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K. J. Frey
Iowa State College

S. C. Wiggans
Iowa State College

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Tillering Studies on Oats: IV. Effect of Rate and Date of Nitrogen Fertilizer Application[1]

By K. J. Frey and S. C. Wiggans

Nitrogen applied to oat fields has many morphological and physiological effects on the plants. Increased grain yields have been reported by Nelson *et al.* (5), Pritchett (6) and many others; increased overall top growth was reported by Gericke (3); and increased nitrogen content of the grain has been found by Wiggans and Frey (7), Brieba (1), and others. In a greenhouse experiment Gericke (3) found that a delay in applying nitrogen to oats in a low fertility soil increased the number of heads per plant. An application equal to 80 pounds per acre at seeding produced approximately 1.5 heads per plant, while an equal application 90 days later (6 to 7 leaves) resulted in over 3.0 heads per plant.

Since, with a given seeding rate of oats, the numbers of tillers produced per plant is a component of yield, it is important to know the effect of different cultural practices on this character. This paper reports the effects of rate and date of nitrogen application on tillering.

Materials and Methods

The experiments were grown in Ames, Iowa, and were of two types relative to nitrogen application:

(a) In one experiment conducted in 1954 and 1955, four varieties were sown with two rates of nitrogen application, none and 40 pounds per acre made at seeding time.

(b) The other experiment was conducted in 1954, 1955 and 1956. Rates of 0, 20, 40, and 80 pounds of nitrogen per acre were applied to 10 varieties in 1954 at planting time and 2, 4, and 6 weeks later. Three varieties were grown in 1955 and 1956 and fertilized with the same nitrogen rates at planting time and 1, 2, and 3 weeks later.

The plot size, eight feet long and four rows wide, with a one-foot spacing between rows, was the same in all experiments except in the

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1954 (b) experiment in which the plots were each one row wide. Planting rates of 1, 3, and 5 bushels per acre were used in 1954 (b). All other experiments were sown at 3 bushels per acre. The experimental design in each case was a split plot with three or four replications. Fertilizer rate and date combinations and varieties occupied the whole and subplots, respectively.

Nitrogen was applied by broadcasting ammonium nitrate on the plots at the prescribed rates. Prior to seeding a uniform application of 300 pounds of 0-20-20 was applied to provide adequate phosphate and potassium to permit expression of nitrogen response. Each of the experiment sites was extremely low in nitrogen available for plant growth before the ammonium nitrate was added.

The number of seedlings and panicles were counted in 2-foot sections of the center rows of each plot 2 weeks after planting and at maturity, respectively. The 2-foot sections were selected at random and marked with 4-inch pot stakes so that seedling and head counts could be made on the same areas. Since the 1954 (b) experiment consisted of one-row plots, every row was staked. Only culms bearing heads were used in calculating total number of tillers per plant. Although analyses of variance were calculated for each experiment, trends are of more interest as a measure of response.

Experimental Results

The average number of tillers per plant for the 4 oat varieties grown in 1954 and 1955 and fertilized with zero or 40 pounds of nitrogen per acre at seeding time are presented in Table 1. Clinton was lowest in tiller number, with an average of 0.99 per plant while Mo. O-205 was highest with 1.15. Cherokee, Clinton, and Mo. O-205 responded significantly to nitrogen application, but Branch produced the same number of tillers per plant irrespective of nitrogen rate. Grafius (4) also noted that Branch variety was unable to compensate for a low planting rate by producing more tillers per plant. The average increase in number of tillers produced per plant

Table 1

Average Number of Tillers per Plant for Oats Seeded with None and 40 Pounds of Nitrogen per Acre in 1954 and 1955

	Pounds of nitrogen per acre		
	0	40	Mean
Branch	1.06	1.06	1.06
Cherokee	1.01	1.07	1.04
Clinton	0.95	1.03	0.99
Mo. O-205	1.11	1.19	1.15
Mean	1.03	1.09	1.06

