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Growing Bread Wheat in the Mid-Atlantic Region

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Introduction

The more than 55 million people who live in the mid-Atlantic region of the United States want to purchase processed grain foods such as bread and other dough products made from hard, or bread, wheat. To meet this demand, regional mills import bread wheat, which comes almost exclusively from the Plains states. These imports make up approximately 30 percent of the total grain needed for the region. Because the market exists for bread wheat, and because it is usually of higher value than soft wheat, growers are interested in using adapted cultivars and developing agronomic techniques to grow bread wheat in the mid-Atlantic region. Millers also are interested because their transportation costs, and thus their total cost, would be greatly reduced if they could by the bread wheat within the mid-Atlantic region.

At this time, bread-wheat marketing is solely through contracts with elevators and/or millers. Identity preservation, high quality, and preplanned marketing is necessary to garner increased value from the grains needed by the mills, because the majority of wheat produced in the mid-Atlantic region is, and will continue to be, soft wheat.

The purpose of this publication is to provide an understanding of wheat classes in the market place and outline production practices most appropriate for high-quality bread-wheat production in the mid-Atlantic region, which is characterized by high humidity and moderate temperatures.

Wheat Classes

Wheat is grouped into market classes associated with the type of wheat grown and its intended end-use. Wheat classes are determined not only by the time of planting and harvest but also by hardness, color, and shape of the kernel. Wheat within each class has similar characteristics as related to milling, baking, and food-use qualities.

The major classes are hard red winter wheat (HRWW), hard red spring wheat, soft red winter wheat (SRWW), durum, hard white wheat, and soft white wheat. A complete description of these wheat classes and their uses can be found at the U.S. Wheat Associates website (*www.uswheat.org/everyNeed/wheatClasses*). Hard red winter wheat is usually grown in semi-arid regions, has a wide range of protein content, usually averaging near 12 percent, and has good milling and baking characteristics for producing bread, rolls, and all-purpose flour. Soft red winter wheat is grown primarily in higher rainfall areas. It is generally higher yielding than HRWW, but has lower protein content, usually less than 10 percent, and has good milling and baking properties for cookies, cakes, crackers, and some flat breads. Soft white wheat is grown mainly in the Pacific Northwest, Michigan, Wisconsin, and New York. Its protein content is similar to SRWW, and the flour is used mainly for making cakes, muffins, cookies and pastries. Hard white wheat is a relatively new wheat class. It is closely related to the HRWW but has a milder, sweeter flavor and is used mainly in yeast breads, hard rolls, bulgur, and oriental noodles. Durum wheat has the hardest ker-

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nels of all U.S. wheat. It is a spring wheat that is grown mainly in the northern Great Plains. Durum wheat is used to make semolina flour for pasta production.

Wheat Kernel Properties

Over 80 percent of the weight of the wheat kernel is starchy endosperm, the part of the kernel that is milled to produce flour. Endosperm cells consist of tightly packed starch granules and seed storage proteins. Surrounding the starch granules is a matrix of gluten-forming proteins. The physical base for determining endosperm hardness is the binding strength between the starch granules and protein matrix. In soft wheat, the starch granules are loosely attached to the protein matrix. Soft wheat is easy to grind and produces fine-textured flour. The binding of the starch granules to the protein matrix is much stronger in hard wheat and more force is required to crush the kernel. This results in coarse-textured flour with more broken starch granules. Hard, or bread, wheat flour is generally preferred for any kind of yeast-leavened bread because damaged starch granules increase water uptake, resulting in soft bread. Broken starch granules are also more readily hydrolyzed by alpha-amylase, providing more fermentable sugars for the yeast. Increased water absorption is not desirable in soft wheat flour because many soft wheat products are baked to low moisture content, and are relatively dense compared to breads.

Wheat Class and Production Region

Growing environment, genotype, and the interaction between these factors greatly influence the yield and end-use quality of wheat. Environmental factors such as temperature, rainfall, and day length are beyond the control of managers. However, environmental conditions have favored the selection of certain types of wheat in various regions. For example, in semi-arid regions, hard wheat cultivars have relatively low yields but high protein content because the protein accumulates relative to starch in the kernels. In humid regions, soft wheats have been favored because the climate is favorable to higher yields, resulting in a dilution of the protein level in the kernels. However, inputs that affect the growing environment, such as seeding rate, fertilizers, herbicides, fungicides, etc. are controlled by managers. Recent breeding efforts have developed more adapted hard wheat cultivars for growth in humid climates, and research has developed improved nitrogen and sulfur fertilization techniques for increasing protein content.

