The Agronomy of Durum Wheats

Dr. R.A. Hare, Durum Wheat Breeder, Tamworth Centre for Crop Improvement

Overview

In 1997-98, Durum wheats attracted a huge premium over bread wheats. Whilst the prices were one-off, Durum wheat offers an alternative to growing prime hard wheat. Durum growers - especially in the Central West - need to emphasise keeping the quality high and keeping a close eye on marketing opportunities. Durum wheat is used especially to make pasta and noodles and various export opportunities exist. Durum wheat is best grown on land that would be used for prime hard wheat.

GROUND SELECTION

a) Select ground that consistently produces high protein grain (13.0% or above), i.e. equivalent to prime hard bread wheat. An application of nitrogenous fertiliser (soil tests available) might be necessary to ensure adequate protein levels.

Highest premiums are paid for plump, hard, vitreous grain that is free from mottling. A small percentage of mottled grains can be tolerated in top grades but a greater proportion of mottled grain is undesirable and will result in downgrading and a reduced premium. The top grade DR1 must be 13.0% or greater in protein, while DR2 has to be equal or better than 11.5% protein.

Vitreous grain contains sufficient protein to combine together all the starch granules, however a shortage of protein will give a mottled grain. Grain protein is a function of available soil nitrogen hence adequate soil nitrogen is essential to produce vitreous grain. The application of nitrogenous fertiliser may be necessary but this cost should be offset by the higher premium payments and yield.

b) The ground should contain very little crown rot inoculum caused by the fungus, *Fusarium graminearum rosenm.* The most conspicuous symptoms of crown rot is the appearance of "white heads" in the crop. On severely affected plants, pink fungal growth is often present on the lower part of the crown. New ground out of natural pasture should not be used, as the native grass species harbour the crown rot fungus. These precautions are the same as those observed in breadwheat cultivation. Both breadwheat and durums are susceptible to this disease.

Ground known to carry high levels of crown rot inoculum should be sown to an alternative crop such as oats, sorghum or the broad leaf crops (e.g. chickpeas, canola, sunflowers) over a period of two years before re-entering the wheat rotation.

GROUND PREPARATION

Ground preparation is the same as that for breadwheat. Adequate scarifying and/or spraying should eliminate all volunteer plants of breadwheat.

SEED

Use sound seed that is true to type, free of weed seed, cracked grain and breadwheat grain. The germination should exceed 80%.

SOWING TIME

Best yields are obtained when the crop is sown from late May to early June. Frost may damage earlier sowings. Sowings delayed until late July should prove satisfactory, however, depending on the north-south location of the property small to large yield declines may be encountered.

SOWING

Use conventional sowing equipment, however, the larger grain size may necessitate appropriate adjustments. A sowing rate of 45 kg/ha (45 lbs/ac) is given as a general guide, however growers may consider a variation both up or down to be of benefit in their particular situation. A reduced germination percentage or a late sowing will make it necessary to increase this rate.

In a well prepared seedbed, the sowing depth should be about 3-6 cm (l"-2.5") and not exceed 8 cm (3"). As Kamilaroi, Yallaroi and Wollaroi are semi-dwarf cultivars, the length of the coleoptile (stem shoot) is reduced and so cannot penetrate greater soil depths. [Note that the article concentrates on these three cultures.]

WEED CONTROL

Kamilaroi, Yallaroi and Wollaroi are about 80-85 cm tall at maturity. Strong weed growth will compete against the crop causing yield reduction, hence weed control is essential.

Herbicide sensitivity trials conducted since 1981 on Kamilaroi, 1987 on Yallaroi and 1992 on Wollaroi suggest that all varieties have a narrow safety margin for the pre-sowing applied chemicals; chlorsulfuron (Glean), (Logran), (Ally), tri-allate (Avadex BW) and the post-emergence chemicals bromoxynil plus MCPA, and picloram plus MCPA (Tordon 242). A narrow safety margin means that if the chemical is applied at a rate above that recommended by the manufacturer crop damage will be caused with a reduction in grain yield. The following chemicals which have a broader safety margin include trifluralin (Treflan), trifluralin plus oryzalin (Yield), diuron plus MCPA, MCPA, Dicamba plus MCPA, diclofopmethyl (Hoegrass), fenoxaprop-ethyl (Puma), and terbutryne (Igran) plus MCPA. Mataven-L is NOT registered for application to durum.

The law requires that all chemical labels be read carefully before the product is used. New products and product formulations may change safety margins etc. Manufacturers or their representatives should be consulted for the latest usage information, especially if mixing chemicals or other products (e.g. zinc sulphate heptahydrate).

