

Parastagonospora nodorum is a necrotrophic pathogen of wheat and triticale. It is known to produce several protein effectors which cause necrosis development in susceptible host genotypes. Pathogen can incite necrosis of leaves as well as glumes. Destruction of green plant parts affects photosynthesis adversely, what results in grain yield loss, quantitative and qualitative in nature.

Among Polish *P. nodorum* population, Tox1, Tox3 and Tox5 are most frequent effectors. ToxA is present only in minority of screened isolates. All of these effectors were purified and used to phenotype wheat and triticale lines. Diversified breeding materials of wheat and triticale were utilized in disease evaluation trials in field and under controlled environment conditions. Tox3 and Tox5 insensitivity were positively correlated with phenotypic resistance. Elimination of Tox3 sensitive lines as well as lines sensitive to other effectors can subsequently be used to increase *P. nodorum* resistance in wheat and triticale breeding materials.

Figure 1. Structure of Polish *P. nodorum* population

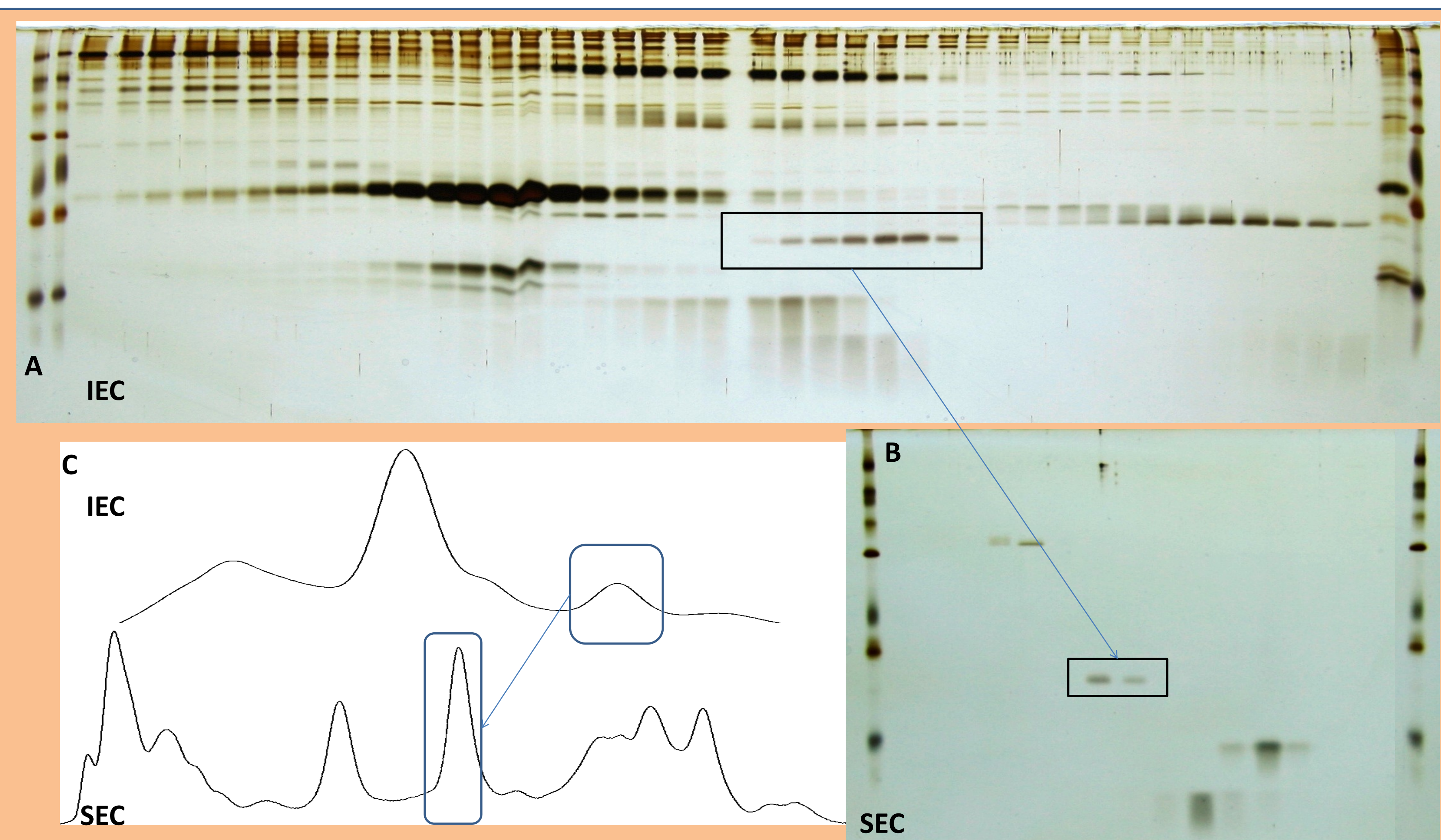
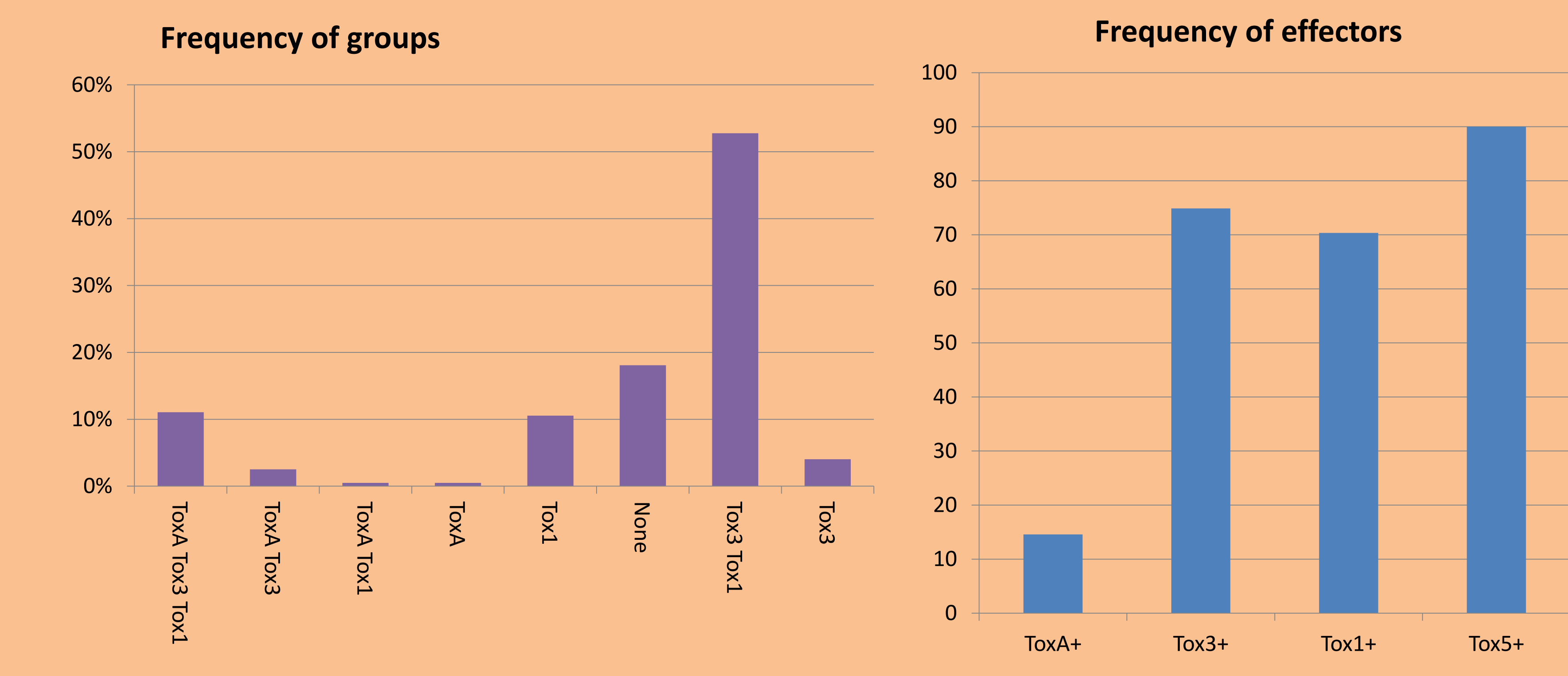
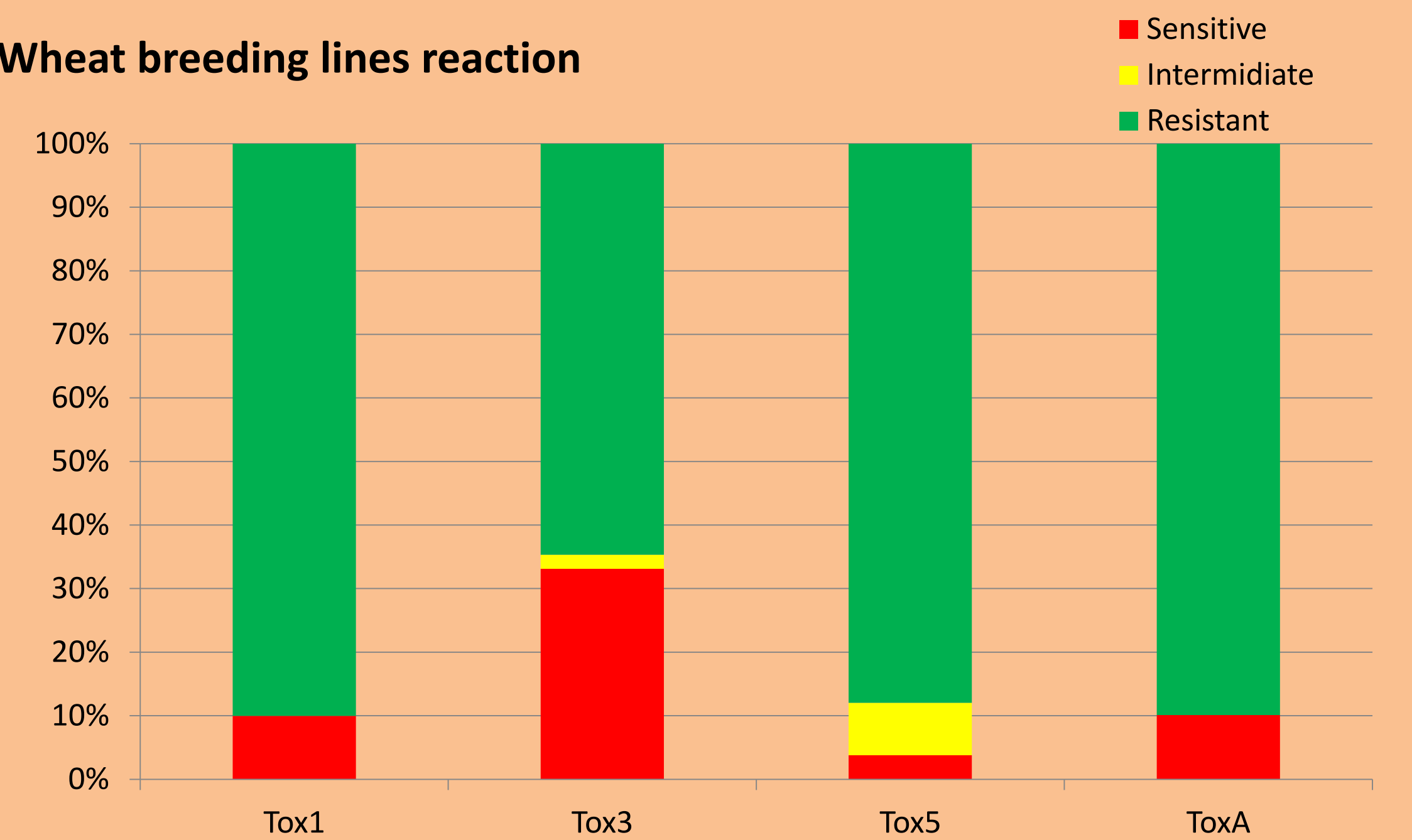


