Appropriate Seeding Rates to Optimize Mid-Atlantic Bread Wheat Yield and Quality

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Abstract

A large proportion of the wheat (*Triticum aestivum* L.) milled and utilized by bakeries in the eastern U.S. is hard red winter wheat (HRWW). Potential for producing this higher-value commodity in the eastern U.S. is dependent on availability of adapted HRWW cultivars that are competitive with soft red winter wheat (SRWW) cultivars and implementation of management systems to enhance end-use quality. The objectives of the present research were to determine seeding rates that optimize plant stand and population, final grain yield, and quality for bread wheat cultivars grown in the Mid-Atlantic region.

Seeding rates were selected to encompass a range below and above normal for SRWW cultivars (five equal increments from 277 to 646 seeds m^{-2}). Five potential bread wheat cultivars; Karl 92, Soissons, Tam 110, Lakin, and Renwood 3260 selected for their diverse backgrounds, quality, and agronomic performance were evaluated at each seeding rate in a randomized complete block design at two locations annually from 2005 to 2007. A significant quadratic effect of seeding rate on early season plant density was observed at all sites. The number of heads was generally increased with seeding rate up through 646 seeds m^{-2} while kernel weight was unaffected. Yield was also increased with seeding rate up through 550 seeds m^{-2} which is approximately 40% higher than the current SRWW recommendation. Seeding rate impacts on grain protein and gluten score were insignificant compared to the influence of cultivar and testing environment.


Objectives

The objectives of the present research were to determine seeding rates that optimize plant stand and population, final grain yield, and milling quality for bread wheat cultivars grown in the Mid-Atlantic region.

Materials and Methods

• Trials were conducted across a range of environments and soil types across Virginia from 2005 to 2007.

Site	Soil Type	N	P	K	Planting Date	Harvest Date
2004-05		---kg ha^{-1}---				
Chatham, VA	Cecil Sandy Clay Loam	134	39	74	18-Oct	23-Jun
Natural Bridge, VA	Frederick Silt Loam	129	44	93	11-Oct	11-Jul
2005-06						
Painter, VA	Bojac Sandy Loam	151	24	46	01-Nov	20-Jun
Holland, VA	Dragston/Eunola Sandy Loam	170	27	101	07-Nov	22-Jun
2006-07						
Painter, VA	Bojac Sandy Loam	151	24	46	02-Nov	19-Jun
Mt. Jackson, VA	Frederick Silt Loam	157	24	46	24-Nov	03-Jul

• All trials employed a randomized complete block design with seeding rates of 277, 369, 461, 553, and 646 seeds m^{-2}. Seed germination (%) prior to planting was determined by the Virginia Department of Agriculture Seed Laboratory and seeding rates adjusted accordingly .

• Plot size was 1.52 by 2.74 m.

• Commercially available bread wheat cultivars 'Karl 92', 'Soissons', 'Tam 110', 'Lakin', and 'Renwood 3260' were chosen for evaluation based on sound performance in other regional trials.

• Post emergence, all plants from 0.92m of the center row in each plot were counted to determine percent emergence and initial plant population.

• After heading, all plants from 0.92 m of row from three locations in each plot were counted to determine spike density.

• Plots were rated for lodging each year prior to harvest using the Belgian lodging index.

• Grain was harvested using a Massey Ferguson 8XP plot combine. Grain yields are reported on a 135 g kg^{-1} moisture basis.

• A subsample was taken from each plot upon which test weight and moisture were determined. Weight $kernel^{-1}$ based on the 1,000 kernel weight was also determined from the subsample.

• Kernels $head^{-1}$ was calculated as the product of kernels m^{-2} and kernels $head^{-1}$.

• Grain protein and zeleny score were determine using a Dickey-John OmegAnalyzer G NIRT unit.

• Statistical analysis was performed using the GLM procedure available from SAS (SAS Institute, 2004).

Results

• Due to the interaction of seeding rate effect with locations and years, results for grain yield, quality, and yield components are presented by site and year (Table 1).

• No cultivar by seeding rate interaction was observed for any measured variable.

Table 1. Single degree of freedom contrasts for linear and quadratic effects of seeding rate on plant stand, grain yield, quality, and yield components.

		2004-05		2005-06		2006-07	
		Chatham	Natural Bridge	Painter	Holland	Painter	Mt. Jackson
		---Pr>F---					
GS 11 Plants m^{-2}	Linear	**	**	**	**	**	**
	Quadratic	ns	**	**	ns	ns	ns
GS 75 Heads m^{-2}	Linear	ns	ns	ns	ns	**	ns
	Quadratic	ns	ns	ns	ns	ns	ns
Lodging Score	Linear	ns	na	na	na	na	na
	Quadratic	ns	na	na	na	na	na
Kernel Weight	Linear	ns	ns	*	ns	ns	ns
	Quadratic	ns	ns	ns	ns	ns	ns
Kernels $Head^{-1}$	Linear	ns	ns	ns	ns	ns	ns
	Quadratic	ns	ns	ns	ns	ns	ns
Test Weight	Linear	ns	ns	ns	ns	ns	ns
	Quadratic	ns	ns	ns	ns	ns	ns
Grain Yield	Linear	*	**	*	**	ns	**
	Quadratic	ns	ns	ns	ns	ns	ns
Protein	Linear	**	ns	ns	*	ns	ns
	Quadratic	ns	ns	ns	ns	ns	ns
Zeleny	Linear	**	ns	ns	ns	ns	ns
	Quadratic	ns	ns	ns	ns	ns	ns

