

## WHEAT VARIETY SPECIFIC AT ONCE PROTECTION OF PARASITES AND PESTS BY PESTICIDES

Zoran JERKOVIC\*, Radivoje JEVTIC, Zeljana PRIJIC, Branka ORBOVIC, Mirjana LALOSEVIC

Institute of field and vegetable crops, Novi Sad, Serbia

\*Corresponding author: jerkovic@ifvcns.ns.ac.rs

### Abstract

Enzymatic relict of S, P or Cl from gluten, dithiocarbamate, thiametoxam, and glyphosate by the products of genes for resistance to wheat leaf rust (Lr) was recognized across effect of consequential acids on chlorophyll. Nine wheat varieties were treated by aforementioned based pesticides at seedlings but these time infected by *Puccinia triticina* isolate. Assumed two last mentioned adequate sources result enhanced hypersensitive reaction or more prolonged the latency period. The Lr 29 in the variety Enigma accelerated degraded all pesticides except kresoxim methyl based while in varieties Simonida, Rapsodia or Tavita (Lr 1), NS 40S (Lr 3a), Metka or Gora (Lr 19) and Ilina (Lr 24) were effective to reaction type decrease when glyphosate dose was increased. Glyphosate was applied 3<sup>th</sup> while dithiocarbamate 5<sup>th</sup> June 2014<sup>th</sup> in field trial. Both pesticides reduced *Puccinia triticina* intensity and growth of *Septoria tritici*. Variety Pobeda exceptional by the difference in one week, application of sulphur containing herbicide with fungicide with fluorine and chlorine additional on C circle in March and sequenced by last mentioned elements ones late in April caused progressive yellowing during last decade of May. Behind the appearance were by heat stress viable Lr genes product, accumulated accelerate degradable residua adequate parasite and gluten. To facilitate of *Pyrenophora tritici repentis* toxin production, favour in reduction of leaf rust, application of herbicides containing S or P near heading while of neonicotinoides in the middle of grain filling appeared to be occasional economical multiple pests reducing solution focusing estimated specific Lr genes constellation.

**Key words:** *wheat integral protection, Lr genes*

### Introduction

Grain yield potential in semiarid regions mostly below 6 t/ha made less space for aforementioned rentable efforts respecting the cost of one treatment approximately equal to 1 t of grain while of each sequenced were halved due to established permanent traces. The single late protection of wheat varieties against parasites when most frequented and damaging one was leaf rust causer was mostly not founded to be economical even when grain yields were stable over 7 t/ha. Expected losses by sustainable applied resistance to *Puccinia triticina* focusing assortment contemporary changes possibility were reduced by two also always present facultative parasites antagonism. Treatments late in grain filling and only when planed intermediate level of resistance achieved by distribution of different resistance genes to leaf rust cause was overcome in assortment part were recognized as economical only when *Pyrenophora tritici repentis* did not covered more than 10% at middle leaves (Jerkovic et al., 2012). Such interactions were for the first time involved in the forecasting model of final parasitic development and grain yield losses while simultaneous predicted was of variety specific time when should loss the green leaf area (Jerkovic et al., 2013a) necessary for of the particular pesticide last application period determination respecting residua. The effects of fungicides described to be excellent efficient to leaf rust reduction were also recognized as

very good or excellent in reducing of the antagonistic facultative parasites (Osborne and Stain, 2009) while currency period in semiarid region also determined Skerbot (2011).

Discovered interactions between leaf rust resistance genes and various to pest specific efficient pesticides (Jerkovic et al., 2012a; Jerkovic et al., 2014) as well as their parasite free primary function to degrade gluten (Jerkovic et al., 2013; Jerkovic et al., 2013b) based expectation that some of them will be usable as practical solution respecting multiple effects on simultaneous present pests while hypothetical become negative effect when all factors were accumulated and viable. When focused were genetically modified wheat lines resistant to glyphosate (Castle et al., 2004) crossed with those containing effective Lr genes to parasite population homozygous products, triple interactions were described by Anderson and Kolmer (2006) while of external to plant factors ones were recognized by Huang et al. (2005). Former, confirmed was lower reaction type transformation from latency period when seedlings of leaf rust resistance genes containing near isogenic lines were treated with labelled dose of mentioned herbicide while related was to growth type controlled by accumulated nonspecific to parasites races resistance genes reducing infection efficacy trough facilitated drying of leaves upper parts (Jerkovic et al., 2014a).

