Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 03, Issue: 01 (JAN-FEB, 2023)
Available online at http://www.agriarticles.com

Hybrid Wheat

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Food production remains dominated by the cereals, which make up around 50% of global food production. Since the introduction of the Green Revolution crops in the early 1960s, there has been a linear increase in total cereal production from around10 million tons to 107 million tons in 2020 in India. Three factors have supported these speedy improvements: (i) improved varieties through the development and adoption of breeding technologies; (ii) expansion of the area under irrigation; and (iii) the widespread use of fertilizers, particularly nitrogen and phosphorus. Future benefits are therefore more likely to come from effective and precise breeding and selection technologies since there is little room to increase the area irrigated or the amount of fertiliser used. Over the previous years, the pace of yield growth in wheat has decreased. The Food and Agriculture Organization of the United Nations (FAO) predicts that major improvements in wheat yields will be critical in ensuring global food security as it is an important staple food globally. As a result, there is a resurgence of interest in technology that can increase output, especially in low-yielding environments where wheat is commonly grown. Capturing the yield benefits from heterosis in a hybrid wheat programme is one of the most promising options.Recent estimates of yield improvements associated with heterosis in wheat range from 3.5 to 15%.The ability to exploit heterosis (hybrid vigour) in wheat has historically been difficult due to the strong inbreeding nature of wheat, a factor governed primarily by floral development and architecture, and the lack of practical fertility control systems. Despite the fact that hybrid wheat programmes have existed for a while, hybrids only make up a small portion of the overall area sown. In the 1960s, the public and private sectors became increasingly interested in hybrid wheat as a result of the discovery of male sterility and restoration systems. However, the hybrid systems that were explored were impractical and, consequently, difficult to use. Since there aren't many genes that can actually restore fertility, cytoplasmic male sterility has proved challenging to use. Due to issues with fertility restoration and the toxicity and selectivity of chemical hybridising agents, genic male sterility has largely failed. It has also been suggested that yield benefits in wheat are due to the combination of dispersed dominant alleles and that similar yield advantages could be achieved by conventional line breeding. Therefore, despite widespread interest, many companies have shut down their hybrid wheat programmes and today only a few still operate. A number of novel new hybrid breeding strategies have been proposed or are currently being developed for wheat using genetic engineering. It is therefore time that 'hybrid wheat' is reassessed, especially in terms of modifying floral architecture to facilitate hybrid seed production based on new strategies, technologies and knowledge.

Heterosis in Wheat

Wheat hybrids produced so far exhibited the following desirable attributes: an average yield advantage of up to 2.05 tons ha^{-1} (10–20%) over the highest yielding pure line, better quality (in terms of both grain and straw), better response to fertilizers, better root penetrance and better rate/duration of grain filling. The hybrids also exhibit higher stability relative to pure lines, so that the hybrid varieties may be suitable for a wider range of environments. In winter wheats, heterosis has also been reported for tolerance against abiotic and biotic stresses such as frost and diseases like leaf rust, stripe rust, Septoria tritici blotch and powdery mildew. Some other advantages include lodging tolerance and uniform plant establishment. Therefore, for hybrid wheat, it may be desirable to pyramid multiple partially dominant alleles of most favourable genes/QTL including those involved in epistatic interactions. Studies conducted in India also demonstrated that higher returns from hybrid wheat can be achieved by small-holding farmers relative to farmers with large-holdings.

Hybrid wheat in India

A network project on hybrid wheat utilising the CMS technique was started by ICAR in India in 2009, however no hybrid varieties could be developed. In 2002, Mahyco (a hybrid seed business with its headquarters in Maharashtra) introduced two wheat hybrids (Pratham 7070 and Pratham 7272) for cultivation in low-input regions of central and peninsular India. Although these hybrid varieties had more than 60,000 acres in six states by 2004, they were abandoned because they were unable to compete with newly created high-yielding pure-line cultivars.

In order to increase yields, hybrid wheat is currently being developed in India for the favourable conditions of the North-Western Gangetic plains. For the primary wheat-growing regions and the fringe areas, certain private corporations like Syngenta are also investing in the creation of hybrid wheat varieties. Despite the fact that nothing is immediately apparent to imply that it will be possible, Syngenta asserts that they should be able to introduce their first hybrid wheat variety in India. Because of this, it may take considerably longer than expected for hybrid wheat to become commercially viable in India, especially in light of the modest development seen in the marketing of hybrid rice, which has seen significant success in China's neighbour.