The use of resistant cultivars for control of wheat rusts

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Three types of rust diseases (stem rust, leaf rust and stripe rust) caused by fungi, commonly infect bread wheat in South Africa. These rusts can be easily distinguished based on visible signs on infected wheat plants.

Stem rust appears as elliptical dark-red pustules (powdery masses of spores) on the stem, leaf and sometimes on the head of wheat (**Photo 1**). Leaf rust primarily develops on wheat leaves as circular and orange-red pustules (**Photo 2**), while stripe rust signs include yellow pustules arranged in longitudinal stripes on the leaf (**Photo 3**), leaf sheath and occasionally on the head of wheat.

Stripe and leaf rust can cause extensive yield and quality loss, mainly by destroying leaves. Stem rust infection may weaken wheat stems, predisposing them to lodging. In addition, stem infection reduces nutrient flow to the head, thereby resulting in the development of small or shrivelled grains.

Environmental factors, primarily moisture and temperature, affect the prevalence and severity of wheat rusts. All three rusts require moisture (free water) for their spores to germinate and infect wheat. Stem and leaf rust are more common under warm weather conditions, but stripe rust mostly occurs under low temperature (10°C - 18°C) conditions. In South Africa, yellow rust is important in the cool-weather wheat production areas such as the eastern Free State, whereas stem and leaf rust are predominant in the warmer, moist wheat growing areas of the Western Cape.

Breeding for rust resistance

Resistant cultivars are often regarded as one of the most effective methods of wheat rust control. Unlike synthetic chemicals, they are environmentally safe, having no potential negative impact on biodiversity or on the health of producers, farm workers or consumers. In addition, genetic resistance can be easily integrated into other control methods. Resistance to rusts can be combined with resistance to other wheat diseases or insect pests.

Two kinds of resistance to wheat rusts are known: Race-specific and race-nonspecific resistance. Inheritance of race-specific resistance is mostly controlled by a single gene. Therefore, it is also referred to as single-gene resistance.

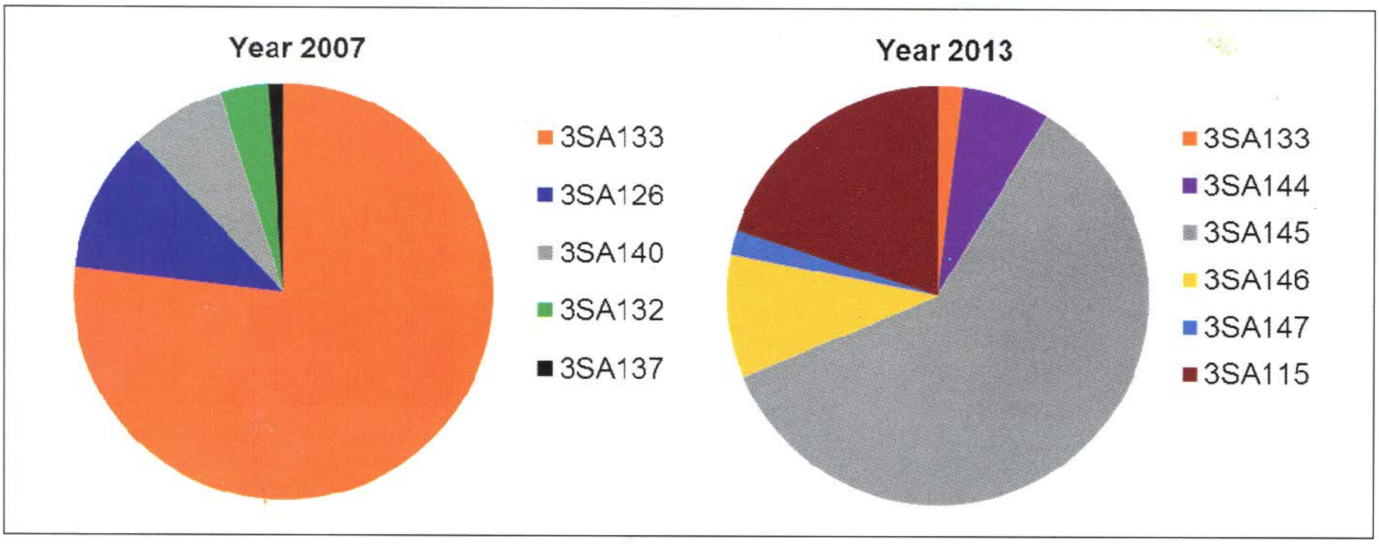
Race-nonspecific resistance is also called multi-gene resistance as it is controlled by more than one gene. Multi-gene resistance is quantitative and it is expressed as different degrees of resistance (disease levels). In contrast, single-gene resistance is expressed qualitatively, i.e. infected plants are either completely resistant or completely susceptible.

It is, therefore, easier to select plants with race-specific resistance. Consequently, race-specific resistance has been most commonly employed in breeding programmes, worldwide. However, single-gene resistance is prone to rapid breakdown with the emergence of a new rust strain (race), hence it is not durable. Multi-gene resistance is durable, because it remains effective regardless of the development of new rust races.

Virulence changes in rust fungi

Unfortunately, single-gene resistance is often short-lived due to the frequent development of new rust races with virulence to resistance genes contained in existing cultivars. More than 25 different races of leaf and stem rust and four races of stripe rust, have been identified in South Africa over the past three decades.

Graph 1 illustrates recent evolutionary changes that have occurred within the South African leaf rust population. In 2007, most of the isolates in the leaf rust population (about 77%) consisted of race 3SA133 and none of the isolates collected in that year were 3SA145 (Graph 1).



Graph 1: Comparison of the leaf rust race population detected in South Africa in 2007 and 2013.