Testing breeding lines for straighthead

Ranjith Subasinghe, Tina Dunn & Dionne Wornes
NSW DPI, Yanco Agricultural Institute, Yanco

in a rice hull

- Straighthead can lead to crop losses ranging from 10–30% in medium grain rice and up to 90% in short and long grain rice
- Research is underway at Yanco Agricultural Institute to find a way that breeding lines can be tested for straighthead susceptibility, and thus eliminated from the breeding program

Straighthead occurs in almost all rice growing areas in NSW across a range of soil types. It has been estimated that straighthead costs the industry over one million dollars per year. Crop losses range from 10–30% in medium grain rice and as high as 90% in short and long grain rice. The true extent of straighthead occurrence is unknown because it is often confused with cold weather sterility and also may occur without any visible symptoms.

Straighthead, also known as 'parrot beaking', is a physiological disorder in rice resulting in distortion and missing grains on the panicle (Figures 1 and 2). There is no known cause of straighthead although it is believed to be related to particular soil conditions. Incorporation of stubble and heavy pastures, continuous flooding, low pH and low free iron, and high arsenic levels are found to be associated with the disorder.

Preliminary investigations conducted at Yanco Agricultural Institute revealed that straighthead could be induced by lowering the redox potential of the soil, ie depleting the oxygen levels in the soil. Straighthead was also known to be induced by addition of straw, sugar and arsenic based compounds from herbicides to soil. Straighthead may also be attributed to toxicity due to several chemicals that occur in reduced soils or deficiency of micronutrients due to the formation of insoluble sulphide under reduced soil conditions.

Australian rice cultivars differ in their susceptibility to straighthead. For example, Langi and Koshihikari are more susceptible to straighthead than Millin and Amaroo. Some investigations showed that high nitrogen application at sowing can reduce straighthead. Draining rice for 10–14 days prior to panicle initiation has been found to successfully control straighthead. However, there is no scientific explanation for the benefit from midseason draining and farmers find it difficult to practise.

Figure 1: Parrot beaking of grains in a rice panicle, due to straighthead.

Figure 2: Missing grains on a rice panicle due to straighthead.

Selection is the long term solution

The long term solution to minimising straighthead occurrence relies on selecting high yielding rice cultivars tolerant to straighthead. However, there is no reliable technique available for breeders to induce straighthead on demand, which could then be used as a screening tool for new breeding lines.

Breeding programs such as that at Stuttgart, Arkansas, USA include a straighthead screening step using soil application of arsenic to induce the disorder. However, the use of arsenic is dangerous as the chemical is toxic and carcinogenic

Stubble incorporation to induce straighthead

Investigations conducted at Yanco during the last few years showed that incorporation of stubble could induce straighthead in rice. This project further investigated the possibility of using stubble incorporation to induce straighthead, refining the amount and type of stubble needed. A glasshouse experiment was carried out in plastic tubs filled with red soil using four cultivars: Doongara, Jefferson (a US variety with known tolerance to straighthead), Amaroo and Reiziq. Five types of stubble (rice, wheat, barley, canola and subclover) at four levels of incorporation (0, 5, 10 and 20 t/ha) were evaluated for straighthead inducement.

The results indicate that rice, wheat, barley and canola stubble, even at 5 t/ha, can induce straighthead in susceptible varieties without any significant difference between rates and type of stubble (Figure 3). Incorporation of subclover resulted in the lowest sterility among the stubble treatments and on most occasions, resulted in significantly lower sterility than the control (zero treatment). This effect was more prominent in the susceptible cultivar Doongara than in the tolerant cultivar Jefferson, suggesting that subclover incorporation could reduce the straighthead occurrence in susceptible cultivars. It was also revealed that straighthead sterility decreased with increasing subclover stubble rate. This could be attributed to its higher nitrogen content compared with the other four stubble types.

Potential test for straighthead

Among the four varieties in the trial, Doongara showed the highest straighthead inducement while Jefferson showed the least. This suggests that the stubble incorporation technique could be used to screen cultivars for straighthead tolerance if combined with Yanco soil (Birganbigil clay loam) in which the tests were conducted. Wheat straw at a 20 t/ha rate would be the best treatment to induce straighthead considering the consistency of the effect among the treatments and the availability of wheat straw.