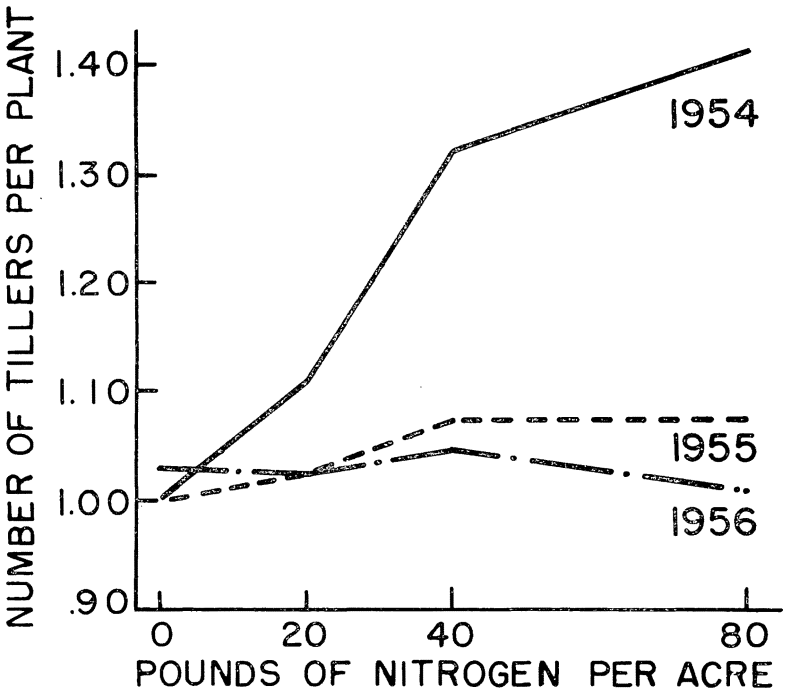

Figure 1. Number of tillers per plant in oats with varying rates of nitrogen fertilizer application. (9 varieties in 1954, 3 varieties in 1955 and 1956 with a seeding rate of 3 bushels per acre.)

for all varieties from an application of 40 pounds of nitrogen was 0.06, a small but significant value.

The effect of several rates of nitrogen application (from none to 80 pounds per acre) on average tiller production for the years 1954, 1955, and 1956 is shown graphically in Figure 1. In 1954 the response was great whereas in 1955 and 1956 no increase in tillering was obtained. Although each added increment of nitrogen fertilizer caused an increase in the tillers per plant in 1954, the greatest response was obtained from the first 40 pounds. In 1955 there was a slight increase from the 20 and 40 pound applications, but the 80-pound rate gave no added increase and in 1956 none of the nitrogen rates increased tillering.

Apparent differential variety response to rates of nitrogen application in 1954 are shown in Figure 2. Varieties could be classified into three groups, each with a different response. Clintland (line a) gave little response with 20 or 40 pounds, but a marked response to 80 pounds; Bond, Gopher, Huron, and Mo. O-205 (line b) showed a consistent increase in tillers per plant with the 20, 40, and 80 pound nitrogen applications; and C.I. 5298, Marion, Park, and

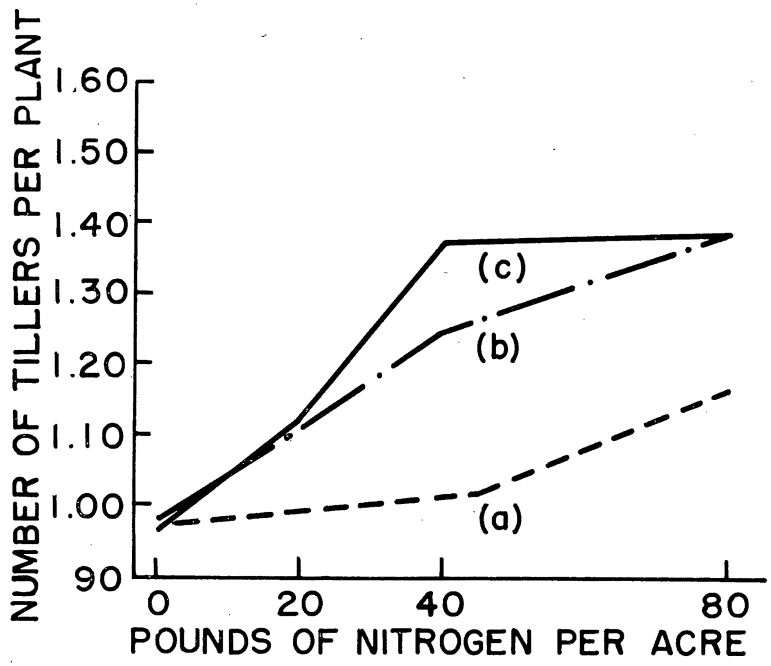

Figure 2. Number of tillers per plant for three groups of oat varieties fertilized with different rates of nitrogen in 1954: (a) Clintland, (b) Bond, Gopher, Huron, and Mo. O-205, (c) C.I. 5295, Marion, Park, and Simcoe.

Simcoe (line c) produced no more tillers with the 80 than with the 40 pound rate. In 1955 one variety from each group (Clintland, Mo. O-205 and Marion) were planted to determine if these varietal responses were consistent. The results of this experiment are presented in Figure 3. Although less pronounced in magnitude, the trends were similar to those of 1954: Clintland gave no response, Mo. O-205 produced a continuous increase up to the 80 pound rate. and Marion produced no more tillers at 80 than at the 40 pound rate. It is interesting that even though curves (b) and (c) differ in magnitude at the 40 pound rates they intercept the 80 pound ordinate at approximately the same level in both years.

