COMPARISON OF SEEDING RATES AND COATING ON SEEDLING COUNT, ROOT LENGTH, ROOT WEIGHT AND SHOOT WEIGHT OF CRIMSON CLOVER

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Cool season annual legumes, especially clovers are utilized thought the Southeast as winter pasture for livestock or as a cover crop. A majority of the clover seed that is sold is coated in order to protect the inoculation with *Rhizobium* bacteria. The coating can account for 30-40% of the seed weight. Crimson clover (*Trifolium incarnatum* L.) coating is typically 33% of the total weight. Therefore a bag of coated seed versus uncoated will have fewer actual seeds. The typical seeding rate recommendation for crimson clover is 12-20 lbs/acre. The objective of this two-year study was to evaluate the effect of various crimson clover-seeding rates (8, 12, 16, 20 and 24 lbs/acre) and seed coating on seedling count, root length, root weight and shoot weight. Our data indicates that coated seed did not result in higher yields or heavier root and shoot weights. Planting coated seed may reduce possible damage to *Rhizobium* bacteria however it does not result in increased yields. Seeding rate had no impact on yield for either year of the experimental period. According to our data, planting crimson clover at a high seeding rate (24 lbs/acre) does not result in higher forage yields.

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In recent years coated (preinoculated) seed of annual clovers has been marketed. The clover seed is inoculated with the appropriate rhizobia bacteria and then coated with a fine clay mineral, lime, or talcum to protect the rhizobia from heat and sunlight. This eliminates the need for the producer to buy inoculant and inoculate the legume seed before planting. Depending on seed size, the coating can account for 25 to 45% of the weight of coated seed. If coated (33% of seed weight is coating) and uncoated crimson clover seed is planted at the same seeding rate, there are a third fewer seed/ft^2 with coated seed. A two-year study was conducted at the Texas AgriLife Research and Extension Center at Overton to compare coated and uncoated crimson clover at 8, 12, 16, 20, and 24 lb/ac. There was no difference in seedling density due to coating the first year, but in the second year uncoated seed had a higher seedling density than coated seed. In the second growing season shoot weight was greater at 34 and 93 days after planting (DAP) and root weight 93 DAP for uncoated than coated seed. There was no difference in yield the first year when only one harvest was taken. The second year uncoated seed produced greater yields than coated seed at the first harvest and for the season. Planting coated seed does

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eliminate inoculating the seed by the producer and may reduce possible damage to Rhizobium bacteria; however it may result in lower yields than uncoated seed.

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Abstract

Cool season annual legumes, especially clovers, are utilized through out the Southeast as winter pasture for livestock or as a cover crop. A majority of the clover seed that is sold is coated. The coating can account for 25-44% of the seed weight. Coating on crimson clover (*Trifolium incarnatum* L.) seed is approximately 33% of the total weight. A two-year study was initiated in Overton, TX to evaluate coated and uncoated crimson clover seed at 8, 12, 16, 20 and 24 lbs/acre. Seedling density, shoot weight, root weight and length, and nodulation score were determined. There was no difference in seedling density due to coating the first year however uncoated seed had higher seedling density the second year. In the second growing season shoot weight was greater at 34 and 93 days after planting (DAP) and root weight 93 DAP for uncoated than coated seed. There was no difference in yield the first year when only one harvest was taken. The second year uncoated seed produced greater yields than coated seed at the first harvest and for the season. Planting coated seed does eliminate inoculating the seed by the producer and may reduce possible damage to Rhizobium bacteria; however it may result in lower yields than uncoated seed.

Introduction: Utilizing cool season annual legumes has become a popular addition to forage systems in order to extend the winter grazing season, add nitrogen to the pasture system through dinitrogen fixation, and provide a protein source to grazing livestock during the winter (Hoveland and Evers, 1995). In the nitrogen fixation process rhizobia bacteria, not the legume plant, remove N gas from the air and changes it to ammonium (NH_4) so it can be used by the plant (Russell, 2008). Different legume species require different rhizobia strains to fix N from the air (Burton, 1985). To ensure that an effective rhizobia strain is present, inoculant (ground peat moss containing the rhizobia bacteria) is applied to the legume seed immediately before planting.