However, the effects of investigated insecticides and fungicides on leaf rust reduction when interacted with responsible Lr genes for their accelerated degradations as well as consequences were not since evaluated trough preliminary effect on parasite development. Increased negative influence on growth by chlorophyll degradation also become hypothetical when residua were accumulated by sequenced treatments with adequate pesticides. Of fluorine containing ones were still not certain. Assuming possibilities facilitated by novel results and described wheat production circumstances in semiarid regions, the main aim of the study was to determine of variety specific occasional economically sustainable protection solution by pesticide.

### Material end methods

The approximately 50 seeds of nine tested wheat varieties were sown in 2 dl of soil each in five replications and grown in the greenhouse during the May 2014<sup>th</sup> at air temperature around 20°C. The infection by isolate of *Puccinia triticina* was six days after germinating while two days behind incubation in humid chamber lasting one day by hand sprayer (0,5 l) applied were 1dl of single pesticides solutions glyphosate (0,2 ml/m<sup>2</sup>), thiametoxam, dithiocarbamate and strobilurine (0,1 ml or gr/m<sup>2</sup>). The estimation of reaction types (Stakman et al., 1962) started seven days after incubation and was daily triple. The same varieties were sown in field trial at 6m<sup>2</sup> using such design that controls were 2 m distanced and parallel to treated varieties. All replications were treated by pendimethalin (5 kg/ha) at last decade of November as well as one of by glyphosate (0,5 l/ha) 3<sup>rd</sup> or dithiocarbamate (2 kg/ha) at 5<sup>th</sup> June 2014<sup>th</sup>. The attack intensity of *Puccinia triticina*, *Septoria tritici* and *Pyrenophora tritici repentis* was presented in percent of covered flag leaf area and estimated just before and ten days after treatments. On third replication grown nearby the attempted was total multi pest protection using simultaneous pesticides based on sulfonil-urea (25 gr/ha), fluoroxyryg (0,5 l/ha) and cyproconazole plus picoxystrobin (0,6 l/ha) at March 18<sup>th</sup> 2014<sup>th</sup> while these containing trifloxystrobine and cyproconazole (1 l/ha) and deltamethrin (0,3 l/ha) were applied at April 29<sup>th</sup>. The yellowing of the leaves was followed from the last decade of May as well as appearance of the *Puccinia triticina* spores at June 1<sup>th</sup> 2014<sup>th</sup>.

### Results and discussion

The pesticides applied in lower doses of proposed except for glyphosate, previous such investigated, was relevant to facilitate recognition of interaction between genes for the resistance and various pesticides because when in labelled doses were applied differences were not recognizable (Jerkovic, unpublished data). Gluten formation in leaves in proposed

environmental conditions at seedlings was not expected by previous parasite free results. The doubled acid forming elements source from parasite isolate and dithiocarbamate based fungicide or thiometoxam insecticide decreased final RT at variety Enigma by Lr 29 on complete resistance level. Of the mentioned gene single presence was recognized by no enhanced resistance to parasite isolate and trough of these agent free interactions with glyphosate (Jerkovic et al., 2014b). Focusing prolonged LP for one day it was discovered that Lr 1 recognized in the varieties Simonida, Rapsodia and Tavita could cleave CI from studied insecticide as well as some of S in dithiocarbamate, previous recognized only when Lr 16 or Lr 29 were present. The effect on variety Rapsodia was supported by nonspecific Lr genes accumulation and recognizable because of in May prolonged sunny periods. With no respect of Lr genes effect in variety sample someone could conclude that the strobilurin based fungicide in average had to be less preventive efficient than dithiocarbamate. Relative low entrance ability in leaves of the last mentioned pesticide was recognized by comparison to phtalamide, thiametoxam and thiaclopid based pesticides throw acid forming elements content while the practical problem was solved by increasing of labelled dose or by daily watering in the similar trial at seedlings (Jerkovic et al., 2012). Lr 20 and Lr 29 were most but different effective to thiamethoxam and thiaclopid residua degradation characterized by ringed C and N and additional CI while the differences between genes responsible for degradation were related to approach ability defined by molecular weight of elements or units nearby accelerate relisted element. Using pesticides in decreased dose, protection by all of them become lousy without adequate Lr genes to parasite isolate confirming expected enhanced resistance of triple interactions. Much increased dose of glyphosate was LP prolonging for one while of labelled was for a half of day focusing variety Pobeda and linked to common herbicidal effect on obligate parasite development (Tab. 1).

