

RESEARCH BRIEF

SHEEP AND CATTLE GRAZING EFFECTS ON TILLERING DYNAMICS AND GRAIN YIELD OF WINTER WHEAT.¹

Research Personnel: Scott Christiansen, Tony Svejcar, W. A. Phillips,
T. D. A. Forbes and J. D. Trent²

Date of Project Initiation: September 1982

Date of Project Termination: September 1986

Rationale for Doing Work:

Wheat (*Triticum aestivum* L.) grazing is an important practice in the Great Plains of the United States and it adds appreciably to the economy of the region. It is necessary to understand the physiology of the wheat plant under grazing to explain the reports of stimulated grain production from wheat that has been grazed (Swanson, 1935; Hubbard and Harper, 1949; Sprague, 1954; Morris and Gardner, 1958).

High irradiance in the Great Plains compared to other regions may cause increased leaf production, more total leaves, and a faster rate of tillering (Friend, 1965). In ungrazed wheat late-developed tillers are less likely to survive due to mutual shading (Ong, 1978; Ong et al., 1978). It has been theorized that cereal crops may produce vegetative growth in excess of that required to support grain yields and that grazing represents an efficient utilization of the excess.

Defoliated plants are more apt to redistribute photosynthate among tillers than undefoliated plants (Quinlan and Sagar, 1962; Gifford and Marshall, 1973; Ong, et al., 1978). It is possible that moderate grazing may increase tillering, assimilate transfer and incident light reaching secondary tillers. In grazed wheat more tillers may be given a better chance to produce grain than in ungrazed wheat where main stem and primary tillers have a more sequential development and dominance (Hay 1978).

¹A contribution from the USDA-ARS Southwestern Livestock and Forage Research Station, P.O. Box 1199, El Reno, OK 73036 Phone: (405) 262-5291

²Research Agronomist, Research Agronomist, Research Animal Nutritionist, Visiting Research Associate, and Graduate Student, respectively.

Objectives:

The objectives of this study were to investigate tillering dynamics and the components of yield in wheat left ungrazed or grazed by sheep or cattle.

Materials and Methods:

Wheat (cv. 'Triumph-64') was planted at a rate of approximately 100 kg/ha at the USDA-ARS Southwestern Livestock and Forage Research Station near El Reno, Oklahoma on 22 September 1982. The soil was a Bethany, fine, mixed, thermic Pachic Paleustoll. Anhydrous ammonia was applied before planting at a rate of 50 kg/ha actual nitrogen.

Wheat pasture was fenced to provide cattle and sheep plots 0.3 and 0.06 ha in area, respectively. Additional areas were enclosed to provide ungrazed control plots. Three grazing pressures were established as treatments in a randomized, complete block design with two replications. The ungrazed control areas were replicated three times.

In each ungrazed area 12 plots (8x7m) were marked to provide five plots that were clipped once on 15 February, 9 March, 22 March, or 22 April at 2.5 cm height. The clipping treatments were designed to assess the effect of a single, severe defoliation through advancing stages of growth on subsequent wheat grain yields. The remaining seven plots in each block were controls for estimating yields from unclipped plants.

Poor wheat growth in autumn 1982 prohibited grazing until spring. Two grazing periods of approximately five day's length were used to defoliate the wheat prior to stem elongation in mid-March when animals were removed. High, medium and low grazing pressures were imposed by using either eight, six, or four animals per sheep or cattle paddock.

Wheat samples were dug and washed free of soil from 20x20 cm quadrats taken randomly from wheat drill rows. Samples were taken before and after grazing during the vegetative phase as well as at the joint, dough and ripened stages. Four subsamples were taken from cattle treatments and two from sheep treatments at all sampling dates.

Measurements included counts of live and dead tillers, separations into leaf, stem, crowns and dead tissue, and summations of leaf, stem and dead for quantification of herbage yield. At harvest, spikes were removed from sample areas 1m² in size. Spikes/m² were counted and then threshed. Weight of 1000 seeds was determined for each sample; seed weight, number and seed per spike were calculated.

