Status of Yellow Rust Disease Resistance of Improved Bread Wheat Genotypes in Hills of Nepal[1]

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Introduction

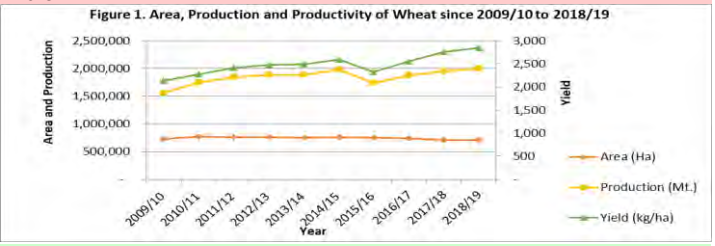
In Nepal agriculture contributes 26.5 percent of national GDP. The final aggregate cereal output of 2019, including wheat, paddy rice, maize was estimated of 10.8 million tonnes (GIEWS - Global Information and Early Warning System, 13-May-2020, FAO). Wheat is the third major cereal crop in Nepal after rice and maize (Table 1). In the year 2018/19, wheat was produced in 703,992 ha area with production of 2,005,665 Mt. yielding 2.85 Mt/ha (MOALD, 2020). The national data on wheat shows increased production and productivity despite the decrease in wheat growing area (Figure 1).

Table 1. Area,Production and Productivity of Major cereal crops of Nepal in 2018/19

Crops	Area (ha)	Production (Mt.)	Productivity (Mt./ha)
Rice	1,491,744	5,610,011	3.76
Maize	956,447	2,713,635	2.84
Wheat	703,992	2,005,665	2.85

Improved wheat cultivation in Nepal began with the introduction of high yielding, disease resistant varieties from CIMMYT, Mexico and introduced via India during 1960s. With strong research and development thereafter, the wheat area increased nearly by seven folds, production by 18 folds and productivity by more than two and half folds. The per capita wheat consumption has been increased from 17.4 kg in 1972 to 67 kg in 2018.

Figure 1. Area, Production and Productivity of Wheat since 2009/10 to 2018/19



Major Challenges to Wheat Production

For increased food security in the country, crop protection from biotic and abiotic stresses is must. The major constraints to wheat production are limited irrigation and low input supply, declining soil fertility, threats from emerging diseases especially rusts and insect pests, climate change and reduced investment support for required irrigation, fertilizers, seeds and timely crop management practices.

Rusts as constraint to wheat production

Yellow rust (*Puccinia striiformis* f.sp. *tritici*) is the main constraint to wheat production and leaf rust is also problematic in Nepal. In 1986, the variety Sonalika (RR 21) lost its resistance due to new virulent race 7E150. Another epidemic of stripe rust and varieties Annapurna 1, Annapurna 3 and Annapurna 4 succumbed to another virulent pathotype 134E150 and 70% of cultivated wheat areas with these genotypes with *Yr*9 were heavily infected (Saari E., 1995) and yield losses were up to 25-30 percent due to stripe rust (Karki 1998). During 2004/05 seasons, wheat varieties BL1473, Nepal 297 were highly infested by *Yr27* virulent yellow rust pathotype. And in 2018/19, stripe rust infestation has also been observed severe on some wheat varieties.

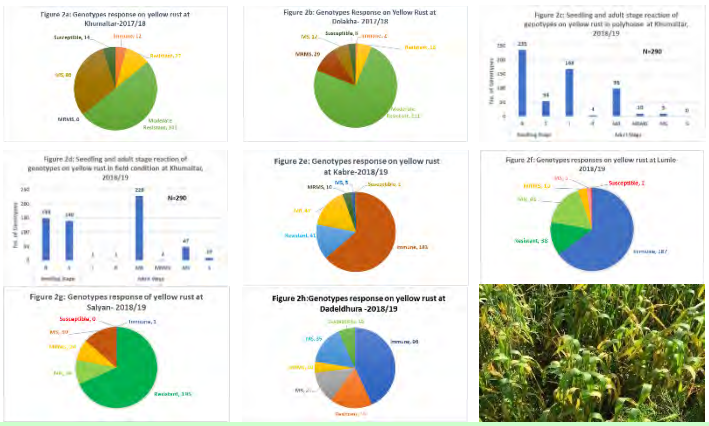
Methodology

During 2017/18 and 2018/19, 280 and 290 genotypes from observation nurseries, yield trials were tested at different sites of hills for rust response. In 2017/18, genotypes were tested at Hill Crops Research Program, Kabre, Dolakha and Plant Pathology Division, NARI, NARC, Khumaltar meanwhile In 2018/19, genotypes were tested at Kabre, Khumaltar, Dadeldhura, Surkhet, Lumle and Salyan. At Khumaltar, genotypes were tested both in polyhouse and field under artificial epiphytotic conditions. Seedling stage disease scoring was done using the 0 – 4 scale (McIntosh et al. 1995) while adult plant by modified Cobb's scale (Peterson et al. 1948).

