Seed Quality, Nitrogen, Screenings and Black Point in Wheat and Barley

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Overview:

Seed quality: Check the germination and vigour of seed harvested in 2000, or other weather damaged seed. If possible, use seed with >90% germination; reject seed with <70%. Be careful with seed dressings, handling seed, trifluralin, and sowing depth.

Nitrogen: Soil nitrogen levels are likely to be lower in 2001, but will vary depending on summer rainfall, fallow weed control and paddock history. A deep soil test remains a good tool for decisions on crop choice and fertiliser rate. The new payment system for wheat grades could make AH varieties more attractive particularly on stubble paddocks. Growers need to consider yield, protein and screenings as well as the grade for each variety.

Screenings: Pinched and small grain can result from drought stress and high temperatures, foliar disease or inappropriate input levels such as excessive early nitrogen, late sowing or poor soil water extraction. Current varieties vary in susceptibility, largely as a result of differences in average kernel size. The problem can be minimised by avoiding leaf disease, timely sowing and good agronomy, particularly matching inputs such as nitrogen to the appropriate yield potential.

Black Point: Black point in wheat is now thought to result from enzyme reactions during ripening, brought on by environmental stresses. Varieties vary in susceptibility and breeding for resistance using field methods is difficult. Where the problem is common, highly susceptible varieties should be avoided. Barley suffers from both black point and kernel discolouration. Western Australian research suggests discolouration is related to high daytime relative humidity in the period from early dough to harvest. In the short term, farmers can do little to improve grain colour. Some Japanese barleys with better colour are now being utilised in Australian breeding programs.

SEED QUALITY

Pre-harvest rain downgraded the quality of most of the winter crop in central NSW in 2000. Visual damage ranged from minor staining or bleaching to swollen and split germ end (sprung) and even emergence (shot). Falling numbers were also reduced indicating that the germination process had started even in samples which appeared visually sound. As good plant establishment is crucial for high yields, seed is probably the single most important input into a crop.

Initial seed quality is determined at physiological maturity of the parent plant, and is determined by grain size, nutrient content and environmental conditions during grain filling. From that time onwards, the seed will begin to deteriorate. The rate of deterioration depends on the species, the initial seed quality, mechanical damage from harvest and handling and the storage conditions.

Premature wetting of the seed prior to harvest initiates germination. The seed takes up moisture and swells and enzymes are released from the embryo and from under the seed coat. These enzymes begin to convert starch to simple sugars which are then transported to the growing points to supply energy for the growth of the shoot and roots. The process ceases when the dry weather returns and there is insufficient moisture for growth to continue.

Seed which has been through this process is likely to have a lower germination percentage and lower vigour. Energy and enzyme activity levels are lower, and the outer layers of the seed coat are often damaged, making the seed more vulnerable to physical damage when handled and to fungal attack.

Germination percentage and seed vigour

Germination capacity is measured as the percentage of seeds which successfully absorb water, mobilise reserves and produce a normal radical (root) and plumule (shoot) in a given time. Seeds which fail to germinate or which produce abnormal seedlings are considered unviable. Accredited seed testing laboratories carry out these tests under standard conditions, usually at 20°C for eight days. However, germination tests done at home can be a useful step in checking seed quality.

Seed vigour is also important in the field where rapid germination and fast root and shoot development are important, particularly if seedbed conditions are unfavourable. Vigour is difficult to test for in the laboratory and is usually estimated by accelerated ageing tests using high temperature and moisture. Farmers can gain some estimate of vigour by testing in soil and checking the rate of germination from depth.

Wheat and barley should have a germination capacity greater than 90%. Where rates are lower, adjustments can be made to the seeding rate but where germination is below 70% it is likely that the seed will be low in vigour. Initial results from the Central West suggest there is a considerable range in seed quality. There is no clear relationship with falling number but seed from paddocks which tested under 200 should be carefully checked.

Using weather damaged seed

If seed of lower than optimal germination or vigour is used, it should be given the best chance by good management. Deep sowing and crusting soils should be avoided as the seedlings are likely to have shorter coleoptiles and be slow in emerging. Pre-emergent herbicides containing trifluralin are likely to exacerbate emergence problems and should be used with extreme care if seed is weather damaged.