Production Programs

Cultivar Selection

Cultivar selection may be the most important management decision made in bread-wheat production. Yield potential is important and typically the first consideration when choosing a cultivar; however, end-use quality and product consistency are of equal importance when selecting cultivars to be produced for specific markets. Decisions on which cultivar to plant should be based on performance data, including disease resistance, insect resistance, heading dates, lodging rates, height, test weight, and yield. Spreading risk by planting several cultivars with appreciably different maturity is recommended, especially if large acreage is planned.

No cultivar is well-suited for all environments or locations. Cultivar selection should consider the production scheme and area where it is to be grown. If plans are to double-crop soybeans following wheat, early maturing cultivars are the most appropriate. Many early maturing cultivars are more at risk for exposure to late spring frost when planted early in the recommended planting period. Planting these cultivars later in the recommended planting window is the best way to avoid excessive growth or very early heading.

Genetic resistance is the simplest and least expensive defense mechanism against diseases and insects. While no cultivar is completely immune to all diseases and insects, wide differences do occur and these factors should be included when making decisions on genetics. Annual evaluation of cultivar selection is necessary to ensure that disease population changes have not reduced the usefulness of the genetic resistance of particular cultivars.

Similar to other traits, cultivars vary in straw strength and height. Select cultivars with good straw strength to prevent harvest losses associated with lodging, especially under high-yield management schemes. A shorter stem height and less straw are favorable when double-cropping wheat with soybeans. Taller cultivars are generally preferred when straw is to be harvested.

The growing environment greatly influences grain test weight, but this trait is also controlled by genetics, which determines the inherent maximum test weight potential of a given cultivar. Because the intended market for this product is flour, the total flour yield of the grain is important. While test weight is not directly associated with flour yield or end-use quality, grain that is sound, not weathered or sprouted, is required for good milling and baking quality. Grain soundness and lack of weathering are the most critical determinants of good end-use quality, and is why test weight is used to screen wheat, even though test weight is not directly correlated to flour yield from grain or baking properties. However, grain exposure to rainfall following physiological maturity until harvest greatly reduces end-use quality and value, and such exposure usually lowers the test weight. Upon ripening, harvesting grain at high moisture and drying it is one means of ensuring that the grain has high end-use quality, and a high test weight. A test weight significantly below 58 pounds per bushel (the standard for #2 US wheat) will probably result in a lower price received or may even exclude the wheat from being purchased for the purpose of milling for bread-wheat flour. Cultivars with genetically high test weight will more readily withstand wet harvest conditions and still achieve high test weights when compared to cultivars that have low maximum test weights.

Once the cultivars have been selected, using certified seed increases the likelihood of obtaining the necessary qualities of cultivar assurance and purity, high germination rate, and freedom from weed seeds. Research consistently shows that certified seed out performs bin run seed for stand establishment, early season vigor, and yield and decreases the introduction of weeds. The extra profit from certified seed more than compensates for the higher seed cost. Because end-use quality is paramount to success in identity-preserved markets and end-use quality depends largely on the genetics of a cultivar, using certified seed is probably the only means to ensure cultivar identity and end-use quality.