Tab.1. Interactions of wheat varieties *Puccinia triticina* isolate and pesticides throw reaction type to parasite

Variety	K	Glyphosate	Dithiocarbamate	Thiametoxam	Kresoxim methyl
Rapsodia	;1 4 4	0; ;	; ;	; ;	; ;1 ;3
Simonida	;12 4 4	0; ;	;1 ;2	;1 ;1	;1 ;2 ;3
Tavita	;1 4 4	0; ;	; 3	;12 ;3	;1 ;3 ;34
NS 40 S	34 4 4	0; ;	;3 ;3 3	3 4 4	;23 ;34 ;34
Metka	34 34 4	;1 1	12 3	3 3 4	;12 34 4
Gora	34 4 4	;2 3	12 34	3 3 4	;12 4 4
Enigma	;1 3 34	0; 0;	; ;1	; ;N	; ;1 34
Ilina	34 4 4	; ;1	3 4	3 34 4	;34 34 4
Pobeda	4 4 4	; 3 4	4 4 4	4 4 4	4 4 4
Average maximal RT	3,95	0,94	2,28	2,44	2,61

When fungicides characterized by tripled F linked to benzene CH ring, were sequential applied respecting proposed currency in spring, continual daily by rain wetting and decreased temperatures below 20 °C in second decade of May inhibited activity of Lr genes. During last decade at temperatures over 25 °C appeared daily continual, recognized were permanent progressive yellowing of the flag leaves relative less fast only et variety Ilina confirming Lr 24 product to be relative most hydrolytic instable. According to previous stated about, the effect of recently studied Lr genes on single fluorine linked to circle was not expected because of linkage strength but on more of them directly associated was indicated. The result of

formed HF acid was likely to be at last  $MgF_2$  more hydrolytic stable of all previous discussed resulting salts from pesticides. The nitrogen acids were not founded to be stable at light (Ammann et al., 2005) while by introduction facilitated change of O with F in described circumstances solved their permanency problem by less amount of last involved element. By the pathway simultaneous was reduced fast chlorophyll recovering and of other proteins synthesis recognized when neonicotinoides were applied by no viable N trough more stable  $NH_4HF_2$  formation reactive also to  $MgO$  expected when PDI enzymes were gluten formatting (Cumming et al., 2004) as well as of intermediate weighted elements oxidation and transformation to acids (Jolivett et al., 1992). When focused were three characters (cleaved linkage strength, hydrolytic stability and approach ability) of all discussed Lr genes accelerated degradation of external S from sulphonil-urea or Cl from fluoroxyryg was also predictable. Only at variety Pobeda recognized as of specific Lr genes free, the complete yellowing happened later in the second decade of June five days earlier than was expected by forecasting model and explained by continual even than previous stronger heath stress and of pesticides adequate energetic conditions for enzyme free hydrolytic degradation. Additionally recognized, early treatments by pesticides decreased SAGR (divided last two internodes with stem length) for 0,05 in average compared to untreated trial while appearance could be related to of herbicide effect on growth point also. Decreasing of those character value caused of *Puccinia triticina* increased infection severity (Jerkovic and Prijic, 2009). The fructification of leaf rust was also present indicating only of pesticide original active substance effect on haustorium, partially similar by structure (Harder and Chong, 1984). Related, the of benzene ring also structuring pendimethalin supported stripe rust early growth for approximately 20% in comparison to those trial when other herbicides were applied much later. Previous described, single treatments by tebuconazole containing single acid forming element (200 ml/ha) even in June were without yellowing consequences but not applicable in assortment respecting proposed currency period of one month recommended by Osborne and Stain (2009). Such, recognized yellowing of leaves was explained by simultaneous relist of acid forming elements from gluten, adequate accumulated pesticides residua and leaf rust fungi population to constellation of Lr genes distributed in the varieties respecting no such evidence in another trial when two pesticides were single later applied.