Care should also be taken in the selection and use of seed dressings. Some fungicides can reduce coleoptile length and impair emergence. Check that any seed dressing used will not increase the risk from lower quality seed.

NITROGEN

Soil nitrogen levels could be lower in 2001 than in 2000 in much of the region unless rainfall is well above average in April or May. Mineralisation conditions have not been as favourable except perhaps in the north. Many stubble paddocks are likely to be low following heavy crops in 2000. There is also likely to be considerable variation across the region based on the variability in summer rain and big differences in the efficacy of late spring and summer weed control. Early deep nitrogen test results confirm the generally lower values this year. However, there are exceptions and deep testing should be used to identify low and high paddocks. The following results are from 0-60 cm sampling on the Research Station in the third week ofMarch:

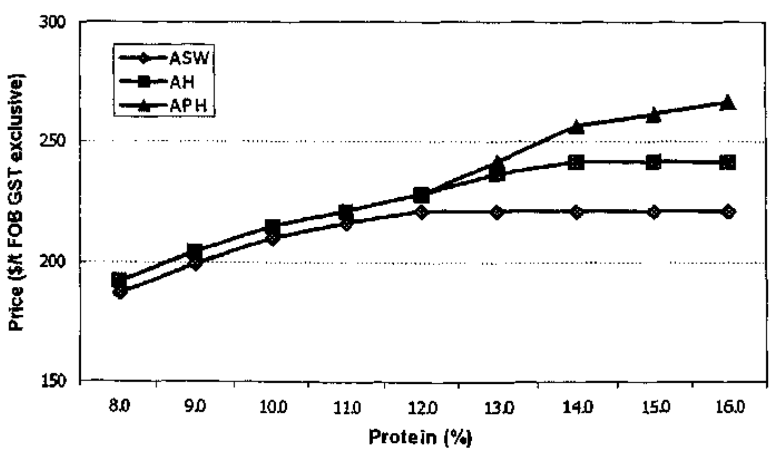
Paddock history	kgN/ha
Fallow, after good legume pasture	189
Fallow, after poor grassy pasture	88
Wheat stubble, one crop after pasture	101
Pea stubble, two previous wheat crops	113
Wheat stubble, three previous wheat crops	63

The benefits from legumes in the rotation can clearly be seen. Not all fallow paddocks will be high in nitrogen and not all stubble paddocks will be low. Better decisions on crop choice and the use of urea can be made if soil test data is used in conjunction with other information such as paddock history.

Wheat varieties, grades and payments

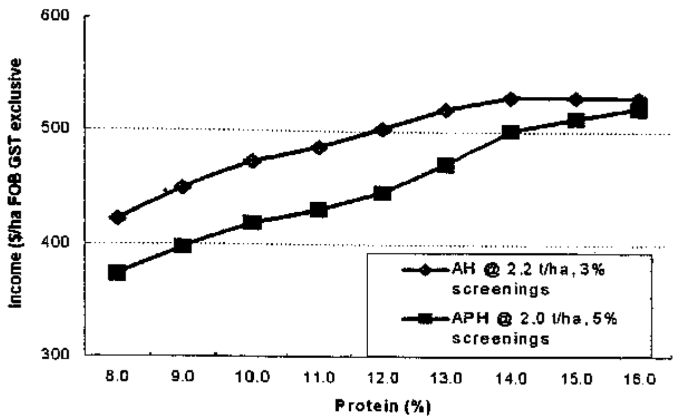
The new AWB Ltd Golden Rewards payment scales can alter the variety decisions for growers. For each grade there is a base rate and then incremental premiums and discounts based on protein and screenings. The system avoids the former "cliff face" pricing that severely penalised growers for just missing a grade specification. The estimated pool returns ($/t, FOB, GST exclusive, 3% screenings) are shown below. There is a substantial price premium for APH over AH above 13% protein and for AH over ASW above 12%.