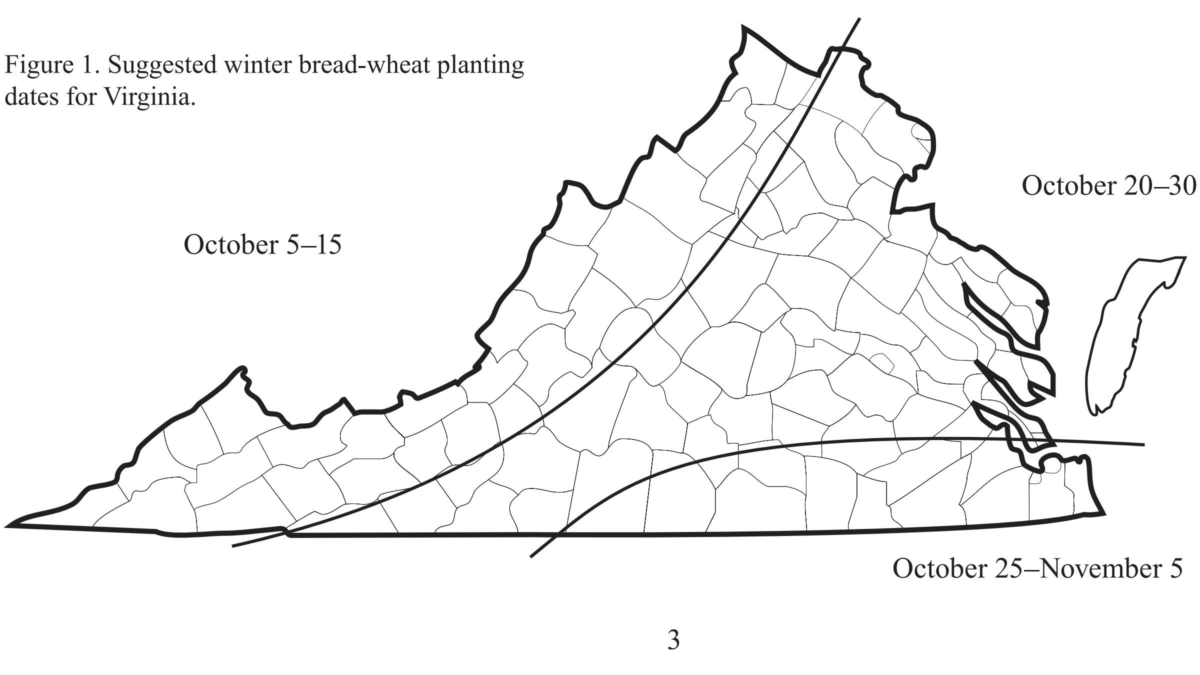
The availability of adapted HRWW cultivars is currently limited in the mid-Atlantic region because plant breeders have only recently focused on developing this type of wheat. Domestically available cultivars being tested along with cultivars imported from Europe have shown promise, both with respect to yields and quality. Available HRWW cultivars generally yield less than our best adapted SRWW cultivars, according to data from the Virginia Elite and Uniform Regional Bread Wheat Trials. Growers should carefully consider the potential yields and contract price premiums before deciding to grow bread wheats in the mid-Atlantic region. However, we anticipate that yield potential will increase as plant breeders develop cultivars specifically adapted to this region.

Seeding

In addition to genetic selection, planting decisions significantly impact the final yield. These planting decisions include seedbed preparation, planting date, seeding rate, and seeding depth. Planting timeliness and precision are key factors in obtaining the best yield. The key to building high yield potential is to establish an appropriate population on time for the particular area and to achieve a uniformly emerging wheat crop.

Planting date is a critical component of successful wheat production. Optimum yield potential is only achieved when planting occurs within the recommended window. This window for optimum yields is usually the date of the first annual fall freeze plus or minus one week. Improper cultivar selection, poor seed quality, late planting, incorrect

Figure 1. Suggested winter bread-wheat planting dates for Virginia.



plant population, and incorrect seeding depth cannot be overcome with in-season management practices. Figure 1 has suggested planting dates across the commonwealth.

These dates were determined based on evaluation by the Virginia Agricultural Statistics Service of 50 percent fall freeze probability for over 90 sites in Virginia. Planting wheat earlier than the recommended period will subject it to greater insect and disease pressure and subsequently to more winter injury. Although wheat emerges sooner and the shoot develops faster in warm soil, the root system develops much faster and more extensively if the soil is cool. Planting later than the recommended date may be even more detrimental to yield potential. Late-planted wheat will have fewer tillers, and thus fewer heads and reduced yield potential. Recommended seeding rates at various planting dates for bread-wheat cultivars are shown in Table 1.

Table 1. Recommended seeding rates for bread wheat in Virginia Tech.

Planting Time Row Width	On-time	Two Weeks Late
--inches--	---seeds/row foot---	
6	22	24
7	24	26
7.5	25	28
8	26	29

Virginia research demonstrates that seeding rates for current bread-wheat cultivars in a conventional, tilled seedbed should be at least 43 seeds per square foot (25 seeds per row foot in 7.5 inch rows) to approach optimum yields. Initial results support the conclusion that seeding at 45 to 50 seeds per square foot is appropriate for sites with high yield potential (>75 bushels per acre). Increased seeding rates are advisable when planting later than optimum and/or with no-tillage planting. It is advisable to increase no-tillage seeding rates by 10 percent over conventional rates when planting into heavy residue, such as corn stover, or when soil conditions make it difficult to maintain a constant planting depth. Increasing seeding rates generally is not necessary when planting after soybeans or when residue levels are not extremely high. If producers are growing both conventional and no-tillage wheat, it would be advisable to plant bread-wheat cultivars with conventional tillage, because no-tillage wheat often yields slightly less than conventionally planted wheat.

Because of the tendency for slower fall growth with no-tillage, extra effort should be expended to plant slightly earlier than with conventional tillage small-grain crops. This gives more time for tiller development in warmer weather. With earlier planting, it is important to consider using cultivars with medium to late heading dates or those that are day-length sensitive regarding initiation of heading to lessen the chance of spring freeze damage.