The effect of dates of nitrogen application on tillering in oats are shown in Figure 4. When nitrogen was applied at seeding time in 1954 the number of tillers produced per plant was 1.18. However, delaying nitrogen application until two, four and six weeks after planting resulted in from 1.31 to 1.33 tillers per plant. It thus appeared that the maximum number of tillers produced was determined within 2 weeks after planting and that nitrogen stimulated tiller growth in contrast to the development of additional tillers when applied at seeding time. In light of the data from 1954, nitrogen applications were made at planting time, and one, two and three

weeks later in 1955 and 1956. There was no response to delayed nitrogen application in 1955, but in 1956 the trend was similar although less pronounced than in 1954. The number of tillers per plant increased with the applications made at one and two weeks, but no further increase was apparent from the application made three weeks after planting. This corroborates the results from 1954, namely, that the maximum number of tillers to develop is determined within the first two weeks after planting. This conclusion probably holds only for a normal seeding rate and for those heads which ripen at the normal time. Oat plants spaced a few inches apart will continue to produce tillers for a longer period than two weeks after planting.[3] Also some varieties produce "late" tillers which are still green when the first crop is mature.

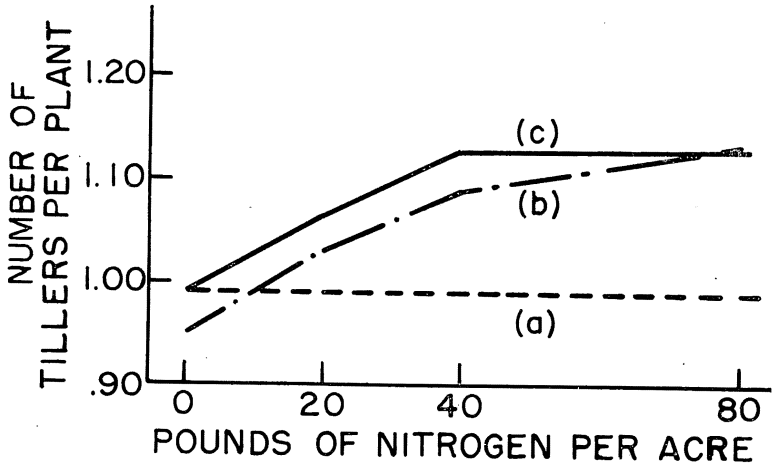

Figure 3. Number of tillers per plant for three oat varieties fertilized with different rates of nitrogen in 1955: (a) Clintland, (b) Mo. 0-205, (c) Marion.

Planting rate has a major influence on the tillering response of oat plants to fertilizer rates (Figure 5). The influence was more pronounced at the lighter rates of planting. With no added nitrogen the number of tillers per plant was approximately 1.0 for all planting rates, but the 20 and 40 pound applications resulted in an increased number of tillers per plant for all planting rates. However, at the 40 pound application the three and five bushel rates appeared to have reached their maximum tiller production, while with the one bushel rate number of tillers increased at the 80 pound nitrogen application. This added tiller production with a one bushel seeding

[3]Unpublished data from Iowa Experimental Station.

