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Cheatgrass Communities: Effect of Plowing on Species Composition and Productivity

Abstract

Thirty-year-old cheatgrass communities were disturbed by experimentally plowing small plots. Cheatgrass, *Bromus tectorum* L., promptly invaded the plowed plots. Plowing enhanced plant production at the high elevation site, 520 m, but depressed production at the low elevation site, 320 m, during a year of near normal precipitation in 1976. During the 1977 drought, plant production was very low at both study sites, but productivity was most depressed at the low elevation site. Possible factors in the explanation of results are discussed.

Introduction

Lands that support natural plant communities in the shrub-steppe region of south-central Washington have steadily diminished over the years as dryland and irrigated agricultural practices have steadily expanded, encroaching upon native plant communities. Once under cultivation the land is usually retained under crop management and not permitted to undergo a self-revegetation process. Daubenmire (1975) reports that an abandoned cultivated field in southeastern Washington was dominated by cheatgrass, *Bromus tectorum* L., for 50 years with little or no invasion by native grasses and shrubs. There apparently is no quantitative information to judge what to expect if old, stable cheatgrass communities are disturbed by plowing and allowed to be self-revegetated.

Two agricultural fields on the U.S. Department of Energy's Hanford Site have been abandoned since 1943 and have not since been disturbed. These fields have been dominated by cheatgrass for three decades. The fields are within 5 km of each other. One field is located at an elevation of 305 m above sea level and the other at 520 m. These fields have been previously described by Cline and Rickard (1973). The low elevation field is small, about 10 ha; but the high elevation field is several hundred ha in extent.

Four small plots, each 10 x 20 m, were plowed on each field in late autumn 1974 as a way to initiate bare ground plant colonization. Both fields were sampled for above-ground productivity and species composition by comparison with adjacent unplowed (control) ground. Harvests were made in the spring of 1976 and 1977, and the results are presented in this report.

Methods

Harvests of live phytomass were made three times during the spring of 1976 and

1977; early, middle, and late in the growing season. Small circular plots, 0.032 m^2, were hand harvested and the live material segregated by species. At each harvest period, five points were randomly selected within each treatment. Dead plant material, standing and prostrate and termed "mulch," was also harvested. Mulch was removed by hand until mineral soil was visible. Care was taken to avoid incorporating mineral soil into the mulch sample. All harvested material was oven dried at temperatures between 50-60°C and weighed. A one-way analysis of variance was performed to test the statistical validity of the harvest estimates (Table 1).

A rain gauge was maintained at each field and read each month. The October to May precipitation was of most concern since this period represents the growth season for cheatgrass and its associated annuals.

TABLE 1. Analysis of variance of phytomass on control and plowed plots, May 21, 1976.[1]

	Location	Treatment	n	$\bar{x}$	SD	CV	ANOVA
Live Phytomass	Upper Field	Plowed	20	9.68	4.7	0.49	P(F)=0.00011
		Control	10	2.73	1.3	0.49	
	Lower Field	Plowed	20	5.28	0.23	0.06	P(F)=3.8 x 10^{-7}
		Control	10	9.42	1.9	0.21	
Dead Phytomass	Upper Field	Plowed	20	1.27	1.9	1.47	P(F)=8.2 x 10^{-9}
		Control	10	12.6	5.8	0.46	
(Mulch)	Lower Field	Plowed	20	1.40	1.5	1.06	P(F)=0.00
		Control	10	11.5	1.7	0.15	

[1]Mean based on 0.032 m^2 plots.

Results and Discussion

Harvests were not made during the spring of 1975 because of the lateness of the plowing in 1974. Harvest results in 1976 and 1977 are shown in Figures 1 and 2. The 1977 growing season was marked by extreme drought: only 6 cm of precipitation was recorded in the low elevation field and only 8 cm on the high elevation field during the period October to May. In 1976, the October through May precipitation amounted to 17.0 cm in the low field and 18.9 cm in the high field. In 1976, production on the unplowed (control) plots at the high elevation was relatively low, only 87 g/m^2 (Fig. 1) in relation to the amount of precipitation. This fact was surprising because in 1977 production was 83 g/m^2 and the precipitation was only one-third that of 1976. The plowed plots in 1976 were almost three times more productive than control plots 240 g/m^2 as compared to 87 g/m^2. In 1977, the plowed plots yielded 35 g/m^2 and control plots 83 g/m^2; the difference suggests that the high yield on the plowed plots in 1976 depleted the soil in some way that was important to plant growth. Rickard and Cline (1975) hypothesize that nitrogen may be the factor limiting growth on the upper field rather than the scarcity of rainfall.

