A NOVEL VARIETY MANAGEMENT STRATEGY FOR PRECISION FARMING

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Abstract: In the Northern Caucasian region the development and deployment of improved varieties and farming systems has lead to increased winter wheat yield and yield-stability. A key element of this success has been an integration of strategies aimed at increasing economic returns to wheat growers through improved crop management and more optimal matching of varieties and management. Advice is provided to farmers based on their planned level of expenditure on inputs such as fertilizer and pesticides, projected income, the scale of their enterprise, and the production system they will use which is greatly influenced by their level of mechanization. Integration of this information is used to assist them in selecting the best mix of varieties for their farm. To manage risk and account for year-to-year variation caused by genotype by environment interaction, between 3 and 6 winter wheat varieties best suited to their enterprise will be chosen based on long term data.

Development of an Agrotechnological Varietal Passport for each variety is an important tool used in the matching of varieties to farm enterprises. The Varietal Passports outline data on the relative performance of varieties following different preceding crops, adaptation to different environment types, optimal sowing date, growing period, pest and disease responses, resistance to abiotic stresses, inherent grain quality characters, suitability for machine harvesting (determined by lodging and shedding resistance), optimal sowing rate, mineral fertilizer requirement, genotype-pesticide response and typical gross margins.

Our novel variety management policy is based on crop pre-adaptation, considering poor long-term climate predictability, and our target that a variety should cover not more than 15% of the region’s sowing area. This variety management policy has allowed the benefits of ongoing scientific advances in both improved varieties and management practices to be captured by the farmers of the Krasnodar region. Over the last two decades a consistent rise of winter wheat yield over the more than one million hectares in the Krasnodar region has increased mean yields from 3.3 t ha\(^{-1}\) to 4.6 t ha\(^{-1}\).

Keywords: maximize yields, genotype × environment responses
INTRODUCTION

The fundamental role of breeding science in the release of improved varieties and their contribution to increasing total grain production is widely acknowledged (Lukyanenko 1973, Borojevich 1984, Vasilchuk 2001, Balla et al. 1987, Bespalova 1998, Valkoun et al. 1987, Nettevich 2002). According to these authors’ estimates, annual yield increases over the last three decades of the 20th century varied from between 0.5 to 1.8%. This increase was largely due to parallel development of more intensive crop management systems and release of improved varieties better suited to these intensive management systems (Romanenko and Lenkova 2004). Continual intensification of agricultural production over more than 50 years has led to environmental degradation and an almost exponential growth in inputs of non-renewable resources per additional unit of agricultural produce (Zhuchenko, 1994, 2001, 2004, 2004a).

The Southern Federal District of Russia including the Krasnodar region is the most favorable area in Russia for achieving high wheat yields. At the same time it is the zone that has suffered the most acute environmental degradation from intensive land use, reduced fertility and moisture levels following high input break crops such as sunflower and maize and macro- and micronutrient imbalances. The high proportion of the cropping area planted to grain crops, increasing application of pesticides and their mutagenic and selective effect on the complex of wheat pathogens hinder further high quality yield growth (Molchan 2002).

Economic changes in Russia have seen a huge range in the uptake of improved management practices and investment in mechanization among grain producers. These differences translate to a large range in wheat yields, even within production regions. For example, at Novokubanskiy rayon (farmland area with near 30000 ha of wheat, in Krasnodar region) average winter wheat yields are 6.0 t ha⁻¹. However within this area some farms regularly achieve 7.0–8.0 t ha⁻¹, while other farms only achieve 30 to 40% of a varieties potential yield (around 2.5–3.0 t ha⁻¹). These differences arise because varieties with the highest yield potentials can only achieve this potential with high levels of input, where they show the greatest advantage compared to less productive varieties. At the same time, intensive cropping practices are justified only when the level of inputs is consistent with the environment and potential of the grown variety (Vasilchuk 2001). If levels of input are in excess of what can be used by a variety in a particular environment, wheat yields may actually fall in spite of increased inputs. According to Zhuchenko (1994), effective implementation of intensive precision farming must be based on an integrated understanding of the key factors driving crop yield, and how they interact and continued adoption of new technology and beneficial interactions. Hence, in addition to the breeding of improved wheat varieties and better crop management practices, further growth of wheat yields will depend on optimizing combinations of the genetic peculiarities of varieties and the conditions in which they grow. That is why our aim to understand and maximize average yields in presence of genotype × environment interactions is an important aspect for increasing winter wheat yields (Shevelukha and Morozova 1986).