In recent years coated (preinoculated) seed of annual clovers has been marketed. The clover seed is inoculated with the appropriate rhizobia bacteria and then coated with a fine clay mineral, lime, or talcum to protect the rhizobia from heat and sunlight. This eliminates the need for the producer to buy inoculant and inoculate the legume seed before planting. Depending on seed size, the coating can account for 25 to 45% of the

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weight of coated seed. The percent weight of the coated seed that is coating increases as seed size decreases.

Seed companies recommend the same seeding rate for coated seed as uncoated seed even though the number of seed planted/ft^2 is less for coated than uncoated seed. For example the coating accounts for about 1/3 of the weight of coated crimson clover (*Trifolium incarnatum L.*) seed. Therefore if planted at the same seeding rate there are 1/3 fewer seed/ac of coated seed vs. uncoated seed. At a seeding rate of 16 lb/ac there are approximately 55 seeds/ft^2 for uncoated seed and 37 seeds/$ft.^2$ for coated seed. The theory is that seed germination and seedling vigor is greater for coated seed and therefore yield from coated and uncoated seed is similar. This difference in seed/acre creates a problem for forage producers who receive funding through the EQIP program with the Natural Resources Conservation Service because seeding rates are based on Pure Live Seed (PLS). Fifty percent more coated crimson clover seed than uncoated seed would have to be planted to meet the specified seeding rate based on PLS. A study comparing uncoated and coated crimson clover seed at five seeding rates was conducted for 2 years at the Texas AgriLife Research and Extension Center at Overton.

Materials and Methods: The study was planted on a Bowie very fine sandy loam (fine-loamy, siliceous, thermic Plinthic Paleudults) both years. Coated and uncoated 'Dixie' crimson seed were purchased each autumn. Germination rates were 85 and 96 % for coated and uncoated seed in the 2008-2009 growing season and 87 and 91 % for coated and uncoated seed in the 2009-2010 growing season.

Coated and uncoated seed were planted at 8, 12, 16, 20, and 24 lb/ac in a prepared seedbed in 7-in rows with a drill equipped with double-disk openers. The treatment structure was a 2 x 5 factorial arranged as a split plot in a randomized complete block design. The main plot treatment was coating and the subplot treatment was seeding rate with four replications. The study was planted on November 3, 2008 and October 20, 2009 and fertilized according to soil test. Seedling counts per 1 ft of row were taken at three random sites in each plot on January 5, 2009 the first year and November 5, 2009 the second year and converted to seedlings/ft^2.

In the second year a total of 10 seedlings were excavated from four random sites in each plot on November 23, 2009 and January 21, 2010. Soil was washed from the seedlings and shoot weight, root weight, and root length recorded at the November 23, 2009 sampling date and shoot and root weights and nodule score at the January 21, 2010 sampling date. Plants were harvested with a sickle bar mower at a 2 in height on April 21, 2009 the first year and April 1 and May 5, 2010 the second year. A subsample of the harvested forage was dried at 140° F for 2 days to determine dry matter percentage. The data were analyzed as a split-plot with coating as main plots and seeding rate as subplots with ANOVA by PC-SAS (SAS Institute, 1999). Mean separation was at the 0.05 level using Fishers Protected LSD.

Results and Discussion: In the first growing season (2008-2009) there was no difference in seedling density (Table 1.) or yield (Table 2) within a seeding rate between coated and uncoated crimson clover seed.

In the second growing season (2009-2010) seedling density of uncoated seed was always greater than coated seed when averaged across seeding rates. However within

each seeding rate there was no difference between coating treatments at the 0.05 level (Fig. 1). On November 23 shoot weight was significantly greater for uncoated seed than coated seed when averaged across seed rates (Table 3). There was no difference in root weight and root length. By January 21 both shoot and root weights were significantly higher for uncoated seed than coated seed when averaged across seeding rates (Table 4). There was no significant difference in nodule score. When averaged across coating treatments, nodule score, shoot weight and root weight decreased as seeding rate increased (Table 5). This was due to increase competition for light and moisture as seedling density increased with increasing seeding rate.