It is important that seed be placed at least 3/4 inch below the soil surface, not counting the residue layer in no-tillage seeding, to reduce the potential for winter kill from frost heaving and root and crown exposure to freeze injury. Too often in no-tillage production, seed is planted too shallow and germinates because of the residue coverage, but then cold temperatures cause significant winter-kill.

Fertilization

The recommended rates and timing for lime and fertilizer applications are similar to those for SRWW production. Nitrogen Management for Winter Wheat: Principles and Recommendations, Virginia Cooperative Extension publication 424-026, *http://pubs.ext.vt.edu/424-026/* and Intensive Soft Red Winter Wheat Production, Virginia Cooperative Extension publication 424-803, *http://pubs.ext.vt.edu/424-803/* have more information on these subjects. If lime is required as indicated by a soil test, it should be spread and, if possible, incorporated with tillage prior to beginning no-tillage production. Surface application of lime is an acceptable practice but the pH will be affected in a much smaller layer of soil. Soil samples should be taken from the depth of the plow layer in tilled fields and to a four-inch depth in no-tillage fields. Because early plant growth and tillering are often slower than with conventional production, topdressing nitrogen (N) is especially critical with no-tillage seeding. Pay close attention to the tiller density in the late fall and winter and apply N as recommended to develop the optimum number of tillers to support high yields. This is especially important with later plantings.

Baking quality of bread-wheat flour typically increases with increased grain protein and a minimum of 12 percent protein is desirable for bread baking. Protein and starch concentrations of wheat are inversely related; therefore, conditions that favor high yields typically favor low protein, and vice versa. One way to overcome this and increase grain protein is with a late-season foliar application of N directly to the crop. Virginia research has found that 30 to 40 pounds per acre of N as low-biuret urea dissolved in water applied between growth stage (GS) 45 and 54 will increase grain protein, even when previous N applications have been sufficient to support high yields (Figure 2). Low-biuret urea has reduced potential for foliar burn and dissolves more easily than granular or prilled urea. However, both granular and prilled urea are acceptable for foliar application. These materials dissolve more easily in warm water and should be strained to remove particles associated with anti-caking and sealing agents.

In some instances, the addition of 30 pounds per acre of sulfur (S) at GS 30 (jointing) is also important to achieving desirable grain protein levels. Figure 2 demonstrates the synergistic relationship between GS 30 S and late season (GS 45) N on grain protein observed in Virginia research.

Grain protein response to S depends on soil S availability. If the soil supply is low, then supplemental S fertilizer is crucial to achieving high grain protein. The best way to evaluate this is through tissue testing. An N : S ratio above 15:1 indicates a likely grain-yield response to S fertilizer and a ratio above 10:1 a protein response.

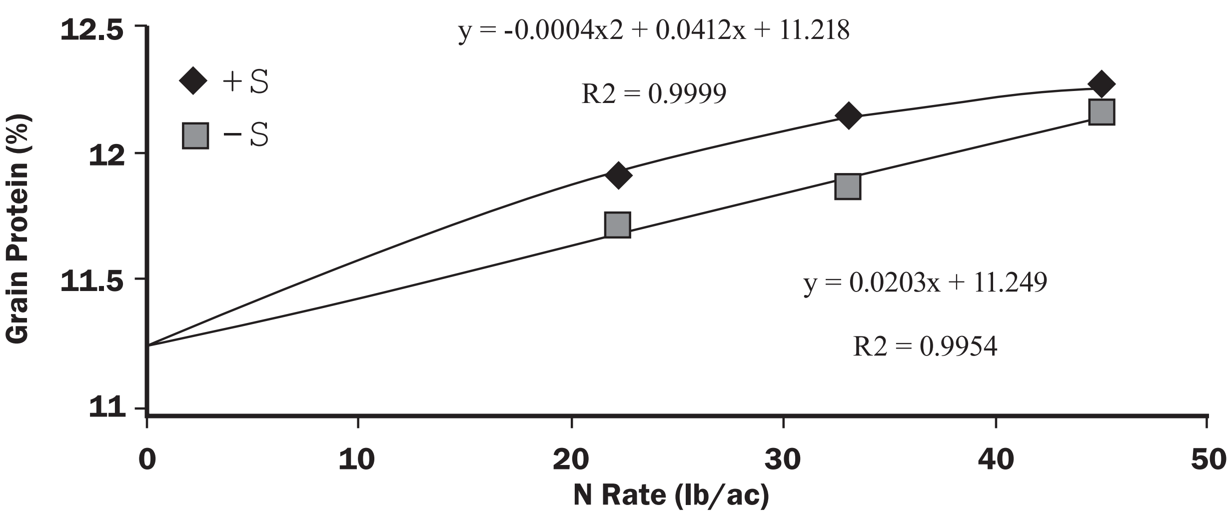
Weed Control

All herbicides that are labeled for use in SRWW (e.g. Harmony Extra, Harmony GT, Peak, 2,4-D, Hoelon, Osprey) are acceptable for use in bread wheat. See the latest edition of the Virginia Cooperative Extension Pest Management Guide, publication 456-016, *http://pubs.ext.vt.edu/456-016/* or your local Extension agent for specific information on appropriate herbicides and application strategies.