STEM RUST

Kamilaroi, Yallaroi and Wollaroi are fully resistant to all existing field strains of stem rust. While stem rust infection is not expected, a new virulent strain may occur and Dr Hare would greatly appreciate receiving infected Kamilaroi, Wollaroi and/or Yallaroi specimens. Identification tests would be conducted and the sender will receive a report. Such strains greatly assist the disease resistance breeding activities.

LEAF RUST

Kamilaroi, Yallaroi and Wollaroi possess slow rusting resistance to all field strains of leaf rust. A small level of infection may be evident as the plant approaches maturity, however this disease level will not affect yield.

STRIPE RUST

Kamilaroi, Yallaroi and Wollaroi show adequate resistance to field strains of this disease, at present.

YELLOW LEAF SPOT

Yallaroi and Wollaroi are moderately resistant to yellow leaf spot (caused by the fungus *Pyrenophthora tritici vepentis)* however, Kamilaroi is susceptible. As yellow leaf spot inoculum is carried over on wheat straw, Yallaroi and Wollaroi are a better proposition in stubble retained situations.

ZINC SENSITIVITY

Kamilaroi, Yallaroi and Wollaroi are usually not sensitive *to* low zinc levels when grown on very heavy self-mulching black earth (pH 8-8.5). When a crop is growing in a very wet high phosphate soil for several weeks, zinc deficiency symptoms may be evident.

Elongated necrotic (dead) lesions on the lower leaves may indicate the onset of zinc deficiency however this problem is difficult to identify. If the soil is known to be low in zinc (soil and plant tests available), a 1% aqueous solution of zinc sulfate heptahydrate applied as a foliar spray (i.e. ~1 kg/ha between two to four weeks after sowing will completely ameliorate the deficiency in the crop). Zinc oxide (5 kg Zn/ha) applications can provide four to five years supply of this essential micro-nutrient. The white oxide powder can be spread with nitrogen fertilisers but not phosphate fertilisers as the phosphate can bind with the zinc and could render the zinc unavailable.

HARVESTING

a) Kamilaroi, Yallaroi and Wollaroi are marginally more difficult to thresh than Hartog and Sunco but easier than Kite, consequently concave adjustments may be necessary.

b) Care needs to be exercised when threshing the crop as the very hard grain has a greater tendency to fracture than bread wheats.

c) The crop should be stripped as soon as the grain reaches dead ripe maturity. Buyers of durum grain consider grain appearance important and pay premiums for large well filled hard vitreous grain with a low percentage of mottled and bleached seeds.

d) Kamilaroi is moderately susceptible to black point. Several percent of infected (discoloured) seeds will be present following a wet pre-harvest when the problem is most severe. This level of incidence should be below minimum dockage limits. Breadwheat varieties will be similarly effected. Yallaroi and Wollaroi carry significantly more resistance to this problem when compared to Kamilaroi.

GRAIN STORAGE AND DISPOSAL

Because durum grain must be strictly segregated, on-farm storage will be necessary if delivery to the GrainCorp receival points or buyer facilities cannot be arranged.

The arrangement of a grower to buyer delivery transaction is strongly recommended prior to sowing which will ensure the prompt delivery and payment for grain following harvest.

DURUM WHEAT GROWERS ASSOCIATION

All durum growers are advised to become members of this association as the group provides a forum for the exchange of information (e.g. marketing prices) of mutual benefit to growers of this crop. Meetings are held regularly. Mr Gerry Allen, "Deni", Edgeroi, NSW, 2390 is the President [ph. 02-6793-8637].

FACTORS INFLUENCING GRAIN AND PASTA QUALITY

THE GRAIN

The endosperm section of the grain is the important part, as it is this fraction that is processed into semolina (a coarse flower) and in turn into pasta. The endosperm is the food supply or life support system for the embryo. The endosperm is composed of numerous constituents: starch, sugars, proteins, amino acids, minerals, fats, vitamins, enzymes, pigments and fibre. The endosperm and embryo are wrapped up in several layers of tissue called the aleurone, pericarp and testa. The embryo and outer grain layers are removed during milling into the bran and pollard fractions, while the endosperm is reduced to semolina.

GRAIN AND PASTA QUALITY

Six aspects of grain and pasta quality are considered.

- Grain size and shape
- Pre-harvest sprouting resistance
- Black point

  Weed seed contamination
- Protein

  Colour

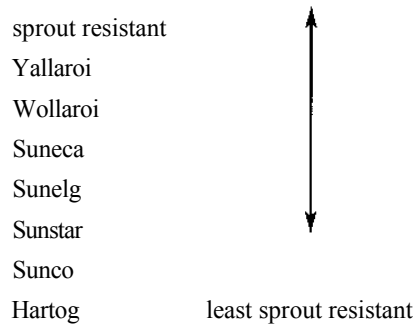
1. Grain Size and Shape

- require a large, well filled grain

  bright amber colour
- oval, plump with minimal crease depth

2. Pre-harvest Sprouting Resistance

Compared with current breadwheat varieties, Kamilaroi, Yallaroi and Wollaroi express a satisfactory level of pre-harvest sprouting resistance.



