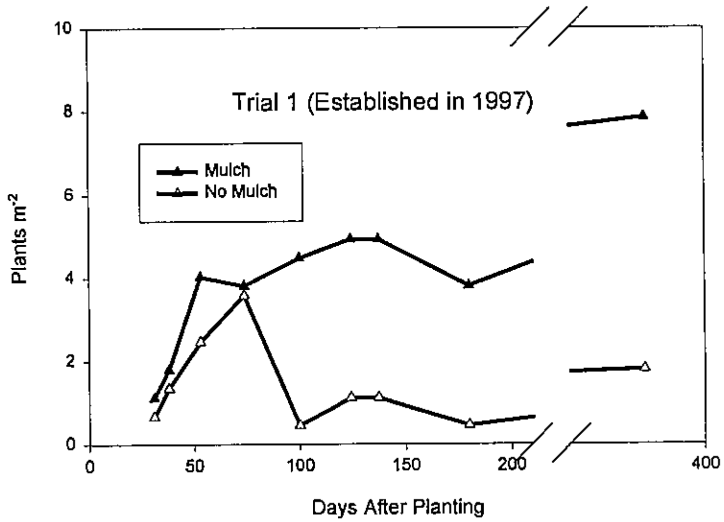

Figure 1. The effect of mulching treatments on stand density of sprigged kura clover in 1997 (values are averaged over seeding treatments).

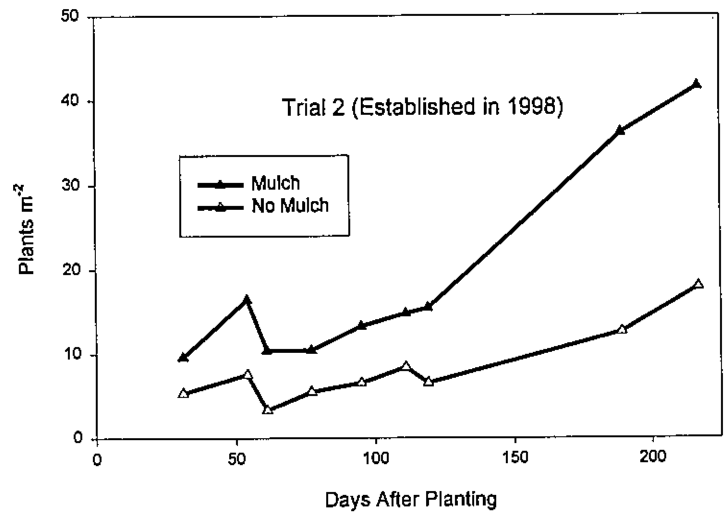

Figure 2. The effect of mulching treatments on stand density of sprigged kura clover in 1998 (values are averaged over seeding treatments).

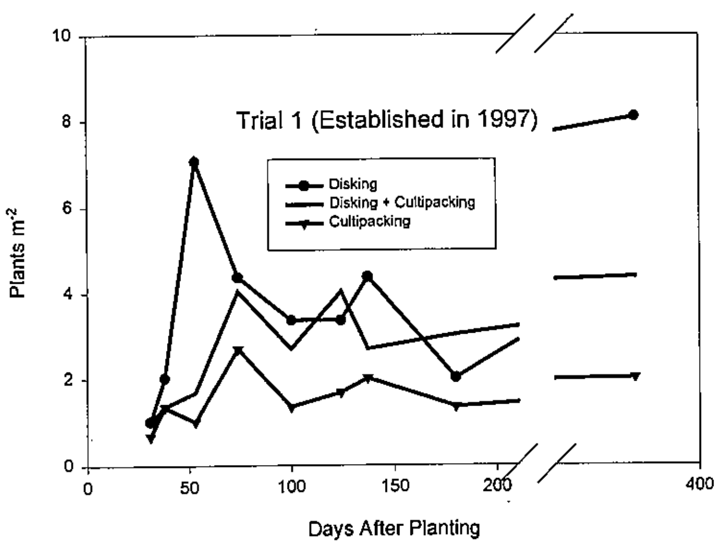

Figure 3. The effect of sprigging treatments on stand density in 1997 (values averaged over mulching treatments).

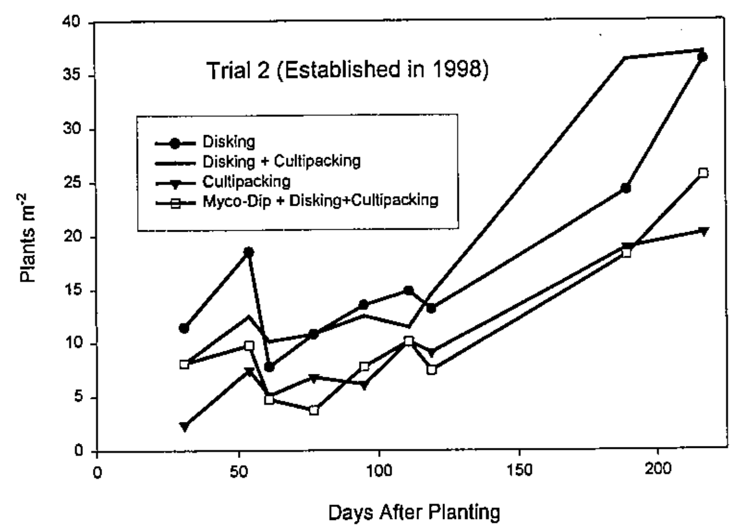

Figure 4. The effect of sprigging treatments on stand density in 1997 (values averaged over mulching treatments).