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Effect of Lodging on Yield and Test Weight of Oats and Establishment of Alfalfa Seedlings¹

By A. J. NORDEN and K. J. FREY²

Lodging in small grains has been shown to reduce yield and quality of the grain in addition to the harvesting difficulties incurred. Eldredge (2) obtained a yield reduction of 47 percent by bending over oat straws as the heads were emerging from the boot. The yield decreased with injury at succeeding weekly intervals until just before ripening when the loss was 12 percent. Pendleton (4) found that Clinton oat yields were reduced 37 and 17 percent by complete lodging four and 20 days after heading respectively. The plots lodged at 45 degrees on the same two dates yielded 14 and three percent less, respectively, than the non-lodged plots. In barley, Sisler and Olson (7) and Day (1) obtained yield reductions of as much as 50 percent when barley was completely lodged. They noted greater losses in barley yields lodged at heading than at 10 or 20 days after heading. Laude and Pauli (3) reported that winter wheat yield was reduced one third by lodging one to two weeks before and after heading. They speculated that the effect of lodging on yield and quality of wheat was associated with the capacity of the plants to recover from tissue damage and the extent to which materials were translocated to the developing kernels prior to the time of injury. All varieties of wheat tested by Schlumberger and Spahr (6) recovered from lodging which occurred during heading.

The effect of lodging of a nurse crop upon the establishment of forage seedlings has not been tested experimentally. However, from observations in farmers' fields, it appears to cause a serious reduction in the number of seedlings established. Pritchett (5) has suggested that competition for light may be a factor which limits the growth of forage seedlings with fertilized oats. The objectives of the experiment reported herein were, first, to determine the effects of lodging at different degrees and dates upon the yield and test weight of oats, and secondly to ascertain whether lodging reduced the number of surviving alfalfa seedlings.

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Table 1
Yields and Test Weights of Oats and Numbers of Surviving Alfalfa Plants After Different Lodging Treatments

Lodging Treatment	Yield			Test weight			Alfalfa plants	
	1956 ^a (bu. per acre)	1957 ^b	Ave. (% of check)	1956 ^a (lbs. per bu.)	1957 ^b	Ave. (% of check)	per sq. ft.	% of check
No lodging (check)	88	114	100	32.4	35.7	100	16	100
Lodged 45° late	76	69	72	31.1	32.7	94	14	89
Lodged 90° late	77	79	77	30.2	33.0	93	10	62
Lodged 45° early	67	82	74	29.2	34.0	93	10	62
Lodged 90° early	54	76	64	27.9	31.1	87	3	19

^a/Ames, Iowa.

^b/Seymour-Shelby experimental farm.

MATERIALS AND METHODS

Clintland oats were drilled at the rate of three bushels per acre in rows seven inches apart at the Agronomy farm, Ames, Iowa, and the Seymour-Shelby Experimental Farm, Seymour, Iowa, in 1956 and 1957. Ranger alfalfa was broadcast over the experimental areas at the rate of ten pounds per acre after which the plots were cultivated. Each experimental area consisted of 20 plots, six by 12 feet in size, to accommodate four replicates of five treatments. The treatments consisted of two degrees of lodging (45 and 90 degrees), two dates of lodging (four and 16 days after heading in 1956, and zero and 12 days after heading in 1957), and the check with no lodging. The period from planting to heading at Ames in 1956 was

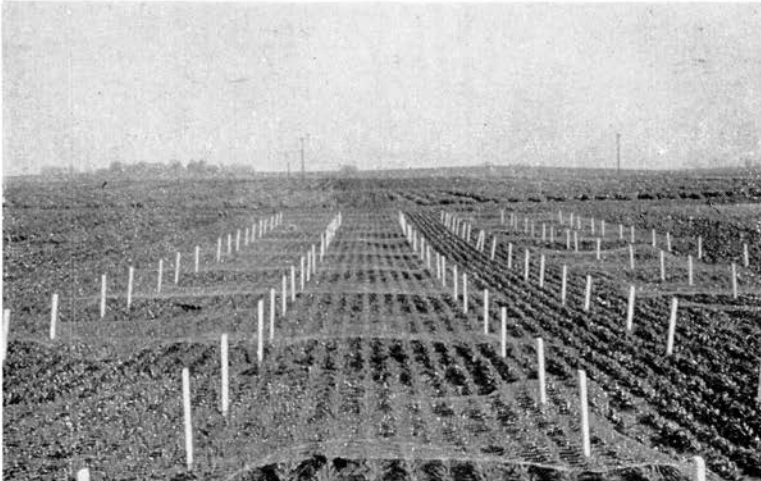




Figure 1. Method used to lodge oat plots artificially. A. Wire mesh in place over plots. B. Lodged 45°. C. Lodged 90°.

68 days and from heading to binder ripe, 25 days. At Seymour in 1957 the periods were 59 and 27 days, respectively. The second lodging was induced only nine days before the oats were binder ripe in 1956, compared with 16 days for this interval in 1957. The 1956 Seymour-Shelby experiment was abandoned due to drought, and the 1957 Ames test was too variable to give reliable yields.