Most Significant Results to Date:

An important lesson learned in this preliminary study was that variability must be strictly controlled or adequately described in order to find significant treatment differences. Random sampling of nonuniformly grazed wheat characterized the variability but was not representative of the treatment. The cattle and sheep grazed in patches, hence future ef-

forts will attempt to stratify sampling into several plant utilization categories. Because of the method of sampling, significant differences in tiller numbers or grain yield among grazing pressure treatments were not revealed. As a result the data presented in this paper are the means of high, medium and low grazing pressure treatments.

Although there was tremendous variability in the counts of live and dead tillers some meaningful results were found. In Fig 1 the live and dead tillers for ungrazed, cattle- and sheep-grazed wheat are graphed across the season. Little meaning can be inferred from the variability of tiller counts during the vegetative phase, except to say that tiller numbers increased until early March. The tiller abortion seen just prior to and at jointing describes the high tiller production characteristic of wheat. The atrophy of tillers is well described (Fraser, et al., 1982) but whether the wheat plant salvages assimilate from these tissues is not well understood. Fig 1 suggests that a higher number of dead tillers occurred early in May and decreased through June. The 14 June sampling was much later and most dead tillers were largely indistinguishable from the surface litter.

The components of yield in cereals are spikes/m², number of seed/spike and seed weight. In Fig 2 the histograms show the components of yield for grazed wheat or for wheat clipped once, but at different dates in the spring. The results are compared to an undefoliated control. Spikes/m² were increased by grazing or a single clipping treatment on 28 February, whereas clipping treatments on 15 February, 9 March and later caused a loss of spikes/m² (Fig 2a). The clipping was severe and removed all leaf area. Effects of the defoliation on 28 February were apparently overcome by the rapid wheat growth rates. One explanation for the lower spike number on 15 February is that these wheat plants may have been influenced by the same factors as present in the control plots. The wheat had time to accumulate abundant growth and self-shading may have reduced tillering. A comparison of the 15 February clipping to the control histograms in Fig 2 shows much similarity. Jointing occurred the third week of March, therefore some growing points may have been removed on 22 March and later. The results from the late clipping on 22 April were surprising in that the wheat was still able to produce 325 seed bearing spikes/m² from secondary tillers.

Seed weight (Fig 2b) was not greatly altered by grazing. Slightly higher seed weights were associated with the cattle grazing treatment. Up until stem elongation there was little change in subsequent seed weight caused by clipping, whereas clipping after jointing had a large negative effect on seed weight.

Fig 2c shows the histograms for numbers of seeds/spike. Clipping of wheat on 15 February through 22 April caused a progressive decline in seed formation. The sheep and cattle grazing resulted in a decrease of seed/spike compared to the control. The wheat that was grazed by cattle had fewer seeds/spike than the wheat grazed by sheep, but seed weight was higher for the cattle treatment when compared to the sheep treatment (Fig 2b). Therefore, seeds/spike and seed weight counterbalanced to yield equal weight of seed/spike for the grazed treatments (Fig 2d).

Total grain yield for cattle, sheep and control treatments were the same (Fig 3), however, yield components differed. The uncut wheat had fewer spikes/m² (Fig 2a), but higher seed weight/spike (Fig 2b). Hence, spikes/m² and weight of seed/spike counterbalanced to result in the same grain yield for uncut and grazed wheat.

The increase in herbage mass for undefoliated wheat is shown along with information on components that contributed to the forage yield in Fig 4. As mentioned, jointing occurred about 20 March and this corresponds to the sharp increases seen in stem production and total herbage mass. The senescence process began between the 4 April and 5 May samplings as indicated by the loss in weight of leaves. The separations of plant components was discontinued at the dough stage. However, by using information from Fig 3 and Fig 4 it is easy to calculate that 210 g/m² (2100 kg/ha) grain yield represents almost 40 percent of the total dry weight harvested at the end of the experiment.

TABLE 1. Average dry weight of stems harvested 5 May 1983 in the dough stage of ungrazed wheat or wheat grazed by cattle or sheep during the vegetative stage.