At the low elevation field, the control plots were more productive than the plowed plots, 292 g/m^2 as compared to 164 g/m^2 in 1976 (Fig. 1). In 1977 productivity was extremely low in both control and plowed plots; and it is attributed to the extreme drought.

The nearest ecological counterpart to the cheatgrass community is California's

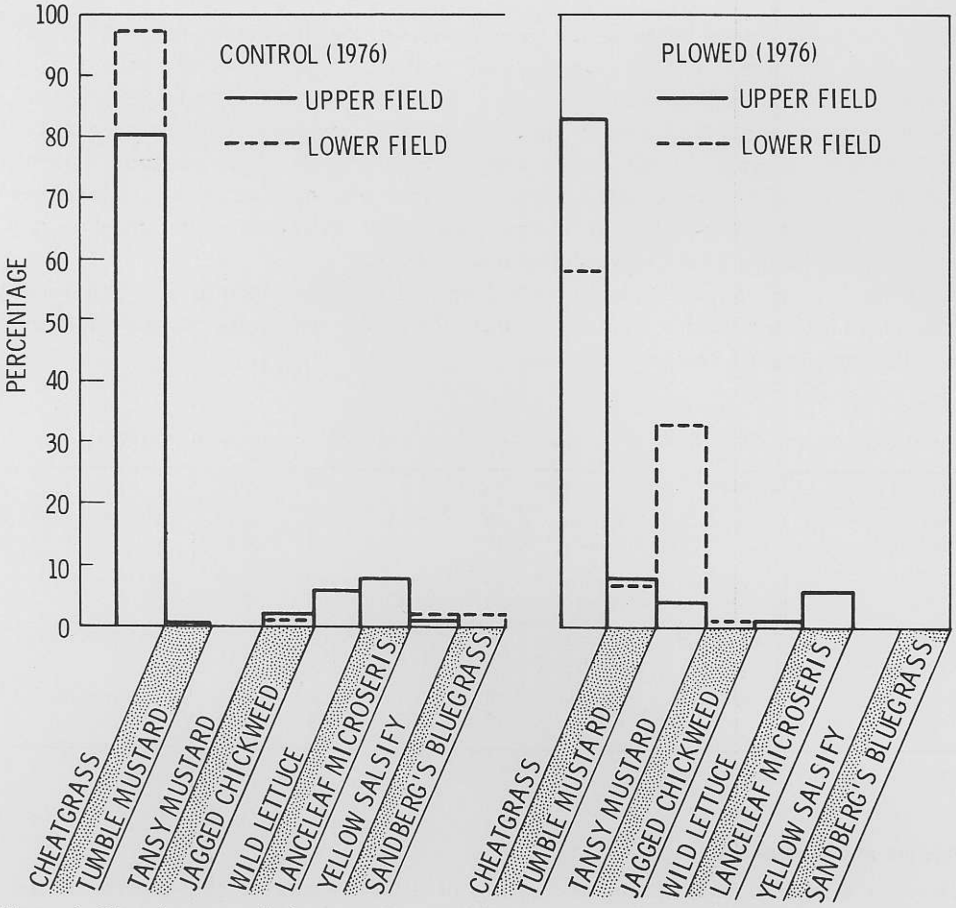

Figure 1. Live aboveground phytomass harvested from control and plowed plots during the spring of 1976 and 1977 at the upper and lower fields.

annual grassland. Mulch is regarded as an important feature of the California annual grassland community. Mulch removed prior to the seed germination period greatly reduced plant production (Hooper and Heady, 1970). Changes in botanical composition were also related to mulch accumulation (Heady, 1958, 1961). In our study, plowing effectively removed most of the mulch from the surface and placed it below the surface. Clearly the plowed plots in 1976 did not have as much mulch as the control plots (Fig. 2). Mulch removal by plowing enhanced plant production in the upper field in 1976 but depressed production on the lower field (Fig. 1). Enhanced production in 1976 contributed to the enhanced mulch accumulation on the plowed plots at the upper field in 1977, indicating that decomposition of dead plants is not very rapid.

The cheatgrass community is characterized by low species diversity (Fig. 3). After 30 years, most of the species are alien annuals. Only one native grass species was recorded on the study plots, sandberg bluegrass, *Poa sandbergii* Vasey. Lance leaf microseris, *Microseris lanciniata* (Hook). Schultz-Bip., a perennial forb and yellow salsify, *Tragopogon dubius* Scop., a biennial forb, were found only on the upper field.