The results indicate that there is no significant effect of stubble incorporation on germination rates. Incorporation of stubble significantly increased the tiller number compared with the control, in susceptible cultivars like Doongara and Amaroo. However, there is no significant effect of stubble incorporation on tiller numbers in Jefferson (a tolerant cultivar). This indicates that there is a strong correlation between straighthead sterility inducement and tiller number and suggests that an increase in tiller numbers in response to an environment prone to straighthead is a varietal character.

The results also suggest that incorporation of rice, wheat, stubble and barely prior to sowing could significantly reduce the rice yield through straighthead. Green manuring with subclover could significantly increase the rice yield in soils liable to straighthead occurrence.

The impact of stubble on straighthead inducement may be different in other soil types. Therefore, it is worthwhile to further investigate the effect of soil type on straighthead occurrence. It is also important to study the varietal characters contributing to straighthead tolerance.

RIRDC Project DAN-249A

Dr. Ranjith Subasinghe
Research Agronomist
Yanco Agricultural Institute
T: 02 6951 2679
E: ranjith.subasinghe@dpi.nsw.gov.au

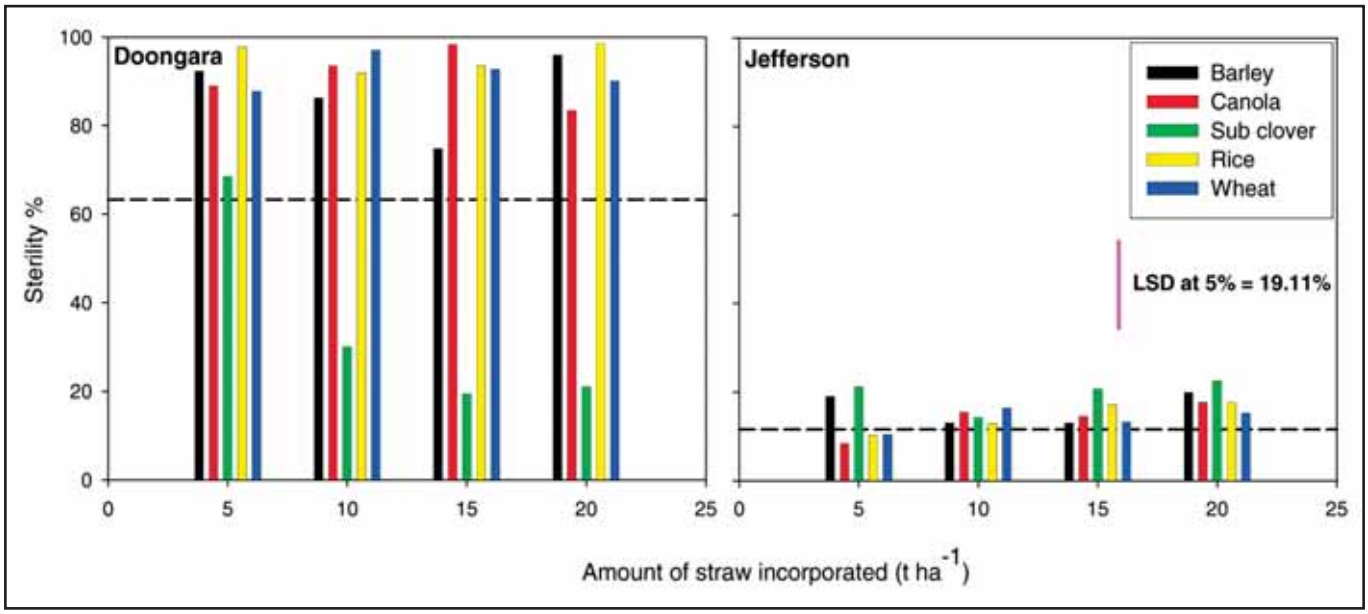

Figure 3. Sterility percentages due to straighthead of two rice varieties at different types and levels of stubble incorporation. The dotted lines indicate the sterility level of each variety without stubble incorporation (control).