Perspective on wheat rusts in India

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INTRODUCTION

Indian National Wheat Rust Survey programme has conducted national pathotype surveys for the three rust pathogens since 1930. This facility has served the national wheat programme through a range of activities like identification of new sources of rust resistance, working out the genetic basis of rust resistance and enhancement of genetic resistance. In the beginning identification of pathotypes was mainly done on the differentials now known as World Differentials. Realizing the importance of single gene/ near- isogenic lines, the scope of operation was further expanded in 1980 to include near- isogenic lines, present day cultivars and other commonly used resistance genes/ cultivars in India. It has strengthened the national wheat-breeding programme regularly by providing diverse sources of resistance for introgression and preventing the release of rust susceptible lines at the national level. The Indian Wheat Rust Programme remains one of the very few programmes in the world that continued screening for stem rust though it was widely believed that stem rust population has stabilised and many global wheat breeding programmes suspended screening against stem rust of wheat. This certainly led to uniformity of resistance against stem rust all over the world. The present information is proposed to discuss the relevant information generated from surveys and the impact it had on host resistance of Indian wheat. At the end we would enlist some of the challenges and thrusts which need to be addressed to tweak the relevance of pathogenicity surveys further

WHEAT RUST SURVEYS

The systematic survey and surveillance wheat programme of the country provided back drop information through following aspects-

- information on new virulences
- Identification of new sources of resistance through rust screening nursery
- Suggesting the strategy of gene deployment

Pathogenicity surveys built up the information on new virulences with new sources of resistance. The systematic surveys on wheat rusts began with the founding of this station by Dr. K.C. Mehta in 1935. The collection of samples initially done through visits to the farmers fields was later supplemented with samples received from cooperators and planting of trap plot nurseries at critical sites. The constituent of this nursery comprised lines with known genes, current cultivars and few promising lines for the future. For the sample analysis the bulk inoculum is used on the differential system that is adopted for identification of pathotypes. The low response of single gene lines then enables us to determine the pathotypes in the farmer's fields. Since the system was related to the field situation, so the information of the virulence and avirulence formulae of the pathotypes was also obtained. This information was then translated further to suggest new resistant genes or their combinations to prevent the large scale spread of wheat rusts . As a result this era is characterised by absence of any major loss to wheat crop in the country. The present detailed account given here deals with the major/new changes that occurred in the wheat rusts and their impact on the national wheat programme of the country.

LEAF RUST

The wheat varieties Mediterranean and Democrat, resistant to brown rust were included in crossing programme in 1934-35. Other wheat varieties such as Kenya (E 144) , Mentana (E 231), Timstein in 1952-53 and Ridley, an introduction from Australia, were used in 1954 later as donor lines. Upto early 1950's all the pathotypes of *P. triticina* were avirulent on *Lr3*. Later, Democrat (*Lr3*) and Mediterranean (*Lr3*) followed by Timstein (*Lr10, Lr23*) and Sonora 64 were used in breeding for rust resistant varieties. Subsequently, new pathotypes such as 45R31, 93R7, 93R15, 5R5, 17R23 with matching virulence to *Lr3* and or *Lr1* and partially for *Lr10* became common. In fact, all the pathotypes of *P. triticina* barring few detected after 1955 had virulence for *Lr3*. Use of Frontana (*Lr13+*), Gabo (*Lr10, Lr23*) favoured the selection of virulences for *Lr13, Lr23* and *Lr10* viz. 45R31, 5R31, 109R31, 109R23, 1R5, 29R23 and 109R31-1. During early eighties resistance based on 1B/1R translocation was used to develop varieties like HUW206, CPAN 1922, CPAN3004, Macs 2496 and PBW343. Thereafter, virulences for *Lr23* and *Lr26* increased in frequency. During 1990's there were further gains for virulence in 12, 77, 104 and 162 groups of pathotypes (Nayar *et. al*., 2001) and at present we have 14 pathotypes virulent *Lr23* alone*,* 15 only on *Lr26* and six on both *Lr23* and *Lr26.*

STRIPE RUST

After the introduction of Mexican wheats, Kalyansona, Sonora 64 and Sonalika maintained resistance to yellow rust upto 1970. Thereafter, Kalyansona (*Yr2*) became susceptible to 3 new pathotypes i.e. 66S64, 70S64 and 66S64-1. Pathotype 38S102 was identified from Nilgiri hills in 1973 whereas 47S102 which rendered Sonalika susceptible, was detected from Punjab in 1982. During early 1990's, three pathotypes 70S69, 46S103 and 47S103 having virulence for Hybrid 46 (*Yr4?+*) were picked up. Following widespread cultivation of varieties with 1B.1R translocation, 46S119 having virulence for *Yr9* was identified from Punjab (Prashar *et al*., 2007). Large scale cultivation of PBW343 in about 7-8million hectares facilitated the selection of virulence for *Lr9* and *Yr27* designated as 78S84 (Prashar *et al*., 2007).