<u>Grazing Treatment</u>	<u>Stem Dry Weight</u> (kg/ha)
Control	3283
Sheep	2538
Cattle	1897

In order to determine whether grazing reduced straw weights the stem weights from 5 May were averaged for the three treatments and are shown in Table 1. As reported elsewhere (Washko, 1947; Sprague, 1954; Morris and Gardener, 1958), defoliation in the vegetative stage of wheat reduced the resulting straw component. It appears that the wheat plant "conserves" assimilate for grain in deference to normal partitioning to stems that occurs in the non-grazed condition.

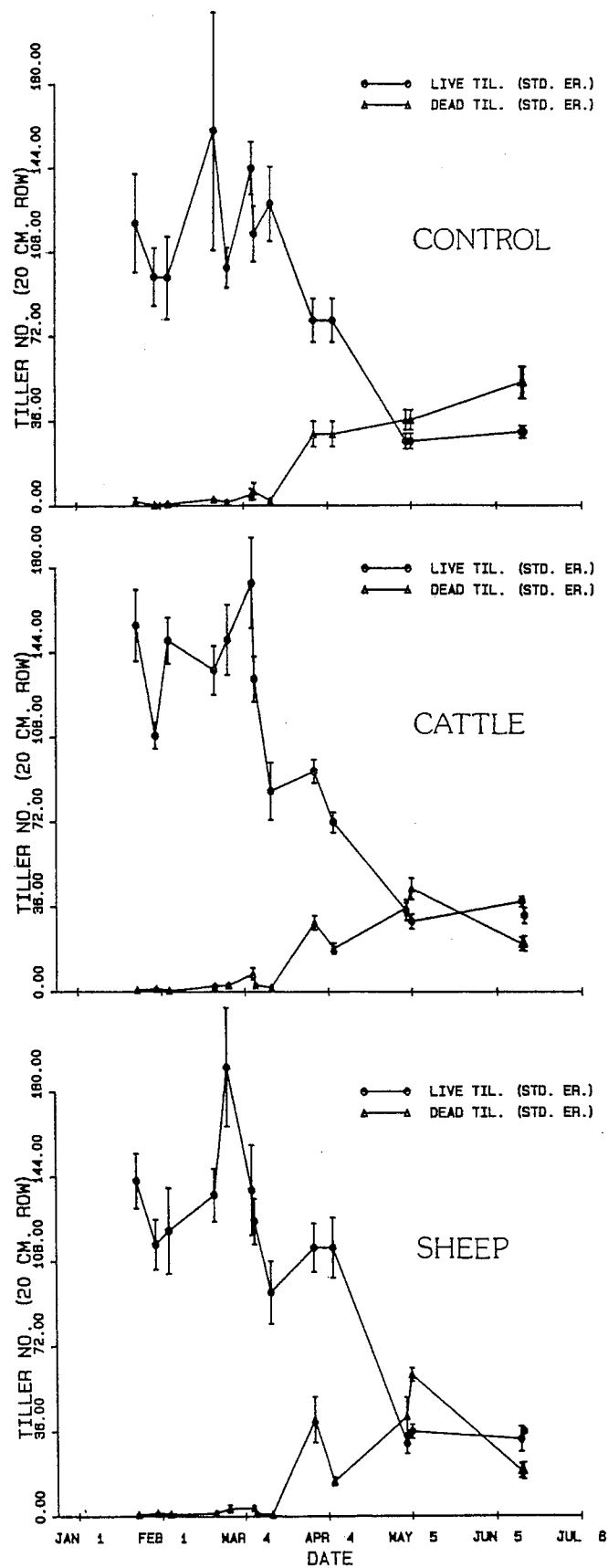


Fig 1. Live and dead tiller (TIL.) counts for ungrazed and grazed wheat. Brackets represent the standard error about the mean.