Insect Management

With a few exceptions like cereal leaf beetle and aphid transmitted barley yellow dwarf (BYDV), insects have historically not been a major problem in Virginia small grains. However, damage has occasionally been severe and certain pests could become more common with an increase in reduced or no-tillage practice across the state. Traditionally, producers have avoided damaging populations of Hessian fly and the risk of high levels of aphid attack and BYDV by planting later in the fall. The need to establish no-tillage small grains earlier exposes the crops to more pressure from these insects and increases the risk of economic damage. Insect pests such as cutworm/fall armyworm, the wheat curl mite, and Hessian fly are associated with fields where producers have continuous wheat/soybean rotations, or where volunteer grain in soybean fields is present when fall grain crops are planted. Volunteer small grain serves as a "green bridge" for these pests and can lead to infestation problems. Producers should be vigilant when scouting for insects in small grains. For insect population threshold levels and control options available see the latest edition of the Pest Management Guide Field Crops, Virginia Cooperative Extension publication 456-016, *http://pubs.ext.vt.edu/456-016/* or your local Extension agent.

Figure 2. Bread wheat response to rates of foliar N at GS 45 with and without 30 pounds per acre of sulfur at GS 30.



Disease Management

The fact that most currently available suitable bread-wheat cultivars were developed in states having drier climates typically means that disease resistance to the most common pathogens in humid areas has not been fully evaluated, or has not been a selection criterion. This is especially the case for powdery mildew (PM). This disease can occur in the fall and persist through grain filling and results in significant yield loss due to tiller mortality and reduced photosynthesis associated with colonization of a large amount of leaf area. In two years of Virginia testing, PM incidence has been low, so we have seen no response to systemic fungicide seed treatment with low disease pressure. However, if cultivar resistance to PM is rated as moderate to susceptible, a preventive treatment is recommended.

Foliar wheat diseases are also more severe in humid environments. These include leaf rust, stripe rust, tan spot, and Stagonospora leaf and glume blotch. Management of foliar diseases should be based on integrated pest management techniques where treatment decisions are based on scouting fields and assessing the level of disease presence. Fields should be scouted weekly from GS 31 through 58 for disease incidence and severity. For scouting techniques, threshold levels, and available control options, see the latest edition of the Pest Management Guide Field Crops, Virginia Cooperative Extension publication 456-016, *http://pubs.ext.vt.edu/456-016/* or your local Extension agent.

One especially damaging disease for winter wheat is fusarium head blight (FHB), or scab, caused by the fungal pathogen *Fusarium graminearum*. Head infection is most severe when moist, warm weather occurs during flowering and fungal spores are present. If a rain event occurs during anthesis (flowering), the incidence and severity of FHB can dramatically increase if temperatures are optimal for infection. Depending on the timing of the infection, one to several spikelets can be infected, colonized, and display a bleached appearance at a time when "healthy" spikelets are still green. The grains produced in colonized spikelets may contain mycotoxins that are harmful to livestock and humans. There is no effective fungicide treatment once the head is infected and colonized. As yet, there are no cultivars available with complete resistance to initial FHB infection. Similar to SRW wheat, some bread-wheat cultivars exhibit moderate resistance to the spread of the pathogen from one colonized spikelet in the head to others. When possible, it is advisable to select cultivars with at least moderate resistance to FHB.

More information about small-grain diseases is available at the Integrated Disease Management in Small Grains website (*oak.ppws.vt.edu/stromberg/smallgrain/sgrain.html*).

Harvesting

Harvest and dry wheat the first time it reaches 20 percent moisture, or the first time it reaches 15 percent moisture, if drying is not possible. Make sure the combine and all other critical equipment, including hauling equipment, are cleaned prior to harvest as contamination with foreign matter and other crop seeds will lead to discounts and possibly rejection for bread milling. Set the combine properly and modify the cylinder speed and/or concave clearance as harvest conditions change during the day. Your particular combine manual is the best place to go for information about set up. Timely harvest to produce the highest quality possible is needed to earn bread-wheat price premiums in our humid climate.