Phosphorus use efficiency in the recombinant [normal × *accacia* leaf] lines of the field pea (*Pisum sativum* L.) mapping population.

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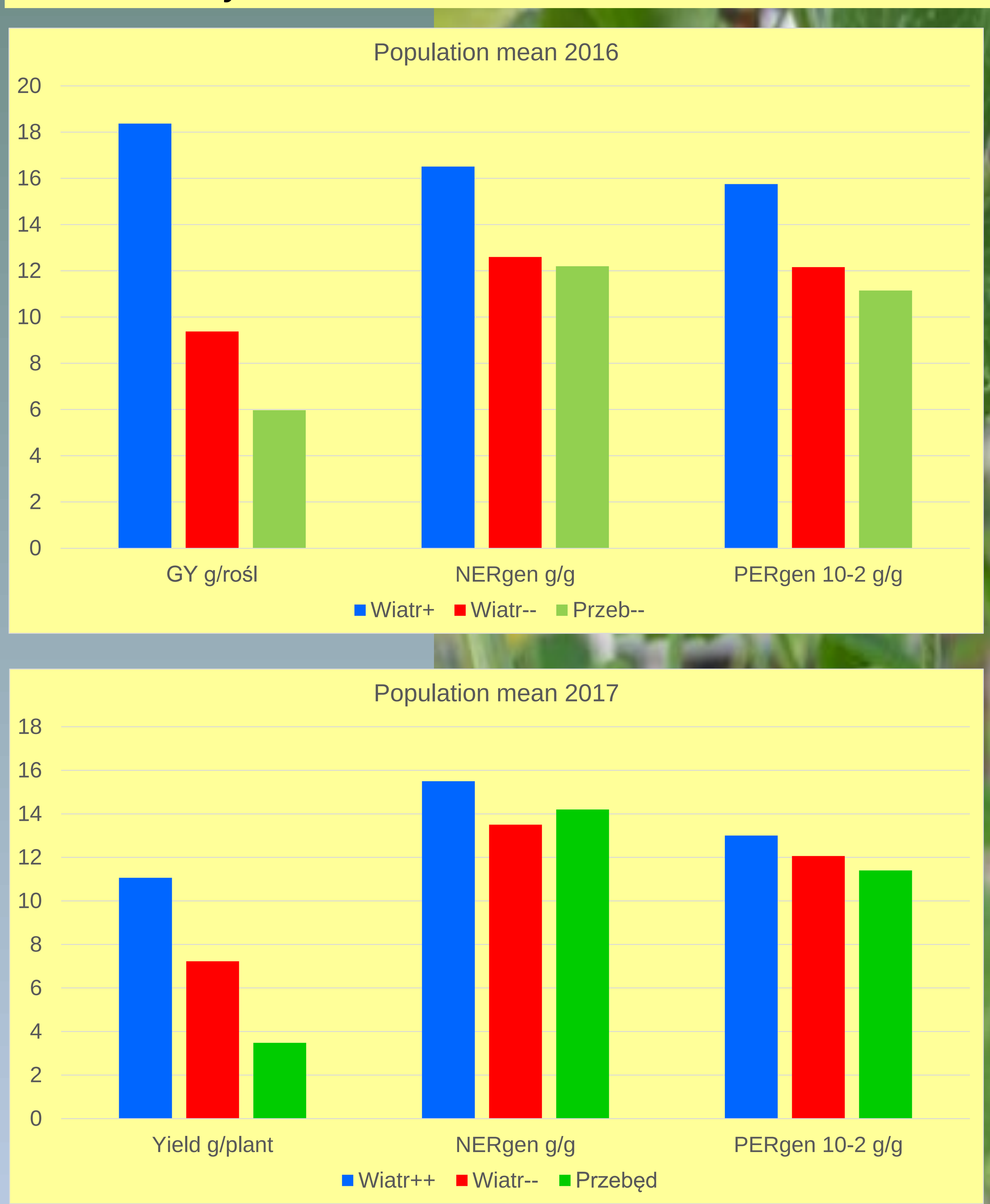
Introduction. During vegetation, pea is subjected to the climatic stresses, i.e. periodic fluctuations of the temperature and soil water content, as well as abiotic stresses related to the phosphorus and nitrogen content in the soil. The physiological efficiency of pea includes such features as: the root system construction, water, nitrogen and phosphorus efficiency in seed (biomass) plant formation, photosynthetically active light transmission in the field, leaf photosynthetic activity, leaf gas exchange efficiency, photoreceptor performance II and translocation and distribution of assimilates in the plant. Pea uses atmospheric nitrogen through its biological binding. In optimal conditions, this process secures the plant's nitrogen demand. However, under conditions of stress affecting photosynthesis (drought, phosphorus deficiency), nitrogen supply proves to be insufficient. Recognition of variance and co-variance between components of the physiological efficiency components will allow to avoid excessive use of mineral fertilization, as well as deficiencies in field conditions, and will allow to determine relationships with nitrogen use efficiency and yield.