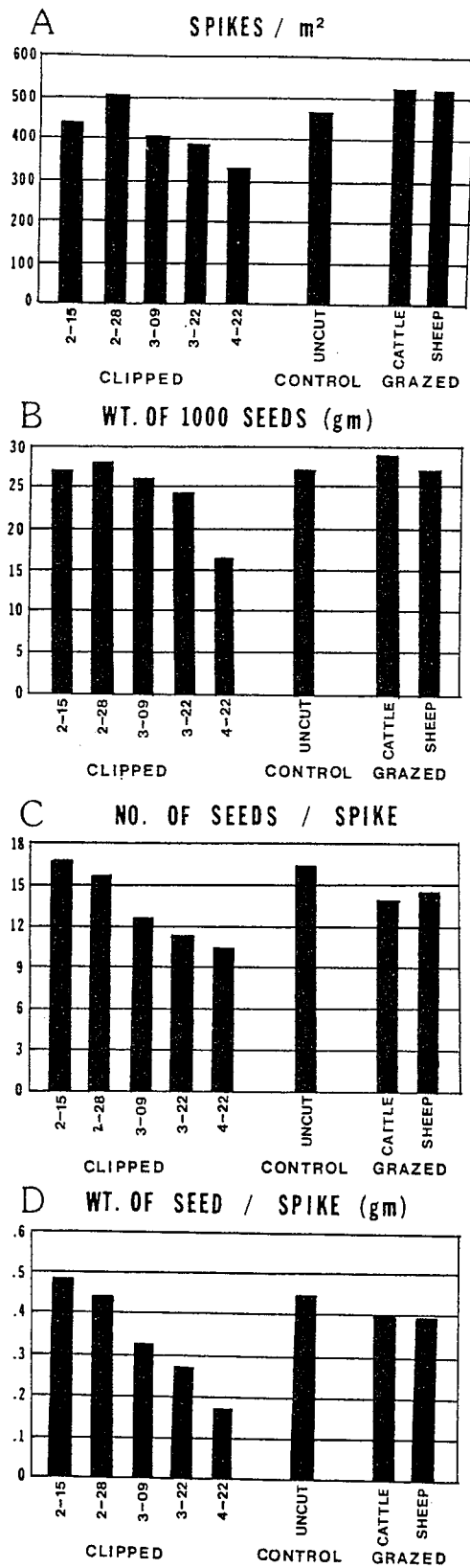


Fig 2. Components of yield for wheat that was clipped once, grazed by cattle or sheep or undefoliated in 1982-1983.

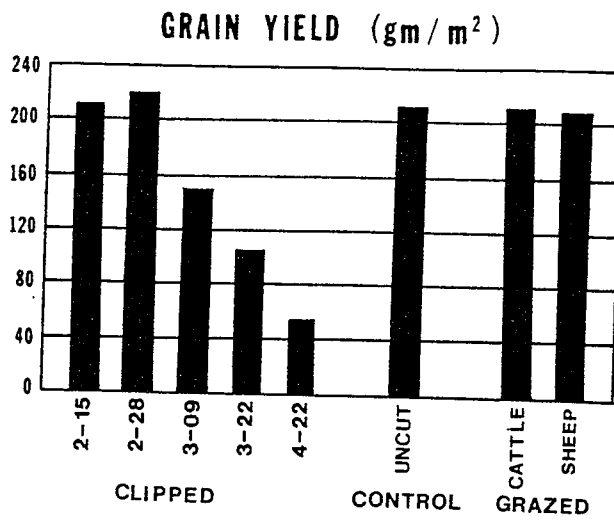


Fig 3. Grain yield of wheat that was clipped once, grazed by cattle or sheep, or undefoliated in 1982-1983.

