SECTION 1. EXPERIMENTAL BOTANY

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EFFECT OF BACTERIZATION ON THE GROWTH OF *PISUM SATIVUM* L. WITH A CONTRASTING PHOTOPERIODIC RESPONSE

ВПЛИВ БАКТЕРИЗАЦІЇ НА РІСТ *PISUM SATIVUM* L. З КОНТРАСТНОЮ ФОТОПЕРІОДИЧНОЮ РЕАКЦІЄЮ

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Field pea (*Pisum sativum* L.) is a major legume crop that plays an important role in global food security and sustainable agriculture thanks to its ability to fix atmospheric nitrogen through symbiosis with rhizobia [1]. In the face of climate change and the need to reduce synthetic nitrogen fertilizers, improving the efficiency of this symbiosis has become a key research priority [4, 5].

Photoperiod sensitivity is one of the main factors controlling pea development and the switch from vegetative to reproductive growth. The genetic control of this trait is well understood: key genes include Sn (photoperiod response), E (early flowering), Hr (high response), Lf (late flowering), and the GIGANTEA ortholog LATE BLOOMER1 (LATE1), which is involved in circadian regulation and de-etiolation [3]. Most modern pea varieties are facultative long-day plants – long days (over 12–14 hours) speed up flowering, while short days' delay it by several days depending on the alleles present [3]. In contrast, day-neutral varieties show little or no response to day length, making them more stable across different latitudes and growing conditions.

Although photoperiod regulation and symbiotic nitrogen fixation are well studied, their interactions, especially cultivar- and strain-specific ones, remain poorly understood [5]. Genotypes differing in photoperiod sensitivity may allocate assimilates differently between shoots and roots, which can affect nodule formation and nitrogen-fixation efficiency [2, 5]. Investigating this interaction in Ukrainian breeding varieties will help select the best genotypes for use with bacterial inoculants in modern farming.

The aim of this work was to analyse the effect of bacterization with a symbiotic diazotroph *Rhizobium leguminosarum* on growth processes and nitrogen accumulation (measured as soluble protein) in five Ukrainian-bred pea varieties with different photoperiodic sensitivity.

The plant material consisted of seeds of five varieties of field pea (Pisum sativum L.) selected at the Yuriev Institute of Plant Production of the National Academy of Sciences of Ukraine: Ataman, Oplot, Metsenat, Tsarevich, and Haiduk. The symbiotic diazotroph used in this study was the Rhizobium leguminosarum 250a strain, provided by the Institute of Agricultural Microbiology and Agroindustrial Production of the National Academy of Sciences of Ukraine. Field phenological observations to assess the photoperiodic response were carried out under natural long-day conditions. At the V3 stage, 50% of the plants were transferred to short-day conditions for two weeks, and growth stages were recorded when more than half of the plants in each replicate reached each stage. At the second stage, a controlled experiment was conducted in a climatic chamber. The seeds were bacterized with a suspension of Rhizobium leguminosarum with a concentration of 7.8×10^8 CFU/ml. In 35-day-old plants, dry biomass of shoots and roots, as well as the content of water-soluble proteins, were determined by the Bradford method. The results were statistically processed by the pairwise comparison method, and the significance of differences was assessed at a value of $p \leq 0.05$.

In the field experiment, long-day sensitive varieties (Otaman, Oplot, Mecenat) showed a clear delay in flowering under short photoperiod (6–9 days), confirming their long-day response. Day-neutral varieties (Tsarevich, Haiduk) were almost unaffected (delay of 0–3 days) (Table 1).

Table 1

Delay of flowering onset in pea (*Pisum sativum* L.) cultivars under short-day conditions.

Variety	Duration PGF, days		Delay, days	Photoperiodic reaction (PPR)
	LD 16 h	SD 9 h		
Otaman	45±3	53–54	8–9	LDP
Oplot	51±4	58–60	8–9	LDP
Mecenat	47±2	53–54	6–7	LDP
Tsarevich	45±1	45–47	0–2	SDP
Haiduk	46±2	48–49	2–3	SDP

LD – lond day; SD – short day;
LDP – long-day plants; SDP – short-day plants

Bacterization affected biomass accumulation differently depending on variety type. In long-day varieties the effect on shoot biomass was mixed or negative, and root biomass remained stable or slightly decreased (Fig. 1). In day-neutral varieties, Tsarevich showed a 9.7 % increase in shoot biomass and a 23.5 % increase in root biomass; Haiduk had a 13.7 % increase in root biomass despite a slight decrease in shoots.

