Breeding durum wheat for crown rot tolerance

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Abstract. Our approach involves a multi-pronged strategy to identify, characterise and use the available variation for crown rot (CR) tolerance in material from pre-breeding projects, advanced breeding lines, germplasm lines and released varieties, to incorporate it into commercially suitable backgrounds. Our preliminary results have shown the presence of useful genetic variation within durum germplasm for resistance (reduced expression of disease symptoms) and tolerance to CR (reduced loss of yield potential in the presence of crown rot), both of which are part of our strategy. Compared with resistance to CR, we consider tolerance to CR a more worthwhile trait to target because it represents all the processes in the plants leading to better yield performance under high disease pressure. Our approach for developing CR tolerance includes establishment of trial sites in CR prone areas in western NSW and also evaluation of advanced lines for tolerance to CR in inoculated yield trials. A permanent CR disease nursery to screen material for resistance to CR is being established. Molecular markers will be used to provide additional data. Whilst progress is expected to be gradual, these strategies should generate high quality data to conduct effective selection for CR tolerance.

Keywords. Durum wheat – Crown rot – Resistance – Tolerance – Breeding.

Amélioration du blé dur pour la tolérance à la pourriture du collet

Résumé. *Dans le présent travail, nous allons illustrer une approche multiforme utilisée en vue d'identifier, caractériser et exploiter la variabilité disponible pour la tolérance à la pourriture du collet dans le matériel issu des projets de pré-sélection, des lignées de sélection avancées, des lignées de matériel génétique et des variétés homologuées, pour l'incorporer dans des génotypes adaptés aux besoins du marché. Nos résultats préliminaires ont indiqué la présence d'une variabilité génétique dans le matériel de blé dur utile pour la résistance (réduction de l'expression des symptômes de la maladie) et la tolérance à la pourriture du collet (moindre réduction du potentiel de rendement en présence de la pourriture du collet), qui sont toutes les deux intégrées dans notre stratégie. Par rapport à la résistance à la pourriture du collet, la tolérance est un caractère plus intéressant à cibler parce qu'elle renferme l'ensemble des processus déterminant une meilleure performance des plantes, en termes de rendement, dans des conditions de pression élevée de la maladie. Notre approche pour le développement de la tolérance comprend l'établissement de sites d'essai dans les zones exposées au risque de pourriture dans l'ouest de la Nouvelle-Galles du Sud (NSW) et aussi l'évaluation des lignées avancées pour la tolérance dans des essais de rendement sous l'effet de l'inoculation. Actuellement, nous travaillons à la mise en place d'une pépinière où sera maintenue en permanence la pourriture du collet pour sélectionner le matériel résistant. Les marqueurs moléculaires seront utilisés pour fournir des données supplémentaires. Bien que nous prévoyions des résultats progressifs, ces stratégies devraient générer des données de haute qualité pour procéder à une sélection efficace pour la tolérance à la pourriture du collet.*

Mots-clés. *Blé dur – Pourriture du collet – Résistance – Tolérance – Sélection.*

I – Introduction

Crown rot (CR) of Wheat is caused by the fungal pathogen *Fusarium pseudograminearum*. It is the most important disease of durum wheat in Northern NSW and Queensland and is a significant factor limiting expansion of the durum industry. With the wide adoption of minimum tillage based production systems, CR disease pressure is expected to increase in future seasons. Also, the expected increase in frequency of droughts due to climate change will add to the increasing risk of CR because of the observed link between drought conditions and higherexpression of CR disease. It is therefore important to develop genetic resistance and tolerance to the disease. The best source of resistance to date has been a bread wheat line, 2-49 (Gala/Gluyas Early) but it is agronomically poor. Sunco, an Australian commercial bread wheat cultivar, has useful adult plant resistance to CR but it is susceptible in seedling stages (Martin *et al*., 2013). Variation for CR resistance/tolerance within durum germplasm has not been studied in detail to date. This study describes our initial examination of genetic variation for CR resistance and tolerance in durum lines, and, development of a breeding approach based on these results.

II – Material and methods

A set of durum lines containing released varieties and advanced breeding lines, including bread wheat check varieties, was evaluated for CR tolerance in a yield trial at Tamworth Agricultural Institute in the 2010 season containing inoculated (2g CR inoculum/m row) and uninoculated treatments as described by Dodman and Wildermuth (1987). The trial was designed as a randomised complete block with 3 replicates on a red-brown vertosol with light-medium clay content, pH 6.4 (1:5 CaCl2). 50kg/ha of N as urea and 50kg/ha of Granulock 12Z were applied at sowing.

Disease severity was visually assessed at harvest on 25 random plants from each plot as the extent of basal browning. Each plant was assessed for total number of tillers (a), number of tillers with any browning of the first internode (b), and the height of browning on a 0-3 scale designated as “c” (0 = no browning, 0.5 = partial browning of the first internode, 1 = complete browning of the first internode, 1.5 = complete browning of the first internode plus partial browning of the 2nd internode etc.). CR severity was calculated using this data as ((b/a X 100)/3)X c as described by Martin *et al*. (2013). The above set of lines was also put through a glasshouse CR pot test (Raju and Turner, 2008) at The University of Sydney, Cobbitty, to obtain additional CR resistance data (based on a 0-4 scale incorporating basal browning and whiteheads/deadheads). This test involved placing a 5mm plug of the fungal mycelium from a 5 day old culture near the base of the seedlings and covering with unprocessed wheat bran. Fungus growth on wheat bran around the seedlings was visible in 48-72h after inoculation and crown rot symptoms (leaf and stem browning) were seen within 7 days after inoculation. The plants were allowed to grow normally until maturity. At maturity disease severity was assessed on a 1-4 scale (0 = No lesions, 1 = First internode partially lesioned, 2 = First internode full lesioned and second internode fully or partially lesioned, 3 = More than two internodes lesioned, 4 = Dead head (white head or no head) due to crown rot.