The method (7) used to induce lodging is shown in Figure 1. A wire fence with two-inch mesh was stretched on stakes about 18 inches above the ground when the oat seedlings were two inches high. The plants grew through the fence, and oat culms were lodged by shifting the wire horizontally until the desired degree of lodging was attained. Wire was used on the check plots to prevent natural lodging from occurring.

Just prior to harvest the pieces of wire fence were lifted from the plots when the plants were wet with dew or rain to avoid shattering. Three samples per plot, each covering 9.62 square feet (five drill rows 39.5 inches long) were harvested for yield and test weight determinations. Alfalfa stand counts were taken in September, 1957 on the Ames and Seymour-Shelby experiments. The alfalfa seedlings were complete failures in 1956 due to drought. Four randomly selected quadrats (one-foot square) were used to estimate the number of surviving alfalfa seedlings per plot.

RESULTS

Mean oat yields and test weights from the 1956 trial at Ames and the 1957 trial at Seymour, together with the average number of surviving alfalfa seedlings per square foot from the 1957 experiments

are given in Table 1. Pertinent mean squares from the analyses of variance for yield and alfalfa stand count data are presented in Table 2. Except in one or two instances, oat yields and test weights were better in the 1957 than in the 1956 experiment. Discrepancies in the effect of a given lodging treatment in the two years may be due in part to the fact that lodging was not induced at the same stage of maturity each year.

Table 2
Pertinent Mean Squares from Analyses of Variance of the Grain Yields and Alfalfa Stands from Lodging Experiments

Source	D.F.	Mean squares		
		Yield		Alfalfa stand counts
		1956 ^a	1957 ^b	
Treatment	4	634**	1,259**	95**
Lodged vs. non-lodged	1	1,159**	4,668**	136**
Early vs. late lodged	1	1,035**	96	114**
45° vs. 90°	1	161	20	124**
Date x degree of lodging	1	183	254	7
Error	12	53	185	11

**Exceeds the .01 level of significance.

^a/Ames, Iowa.

^b/Seymour-Shelby experimental farm.

In each year lodging of the oat plants caused a highly significant reduction in yield. Average reduction for the two experiments was approximately 25 percent for the 45° early, 45° late and 90° late lodging treatments, and 35 percent for the 90° early treatment. In 1956 the early lodging caused a significantly greater reduction in yield than the late lodging did, but in 1957 lodging at both dates resulted in approximately the same reduction. Both degrees of lodging decreased the yield approximately the same amount and the date x degree of lodging was not significant in either year.

In general, test weights were reduced less percentage wise by lodging than were yields. The average reduction was seven percent for the 45° and 90° late and the 45° early treatments and 13 percent for the 90° early treatment. All lodging treatments except the latter one produced grain with respectable test weights in 1957.

The number of surviving alfalfa seedlings per square foot in September, 1957 was reduced significantly by the lodging treatments. Furthermore, the 90° lodging and early lodging at 45° and 90° caused significantly lower numbers of seedlings to survive than did the 45° and late lodging treatments, respectively. It has been estimated that from six to ten alfalfa plants per square foot will produce optimum hay yields in Iowa.³ If so, all of the stands

³Personal communication with J. M. Scholl, Associate Professor of Farm Crops, Iowa State College, Ames, Iowa.

except that from the 90° early lodging treatment should be adequate providing that the number present in September, 1957 are still surviving in the spring of 1958.

DISCUSSION

A farmer can easily recognize mechanical losses of oats due to difficulties in harvesting lodged grain, but he is less able to visualize the losses caused by a reduction in food material synthesis and translocation. The 25 to 35 percent loss in yield obtained in these studies resulted from the latter cause only. The loss to the farmer would undoubtedly be greater. On the other hand, oat plants which lodge from natural causes at an early stage often bend upward at the nodes, whereas in this study the plants were mechanically held in the lodged position until harvest.

The time of lodging was important in the 1956 season but not in 1957. This results from the fact that the oats were nearly mature at the second lodging date in 1956 but not in 1957. In other words, both lodging dates were early in 1957 when compared to the second date in 1956. Laude and Pauli (3) reported similar results in wheat. They found that number of kernels per head and weight per kernel were both affected by early lodging, but only weight of kernels was affected by late lodging.

The two degrees of lodging reduced yield and test weight about the same amount. The bending of culms at 45° apparently restricted the flow of nutrients and translocations of food materials in the plants as much as the 90° treatment did.

Apparently both the time and degree of lodging of oats has an effect upon the forage stand. Severe lodging at an early date nearly eliminated the alfalfa stand leaving only three seedlings per square foot. Furthermore, the alfalfa stand counts reported herein were probably higher than might be expected under natural lodging, because both grain and the straw were removed, whereas combining would leave the straw on the field to further smother the alfalfa seedlings.

SUMMARY

Experiments were conducted at Ames, Iowa, in 1956 and Seymour, Iowa, in 1957 to determine the effects of time and degree of lodging on yield and test weight of Clintland oats and on the stand of the alfalfa companion crop.

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