Weather affected grain is soft which reduces the semolina extraction in the mill. Weathered semolina gives a weaker pasta dough strength due to the partial enzymatic breakdown of starches and proteins. These small protein and starch molecules have reduced cohesive properties. Weak doughs make inferior pasta. It is not advisable to leave your durum harvest till last and rely on its weathering resistance. Its resistance is only relative compared to other varieties and will eventually fail. Weathered durum is not valuable and may be received as feed grain.

High protein durum grain with a bright amber bloom is certain to attract a good premium.

3. Black Point

Black point is a discolouration of sections of the external layers of the grain (i.e. pericarp/testa). Several percent of discoloured seeds will be present following a wet pre-harvest period when the problem is most active. This level of incidence should be below the minimum dockage limits.

Because small fragments of bran are included in semolina, discoloured grain will leave small black specks which can be seen in the pasta. Consumers may believe that these specks are faecal residues and show some reluctance to purchase the product.

If sown, grain with black point will germinate satisfactorily.

Yallaroi and Wollaroi are significantly more resistant to black point when compared to Kamilaroi.

4. Weed Seed Contamination

It is most important to control weeds in the crop as some weed species such as bindweed and New Zealand spinach have small black seeds that can be difficult to remove from the grain. These seeds have the same effect on consumer acceptance as black point contamination.

5. Protein

i) Protein content

Receival

An important factor is grain classification at receival. Classes are:

DR1 > 13.0% protein on an 11% moisture basis

DR2>11.5%

DR3 > 10.0%

Below 10.0% received into feed, usually

Premiums: DR1 attracts a premium around PH or better

DR2 attracts a premium around NH or better

Milling

Grain with adequate protein is very hard, vitreous and free from mottling. A small percentage of mottled grains can be tolerated in top grades but a greater proportion will result in downgrading and a reduced premium.

Vitreous grain contains sufficient protein to combine together all the starch granules, however, a shortage of protein will give a mottled softer grain. Hard, vitreous grains shatter into rough aggregates and produce a high semolina yield.

Mottled regions in grain are soft and breakdown readily into fine particles. This mottled grain gives a lower semolina yield on milling. The mill yield of semolina is a key economic consideration for millers. The fine particles or the "flour" fraction has a lower monetary value to the miller. The formation of fine particles must be kept to a minimum.

Pasta making

The canning industry specifies high protein semolina for canned pasta. High protein pasta withstands the high pressure/temperature cooking and retorting processes in a acidic tomato pasta. Further, this pasta retains its consistency on warming and serving by the consumer. Dry pasta manufacturers require acceptable levels of protein but not as high as that of the canning industry.

Low protein semolina is unsuitable for pasta making as it has insufficient protein to give the product acceptable keeping, cooking and eating consistency.

Control of protein content

The protein content of grain is largely under environmental control. Plants growing in soils with adequate nitrogenous fertility will lay down acceptable protein levels in the grain. Kamilaroi and Wollaroi usually yield grain with a higher protein content than Yallaroi.

ii) Protein composition

The grain protein called gluten is composed of a large number and complex range of protein types. The proteins go from short molecules to long folding molecules. The long molecules adhere to each other and form an interlocking network which prevents the starch and other components from moving freely. The degree of interlocking between these long chained proteins determines the mobility of the pasta dough which is called the dough strength.

The pasta dough strength or the resistance of the dough to move under work, is mainly under genetic control. Cultivars that offer strong to very strong pasta doughs are released. Yallaroi and Wollaroi have a stronger protein then Kamilaroi.

The dough strength, which is equivalent to protein strength, is a key determinant of pasta quality through its effect on the internal consistency of extruded product. Pasta made from strong protein doughs retain their shape and consistency on cooking and eating. Weaker pastas tend to breakdown during cooking to a rather unpalatable mess. Breadwheat pastas are of this undesirable type.

6. Colour

The colour of pasta is a factor in consumer acceptance. Pale to white or brown pastas do not have a pleasing appearance and are passed over for the bright clear yellow pasta by the consumer. Only durum wheat can provide this colour without the addition of expensive synthetic pigments or egg products. The addition of artificial colours is banned in Italy and France. Durum wheat must be used for dry pasta in these countries. Pasta colour is principally under genetic control, therefore only highly coloured varieties are released, i.e. Kamilaroi, Yallaroi and Wollaroi.