Project Title: Nitrogen Management in Wheat – Promoting Main Stems or Tillers?

Principle Investigators and Cooperators:

PI: Chengci Chen, Cropping Systems Agronomist,
Central Agricultural Research Center,
Moccasin, MT. Tel: (406) 423-5421, Fax: (406) 423-5422
E-mail: cchen@montana.edu

Other Personnel and Cooperators:
Karnes Neill, Research Associate, Central Ag. Research Center, MSU
Dave Wichman, Agronomist, Central Ag. Research Center, MSU
Leann Fox, Temporary Research Assistant, Central Ag. Research Center
Joe Vavrovsky, Research Specialist, Central Ag. Research Center

Objectives:

1. Investigate plant population, row spacing, and split-application of N affecting growth, development, and yield and yield components of main stems and tillers of wheat.

2. Determine if agronomic strategies that promote head-bearing main stems are superior to those that promote tillers in improving wheat yield.

Materials and Methods:

A field experiment was conducted in the spring of 2003. The experiment was carried out at the Central Agricultural Research Center of Montana State University, Moccasin, MT. McNeal spring wheat was planted in a tilled re-cropped field after yellow mustard.

Treatments:

1). Plant density: PD1 = 10, PD2 = 20, PD3 = 30, and PD4 = 40 seeds ft^{-2}.
2). Row spacing: RS1 = 6" and RS2 = 12".
3). Fertilizer N split-application: FA1 represented 100% applied at seeding, FA2 represented 50% at seeding and 50% at tillering, FA3 represented 50% at seeding and 50% at elongation. Total amount of N was 90 lbs a^{-1} using a mixed liquid fertilizer.

The experiment was arranged as a split-split-plot design, with row spacing as main-plots, split-N application as split-plots, and plant population as split-split-plots. Plot size was 4 ft x 30 ft. A 4-ft wide plot drill with disk-type openers was used to seed the plots. Plots were planted on April 22, 2003. Herbicides, Glyphosate and Bronate, were applied as pre-seeding and post emergence weed control, respectively.

Project Results and Relevancy to Montana:

Row spacing and fertilizer split application did not affect the total number of tillers per plant, but plant density significantly affected the total tiller numbers per plant ($P<0.05$). The number of tillers reduced from 5.3 to 2.4 when plant density increased from 10 (PD1) to 40 (PD4) plants ft^{-2} (Table 1).

Total number of tillers bearing heads was also significantly affected by plant density ($P<0.05$). The number of head-bearing tillers reduced from 3 to 1 when the plant density increased from PD1 (10) to PD4 (40). There was a slight difference between the two row spaces (Table 2).

Table 1. Total tillers per plant at tillering stage.

Row Space		Fertilizer Application		Plant Density	
RS 1	3.54[a*]	**FA 1**	3.39[a]	**PD 1**	5.27[a]
RS 2	3.58[a]	**FA 2**	3.72[a]	**PD 2**	3.84[b]
		FA 3	3.56[a]	**PD 3**	2.69[c]
				PD 4	2.43[c]

* Different letters in the same column indicate significant differences based on Fisher's protected LSD ($p<0.05$).

Table 2. Total tillers per plant bearing heads.

	RS 1	RS 2
PD 1	3.45[a*]	3.12[a]
PD 2	1.76[b]	2.02[b]
PD 3	0.83[c]	1.37[c]
PD 4	0.67[c]	1.10[c]

*Different letters in the same column indicate significant differences based on Fisher's protected LSD ($P<0.05$).

Row space did not affect the grain yield, but fertilizer application and plant density had significant effects on grain yield ($P<0.05$, Table 3). The treatment with 50% N applied at elongation (FA3) increased grain yield 2.7 bushels per acre compared with the treatment with 100% N applied at seeding (FA1). Spring wheat with plant density of 30 and 40 plants ft^{-2} (PD3 and PD4) had 2.9 bu a^{-1} higher grain yield than that with 20 plants ft^{-2} plant density (Table 3).

Table 3. Grain yield (bu a^{-1}) as affected by row spacing, fertilizer application, and plant density.

Row Space		Fertilizer Application		Plant Density	
RS 1	23.4[a*]	**FA 1**	20.5[b]	**PD 1**	20.7[ab]
RS 2	20.1[a]	**FA 2**	21.6[ab]	**PD 2**	20.2[b]
		FA 3	23.2[a]	**PD 3**	23.1[a]
				PD 4	23.1[a]

*Different letters in the same column indicate significant differences based on Fisher's protected LSD ($P<0.05$).

The contribution of main stem to total yield was significantly affected by row spacing and plant density ($P<0.05$), but it was not affected by the split application of fertilizer. Main stem had greater contribution to the total grain yield at 6" (RS1) than at 12'' (RS2) row spacing. The proportion of main stems contributed to the total yield increased with plant density increased (Table 4). The relationship of grain yield for the main stem, tillers, and expected total yield as affected by plant density can be seen in Fig. 1.

Table 4. Contribution of main stem to total grain yield (%).