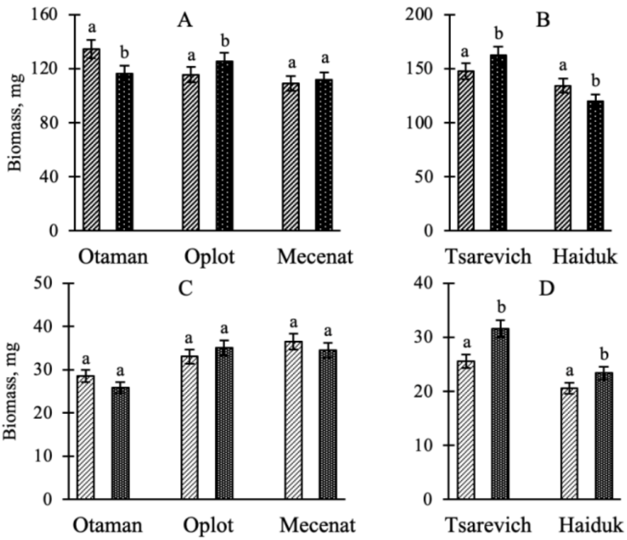

Fig 1. Biomass of plants of *Pisum sativum* L. varieties under the action of bacterization in the aboveground (A, B) and underground (C, D) parts; – control; – bacterization

Different letters indicate significant differences between control and bacterization.

Soluble protein content in roots increased markedly in day-neutral varieties after bacterization: +4.9 % in Tsarevich and +20.0 % in Haiduk (Fig. 2). Long-day varieties showed either a decrease or only a small increase.

The results agree with earlier reports showing that *Rhizobium leguminosarum* generally improves growth and nitrogen nutrition in pea. The stronger response in day-neutral varieties, particularly the increase in root biomass and protein content, is probably linked to more favourable allocation of assimilates to the root system, which supports better nodule development and nitrogen fixation. In long-day varieties, the transition to flowering under the long-day conditions of the phytotron may have limited resources available for symbiosis, resulting in weaker or even negative effects of bacterization.

The results suggest a possible association between photoperiod type and responsiveness to bacterization. Day-neutral pea varieties (Tsarevich and Haiduk) responded more positively to bacterization with *Rhizobium leguminosarum* strain 250a than long-day varieties. They showed the greatest increase in root biomass and the highest gain in root protein content.

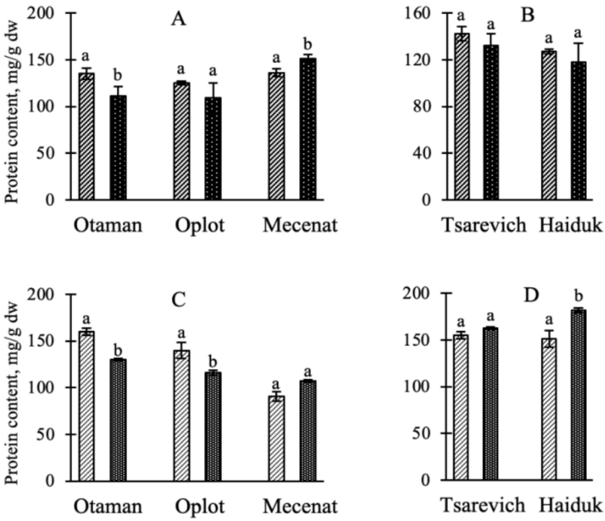

Fig. 2. The content of water-soluble protein in plants of *Pisum sativum* L. varieties under the influence of bacterization in the above-ground (A, B) and underground (C, D) parts; – control; – bacterization

Different letters indicate significant differences between control and bacterization.

These results suggest that day-neutral genotypes are promising for breeding programmes and for maximising the benefits of bacterial inoculants in sustainable pea production.

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