RESEARCH HIGHLIGHT: Creating aluminium-tolerant wheat varieties using genes from a wild relative

Wheat is one of the mainstays of smallholder agriculture in Nepal, Ethiopia and Kenya. Improved agronomy alone is still unable to counter the phytotoxic combination of acid soils and soil aluminium. Previously, only a gene found in Brazilian wheats facilitated the breeding of tolerant wheats. In PSP-funded research, a wild relative of wheat known as Goatgrass (*Aegilops uniaristata*) has been identified as a useful source of alternative tolerance genes. The 3N chromosome carrying the tolerance gene was transferred into a model wheat variety (Chinese Spring) (Fig. 1).

***Figure 1*. The wild relative of wheat, *Aegilops uniaristata* (far left) has been used as a source of tolerance genes. Wheat lines of Chinese Spring (on the right) show the undesirable trait 'split neck break'.**

Subsequently undesirable genetic contributions from the Goatgrass donor were reduced either by inducing recombination between wheat and 3N using a cytogenetic technique or by irradiation with fast neutrons. In particular there was a need to remove the single gene on 3N that controls the undesirable trait 'spike neck break'. Fortunately, highly aluminium tolerant selection lines without this trait were identified and four were sent to CIMMYT breeders in Mexico for crossing into a range of popular varieties from the target countries:

Brazil	CEP 30, BRS 179, ONIX and IAPAR 78
Ethiopia	Tura, Sirbo, Bobitcho, Simba, and K6295.4A
Kenya	Kenya Heroe, Kenya Yombi, Njoro BW1 (KM14) and Njoro BW2 (R809)
Nepal	Annapurna 1, Annapurna 4, Phasang Lamu, BL 1813 and BL 1473

Backcross breeding was employed and all progeny were selected for leaf rust resistance and agronomic superiority at each backcross. The breeding programme is at an advanced (third backcross) stage where the agronomic performance of the original parents has been recovered (Fig. 2). These lines will soon be supplied to breeders in the target national programmes for testing in areas with acid soils where wheat suffers from aluminium toxicity.

For long-term breeding efficiency it is very effective if the gene from the donor can be tagged with a molecular marker (Box 1). This allows marker-assisted selection (MAS) and removes the need for expensive and time-consuming hydroponic screens for aluminium tolerance. It also allows the gene from the Goatgrass to be more easily 'pyramided' with other resistant sources. In conventional screening it is more difficult to do pyramiding as it requires a screen that is precise enough to reliably distinguish among resistant lines i.e., those with two resistant genes from those with only one.

Figure 2. **Harvest of advanced backcross lines at CIMMYT, Mexico in October 2004.**

Box 1. Tagging the aluminium tolerance gene

To facilitate easy selection of the aluminium tolerance gene trait during backcrossing, twelve SSR molecular markers were identified that were linked to the 3N chromosome. Of these *barc 1040* appears to be the most useful for tagging the tolerance from Goatgrass.

Using these markers at the John Innes Centre, new lines having the marker for the aluminium tolerance gene with a minimum of other markers from the Goatgrass are being identified. These will be supplied to CIMMYT breeders as an additional genetic resource for breeding for aluminium tolerance.