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Nitrogen Yield in Reproductive Organs of Crested Wheatgrass[1]

Abstract

Nitrogen yield of reproductive organs in crested wheatgrass (*Agropyron desertorum*) were, in 3 years, approximately 0.9, 2.4, and 3.0 kg/ha per annum and were associated with herbage yields of 298, 1636, and 1522 kg/ha, respectively. In 1 year, heavy rains shortly after anthesis caused increases in herbage yield and, despite a decline in herbage N concentration, no net decrease in absolute N in the aerial biomass occurred in the subsequent 6 weeks. In a year, with dry conditions prevailing after anthesis, a net loss of absolute N (5.5 kg/ha) occurred in the aerial portions in the following 5 weeks. Of that 5.5 kg, 3.0 kg/ha (55 percent) was accounted for by N contained in the reproductive organs.

Introduction

Westselaar and Farquhar (1980), after a comprehensive review of the world's literature, infer the absolute amount of N in the aerial biomass of plants peak near anthesis and subsequently decreases with time as the crop matures. They conclude, "For perennial species such losses are at least partially accounted for by accumulation in below-ground storage organs," and "Net losses from tops may result from cumulative effects of a large number of small losses, some of which increase with N content or with senescence." Quantitative estimates of the various N-loss compartments are needed when assessing nitrogen balance in the plant-soil system. This paper reports quantitative estimates of N in the reproductive organs of Nordan crested wheatgrass (*Agropyron desertorum*) and concomitant N yield change in herbage from anthesis to seed development.

Locale and Procedure

The study was conducted on a sandy loam soil located on the Squaw Butte Experiment Station, 68 km west of Burns, Oregon. Median precipitation amount for the period 1 September to 30 June is 25 cm. The months of July and August are usually dry (median precipitation is less than 0.4 and 0.6 cm, respectively). The 9 x 18 m plots selected were seeded in 1954 and revelant data collected in 1967, 1969, and 1978.

In 1967, 100 yield plots (.093 m^2) at random along rows 0.3 m apart were harvested on 29 June (onset of anthesis) and the numbers of reproductive stems counted in each. The number of spiklets/head was determined from 100 randomly selected heads and the number of florets/spiklet determined from a random sample of 30 stems. Twenty samples of reproductive organs, each containing 10 floral units (30 anthers plus filiments, style, plumules, and ovaries) were obtained with the aid

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of tweezers for N determination. An additional sample of anthers only was obtained by hand stripping the heads in the field.

In 1969, herbage yield plots (0.19 m^2) at random along rows 0.6 m apart were harvested on 13 June (anthesis onset), 1 July (anthesis termination), and 23 July (seed firm). Reproductive stems in all samples of the first two harvest dates were counted. Nitrogen concentration of 15 randomly selected yield samples for each harvest date was determined. Head length was measured to the nearest mm on nine reproductive heads selected at random on 13 June and N determined on the reproductive organs plucked from each seedhead.

Attempts to continue the study were made in a number of subsequent years, but precipitation following anthesis caused the author to abort the study. In 1978, a favorable dry sequence occurred and scheduled sampling was completed. In that year on 1 July when anthesis was noticed, 100 herbage yield plots (0.19 m^2) at random along rows 0.6 m apart were harvested, reproductive stems in each sample counted and oven dry weight and N concentration determined. The lengths of 25 seedheads selected at random were measured to the nearest mm and the reproductive organs removed and analyzed for N. An additional 350 seedheads collected at random were also measured for length. On 8 August terminal yield and N concentration were obtained.

Yield samples were oven dried at 50-60°C, weighed, and then processed in a Wiley mill for N analyses. Reproductive samples were air-dried prior to laboratory analyses and results reported on a dry weight basis. The Kjeldahl procedure used did not include special techniques to ensure total reduction of nitrate-N present. Data means within a year were tested with "t" at the 5 percent probability level.

Results and Discussion

Mean weight, numbers, and statistics for the various components in 1967 are presented in Table 1. The mean N yield in the reproductive organs from component estimates

TABLE 1. Seedhead components measured in crested wheatgrass, 29 June 1967.

Component	Measure	Sample size
Floral yield (grams/unit[1])	0.0042±0.0005[2]	20
Florets (number/spiklet)	2.69±0.01[2]	30
Spiklets (number/head)	15.61±1.32[2]	100
Heads (number/m^2)	150.4±11.7[2]	100

[1]Unit=30 anthers plus associated reproductive parts.

[2]P=0.05.

was 0.92±0.10 kg/ha at the 5 percent probability level. That amount was associated with a mean herbage yield of 928 kg/ha resulting from a September to June precipitation amount of 30 cm. Nitrogen concentration of anthers hand-stripped in the field (2.9 percent) was about 0.6 percent lower than contained in hand-plucked samples of all reproductive organs (3.5 percent).

The mean N concentration of reproductive organs was 4.2 percent in 1969 and the mean yield of nitrogen per head estimated at 0.88±0.4 mg at the 5 percent probability level. With 268 reproductive stems per m^2 (Table 2), the nitrogen yield of floral parts per hectare was estimated at 2.4 kg on 13 June. During the period 20 to 28

TABLE 2. Sampling estimates for crested wheatgrass in 1969.