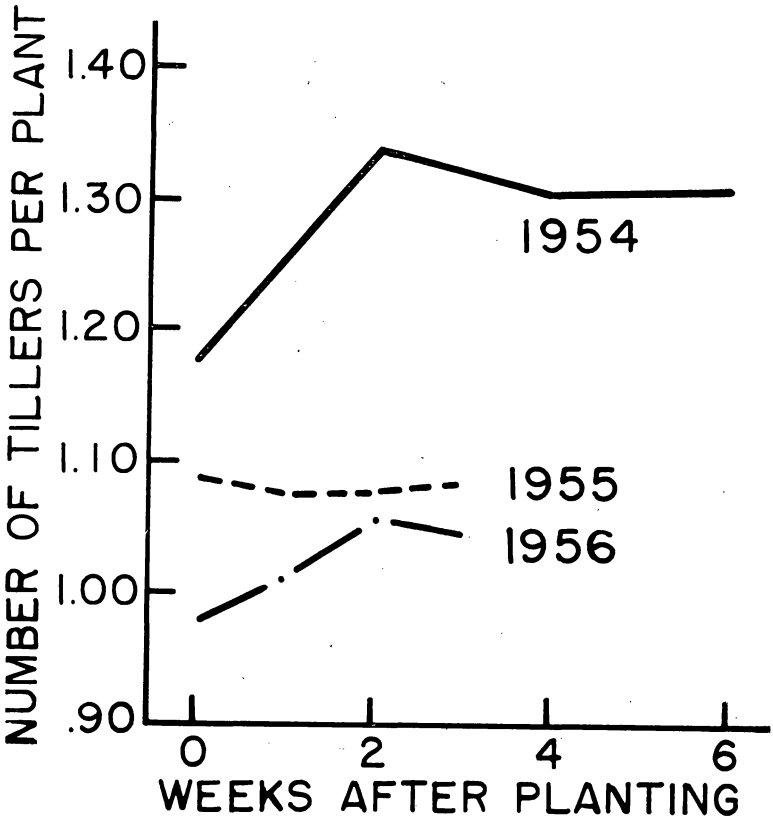

Figure 4. Number of tillers per plant in oats with nitrogen application at different intervals after planting. (9 varieties in 1954, 3 varieties in 1955 and 1956 with a seeding rate of 3 bushels per acre.)

rate and 80 pound nitrogen application was, nevertheless, determined within the first 2 weeks after planting.

Discussion

The value of applying nitrogen fertilizer to an oat crop to increase tiller production would be questionable. Frey and Wiggans (2) have shown that tillering of oat plants sown at a 3 bushel seeding rate had little relation to oat yields. However, several interesting speculations arise from this study. The general tillering response with similar seeding and nitrogen application rates, was different for the 3 years. In 1954 the response was large, in 1955 it was small, and in 1956 essentially none, even though at the no nitrogen application, the level of tillering was about the same each year. The spring was cool and moist for a period after planting in 1954—conditions which were not conducive to rapid growth. In contrast, the spring of 1955

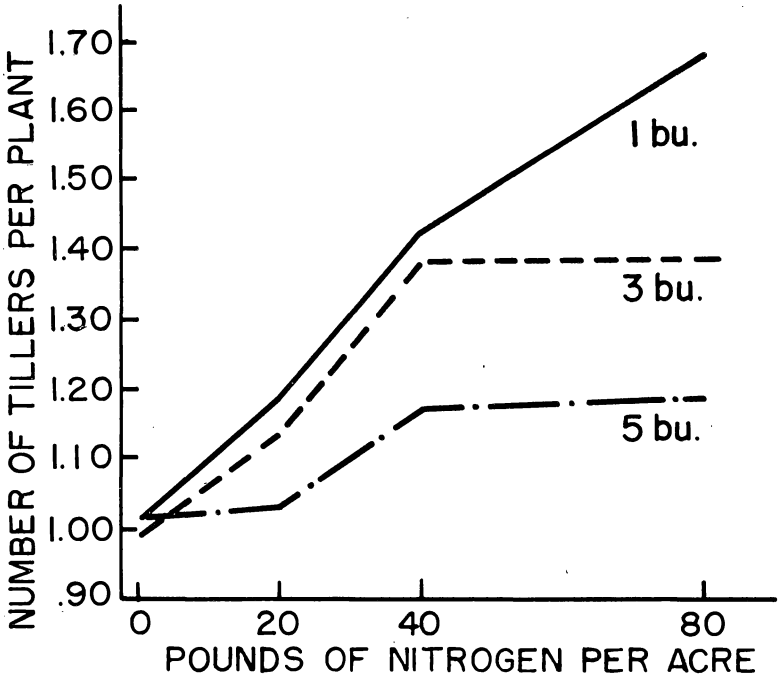

Figure 5. Number of tillers per plant for oats with varying planting rates and nitrogen fertilizer applications in 1954. (9 varieties.)

was warm and moist for the entire season—conditions favorable for rapid early growth. Both seasons were good oat years. This would indicate that environmental conditions conducive to rapid growth were not conducive to initiating tiller growth. Further evidence of this phenomenon is the increase in tillers per plant from delayed nitrogen application in 1954 and 1956. Theoretically nitrogen application would cause rapid growth. If applied at seeding time it promotes growth of only a few tillers, but if delayed for one or two weeks growth was initiated in more tillers. The year 1956 was the poorest "oat season" since 1936, and it appears that even though growth may have been initiated in many tillers, they did not produce heads because of the extreme drought.

Summary

From experiments with different rates and dates of nitrogen application to oat plots the following conclusions were drawn:

1. Nitrogen fertilizer application increased the number of tillers produced per plant in some cases.
2. With normal planting rates, maximum tillering appeared to

be determined within the 2 weeks immediately after planting.

3. Some varieties produced the maximum number of tillers per plant with a 40 pound application of nitrogen while others did not.

4. Environmental conditions, including nitrogen fertilizer application, which were conducive to rapid growth tended to inhibit initiation of growth in oat plant tillers.

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Departments of Agronomy and of
Botany and Plant Pathology
Iowa State College
Ames, Iowa