Wheat Price by Grade Across Protein Levels



Prime Hard varieties, however, may not always be the best choice. A number of AH varieties such as H45 and Diamondbird have a yield advantage over their PH equivalents and also tend to have lower screenings and better disease resistance. As an example, compare Janz and H45 in a good fertility stubble paddock. If Janz was to yield 2.0 t/ha, H45 might be expected to yield 2.2 t/ha at the same protein level. This is based on trial results which show H45 to average 6% higher yield than Janz overall; however, on a stubble paddock this could be higher given H45's better yellow spot tolerance. Similarly, screenings are likely to be lower for H45, and the example assumes a value of 3% for H45 and 5% for Janz. The resulting income ($/ha) is shown below. The AH variety produces a significantly higher income at all protein levels below 16%. The changes to pricing make decisions about which variety to grow and which protein level to target more complicated. This example shows the importance of considering all factors when making those decisions.

Income from AH and APH Varieties across Protein Levels



Grain Size and Screenings

In the past few seasons there has been a high incidence of both small grain and pinched or shrivelled grain leading to many deliveries being downgraded for high screenings. The problem has affected different regions each year and even different paddocks on the one farm. Overall, significant amounts of grain have been affected, returns to growers have been reduced, and extra segregations have been required. Small and shrivelled grain can be caused by disruption to starch synthesis in the grain, by a lack of assimilate (sugars) reaching the developing grain or by the death of the grain prior to the completion of grain filling. The problem is accentuated in varieties with inherently small grain size.

Genetic factors

Wheat varieties differ in their average grain size. Many achieve high yield potential by setting a large number of kernels per square metre at the expense of average kernel weight, examples being Silverstar and Sunbrook. Under favourable conditions this is not a problem; under dry conditions, however, these varieties often yield well but suffer from high screenings.

Potential grain size is also under strong genetic control in barley. A series of trials across SE Australia showed that variety ranking for grain size was consistent despite large variations in absolute values resulting from the different environments. Semi-dwarf varieties such as Franklin and Skiff tended to set more grains but were more susceptible to high screenings under adverse conditions. Large grain size can be achieved either through a rapid rate of grain filling (eg Kaputar) or by a long duration of grain filling (eg O'Connor), and either approach appears equally successful in maintaining grain size.

Within grain samples there is usually considerable variation in kernel weight. In barley, the heaviest kernels come from spikelet positions 5 to 20 on the main stem;

kernels from the base and from the upper part of the ear are smaller. Grains from the centre of tiller ears are typically 20% smaller than from the centre of the main stem while the smallest grains come from the upper part of the tiller ears. In wheat also, grains from the tiller ears are smaller than those from the main stem. Grain size commonly decreases in each extra tiller per plant, and grains from upper florets within each spikelet are smaller than from the basal florets. Crops which have many tillers per plant or which fill "five wide" are likely therefore to have a greater spread of grain size and to be more vulnerable to high screenings. Higher than normal seeding rates have been suggested as one way of increasing the proportion of main stems in the crop and thereby reducing screenings. Results to date are not clear cut, particularly with barley.

Grain shape can play an important role in determining screenings, as long narrow grains can pass through a slotted screen despite a high kernel weight. Some semi-dwarf barleys fall into this category. In wheat, varieties with "rounder" kernels such as Corella tend to have lower screenings. Krichauff is another variety which consistently has less screenings than varieties with equivalent or even larger kernel weights.

It is possible to produce cultivars which rely on large grains rather than high kernel number to achieve high yield. An example is RAC875 which was at the top of the 1999 South Australian Stage 4 Trials and also had the largest grains (almost 30% heavier than Janz) and the lowest screenings. This line has fewer tillers as do reduced tillering wheats being developed by CSIRO which also have large grains and which appear less sensitive to some stresses such as excessive nitrogen.

Environmental and management factors

Moisture stress and "haying-off

Dry periods during grain filling can result in pinched or shrivelled grain with a low test weight and high screenings. This condition is exacerbated by a high nitrogen status and in its extreme form is often referred to as "haying-off' as it leads to premature ripening of the crop. Haying-off follows vigorous vegetative growth stimulated by high soil nitrogen and is associated with reduced post-flowering growth in response to a lack of moisture. Thick, high nitrogen status crops also contain lower reserves of water-soluble carbohydrates (stem sugars), which can normally be used to buffer grain filling in times of stress, and also appear less capable of regulating their leaf water status. In dry seasons, thinner, low nitrogen crops experience less stress during grain filling because less early growth reduces water use before flowering. They also have larger stem reserves and these two factors usually lead to larger grains and often to higher yields.