STEM RUST

Khapli and Reliance were used in breeding for black rust resistance in 1934-35 which followed the identification of pathotype 7G35 with virulence for Khapli in 1947. None of the pathotypes had virulence to *Sr11* prior to 1945. Subsequent to the use of exotic material in breeding programme in 1940's, pathotypes 37G3 with virulence for *Sr11* and 7G35 with virulence for both Khapli and *Sr11* were detected. Later on, Timstein was used as a source for resistance followed by Ridley, Gabo, Yalta, Gaza and other exotic introductions in 1950's. Consequently, pathotypes 79G31 virulent on *Sr5, Sr11* in 1962, 16G2 with virulence on *Sr8b* in 1959, 73G7 with virulence for *Sr28* and *Sr30* in 1954, 7G11 in 1952, 36G2 in 1961 and 7G43 in 1962 were identified. Cultivation of CIMMYT wheats like Chhoti Lerma in Nilgiri hills led to selection of pathotypes such as 62G29. Pathotype 62G29-1 with virulence for *Sr24* was detected in 1989, much ahead of the release of variety HW 2004 (*Sr24*) in 1995 (Bhardwaj *et. al*., 1990).

WHEAT RUST SCREENING NURSERY

The national wheat rust programme has the access to all the pre-released/ elite lines developed in the country. Every year these accessions were screened at seedling stage with individual pathotypes for postulating gene/s. Whereas at adult plant stage, these were subjected to screening with mixture of prevalent and most virulent pathotypes. This screening thus made sure that only resistant lines were promoted for release. Since this rust screening was undertaken for all the three rusts, it not only enhanced the level of resistance but also was able to diversify the rust resistance in some cases.

IMPACT OF WHEAT RUST VARIANTS ON HOST RESISTANCE

In the past, India witnessed two major changes in stripe rust on Kalyansona (Nagarajan and Joshi, 1985) and *Yr9* and later *Yr9* with *Yr27* (Prashar *et al* , 2007). On both these occasions, the wheat rust screening programme of the country responded quickly through identification of resistance for the new variation. Therefore, even before the build up of inoculum in the farmers fields, the resistant varieties were deployed in the field. This happened through identification of Sonalika, HS240 and UP2338 followed by PBW343. During this period no large scale spread of stripe rust was reported whereas adjoining country reported large scale spread in this period. Similarly, initiatives were undertaken when emergence of Ug99 was reported in Kenya in 2001. Directorate of Wheat Research recognised this as a threat and through the auspices of ICAR (Indian Council of Agricultural Research) took immediate action by sending 200 lines to Kenya for screening. This timely action helped identification of resistant sources namely FLW2, FLW6 and FLW8 carrying *Sr24* and *Sr25*. These sources of resistance were later distributed to wheat workers for their use. This proved very effective as wheat breeding programme of few zones in the country started using these sources and are now very near to developing promising lines with targeted resistance. This was the second occasion when steps to address the threat were initiated much before the virulent population threatened the crop in the country.

FUTURE THRUSTS AND CHALLENGES

Few challenges still remain for us, which need our attention. The cultivation of PBW343 (now susceptible to stripe rust) over a large area and the susceptibility of all the mega cultivars like HUW234, HD2189, WH147 and C306 to Ug99 are the major concerns. Replacing these cultivars with resistant ones immediately would entail some rapid adjustments to avoid any loss to the wheat crop of the country. The food grain crisis being experienced in the world today needs to be addressed by using all our resources. The loss of any quantity of wheat can have a cascading effect on the economies of nations. Also the non- availability of near- isogenic lines / single gene lines for stripe rust in susceptible background is very limiting for our pathotype identification. The available near-isogenic lines in Avocet background could not be used in India as many pathotypes were found avirulent on Avocet resistant and susceptible selections. The usage of molecular markers is need of the hour to unravel the evolution of rust pathotypes. For tracing the evolutionary tree, the use of SSR markers has proved to be very informative (Robert Park personal communication) at Plant Breeding Institute, Cobbitty, Sydney (Australia).

Thus, this wheat rust surveillance programme has paved the way for a sound and focussed wheat-breeding programme of the country. If this programme is further tweaked to adjust to these present needs and changes, it would continue providing long term support to wheat breeding programme of the country..

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