Figure 3. Tox5 purification process. A, SDS-Page of IEC fractions. B, SDS-Page of SEC fractions. C, IEC and SEC chromatograms.

Wheat breeding lines reaction



Triticale breeding lines reaction

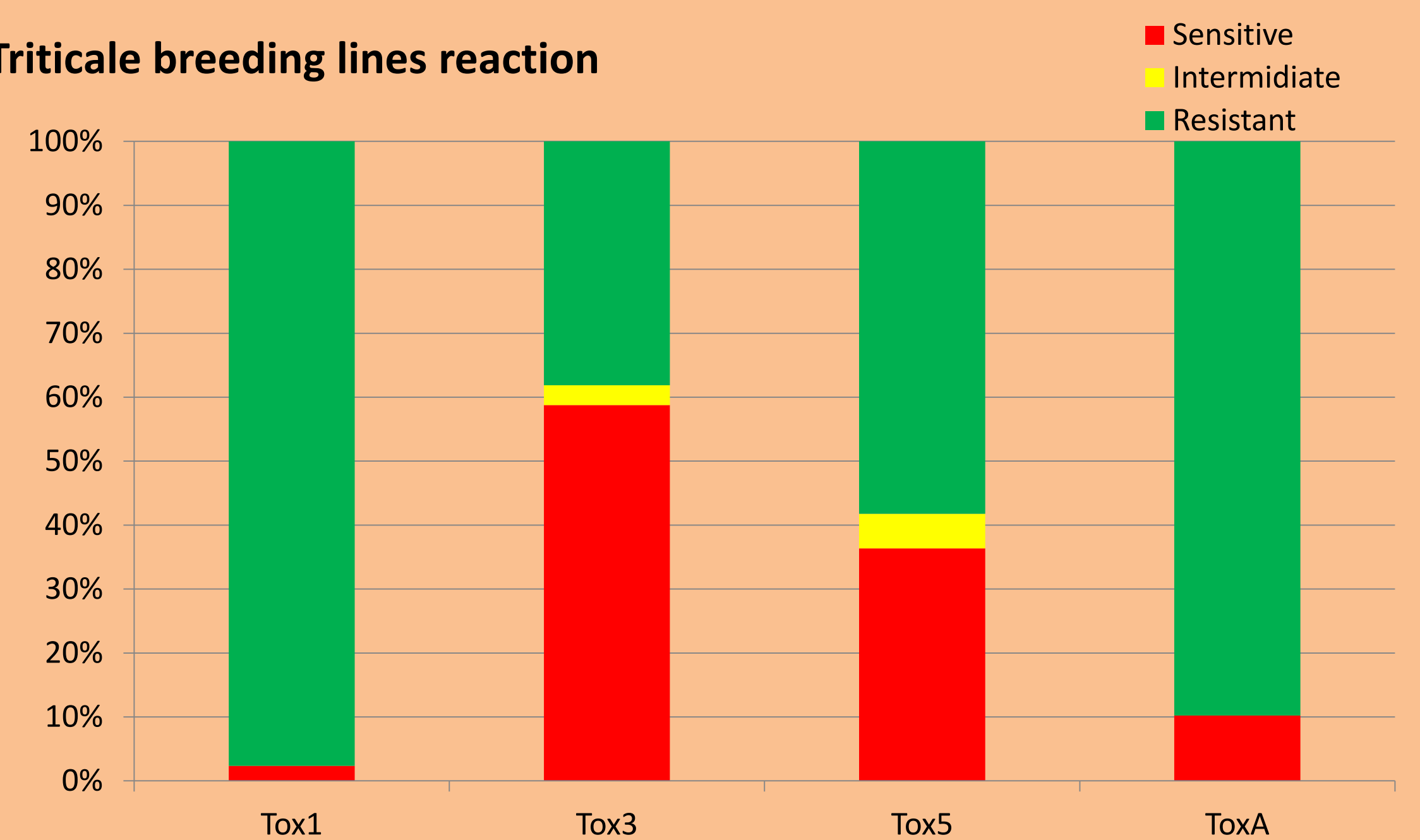


Figure 2.

Effectors resistance among Polish breeding lines of wheat and triticale. Reaction type were shown: Resistant – no change, Intermediate sensitive – chlorosis or light necrosis and Sensitive – complete necrosis of tissue.

Table1.

Correlation between SNB field resistance and Tox3 insensitivity $p < 0,05$

	2015	2016	2017	2018
Wheat	0,250	0,173	0,249	0,054
Triticale	0,216	0,180	0,212	0,332

Table2.

Correlation between SNB seedling resistance and Tox3 insensitivity $p < 0,05$

	2015	2016	2017	2018
Wheat	0,412	0,567	0,648	0,702
Triticale	0,442	0,274	0,629	0,495

Results:

In Polish population of *P. nodorum* ability to produce Tox1, Tox3 and Tox5 is widespread (fig. 1). ToxA is present only in minority of screened isolates.

Analysis of variance and correlations between Tox1 insensitivity and SNB resistance reveal that this effector had marginal effect on SNB development in Polish environment (fig. 4). Insensitivity to Tox1 is widespread among wheat and triticale breeding lines in Poland (fig. 2).

In Polish germplasms Tox3 sensitivity is most widespread, especially in triticale were 60% breeding lines is sensitive (fig. 2). In last year trials, sensitivity to Tox3 was an essential factor in SNB development at the seedling stage, where it determined 49% and 24% of SNB variation. In field trails insensitivity on Tox3 were correlated with SNB resistance only in triticale. Correlation between Tox3 insensitivity and SNB resistance was routinely observed in past years (fig. 4, tab. 1 and 2). This last year aberration was caused by severe drought after pathogen inoculation.

We have found weak positive correlation between insensitivity to Tox5 and SNB resistance in triticale. Tox5 insensitivity explain 10,5% and 6,3% of SNB variation in field and seedling stage trials (fig. 4).

Conclusions:

Relatively high impact of Tox3 and Tox5 effectors on SNB development on wheat and triticale was observed. This might be connected with widespread of strains able to produce Tox3 and Tox5 in Polish *P. nodorum* population.

There is a need to continue screening and selection of breeding materials of both crops against Tox3 and Tox5 sensitivity genes what may result in lower SNB incidence.

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Figure 4. Effects of insensitivity to necrotrophic effectors on SNB resistance.

Plants were inoculated with mixture of isolates arranged to emulate Polish *Parastagonospora nodorum* population. On charts, height indicates SNB severity both in field and phytotron trails. Bars indicate confidence intervals of 95%. Charts with statistical significance lower than 0,05 are marked.

