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Vegetative and Floral Development of the Oat Plant as Influenced by Clipping and Nitrogen Fertilization[1]

By F. P. Gardner and S. C. Wiggans

Grazing small grains at early stages of growth is a common practice throughout much of the United States. In the South grazing of small grains is a means of providing both high quality forage and grain from the same plantings. Mechanical clipping has been practiced in some areas for its secondary effect of reduced lodging by decreasing the plant height. Although clipping oats in Iowa is not common, there is interest in the practice as a possible means of reducing lodging.

Several investigations (7, 8, 9) have shown that lodging in small grains can be decreased by clipping. Plant height, yield, test weight, stem and root internode and second internode length also were reduced (7). However, these effects vary with seasons. It has been observed (1) that clipping in the fall has less effect on winter oats than does spring clipping. Clipping injury to small grain plants has been found (3, 4) to be closely associated with floral development and stem elongation of the plant. Clippings could be made without serious detrimental effects as long as the plant was vegetative. Winter wheat and winter rye were more seriously injured than were winter oats by early spring clipping due to earlier initiation of inflorescences.

A recent study (5) showed that the transition from the vegetative to the floral stage in the shoot apex of Cherokee, an early variety of oats occurred from 17 to 20 days after planting at which time four expanded leaves and one tiller leaf were developed. Both branch and bract primordia were evident in 17 to 26 day old plants.

This study was designed to determine the effect of clipping and nitrogen fertilization on the development of the shoot apex, stem growth, and maturity of oats.

Methods and Materials

Two spring oat varieties, Mo. 0-205 and Clintland, high- and low-tillering varieties, respectively (2), were selected for this study.

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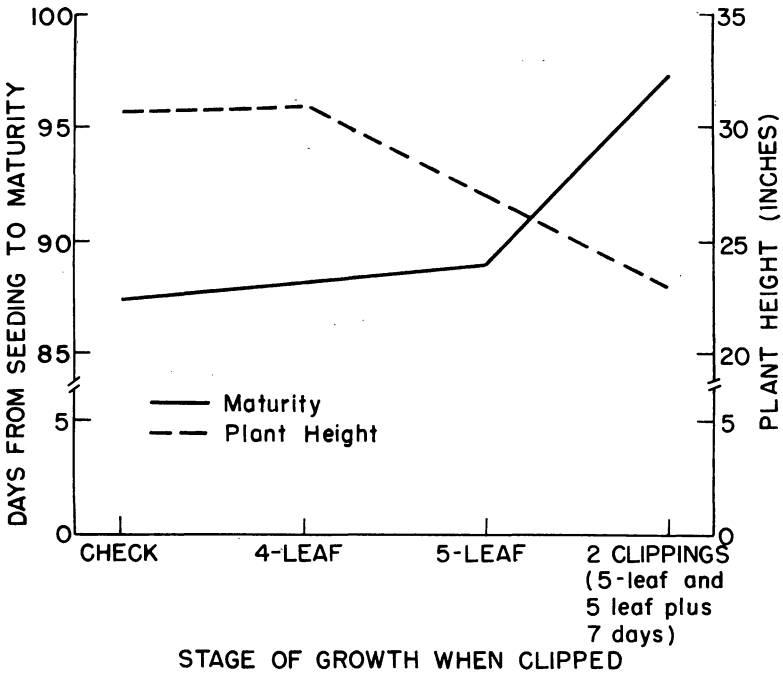