According to recognized additional nutrition by N units (Vurdue and Tonneyck, 1978) when S or Cl were not accelerate relisted by enzyme, N from ring of thiametoxam appeared to be liberated most likely by some of common proteases. Beside, while enzyme behind sulphur and magnesium from salt relist and accounted curative effect to the parasite strongly supported such solution vice versa of than expected increased gluten synthesis. However, practical adequacy of aforementioned forecasting model was increased by prolongation of period for treatment application. Of single late multi pest targeted treatments effect to obligate parasites was enhanced by variety specificity across adequate Lr genes for by both agents increased preventive effect on than low frequented leaf rust causer. If opposite by overcome of variety resistance, these yellowing factor was excluded, curative effect had to be dominant while respected currency period. By shortened time between treatment and green leaf area disappearing on two weeks in regions where average temperatures were continually below 25 °C even when resistance to *Puccinia triticina* was not overcome and Lr 20 and Lr 29 were present, could be facilitated protection from than often aphids at spike and prevented spreading of last generation of leaf rust.

When used was the herbicide with phosphorus or dithiocarbamate, similar reduction of *Septoria trititica* growth for 5% and leaf rust intensity for approximately 20% was recognized while confirmed not significant influence on *Pyrenophora tritici repentis* growth (Sharma and Pfender, 1989). Late treatment by glyphosate caused fast whitening of spike at all varieties except Pobeda without genes for its accelerated degradation. Focusing spike in that period

there was no temporary inactivated Lr genes during daily longer lasting heath stress while simultaneous gluten formation in glumes was obvious. The adequate temperature around 20 °C during drought period when Lr genes had to be activated even without parasite as was recognized at seedlings were often before heading in semiarid regions while of chlorophyll recovering ability was expected to be increased and treatment consequences less harmful. Recently achieved presence of *Puccinia triticina* isolate below 30% at first leaf of seedlings was same directed to activate Lr genes and founded not to be limiting factor while in focused period gluten formation was not expected. The essential of the effort was to eliminate of *Puccinia striiformis* and *Septoria tritici* growth and development and promote on upper leaves spreadable toxins produced by *Pyrenophora tritici repentis* when located on intermediate leaves at least 14 days before last decade of May. By recent results, suggested were further regional investigations focusing allowed residua amount in seed. The Lr 16, Lr 19 and Lr 29 were predicted to be such most restrictive when focused was glyphosate. When herbicides containing sulphur were such applied the risk had to be decreased while result was expected to be similar speculated across dithiocarbamate effect. The *Septoria tritici* adaptation to strobilurine similar to pendimethalin structure was recognized by HGCA 2003<sup>th</sup>.

### Conclusion

Defined currency period of all applied pesticides was prolonged at air temperatures below 20°C. Generally, of pesticides changed schedule using later those with less or no stable acid forming elements when some of discussed Lr genes were present in semiarid region had to be rejected because instead of rent ability one of two treatments, problem with benzene ring as residua of viable pesticides for fungi reduction was solved by insecticides containing N. Another variety specific approach trough herbicide with S appeared recommendable while of glyphosate with external P without benzene ring was of conditions for some of Lr genes activity dependent and all round risky focusing regional environmental conditions. Investigations of residua in seed were abbreviated when was applied before heading in semiarid regions while earlier ones were predicted to be risky.