Yields were significantly greater for uncoated seed than coated seed when averaged across seeding rates at the first harvest and for the overall season total (Table 6). However, there was no significant difference in yield at the second harvest. Only 1 in. of rain occurred between harvest dates, which limited clover growth, and potential differences between coating treatments at the second harvest. When averaged across coating treatments, yields tended to increase with seeding rate for the first harvest and total yield (Table 7). Maximum yields occurred at 16 lb/ac at the first harvest and 20 lb/ac for total yield.

In both growing seasons there was no significant difference in seedling density due to coating within a seeding rate. This supports the forage legume seed industry's claim that similar stands are obtained with coated and uncoated seed at the same seeding rate. When crimson clover seedlings were sampled two additional times the second growing season, shoot weight of uncoated seed was greater than coated seed. This resulted in greater yields at the first harvest and for the season. In both years the first harvest was not taken until April when crimson is flowering and maturing. If the first harvest were taken in early or mid-March with a second harvest in April, yield would probably have shown the difference in seedling weight. Plans are to repeat the study a third year.

Conclusion: There was no difference in seedling density of coated and uncoated seed even through there were a third fewer seed/ft.^{2} for the coated seed. Uncoated seed produced greater yields than coated seed when more than one harvest was taken. Planting coated seed does eliminate inoculating the seed by the producer and may reduce possible damage to Rhizobium bacteria; however it may result in lower yields than uncoated seed.

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Table 1. Crimson clover seedling density (January 5, 2009) at five seeding rates of coated and uncoated seed.

Seeding rate (lbs/ac)	Coated	Uncoated
	Seedlings/ft^{2,a}	
8	4.8	5.7
12	6.9	7.6
16	11.4	9.5
20	13.1	13.7
24	12.7	15.8

[a] There was no significance difference in seedling density between coated and uncoated seed at any seeding rate at 0.05 level, Fisher's Protected LSD.

Table 2. Crimson clover yield (April 21, 2009) at five seeding rates of coated and uncoated seed.

Seeding rate (lb/ac)	Coated	Uncoated
	Yield (lb DM/acre)[a]	
8	2135	2762
12	2488	2595
16	2783	2725
20	2737	2984
24	3065	2690

[a] There was no significance difference in clover yield between coated and uncoated seed at any seeding rate at 0.05 level, using Fishers Protected LSD.

Table 3. Crimson clover seedling shoot weight, root weight, and root length averaged over five seeding rates for coated and uncoated seed 34 days after planting (Nov. 23, 2009).

	Coated	Uncoated
Shoot weight (g)	35.5 b[a]	46.4 a
Root weight (g)	8.8 a	10.5 a
Root length (cm)	7.3 a	7.8 a

[a] Values in a row followed by the same letter are not significantly at the 0.05 level, Fisher's Protected LSD.

Table 4. Crimson clover seedling nodule score, shoot weight, and root weight of coated and uncoated seed averaged over five seeding rates 93 days after planting (Jan. 21, 2010).

	Coated	Uncoated
Nodule score [a]	3.18 a[b]	3.16 a
Shoot weight (g)	0.26 b	0.35 a
Root weight (g)	0.07 b	0.09 a

[a] Nodule score: 0 = No nodules visible on roots; 1 = Nodules tiny and whitish to yellow; 2 = Nodules light pink, smaller than average, 1 to 5 on upper 1 in.; 3 = Nodules pink, average size, 1 to 5 or 6 or more small pink ones in upper 1 in.; 4 = Nodules very healthy pink color, large, at least 5, or 6 or more average ones in upper 1 in.; 5 = Nodules large, good color, 6 or more within upper 1 in.

[b] Values in a row followed by the same letter are not significantly different at 0.05 level, Fisher's Protected LSD.