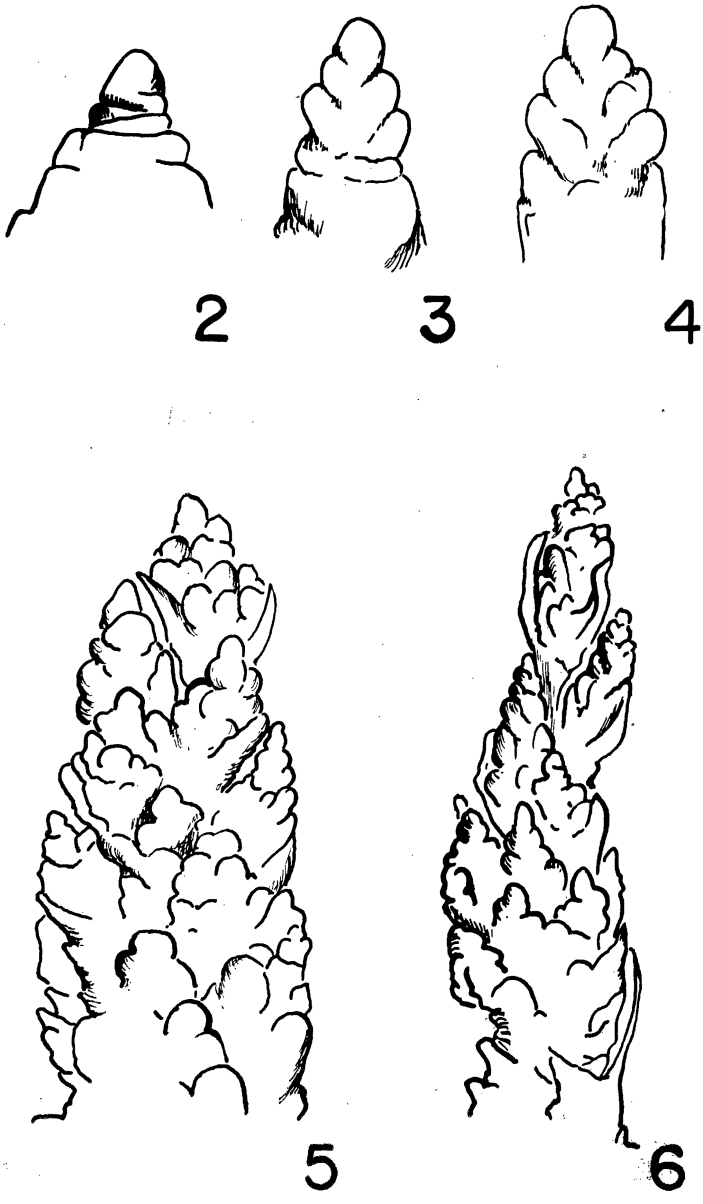
Figure 1. Effect of clipping at various stages of growth on the maturity and plant height of two oat varieties (Clintland and Mo. 0-205).

Seedings were made in early April with a grain drill at a rate of 2 bushels per acre using replicated plots 6′ x 20′ in size. A split-plot design with 4 replications was used. The whole plots consisted of varieties and the sub-plots were of nitrogen and clipping combinations. Nitrogen was applied as ammonium nitrate at two rates, zero and 100 pounds of nitrogen per acre. All plots were uniformly fertilized with 60 pounds of P_2O_5 and 60 pounds of K_2O per acre.

Clippings were made at five stages of growth; 4-leaf, 5-leaf, 7-leaf, 5-leaf plus an additional clipping 7 days later (approximately the 6-leaf stage) and 5-leaf plus additional clippings 7 days and 14 days later (approximately 7-leaf stage). A one to one and one-half inch stubble remained after each clipping. Growing points were collected at each clipping date and preserved in an FAA solution (6). The growing points were measured and classified subsequently as floral or vegetative.

Experimental Results

The effects of clipping at the various stages of growth upon height and maturity of the oats are shown in Figure 1. Since neither nitrogen fertilization nor varieties had a significant effect on plant height



Figures 2-6. The development of the shoot apex of two oat varieties (Clintland and Mo. 0-205) at different growth stages and clipping treatments.

Figure 2. Vegetative growing point characteristic of oats prior to the 4-leaf stage (x50).
Figure 3. Inflorescence primordia of Clintland at the 4-leaf stage (x47).
Figure 4. Inflorescence primordia of Mo. 0-205 at the 4-leaf stage (x47).
Figure 5. Inflorescence primordia of Clintland at the 5-leaf stage (x35).
Figure 6. Inflorescence primordia of Mo. 0-205 at the 5-leaf stage (x35).

and days required for maturity the variety and nitrogen treatments were averaged to show the effect of clipping on height and maturity. The apical meristems at the 4-leaf stage were slightly below ground level. Clipping at this stage had no apparent effect on the height of the plants at maturity. However, clippings made at the 5-leaf stage or later decreased progressively the mature plant height. Clipping at the 7-leaf stage or at the 5-leaf stage plus two subsequent clippings made 7 and 14 days later, injured the plants so severely that regrowth was negligible and plant height was not measured. The decreases in plant height were highly significant.

Clipping the oats at the 4- and 5-leaf stages slightly increased the number of days required for maturity. However, clipping at the 5-leaf stage plus another clipping 7 days later delayed maturity by approximately 10 days with each variety.

The length of the growing points at various stages of growth and with differing nitrogen fertilization levels are given in Table 1. In general, the growing points were longer when no nitrogen was applied than when 100 pounds per acre was used. At the 4-leaf stage the average length of the growing points of both varieties was less than 1.0 mm. with Mo. 0-205 being longer for both nitrogen levels. At the 4-leaf stage the vegetative growing points (Figure 2) were largely replaced by floral primordia (Figures 3 and 4).

The floral primordia at the 5-leaf stage with branch, spikelet, and glume primordice, as shown in Figures 5 and 6 for Clintland and Md. 0-205 varieties, respectively. The floral primordia of Mo. 0-205 averaged 0.7 mm. longer than those of Clintland.