Results and Discussion

- The parental line Wt10245 had lower value of the nitrogen use efficiency than Wt11238, but higher phosphorus use efficiency PERg in the optimal condition in one year. In the second year and in the stress conditions the line Wt10245 was less efficient in the phosphorus economy. The Wt10245 PERg in 2017 was 35% lower than in 2016 (132 in 2016 mg/ mg, 86 mg/ mg in 2017).The yield from a plant in both seasons was the largest in Wiatrowo, in the optimal location, the smallest in Przebędowo. The yield in "optimal" and "weak" Wiatrowo and Przebędowo location was lower in 2017 than in the previous year for this population [Wt10245×Wt11238] (Fig.1). The pea yield and phosphorus utilization efficiency (PER_{gen}) were positively correlated in optimal and stress locations (Wiatrowo, optimal conditions r=0.59-63, stress conditions: Wiatrowo r=0.71-0.73, Przebędowo r=0.36-0.53) (Fig.2).

Fig. 1. Relations between phosphorus, nitrogen efficiency indices and yield.



Materials and methods.

- material: 65 pea lines from mapping population [Wt10245×Wt11238] in the optimal condition and 20 lines in the stress, formed diverse leaf-types [conventional or *accacia* leaves] and vary in yield potential and its stability.

The materials were grown in field conditions under varied nutrients supply in **two years** (Tab.1). The components of nitrogen and phosphorus utilization efficiency and yield traits were determined. Whole plants were hand-harvested at their full maturity. The vegetative (stems + leaves) and generative (seeds) plant parts were separated and their dry weights were determined by oven drying at 65°C for 72 h. Phosphorus analyses were made in the dried and ground homogeneous sub-samples of the parts (IKA mill processed) and measured by the Central Agroecological Laboratory in Lublin (**seed P%** and **straw P%**). According to Moll et al. (1982), the following components of P efficiency were determined: P harvest indices (**NHI**%), the generative and vegetative indices of the physiological efficiency of P utilization in seed and vegetative mass formation (PERgen, PERveg utilization efficiency ratios).

One of the way to increase the use of phosphorus by plant is to minimize the accumulation of P in the soil in forms of organic and mineral compounds. For this reason, it is necessary for the agricultural practice to recognize the possibility of using phosphorus by a plant that has accumulated in the past. By proper selection of plant species, it is possible to maintain soil fertility and reduce component losses. The main idea of plant cultivation is focused on increasing the proportion of legume plants in the process of more efficient use of phosphorus (Gaj 2013).