Table 5. Crimson nodule score, shoot weight, and root weight at five seeding rates averaged across coating treatments 93 days after planting (Jan 21, 2010).

Seeding rate	Nodule score[a]	Shoot weight	Root weight
lb/acre		g	g
8	3.288 ab[b]	0.359 a	0.092 a
12	3.300 a	0.336 ab	0.086 ab
16	3.100 c	0.286 bc	0.070 c
20	3.025 c	0.281 bc	0.082 a-c
24	3.113 bc	0.272 c	0.075 bc

[a] Nodule score: 0 = No nodules visible on roots; 1 = Nodules tiny and whitish to yellow; 2 = Nodules light pink, smaller than average, 1 to 5 in upper 1 in.; 3 = Nodules pink, average size,1 to 5 or 6 or more small pink ones in upper 1 in.; 4 = Nodules very healthy pink color, large, at least 5, or 6 or more average ones in upper 1 in.; 5 = Nodules large, good color, 6 or more within upper 1 in.
[b] Values in a column followed by the same letter are not significantly different at 0.05 level, Fisher's Protected LSD.

Table 6. Dry matter yields of crimson clover with coated and uncoated seed averaged across seeding rates in 2009-2010 growing season.

	April 1	May 5	Total
	Dry matter (lb/ac)		
Coated	965 b[a]	355	1320 b
Uncoated	1779 a	483	2262 a

[a] Values in a column followed by the same letter are not significantly different at 0.05 level, Fisher's Protected LSD.

Table 7. Dry matter yields of crimson clover at five seeding rates averaged across coating treatments in 2009-2010 growing season.

Seeding rate	April 1	May 5	Total
lb/ac	Dry matter (lb/ac)		
8	1078 b[a]	335	1413 c
12	1172 b	414	1586 c
16	1347 ab	423	1770 bc
20	1715 a	488	2203 a
24	1550 a	434	1983 ab

[a] Values in a column followed by the same letter are not significantly different at the 0.05 level, Fisher's protected LSD.

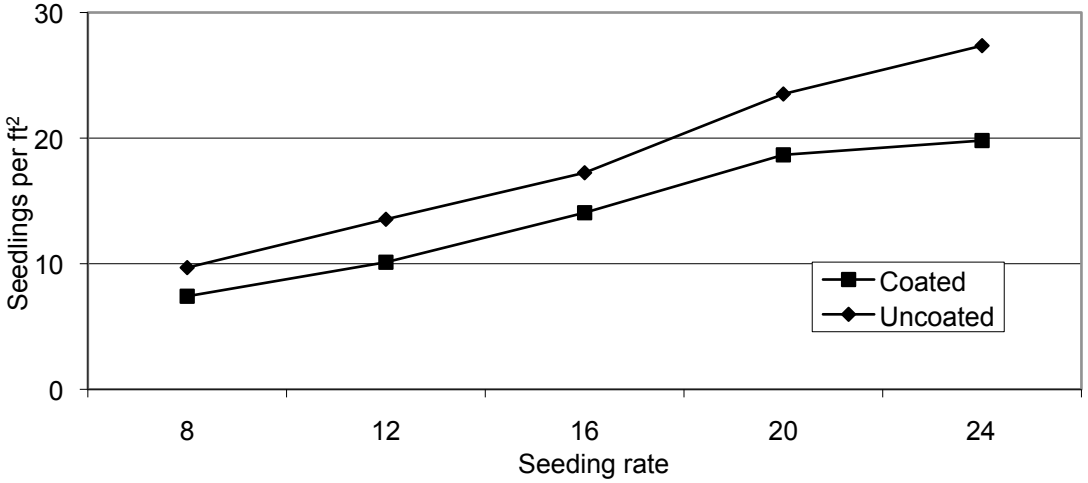

Figure 1: Crimson clover seedling density of coated vs uncoated seed 16 DAP (Nov. 5, 2009). There was no significant different difference at the 0.05 level between coated and uncoated seed within seeding rate.