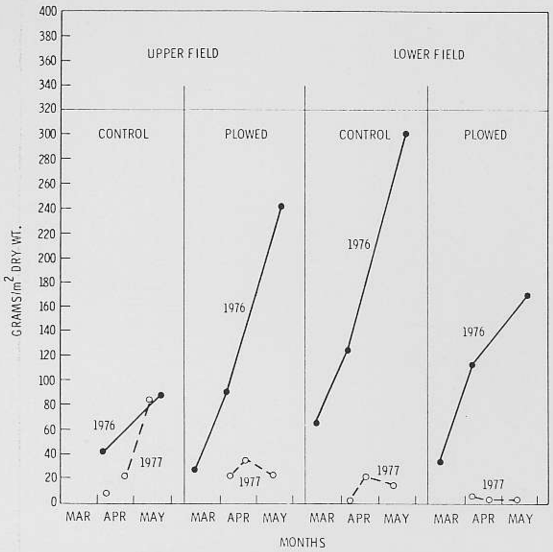

Figure 2. Dead aboveground phytomass (mulch) harvested from control and plowed plots during the spring of 1976 and 1977 at the upper and lower fields.

Cheatgrass, *Bromus tectorum* L., Tansy mustard, *Descurainia pinnata* (Walt.) Britt., jagged chickweed, *Holosteum umbellatum* L., and wild lettuce, *Lactuca serriola* L., were also present. In 1976 control plots were predominantly cheatgrass, but the plowed plots on the lower field supported a larger percentage of annual forbs than the adjacent control plots (Fig. 3). This finding suggests that heavy mulch favors cheatgrass and light mulch favors forbs.

Although the two fields were only slightly different in terms of climate and botanical composition, the response to plowing was very different. Plowing greatly enhanced production in the upper field but decreased production on the lower field, at least in 1976.

The data indicate that cheatgrass communities respond to plowing as a soil disturbance by promptly re-establishing the same species composition. Cheatgrass communities, although capable of occupying a site for a long time (decades), are poor in species composition and life forms as compared to stands of the climax *Artemisia tridentata/Agropyron spicatum* association (Daubenmire, 1970). Clearly the inadvertent introduction of cheatgrass and associated annuals to the shrub-steppe region more than a century ago has greatly interfered with the classical secondary succession pattern. With continuous disturbance by man, the role of cheatgrass in plant succession in the shrub-steppe region needs to be realistically evaluated when revegetation of severely disturbed ground is considered in situations other than continuous cultivated agriculture. The data also point out the fact that once disturbed by man's activities, native communities are very slow to return to the site. It is reasonable to expect that if the few remaining stands of native vegetation in the shrub steppe region are not offered some substantial protection, they could also disappear. As stated by Horn (1974), the conscious conservation of climax communities needs to be based upon the idea that climax communities are vulnerable to man's activities rather than

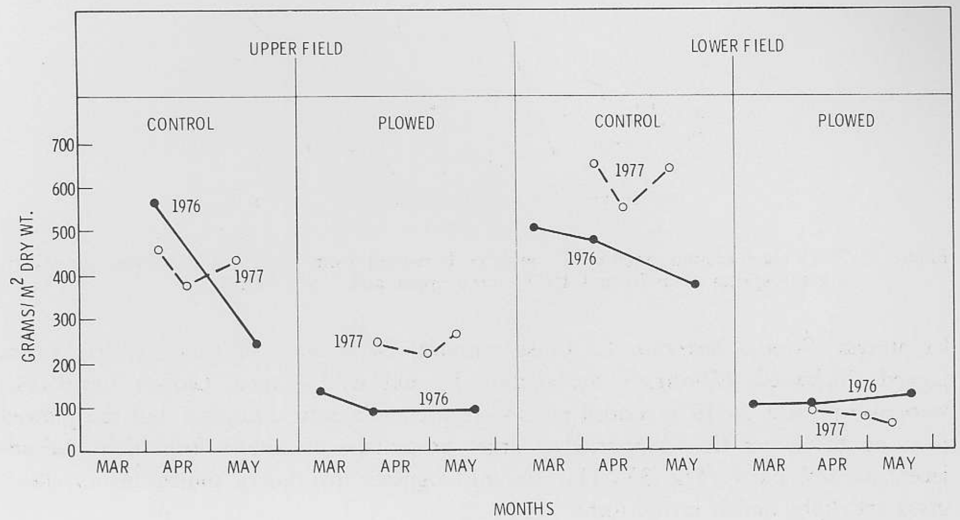

Figure 3. Species composition and contribution (percent) of each species to total live aboveground phytomass in plowed and control plots in cheatgrass communities during the spring of 1976 and 1977 at the upper and lower fields.

inherently stable. The cheatgrass communities are more productive than climax communities (Rickard *et al.*, 1974), at least in terms of aboveground production.

Acknowledgments

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