Clipping at the 5-leaf stage had a very pronounced effect on the floral primordia causing a reduction in length of from one-half to two-thirds over that which was not clipped. Representative floral primordia of Clintland and Mo. 0-205, collected at the 6-leaf stage which also had been previously clipped at the 5-leaf stage are compared with those which had not been previously clipped in Figures 7 and 8. In both varieties the length of both the clipped and non-clipped floral primordia were decreased by nitrogen fertilization.

Discussion

Most oat varieties grown in Iowa are rapid growing annuals that complete the growth cycle in approximately 90 days. Thus, the production of carbohydrates must be sufficient for the plant to become fully developed, mature, and sets of high quantity of seed.

Clipping, particularly at an advanced stage of growth, tends to stop the development of floral primordia, stem height, and maturity, by destroying the floral primordia or by decreasing the food reserves.

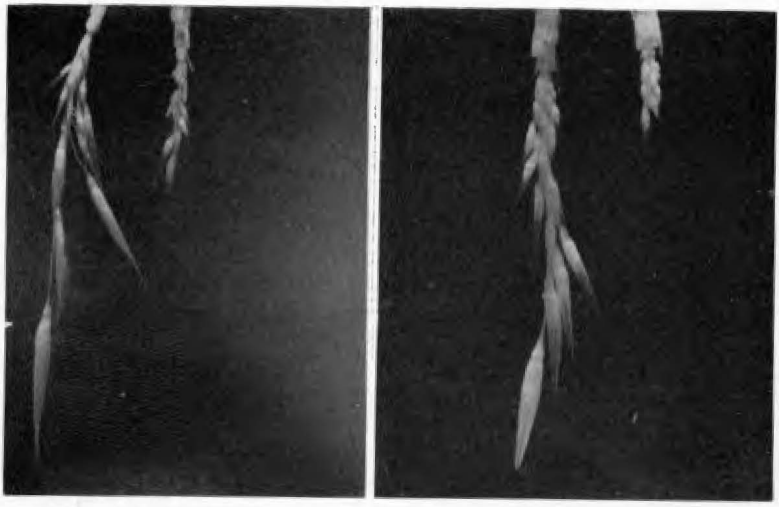


Figure 7. Inflorescence of Clintland at the 6-leaf stage (x2.4), left—clipped at the 5-leaf stage, right—unclipped.

Figure 8. Inflorescence of Mo. 0-205 at the 6-leaf stage (x2.4), left—clipped at the 5-leaf stage, right—unclipped.

Although the floral primordia are not injured by clipping at the 5-leaf stage, the diminution of carbohydrates arising from the removal of leaves results in retarded growth of the shoot apex while another clipping 7 days later further reduces carbohydrates and diminishes the growth rate even further. Additional clippings beyond this essentially nullify recovery, and growth of the oat plant ceases. Clipping at the 7-leaf stage completely removes the floral primordia. These data indicate that clipping at the 5-leaf stage probably could be used to shorten plant height and mitigate against lodging.

Nitrogen fertilization had little or no effect on the early floral growth of the various clipping treatments. Apparently nitrogen was adequate at this stage of development, but it may have become an important factor in later stages. Although Clintland and Mo. 0-205 varieties are both mid-season in maturity and are approximately the same height, growth of the floral primordia of the latter variety appeared to develop at a more rapid rate.

Summary

Two oat varieties were seeded at Ames, Iowa, fertilized with two rates of nitrogen, and clipped at 5 stages of growth and development. The following results were obtained:

(1) clipping at the 5-leaf or later stages reduced the plant height and increased the time required for maturity of the grain.

(2) Shoot apices at the 4-leaf stage were primarily floral. At the 4-leaf stage all growing points were less than 1.0 mm. long with Mo. 0-205 being approximately 0.2 mm. longer than Clintland.

(3) Plants clipped at the 5-leaf stage of growth had well developed floral primordia and were approximately 2.0 to 3.0 mm. in length and branch, glume, and spikelet primordia were evident. Although clipping at the 5-leaf stage did not generally remove the growing point it significantly reduced the length of the growing points and plant heights.

(4) Clipping at stages later than the 5-leaf removed the floral primordia *per se* and nullified growth and recovery.

Table 1

Average Length of Growing Points in mm. of Two Oat Varieties at Various Stages of Growth, with and without Nitrogen Fertilization.

		Stages of Growth when Harvested			
	N	Not Clipped			Clipped
	(lbs./A.)	4-leaf	5-leaf	6-leaf	6-leaf*
Clintland	0	.80	2.18	44.25	17.60
	100	.57	2.55	32.00	8.45
Mo. 0-205	0	.89	3.40	41.78	23.55
	100	.82	2.87	40.85	12.15

*Clipped at 5-leaf stage.

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