Small grain

Small but filled grain (not shrivelled) can result from stress which occurs prior to or just after flowering. In the first 10 days after flowering, the potential grain size is set as the cells in the developing kernel divide. Each cell has an upper limit to its size and it has been shown that severe drought stress during this period can result in a low number of cells and to smaller cells. If such crops receive rain later during grain growth the grain can fill properly but the kernel size will be greatly reduced. Screenings in this case are short in length but of smooth, filled appearance.

Frost affected grain

Yield losses from frost damage usually occur prior to ear emergence when the whole stem is damaged (stem frosting) or around flowering which results in the death or abortion of some or all of the ovules or developing kernels. In this latter case, frosted grain dies and any grain which does develop is usually quite large and plump and of good quality. Frost damage during early grain filling is less common but did occur widely in southern NSW in 1998. This resulted in shrivelled or collapsed grains of a dark greenish-brown colour or deformed grain where damage occurred in only part of the kernel. This type of frost damage appears to occur from about 10 days after flowering when the kernels have expanded to their potential size and are full of a clear liquid through to the early milk stage when the liquid filling the kernels begins to turn milky in colour. Frost during this period stops any further filling of the kernel with starch while the outer seed coat remains green and resembles a normally developing kernel. As the crop dries off prior to harvest the green seed coat collapses and does not lose its colour resulting in shrivelled, green grains. Frost from the mid milk stage onwards does not appear to significantly affect the final quality of the grain.

Root Diseases

Root diseases exacerbate the effect of drought because the diseased roots and stem bases reduce the extraction and transport of water from the soil to the leaves and developing grains, reducing photosynthesis and interfering with remobilisation of reserves. This results in a high percentage of shrivelled grain in infected plants and high screenings, unless rainfall is plentiful during grain filling.

***Foliar** Diseases*

Foliar diseases limit the supply of assimilate from the leaves to the developing grain by reducing the photosynthetic area of the crop. In some diseases this limitation appears to be proportional to the reduction in leaf area caused by the disease plus a wounding response. With other diseases, the reduction in assimilate supply from the leaves is greater than the reduction in leaf area due to production of an enzyme called "invertase" in the leaves in response to infection. Invertase traps assimilate in the leaf in the form of simple sugars, preventing it from being transported to the developing grain. This second type of disease can have a devastating affect on crop yield resulting in pinched grain even if water supply is adequate. High screenings have resulted from crops badly infected with yellow spot in recent years.

Black point and kernel discolouration

Wheat

Black point is a dark discolouration at the germ end of otherwise healthy grain. The discolouration occurs in the outer pericarp and inner seed coat tissue and may even extend along the groove on the ventral side of the grain. The condition was previously thought to result from saprophytic fungi. However, it is now thought that enzyme reactions during ripening, brought about by stressful conditions, might be responsible. The precise nature and timing of environmental stresses which induce black point symptoms are not fully understood but humidity and temperature are likely to be involved. Black point alone does not affect grain health or germination. In fact, affected grain has been found to germinate faster than normal grain and may be predisposed to sprouting should further rainfall occur. However, the discoloured grain is downgraded because it can contaminate flour and flour products.

Black point occurs more often in wheat grain of larger size and high yielding wheat crops are generally worse affected. Its incidence has been reported to increase with applied nitrogen and grains exhibiting the symptoms usually have higher protein levels. Varieties vary in susceptibility but breeding for resistance based on field testing is time consuming and expensive. Current research is aimed at finding molecular or biochemical markers to aid selection. Of the locally grown varieties, Sunvale, Sunco, H45, Sunmist and Rosella have some resistance while Janz, Cunningham and Batavia are relatively susceptible..

Barley

Grain colour and brightness are key quality parameters for malting barley, particularly for the export market yet the quantification of these requirements and the difficulty in achieving receival standards is a major source of frustration for barley growers. Barley suffers from black point but differs from wheat in that the discolouration occurs in the glume tissue (husk or palea and lemma) which remains adhered to the seed coat at maturity. Yellowing or a “caramelling” of the germ end or of the whole grain is also seen in barley. Western Australian research suggests discolouration is related to high daytime relative humidity in the period from early dough to harvest. In the short term, farmers can do little to improve grain colour. Some Japanese barleys with better colour have been identified and are now being utilised in Australian breeding programs.

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