### References

- Amman, M., Rossler E., Streckowsky R., George E C. (2005). Nitrogen dioxide multiphase chemistry. Uptake, kinetics on aqueous solutions containing phenolic compounds. *Physical Chemistry Chemical Physics* 7: 2513-2518.
- Anderson, J.A., Kolmer, J.A. (2005). Rust control in glyphosate tolerant wheat following application of the herbicide glyphosate. *Plant Disease* 89: 1136-1142.
- Castle, L.A., Siehl, D.I., Gordon, B., Patten, P.A., Chen, Y.H., Bertain, S. (2004). Discovery and directed evaluation of a glyphosate tolerance gene. *Science*, 304:, 1151-1154.
- Cumming, R.C., Andon, N.I., Haynes, P.A., Park, M., Fisher, W., Shubert, D. (2004). Protein disulfide bond formation in the cytoplasm during the oxidative stress. *Journal of biological chemistry*, 279: 21749-21758.
- Feng, C.C., Baley, G.J., Clinton, P.W., Bunkers, J.G., Alibhai, F.M., Paulitz, C.T., Kidwell, K.K. (2005). Glyphosate inhibits rust diseases in glyphosate - resistant wheat and soybean. *Proceedings of the National Academy of Sciences of the United States of America*, 102: 17290-17295.
- Harder, D.E., Chong, P. (1984). Structure and physiology of haustoria. In *Cereal rust*, Vol. I, edited by Roelfs AP, Bushnell WR. Academic press, pp 431-473.
- Jerkovi, Z., Priji, Ž. (2009). Parasite developmental consequences of growing the different wheat types in semi arid region. IV Symposium with international participation Innovation in crop and vegetable production. 23-24. October, Belgrade. Book of Abstracts, 34-35.

- Jerkovi Z., Jevtic R. (2012). A solution for economical and safe wheat protection from parasites. Proceedings of Safe food ECO conference, 97-102.
- Jerkovic, Z., Prijic, Z. (2012a). Leaf rust specific resistance genes effect on degradation of fungicides with sulfur. Plant protection 63: 29-35.
- Jerkovic, Z, Prijic, Z., Djuric V. (2013). Effect of accumulated resistance genes to *Puccinia triticina* on transfer of seed proteins. Field Vegetable Crops Research 50: 60-64.
- Jerkovic, Z., Jevtic R., Lalosevic M., Prijic Z. (2013a). Integrated protection from prevalent wheat pathogens in semiarid regions. Journal of agricultural sciences, 58: 1-18.
- Jerkovic, Z., Prijic, Z., Djuric, V., Jevtic, R., Lalosevic, M. (2013b). Functions of Lr genes beside reduction of *Puccinia triticina*. Field and Vegetable Crop Research, 50: 6-12.
- Jerkovic Z., Prijic Z, Jevtic R., Lalosevic, M. (2014). Interaction of two neonicotinoid insecticides and Lr genes focusing wheat growth and residua. Plant Prot. Sci., received in May.
- Jerkovic Z, Prijic Z, Jevtic R, Orbovic, B., Lalosevic, M. (2014a). Lr genes facing glyphosate considered by residua, influence on wheat growth and leaf rust development. J. Plant Dis. Protect., received in May.
- Jerkovic Z, Prijic Z, Jevtic R, Orbovic, B. Lalosevic, M. (2014b). Tolerance of wheat varieties seedling by glyphosate accelerated degradation. Field and vegetable crops, received in June.
- Jolivet, P., Bergeron, E., Kein, P. (1992). Oxidation of Elemental Sulfur and Sulfite by Chloroplasts. *Phyton- Ann. Rei Bot.*, Horn 32: 59- 62
- Osborne, L. and Stein, J. (2009). Wheat fungicide recommendations. Pp 1-4. <http://www.sdstate.edu/ps/extension/plant-path/upload/FS952.pdf> (accessed Nov 15 2013).
- Vudue, J.W.L., Tonneyck, A.E.G., (1978). Effect of foliar application of urea on wheat growth in relation to plant age, soil fertility and light intensity. *Plant and Soil* 50: 473-477.
- Sharma, U., Adee, E.A., Pfender, W.F. (1989). Effect of Glyphosate Herbicide on Pseudothecia Formation by *Pyrenophora tritici-repentis* in Infested Wheat Straw. *Plant Disease* 73: 647-650.
- Skerbot, I. (2011). Varstvo žiti pred boleznimi. <http://www.kmetijskizavod-celje.si>
- Stakman, E.C., Stewart D.M., Loegering, W.Q. (1962). Identification of the physiological races of *Puccinia graminis* var. *tritici*. USDA, Publ. E617, Washington, DC, USA.