Current status of wheat rusts in South Africa

The three rusts present in South Africa, stem rust, leaf rust and yellow rust, can cause more than 50% yield losses under favourable weather conditions on susceptible cultivars. The most common methods of control are growing resistant cultivars and the application of fungicides. The ARC-Small Grain Institute conducts annual rust surveys to timely detect potentially dangerous rust races.

**Dr Tarekegn Terefe**
ARC-SMALL GRAIN INSTITUTE, BETHLEHEM – AN INSTITUTE OF THE FIELD CROPS DIVISION

WHEAT RUSTS ARE caused by small micro-organisms known as fungi. There are three kinds of rusts which commonly infect wheat: Stem rust (black rust), leaf rust (brown rust) and yellow rust (stripe rust).

The three rusts differ in the colour and shape of the pustules (powdery spore masses) they produce on infected wheat. These different signs are useful in the identification of the three rusts. Stripe rust appears as yellow spore masses arranged in stripes on the leaves (Photo 1). Stem rust produces dark-red, elliptical masses of spores on the stem, leaf and sometimes on the head of wheat (Photo 2). Leaf rust develops on leaves as circular and orange-red pustules (Photo 3). Pustules of leaf rust are more circular and smaller than those of stem rust.

All three rusts are present in South Africa, but their severity and importance in a specific area is largely affected by climatic factors. Stem and leaf rust are favoured by warm temperatures of 20°C, but yellow rust infection commonly occurs under cool weather conditions (<15°C). Therefore, yellow rust is more important in the cooler wheat production areas (e.g., Eastern Free State) whereas stem rust and leaf rust are more prevalent in wheat growing regions with mild winter temperature (e.g., Western Cape).

Wheat rusts can cause extensive yield and quality losses by damaging the leaves and stems of wheat. Under favourable weather conditions, any of the three rusts can cause more than 50% yield losses on susceptible cultivars.

**CONTROL METHODS**
The most common methods of wheat rust control are growing resistant cultivars and application of fungicides.

**Resistant cultivars**
Resistant cultivars provide an effective and environmentally friendly method of rust control. Therefore, rust resistance has been an important component of wheat breeding objectives at the ARC-Small Grain Institute (ARC-SGI). Several resistant cultivars have been developed over the past years. The resistance status of commercially available cultivars is annually updated by testing them with relevant rust races through an ongoing collaboration between the ARC-SGI and University of the Fee State. The results are regularly published by the ARC-SGI in the Small Grain Production Guideline. Such information is useful to farmers in making decisions as to which cultivar to grow in a specific production area.

There are some challenges in using genetic resistance (resistant cultivars) to control wheat rusts. One of the major limitations of resistant cultivars is that their resistance is often short-lived. Rust carrying fungi frequently acquire new virulence to overcome the resistance in existing cultivars. Virulent races mostly develop locally through genetic mutation in existing rust populations. Sometimes new rust races can be introduced into South Africa from other countries, via windborne spores or probably by sticking to travellers clothes.

It is therefore important to regularly monitor wheat rust growing areas to timely detect and control new races before they multiply and cause epidemics and economic loss. For this reason, the ARC-SGI has been conducting annual rust surveys to timely detect potentially dangerous rust races. Through such rust surveillance conducted by the ARC-SGI during the past three decades, more than 25 leaf and stem rust races and four yellow rust races have been detected. The results are used to continually improve wheat rust resistance in the cultivars that have been regularly released.

To minimise the effect of migrating new races on wheat production in South Africa, breeders and pathologists from the ARC-SGI are proactively identifying germplasm with broad spectrum of resistance in East Africa where a number of dif-
different rust races are present. The ARC-SGI’s breeding materials are annually tested at the international rust screening nursery in Kenya. This has allowed identification of resistance sources which are being used to develop new cultivars which will be resistant not only to South African rust races, but also to virulent East African races which are not yet detected in South Africa.

As rust pathogens continue to evolve and develop new races, researchers should also continue monitoring rusts, identifying new resistant sources and incorporating resistant genes into new cultivars. Breeding for rust resistance is a nonstop and continuous research activity.

**Fungicides**

When resistant cultivars are not available or when resistance in existing cultivars breaks down due to the emergence of new races, fungicides can be used to control wheat rusts. However, excessive use of fungicides is harmful to the environment and it could also present a health risk to farmers and farmworkers. It can also increase the chance for the emergence of fungicide-resistant rust strains which will lead to the ineffectiveness of the chemicals. Therefore, the use of fungicides should be considered only on susceptible cultivars where rusts are likely to cause significant yield loss. Wheat producers should avoid applying fungicides on resistant cultivars.

**RUST SURVEILLANCE 2015**

Surveys were conducted on trap nurseries planted across the major wheat growing regions (Free State, KwaZulu-Natal and Western Cape) and on commercial wheat fields to determine occurrence and distribution of wheat rust races in South Africa during the 2015 season.

Leaf rust was observed mainly on trap nurseries in the Western Cape with a severity of mostly less than 5%. Although leaf rust was detected in more than 50% of farmers’ fields surveyed in the Western Cape, its severity in the majority of these fields was not significant. The Free State experienced severe drought in 2015 and this prevented leaf rust development in almost all localities surveyed.

A moderate amount of stem rust was observed on trap entries in a few localities in the Western Cape, but most localities had less than 5% infection. Stem rust was not observed in any of the farmers’ fields surveyed in the Western Cape, Free State or KwaZulu-Natal.

Trace to 5% yellow rust severity was observed on a few trap entries in Eastern Free State. The remaining trap localities (nearly 70%) and almost all the farmers’ fields surveyed in 2015 were free of yellow rust.

Generally, the level of wheat rust infection was lower in 2015 than in the previous season. No new rust races were detected from hundreds of samples processed. The last new race identified in South Africa was leaf race 3SA115, which was detected in 2012 in the Eastern Cape and later also spread to the Western Cape. Although this race has become predominant in the Western Cape, virulence tests on current cultivars and breeding lines indicate that this race will not be a threat to wheat production as it was found to be less virulent than previous races.

**UG99 UPDATES**

Ug99 is a highly virulent stem rust race which was discovered in 1999 in Uganda, East Africa. Ug99 overcame a resistance gene Sr31 which had been effective for more than 30 years. This rust race is considered as a serious threat to global wheat production, as most breeding lines and wheat cultivars grown around the world are susceptible to this race.

During the past 15 years, Ug99 has evolved to different races, some of which have overcome important resistance genes other than Sr31. Ug99 variants have also spread to different wheat growing countries. To date, 13 Ug99 variants have been identified and one or more of these variants have been confirmed in 13 countries (Uganda, Kenya, Ethiopia, Eritrea, Sudan, Egypt, Tanzania, Zimbabwe, Mozambique, South Africa, Rwanda, Yemen and Iran). Two of the 13 Ug99 variants were detected in 2015 in Kenya.

Four of the 13 Ug99 variants have been confirmed in South Africa. However, only one (race 2SA88) was detected in 2015. The remaining three have been rarely found since 2010. South African wheat breeding materials are being screened and selected against the four Ug99 variants. Most of the current breeding lines in the ARC-SGI are therefore expected to be resistant to these races.

Most wheat cultivars become susceptible to new races mainly when their resistance is based on a single gene. To mitigate such problems, efforts are under way in the ARC-SGI to develop lines with multiple resistance genes. This may help in increasing the durability of resistant cultivars. In these rust resistance breeding processes, the conventional breeding methods are being supported by molecular techniques.