Result

Fourteen and eighteen genotypes were found susceptible at Khumaltar and Dolakha respectively among 280 tested genotypes in 2017/18. During 2018/19 in polyhouse of Khumaltar, 235 genotypes were resistant and 54 were susceptible to yellow rust at seedling stage but none of them were susceptible at adult stage (Fig. 2c). While at field condition, 49 genotypes were resistant and 140 genotypes were susceptible at seedling stage but 228 genotypes were moderately resistant (MR) and only 10 genotypes were susceptible at adult plant stage (Fig. 2d).

Figure 2: Genotypic response on yellow rust at different locations



Only 1 genotype was susceptible at Dolakha and Lumle at adult stage which may be due to absence of conducive environment for yellow rust development during crop season (Fig. 2e & f). In Salyan, none of these genotypes were found susceptible to yellow rust (Fig. 2g) and in Dadeldhura 15 genotypes were found susceptible (Fig. 2h).

Wheat Germplasm Development Approaches

Germplasm is vital and it should be in stocks forever for improvement, adaptation, production. CIMMYT 's support on providing germplasm, capacity enhancement is always invaluable. In varietal improvement, local and improved germplasm has been utilized for high yielding with better qualities, durable rust resistance (race specific and non-specific minor genes). Selected modified bulk method was applied at early generations and single plants selection at advanced. Shuttling was conducted at Marpha, Nepal and KARI, Njoro, Kenya rusts resistance. Rust trap nurseries were also conducted at Khumaltar, Kabre. Uniform lines were evaluated at hot spots for its rust resistance both on seedling and adult plant stages. Targeted traits and environment specific nurseries, yield trials from NPBGRC (formerly ABD), NWRP and CIMMYT were evaluated and further selected cultivars for advanced varietal trials, PVS and then farmer preferred cultivars were proposed for variety release.

Achievement of Adult plant resistant varieties

Since 1960, 44 wheat varieties has been released. Following genotypes with durable rust resistant are resulted from wheat breeding research program in Table 2.

Table 2. List of released and pre-release durable rust resistant genotypes

Variety/Parentage	Year of Release	Gene available
Pasang Lhamu (PGO/SERI)	1997	*Yr7*, and *Sr2* complex
WK 1204 (SW89-3064/Star)	2007	*Lr46/Yr29*
Dhaulagiri (BL1961/NL86)	2012	APR on all rusts,
Danphe (KIRITATI//2*PBW65/2*SERI.1B)	2014	APR on rusts with Sr2+
Sworgadwari (XIA-984-10YAASKUNMING/BL1868)	2016	Yellow rust resistant
Munal (WAXWING*2/KIRITATI)	2017	Sr2+, yellow & brown rust APR
Chyakhura(WHEAR/VIVITSI/3/CBO.1/3*BATAVIA//2*2WBLL1)	2017	Sr2+, yellow & brown rust APR
To be released		
WK1712 (URES/JUN//KAUZ/3/MOMCHIL/KATYA1)	(2020!)	Yellow rust resistant
WK2286 (Acc#05999/3*WK1204)	(2020!)	Yellow rust resistant
WK2370 (ND31/WK1204)	(2020!)	APR on Yellow rust
WK2422 (WBLL4/KUKUNA// WBLL1/3/ WBLL1*2/ BRAMBLING)	(2020!)	APR on Yellow rust

Conclusion

- Substitution of old susceptible and popular varieties vulnerable to newly developed yellow rust pathotypes by recently released superior resistant varieties namely Munal, Chyakhura and proposed resistant varieties WK 1712, WK 2286, WK 2370 and WK 2422.
- Selection and release of improved lines with APR on rusts are on progress.
- *Yr5*, *Yr9*, *Yr10*, *Yr15*, *Yr24*, *Yr26*, *Yr27*, *YrSp* and *Yr18* (Jupateco R) were found effective to yellow rust disease against the pathotypes, while gene(s) *Yr1*, *Yr6*, *Yr7*, *Yr8*, *Yr17*, *Yr18*, *Yr32* and *YrA* were ineffective.

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