III – Results and discussion

All entries, including 2-49 (resistant bread wheat check), showed reduced yield in inoculated plots relative to the untreated checks (Figure 1) although 2010 season was not conducive to CR disease development. As expected, 2-49 was the lowest yielding line in the trial in both inoculated and un-inoculated categories. Yield loss due to CR was highest in EGA Bellaroi and lowest in BO4-17, a CIMMYT durum line. Lines 241000, 241046 (both NSWDPI) and Hyperno (released SA variety) also showed relatively low levels of yield loss from CR infection. Caparoi showed significantly better tolerance to CR relative to EGA Bellaroi and this is consistent with the observation that Caparoi performs well under both dry and wet conditions. Five lines including 241046 (NSWDPI), BO4-17 (CIMMYT) and three from University of Adelaide node of DBA (WID052, Yawa and WID091) produced high yields in inoculated treatments (Table 1).

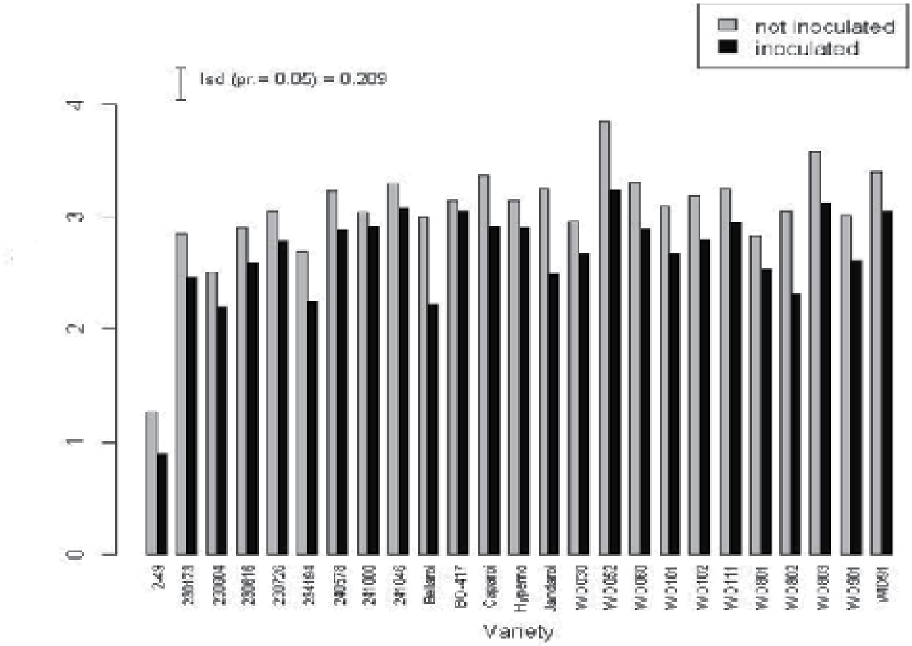

Figure 1. Performance (Yield /ha) of durum lines in presence of CR relative to un-inoculated checks in 2010 in Tamworth.

The apparent lack of agreement between yield loss and disease severity assessments, for example, BO4-17 showing the lowest loss of yield but high levels of disease severity could be explained on the basis that the measures based on the extent of disease symptoms do not fully represent the impact of the disease on yield performance of the genotype. For this reason tolerance to CR would be a better trait to target although it is difficult to screen genotypes in large numbers for this trait.

Table 1. CR tolerance and resistance data for selected durum lines.

Lines	Yield (added CR kg/ha)	Yield loss (%)	Field CR severity (%)	Pot test CR severity
WID052	3250	15.5	39.6	3.8
Yawa	3123	12.9	39.2	3.6
BO4-17	3059	2.8	44.7	3.2
WID91	3050	10.1	40.8	3.2
241046	2998	9.0	37.7	4.0
Caparoi	2914	13.6	42.7	3.7
EGA Bellaroi	2231	25.4	45.5	3.7
LSD (0.05)	289		4.7	0.7

Correlation between CR severity data from the two tests was low (0.26), most likely as a result of lower disease pressure in the field trial due to lack of moisture stress. However, both tests detected significant variation among durum lines. On the basis of these results we conclude there is useful genetic variation for CR tolerance in durum wheat which can be characterised using resistance and tolerance criteria.

IV – Breeding approach

We are working to characterise the material generated by GRDC-funded durum CR pre-breeding project (NSWDPI/USQ) for CR resistance and agronomic traits. Best selections from this material and other durum germplasm lines that have shown CR tolerance in our work will be crossed to advanced durum lines to incorporate the trait into high yielding and high grain quality backgrounds. In early stages (up to S1), evaluation would be based on performance in disease nurseries, marker information and/or glasshouse tests. For lines in intermediate stages (S2/S3), evaluation will be in CR prone trial sites and disease nursery. Advanced (S4) lines will be assessed in inoculated trials to provide CR tolerance data.

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