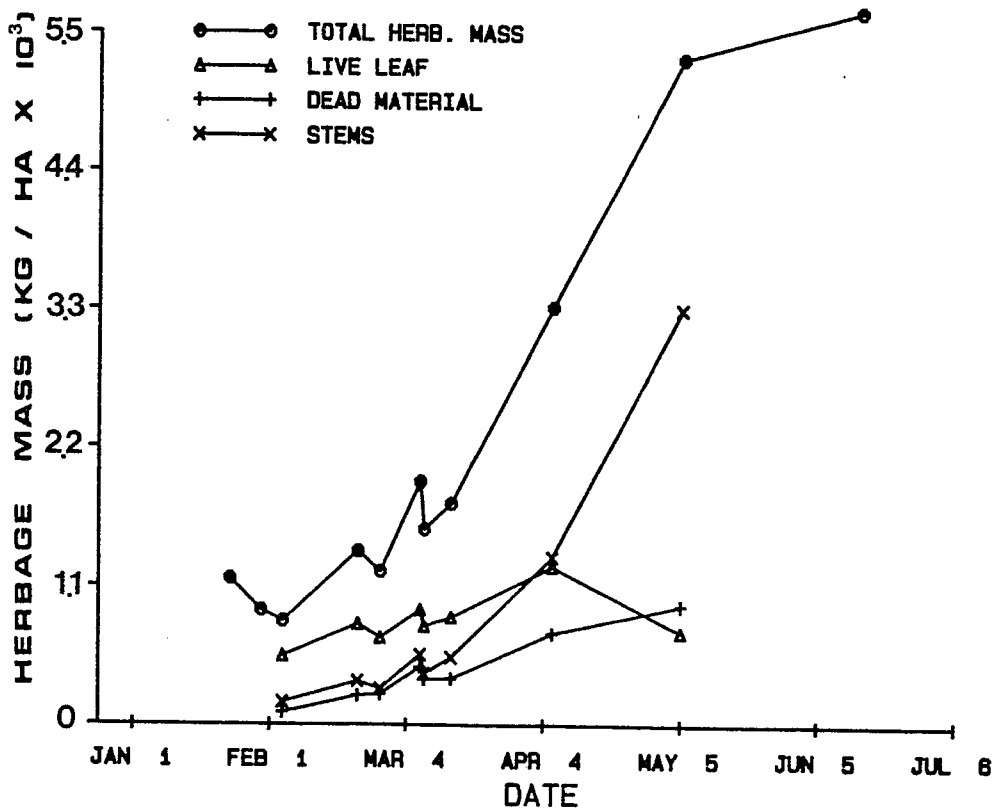


Fig 4. Herbage mass and plant component yields for undefoliated wheat in 1982-1983.

LITERATURE CITED

- Fraser, J., C. T. Dougherty and R. H. M. Langer. 1982. Dynamics of tiller populations of standard height and semi-dwarf wheats. N. Z. J. Agric. Res. 25:321-328.
- Friend, D. J. C. 1965. Tillering and leaf production in wheat as affected by temperature and light intensity. Can. J. Bot. 43:1063-1076.
- Gifford, R. M. and C. Marshall. 1973. Photosynthesis and assimilate distribution in *Lolium multiflorum* Lam. following differential tiller defoliation. Aust. J. Biol. Sci. 26:517-526.
- Hay, R.K.M. 1978. Seasonal changes in the position of the shoot apex of winter wheat and spring barley in relation to the soil surface. J. Agric. Sci., Camb. 91:245-248.
- Holliday, R. 1956. Fodder production from winter-sown cereals and its effect upon grain yield. Field Crop Abstracts. 9:129-135; concluded 9:207-213.
- Hubbard, V.C., and H.J. Harper. 1949. Effect of clipping small grains on composition and yield of forage and grain. Agron. J. 41:85-92.
- Morris, H.D., and F.P. Gardner. 1958. The effect of nitrogen fertilization and duration of clipping period on forage and grain yields of oats, wheat, and rye. Agron. J. 50:454-457.
- Ong, C.K. 1978. The physiology of tiller death in grasses. 1. The influence of tiller age, size and position. J. Brit. Grassland Soc. 33:197-203.
- Ong, C.K., C. Marshall, and G.R. Sagar. 1978. The physiology of tiller death in grasses. 2. Causes of tiller death in a grass sward. J. Brit. Grassland Soc. 33:205-211.
- Quinlan, J.D., and G. R. Sagar. 1962. An autoradiographic study of the movement of 14-C-labelled assimilates in the developing wheat plant. Weed Res. 4:264-273.
- Sprague, M.A. 1954. The effect of grazing management on forage and grain production from rye, wheat and oats. Agron. J. 46:29-33.
- Swanson, A.F. 1935. Pasturing winter wheat in Kansas. Kansas State Agric. Exp. Sta. Bull. 271. 29 pp.
- Washko, J. B. 1947. The effects of grazing winter small grains. J. Am. Soc. Agron. 39:659-666.