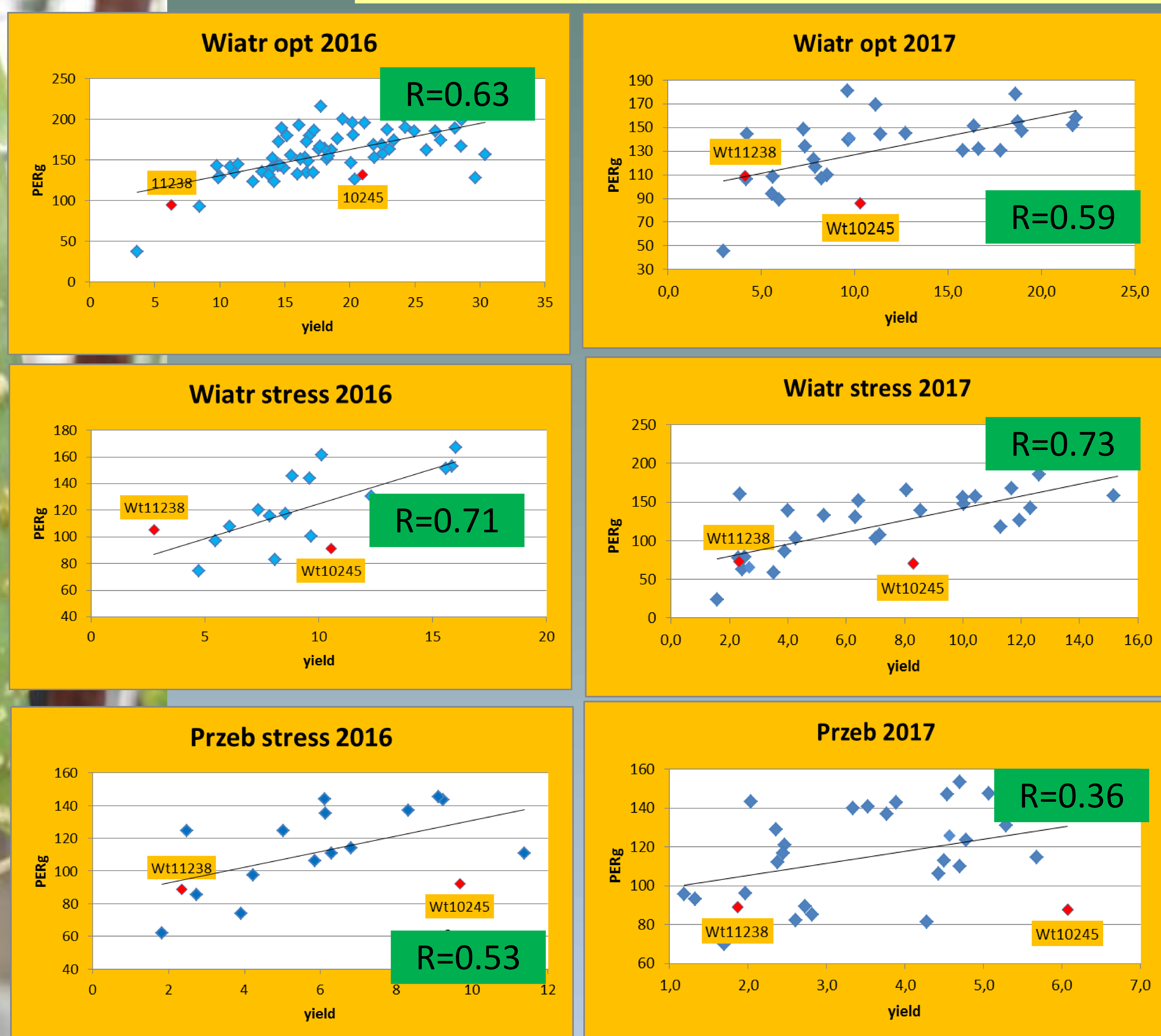
Gaj R. (red.) (2013). Efektywne wykorzystanie składników mineralnych z nawozów we współczesnym rolnictwie. Agricultural Advisory Center in Brwinów, Branch in Poznań, Poznań.

Tab.1. Soil analysis results.

	Macroelements							
2016	mg·100 g^{-1} d.m. soil							pH
sample	N-NH_4	N-NO_3	P	K	Ca	Mg	S-SO_4	
Wiatrowo N – optimum	1.5		N	low	N	N	low	N
Wiatrowo N – shortage	0.7		N	N	N	low	low	N
Przebędowo, stress field	1.1		N	N	N	high	low	N

	Macroelements						pH
2017	mg·100 g^{-1} s.m. soil						
sample	N-NH_{4*}	N-NO_{3*}	P	K	Mg	S-SO_4	
Wiatrowo N – optimum	1,23		high	high	high	low	N
Wiatrowo N – shortage	1,47		high	high	N	low	N
Przebędowo, stress field	0,94		high	high	low	low	low

Fig. 2. Relations phosphorus efficiency indices and yield.



Genotypes effect (G) and soil treatment effects (E) were significant for all characters in 2017, however not significant for %Nzia, NHI, NERgen and phosphorus components in 2016. Genotype-treatment (G-E) interactions were significant for all characters in 2017, except nitrogen and phosphorus content in vegetative mass (%N_{veg}, %P_{veg}) and not significant for all characters in 2016, except pea yield. Noteworthy, relationships between GY and phosphorus efficiency were weaker in nitrogen-limited conditions in Przebędowo and stronger in nitrogen-limited Wiatrowo comparing with optimal Wiatrowo (optimal conditions r=0.66, stress conditions: Wi, r=0.73, P, r=0.36). This could be result of consideration the location No. 2 in Wiatrowo as a weak position (despite a slightly higher nitrogen content than in location No. 1) due to nitrogen deficiency, boron deficiency (micronutrient important for pea cultivation) and iron excess. The tendency of the increase in the correlation value depending on the stressfulness of the environment is confirmed.

Funding and Acknowledgments. The research was financed by the National Project of the Polish Ministry of Agriculture and Rural Development (HOR hn-801-PB-9/18). Phosphorus analyses were made by the Central Agroecological Laboratory in Lublin and reported in 2018.