*, ** - Significant at the 0.05 and 0.01 level, respectively
ns - Not significant
na - Not available

Figure 1. Plants per square meter at GS 11 as influenced by seeding rate, mean of six site-years.

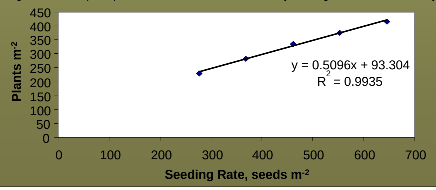


Figure 2. Grain heads per square meter at GS 75 as influenced by seeding rate, mean of six site-years.

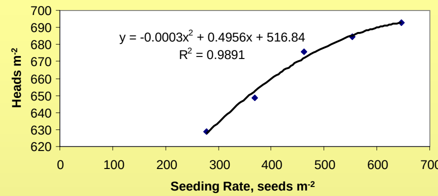


Figure 3. Kernel number per head and individual weight per kernel as influenced by seeding rate, mean of six site-years.

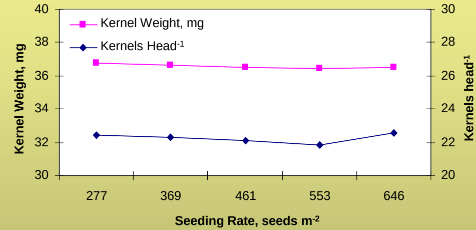


Figure 4. Grain test weight as influenced by seeding rate, mean of six site-years.

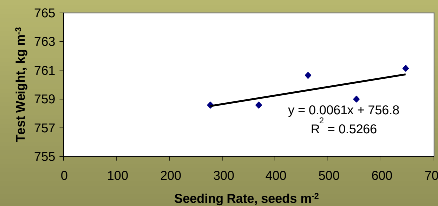


Figure 5. Grain yield as influenced by seeding rate, mean of six site-years.

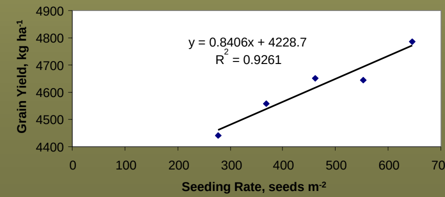


Figure 6. Grain protein as influenced by seeding rate, mean of six site-years.

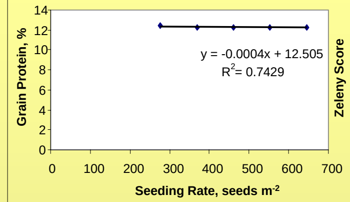
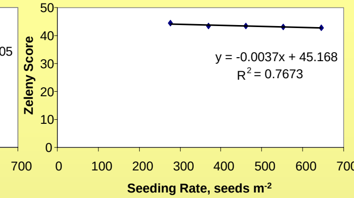


Figure 7. Zeleny sedimentation score as influenced by seeding rate, mean of six site-years.



553 seeds m^{-2}

277 seeds m^{-2}

Results & Conclusions

▪A linear effect of seeding rate on early season plant density was observed across sites. This is to be expected as higher seeding rates result in more seedlings.

▪While often not resulting in a significant trend, overall, Figure 2 demonstrates that the number of heads was increased with increased seeding rate up through 600 seeds m^{-2}. High seeding rates generally result in a fewer tillers and more main stem heads. Interplant competition usually limits the total number of heads per unit area and we observed this phenomenon in these plots.

▪Kernel weight was not generally affected by seeding rate.

▪There was also no consistent effect of seeding rate on kernel number per head. Other researchers have reported a decrease in kernel number at high seeding rates, but this was not observed in these studies. Favorable weather that supported generally high yield levels may have limited any negative impact of high seeding density on kernel number.

▪Grain yield was increased with seeding rate, even at what would normally be considered extremely high rates (Figure 5). For comparison, the recommended seeding rate for soft red winter wheat is approximately 375 seeds m^{-2}. Increase is attributed to the overall higher number of plants that resulted from higher seeding rates, but may also have been influenced by dry early spring conditions in 2006 and 2007. Tillers were aborted due to lack of moisture and the higher seeding rates, which generally produce more main stem heads and fewer secondary tillers, may have had a more developed root system and a greater ability to avoid drought.

▪Grain protein and Zeleny sedimentation scores both trended slightly downward with higher seeding rates but these were not significant based on single degree of freedom contrasts by site.