Estimating Straw Production of Spring and Winter Wheat

Richard Engel[1], Dan Long[2], Gregg Carlson[2], and Rosie Wallander[1]

[1]Dept. of Land Resources and Environmental Sciences, Bozeman, and [2]Northern Agricultural Research Center, Havre, Montana State University

Introduction

Accurate estimates of straw production for spring and winter wheat (*Triticum aestivum L.*) are important in Montana because crop residue provides protection against wind and water erosion, residue influences nutrient cycling and fertilizer recommendations, and historically, many federal crop programs have required growers to submit a conservation plan that preserves a specified level of crop residue. Straw production levels for wheat frequently are estimated based on measurements of grain production and the assumption of a strong relationship between grain and straw. Often this relationship is assumed to be direct or linear. For example, the USDA Natural Resources Conservation Service in Montana uses grain yield and a constant straw to grain ratio of 1.33 and 1.67 to estimate the quantity of residue produced by spring wheat and winter wheat respectively. Wheat cultivars grown in Montana differ greatly in height and tillering from one year to the next, due to factors related to water, N fertility, and cultivar. These characteristics may influence grain to straw relationships and therefore the accuracy of straw production estimates. The objective of this study was to examine the stability of grain: straw relationships in four spring and winter wheat cultivars under a gradient of water and N fertility, and to determine if accurate estimates of straw production can be based on grain yield using constant ratios or NRCS default values.

Methods

Field studies were conducted over 5 years on spring wheat (1996-1998) and winter wheat (2000-2001) at the Northern Agricultural Research Center, near Havre, Montana. Pre-plant soil NO_3-N test levels were 8, 40, 41, 17, and 22 lbs/a (0-24 inch depth) in 1996, 1997, 1998, 2000, and 2001 respectively. A solid-set irrigation system was used to create three distinct water environments (low, moderate, and high) according to the following scheduling scheme. In the low water regime wheat was grown under dryland conditions, except for a single irrigation shortly after crop emergence (approximately 1.5 to 2.5 inches for stand establishment). In the moderate regime, wheat received a single irrigation after crop emergence, plus two irrigation events during the vegetative growth period (late-tillering and heading). In the high water regime, wheat received irrigation as in the moderate regime, plus irrigation during grain-fill (2 events in 1996, 1 event for other seasons). Within each water regime four wheat varieties (Amidon, McNeal, Hiline, Rambo for spring wheat study, CDC Kestrel, Erhardt, Rampart, McGuire for winter wheat study) were seeded in factorial combination with five N fertilizer levels. The N fertilizer rates were designed to provide a wide range of N fertilizer conditions across the study site.

Results

Scatter diagrams reveal that the relationship between straw yield and winter wheat grain yield is linear and consistent with the NRCS default value of 1.67 (Figure 1A). This relationship says that for every bushel of grain produced (60 lbs), approximately 100 pounds of straw is generated. In most cases this relationship predicts the actual winter wheat straw yield to within ±750 lbs (indicated by broken lines). Water and N environments in this study ranged from 2.8 to 13.9 inches of growing season precipitation (rainfall + irrigation) and from 20 to 220 lbs of available N (soil nitrate-N + fertilizer N), respectively. Plant heights were affected by N, water, and cultivar selection, and varied from 12 to 37 inches. Hence the results indicate that even with a diverse set of environments and plant morphology the straw yield vs. grain yield relationship is typically stable. Only in three instances (out of