Harvest date	Sample mean	Confidence interval[1]	Sample size
	Herbage yield (kg/ha)		
13 June	1340	± 24	100
1 July	1622	± 20	100
23 July	1711	± 26	100
13 June	1636	±381	15
1 July	1590	±456	15
23 July	2358	±647	15
	Reproductive stems (no/m²)		
13 June	268	± 6	100
1 July	278	± 5	100
	Herbage nitrogen (%)		
13 June	1.01	± 0.04	15
1 July	.83	± 0.06	15
23 July	.71	± 0.07	15
	Herbage nitrogen yield (kg/ha)		
13 June	16.5	± 0.4	15
1 July	13.2	± 0.4	15
23 July	16.7	± 0.5	15

[1]P=0.05

June, 3.1 cm of precipitation occurred and caused a continuation of growth such that a herbage yield increase occurred between 13 June and 23 July (as judged by the 100 samples). Thus, despite a loss of reproductive organs and a decline in herbage N concentration from 1.01 to 0.83 to 0.71 percent following anthesis during the sampling period, there was no significant change in N yield in the aerial portions between 13 June and 23 July. The mean herbage yield (1636 kg/ha) on 13 June contained 16.5 kg of N including the 2.4 kg in the reproductive organs. During the September to 13 June period 24 cm of precipitation was received.

It is clear from Table 2 that use of 15 yield samples was insufficient to estimate the mean herbage yield with acceptable precision, although that number was adequate (as judged by the 95 percent confidence interval) to estimate mean nitrogen concentration. The nine seedheads from which reproductive organs were removed was only marginally acceptable.

Herbage yield on 1 July 1978 was 1522 and increased to 1611 kg/ha by 8 August, a nonsignificant increase (Table 3). Herbage nitrogen in the same period decreased significantly ($P<0.05$) from 0.93 to 0.54 percent. From these values, nitrogen yield in the aerial portions was estimated to be 14.2 kg/ha on 1 July and 8.7 kg/ha on 8 August, a net loss of 5.5 kg/ha (39 percent of that present on 1 July).

Data in 1969 suggested a linear relation between total nitrogen in the reproductive organs in seedheads with the length of the seedhead. But because of the small sample size and several sterile florets, the relation was not well expressed. In 1978, the mean N/hd was 1.467±0.38 mg based upon the 25 samples with a mean seedhead length of 52.8 mm. However, total N in the reproductive organs was significantly (<0.05) related ($r=0.85$) with head length (Fig. 1). The population mean seedhead length of 44.0 mm as estimated from the 350 samples and the regression relation suggest that the true mean N/hd is about 1.08 mg. Using 1.08 mg/hd and 275 reproductive stems per m^2, 3.0 kg/ha of N is estimated in that compartment of the aerial biomass. This

TABLE 3. Sample estimates for crested wheatgrass in 1978.

Harvest date	Sample mean	Confidence interval[1]	Sample size
	Herbage yield (kg/ha)		
1 July	1522	±182	100
8 August	1611	±140	100
	Herbage nitrogen (%)		
1 July	0.93	± 0.02	100
8 August	0.54	± 0.01	100
	Reproductive stems (no/^{2}m)		
1 July	275	± 8	100
	Seedhead length (mm)		
1 July	52.8	± 7.4	25
1 July	44.0	± 1.8	100

[1]P=0.05.

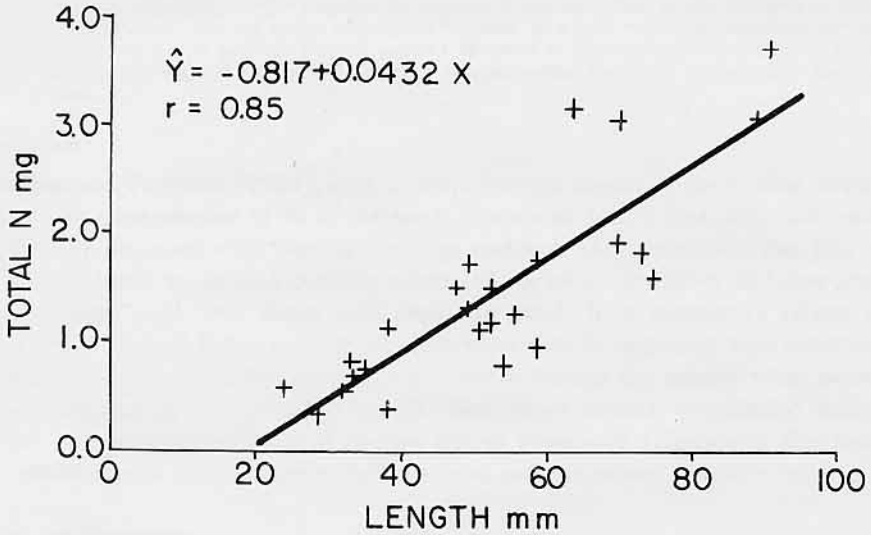

Figure 1. Total N in reproductive organs of crested wheatgrass as a function of seedhead length (1978).

estimate represents about 21 percent of the total N in the aerial portion on 1 July and is 55 percent of the nitrogen that disappeared from the aerial portion between 1 July and 8 August. During the September to June cropyear period, the total precipitation was 32 cm.

Precipitation occurring after anthesis may or may not significantly alter nitrogen contents in crested wheatgrass plants. However, if a sufficient amount of precipitation is received, as in 1969, nitrogen translocation may be delayed or confounded and the likelihood of large errors in sampling increased. Thus, the absence of precipitation following anthesis is more desirable to obtain a clear picture of the N yield-loss relation.

Plucking out the total reproductive unit probably overestimates the amount of N actually lost, as the ovary or a part of it is assimilated in the seed formation process. In contrast, plucking at the first visual observation of anthesis likely underestimates

the N lost as the yield of reproductive organs is perhaps reduced because of immaturity. Also, since the Kjeldahl procedure used did not reduce the nitrate-N component, total N is underestimated to that extent.

Literature Cited

Wetselaar, R., and G. D. Farquhar. 1980. Nitrogen losses from tops of plants. Advances in Agronomy 33: 263-302.

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