Row Space		Fertilizer Application		Plant Density	
RS 1	59.1[a*]	**FA 1**	57.6[a]	**PD 1**	36.8[c]
RS 2	52.8[b]	**FA 2**	56.6[a]	**PD 2**	47.9[b]
		FA 3	53.8[a]	**PD 3**	66.8[a]
				PD 4	72.4[a]

*Different letters in the same column indicate significant differences based on Fisher's protected LSD ($P<0.05$).

Protein content for spring wheat was higher in this year's study than in other normal years due to the severe summer drought. Row spacing and fertilizer application effects on the protein content were not obvious, but there was a trend of increasing protein content with increased plant density (Fig. 2). Higher population might have encountered a greater water stress which could have resulted in higher protein content.

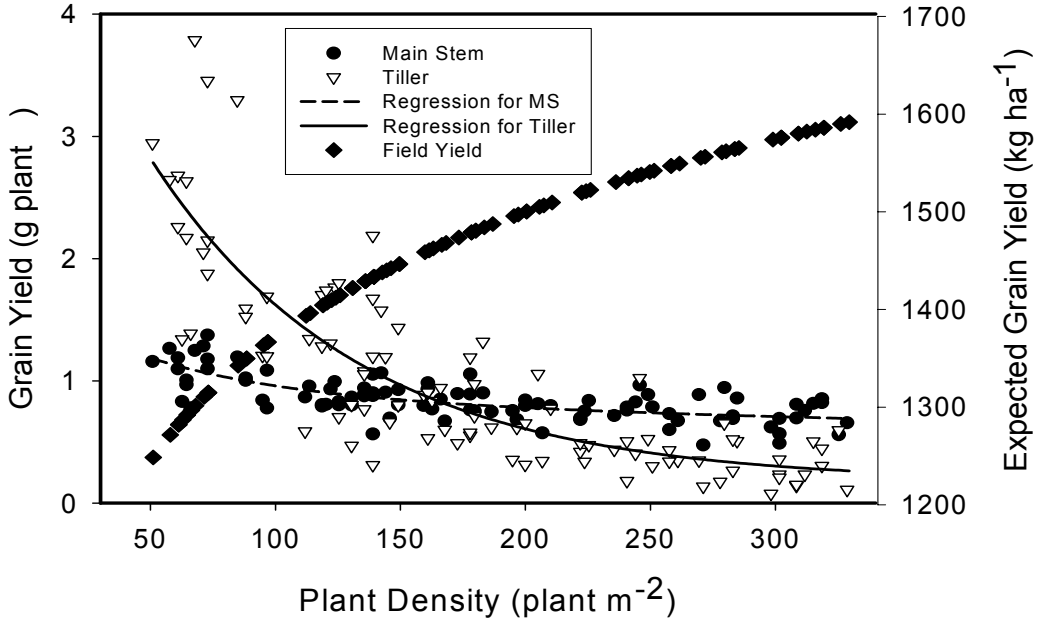

Fig. 1. Relationships between main stem, tiller, and expected total yield.

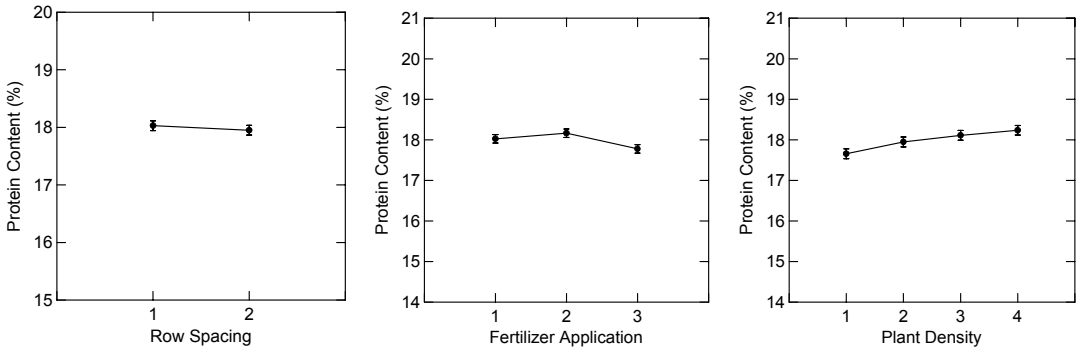

Fig. 2. Protein content as affected by row spacing, fertilizer split application, and plant density.

Summary:

In summery, row space, fertilizer split application, and plant density have shown different degrees of effect on tiller and main stem development and senescence, and consequently on grain yield. Understanding the growth and development of main stems and tillers as well as limiting factors will help growers in Montana to choose the best management strategy to increase spring wheat yield and reduce the adverse impact of environment factors and management practices. The information of tiller development and contribution to total grain yield can also be used in crop insurance appraisals, such information is, so far, unavailable in Montana. Although, very promising results have been obtained in 2003, these results are not adequate for yield estimation or insurance purpose due to the severe summer drought in 2003. It is required to repeat this study in 2004 crop season.

Future Plan:

We intend to run this study for three years. The field study will be repeated in 2004. We acknowledge the funding support from the Montana Fertilizer Advisory Committee.