Fertilizer

F a c t s

F e r t i l i z e r ✔ o f f

Jan 2005

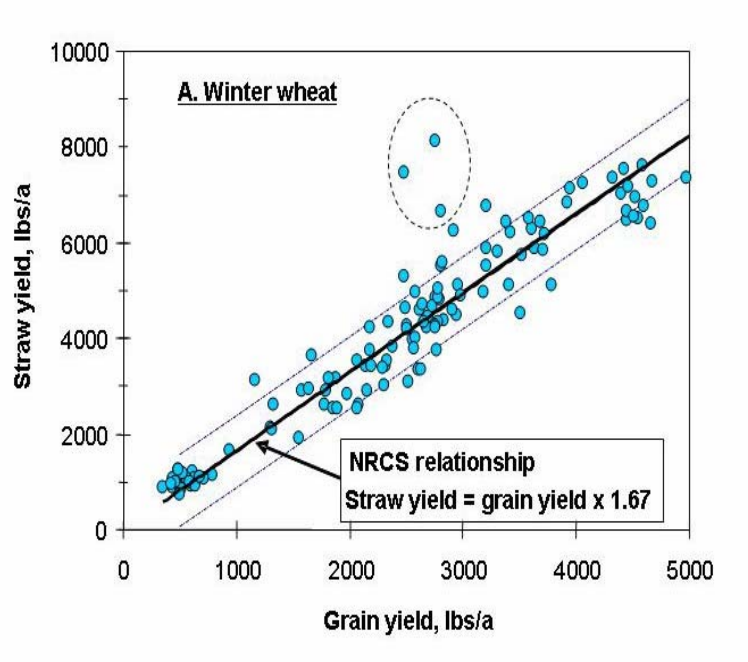
Number 33

MONTANA STATE UNIVERSITY EXTENSION SERVICE

Extension Service
Agricultural
Experiment Station

120) were estimates far outside of this range as denoted by the outliers in the winter wheat diagram (Figure 1).

Scatter diagrams of straw yield to spring wheat grain yield show a more disperse cloud of data-points around the NRCS default value line of 1.33 (Figure 1B). Two things are evident from this figure: first the relationship between straw and grain yield is much more variable in spring wheat than winter wheat, and second, multiplying grain yield by a constant factor (e.g. the NRCS default value of 1.33) frequently does not provide an accurate estimate of straw production. The water and N environments in this study ranged from 7.0 to 17.3 inches, and 10 to 250 lbs of available N (soil nitrate-N + fertilizer N), respectively. Hence, there was similar range of available water and N as was found in the winter wheat experiments. However, unlike winter wheat, spring wheat grain to straw relationships differed greatly with cultivar. Amidon, the tallest cultivar, generally exhibited the highest straw to grain ratios. Most of the data-points above the upper broken line are associated with this cultivar. Conversely, the shortest cultivar in this study (Hiline) frequently had ratios well below 1.33. Many of the data-points below the lower broken line are associated with this cultivar, and/or with the McNeal and Rambo (semi-dwarf cultivars) when grown under a high yield or high moisture environment.



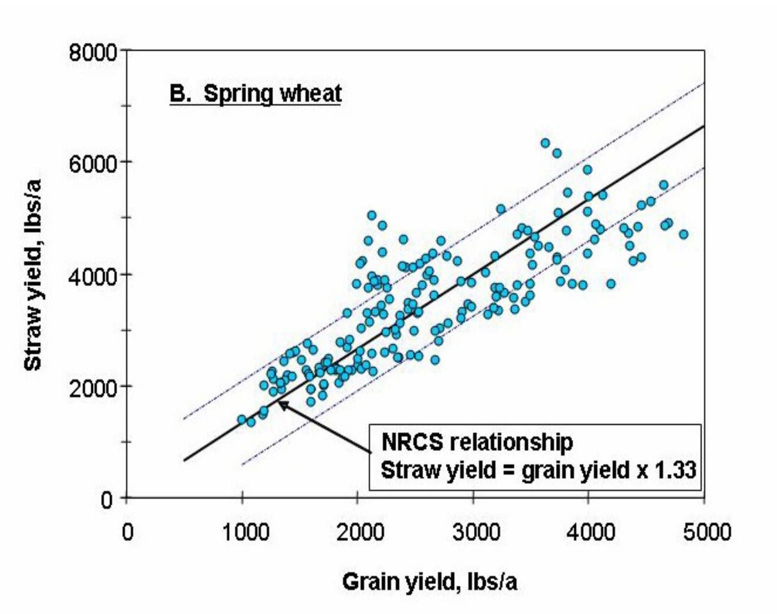


Figure 1. Relationship between straw yield and grain yield in winter wheat (A) and spring wheat (B).

Fertilizer Facts:

- Straw yield to grain yield relationships in winter wheat genotypes are much more stable than in spring wheat.
- The NRCS approach to estimating straw production in winter wheat from grain yield appears reliable under a wide range of water and N environments, and across different cultivars.
- Straw production estimates in spring wheat derived by multiplying grain yield by a constant factor are frequently unreliable.

Edited by Clain Jones, Extension Soil Fertility Specialist, and Evette Allison, Research Associate.