Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2023, 13(9), 7-9, doi: 10.15421/2023_490

MINI REVIEW

Anticipating the adverse effects of barley rust

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Received: *01 September, 2023; Manuscript No: UJE-23-114898;* ***Editor assigned:*** *02 September, 2023, PreQC No: P-114898;* ***Reviewed:*** *15 September, 2023, QC No: Q-114898;* ***Revised:*** *22 September, 2023, Manuscript No: R-114898;* ***Published:*** *29 September, 2023*

Our research delved into unraveling the dynamics governing the distribution and progression of spring barley rust. Over the course of our study, we witnessed the disease's dissemination fluctuate between 21.75% and 30.0%, accompanied by varying intensities ranging from 13.25% to 19.0%. Furthermore, we meticulously observed how the disease impacted the structural aspects of spring barley yield, revealing a strong correlation with coefficients of r=0.973, r=0.980, and r=0.973. In addition to this, we developed predictive models to estimate potential crop yield losses attributed to rust, thereby allowing us to foresee potential reductions in spring barley harvests caused by this disease.

Keywords: Spring barley, Rust, Close correlation, Plant protection.

Introduction

Spring barley occupies the fourth position globally in terms of its cultivation area and holds the second spot among cereal crops in Europe. In Ukraine, it ranks as the second most cultivated cereal, following wheat, due to its nutritional, fodder, and industrial importance, as well as its ability to yield well, adapt to varying environmental conditions, and thrive under effective agricultural practices. Its versatile applications in the food, fodder, and brewing industries underscore its pivotal role in Ukraine's grain production balance. The composition of barley grain, which contains 12% protein, 64.6% nitrogen-free components, 5.5% fiber, 2.1% fat, 13% water, and 2.8% ash, further highlights its nutritional value (Clifford, B.C., 1985).

Ukraine dedicates 3-4 million hectares annually to spring barley cultivation, along with 400–500 thousand hectares for winter barley. Effective disease control necessitates a comprehensive approach, combining organizational, economic, agronomic, and chemical interventions. Scientific management of chemicals emerges as a crucial strategy to minimize environmental contamination from pesticide residues while protecting barley from diseases (Stubbs, R.W., 1985).

In recent years, the significance of plant diseases has grown due to their adverse impact on agricultural yield, product quality, and subsequent economic losses. Among these diseases, rust stands out as a prominent culprit, affecting plants throughout their growth cycle, with a particular manifestation on barley leaves. The causal agent of this ailment is the Puccinia hordenia Lawrow fungus. Rust inflicts significant reductions in yield and impairs winter and drought resilience. The most severe damage occurs when the disease emerges during spring, leading to premature crop maturation and substantial yield deficits, especially under conditions of inadequate soil moisture. Rust-induced losses range from 20-35% almost annually, and in years with high rust incidence, yield drops from 25-30 to 5-6 c/ha. Severe infections result in exceptionally thin grain that is susceptible to wastage. Central Ukrainian regions experience rust epiphytes roughly every other year, while Western Ukraine encounters them less frequently, approximately once every 3-4 years (Qi, X., et al., 1998).

Literature Review

During 2017 and 2019, a series of experimental investigations took place, conducted within the laboratory at the Department of Phytopathology, named in honor of V.F. Peresypkin, and in the phyto-section situated within the fields of the agronomic research station at the National University of Life and Environmental Sciences of Ukraine. These investigations were focused on studying the Avatar barley variety and followed an established protocol (Dinh, H.X., et al., 2020).

The planting process involved sowing seeds at recommended intervals suitable for the specific geographical zone, at a depth of 4-6 cm. Seed quality assessment adhered to established guidelines, and the sowing itself was done manually. Each individual plot measured 4 m^2, with a seeding rate set at 4.0 million seeds per hectare. The experimental setup was replicated four times, and a systematic arrangement of the experimental plot scheme was employed. Rust diseases in grain crops were monitored during the milk ripeness stage of the grain. Rust types were documented using a specialized scale developed for this purpose, which incorporated a composite scale. To monitor rust diseases across fields spanning up to 100 hectares, 20 samples, each consisting of 10 stems, were collected, with an additional two samples taken for every additional 100 hectares. The assessment covered both disease spread (expressed as the percentage of affected plants or their components) and disease intensity (Steffenson, B.J., 1992).

Discussion

To evaluate the prevalence of spring barley rust, comprehensive field surveys were conducted at the "Agronomic Research Station" within the Vasylkiv district of the Kyiv region, spanning the years 2017 to 2019 at the National University of Life and Environmental Sciences of Ukraine (NULES). Rust distribution was consistently observed throughout the entire growth cycle, with initial signs of the disease appearing during the flag leaf formation phase of the spring barley plants. The observed disease spread amounted to 13.0% in 2017, increased to 18.5% in 2018, and decreased to 11.0% in 2019. Correspondingly, disease intensity values were recorded as 5.5%, 9.5%, and 3.5% for the respective years. During the milk-wax ripeness stage of spring barley, disease propagation manifested at rates of 25.0% in 2017, escalating to 30.0% in 2018, and then subsiding to 21.75% in 2019. Concurrently, disease advancement exhibited intensities of 16.0%, 19.0%, and 13.25% in the respective years. Spring barley rust presents a significant threat, emphasizing the critical need to investigate its prevalence and detrimental effects for the development of protective strategies. A thorough analysis of the plant's structure revealed a substantial impact of the pathogen on the growth and development of spring barley. As the level of infestation increased, noticeable reductions were observed in biometric indicators. Our investigations demonstrated a notable slowing of growth and development in spring barley plants as the severity of infestation intensified. Notably, under vigorous disease progression, plant height diminished by 9.5-15.0 cm compared to healthy specimens (Vales, M.I., et al., 2005).

Conclusion

In the surveyed region, rust exhibits a widespread presence throughout the growth cycle of spring barley. During the flag leaf formation phase, it affects a range of 11.0% to 18.5% of plants and expands to a range of 21.75% to 30.0% during the milk-wax ripeness period. Our investigations uncovered variations in the intensity of its development, ranging from 3.5% to 19.0%, depending on the growth stage. Significantly, we observed a pronounced influence of the pathogen on the growth and development of spring barley plants. As the degree of infestation increased, noticeable reductions were observed in various biometric indicators. Specifically, in cases of intense lesions (score 0), both plant weight and the weight of 1000 seeds decreased by 0.61 and 6.8 grams, respectively, representing 67.9% and 77.6% of the corresponding values in unaffected plants. Correlations became evident between the extent of damage caused by rust and parameters such as seed weight per plant, weight of 1000 seeds, ear length, and seed count per plant. Regression equations were formulated, allowing for the quantification of indicator decrement based on the progression of the disease during the flag leaf formation phase.

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Citation:

Sentosh, D.T. (2023). Anticipating the adverse effects of barley rust. *Ukrainian Journal of Ecology.* 13: 7-9.

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