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INFLUENCE OF PHOTOPERIOD ON PRODUCTIVITY AND SPECTRAL INDICES OF LEAF BLADES OF GARDEN CRESS SAMPLES GROWN UNDER LIGHT CULTURE CONDITIONS

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Abstract. *Identification of optimal growing conditions and promising genotypes for specific environmental parameters using modern non-invasive methods is an urgent task. In this work, spectral indices of leaf blades of 17 accessions of garden cress (Lepidium sativum L.) from the VIR collection were studied for the first time under strictly controlled conditions of an agrobiopolygon under different photoperiods (12, 14, 16 h), as well as the productivity of these accessions. As a result of the work, photoperiods of 12 and 16 h were determined as the most favorable for growing garden cress accessions under light culture conditions. Accessions of garden cress, k-112 (Local, Azerbaijan) and k-165 (Gartenkresse, Belgium), were selected as the most productive and promising for cultivation under light culture conditions. Based on the data obtained, it was established that optical indicators can be an effective non-invasive criterion for identifying the most optimal duration of photoperiod for realizing the production potential of garden cress samples, and also serve as predictors for determining the most productive genotypes of interest for subsequent breeding work.*

Keywords: garden cress, Lepidium sativum L., non-invasive methods, light culture, spectral indices

INTRODUCTION

Garden cress (*Lepidium sativum* L.) is an early maturing, responsive crop with valuable biochemical composition, which makes it a promising crop for cultivation under light culture conditions [5, 6]. Light culture implements an approach based on satisfying all the basic needs of the plant and eliminating stress factors affecting their growth and development, and also allows for the selection of optimal environmental conditions for specific crops or genotypes. One of the important objects of selection and regulation are the parameters of the light environment, in particular, the photoperiod [3]. Identifying optimal growing conditions and promising genotypes for specific environmental parameters using modern non-invasive methods is an urgent task.

The purpose of the study is to study the effect of photoperiod on the productivity and optical parameters of leaf blades of garden cress samples grown under light culture conditions.

MATERIALS AND METHODS

The objects of the study were 17 accessions of garden cress (*Lepidium sativum* L.) of different origin, obtained from the collection of Vavilov all-Russian Institute of Plant Genetic Resources (VIR): k-1 (Garten kress, Germany), k-27 (Fine curled, Canada), k-41 (Broad leaf, Canada), k-42 (Narrow-leaved 3, Russia), k-48 (no name, Azerbaijan), k-63 (no name, Georgia), k-66 (no name, Afghanistan), k-78 (Local, Russia), k-79 (Local, Russia), k-85 (Cresson aienois, France), k-91 (no name, Iran), k-97 (Local, Armenia), k-112 (Local, Azerbaijan), k-118 (no name, Pakistan), k-127 (Local, Azerbaijan), k-165 (Gartenkresse, Belgium), k-185 (Almindelig, Denmark). The vegetation experiments were conducted under strictly controlled conditions of the agrobiological testing ground of the Agrophysical Research Institute (AFI). The plants were grown using flow hydroponics under three light conditions: 12, 14 and 16 hour photoperiod. The light source was gas-discharge mirrored sodium lamps DNaZ-400 (manufactured by OOO Reflax, Russia), and the substrate was peat-based soil Agrobalt-S (OOO Pindstrup, Russia). A modified Knop solution was used for flow hydroponics. The experiment was repeated three times, the sample size was 16 plants. The morphological description of the cress plants was carried out in the phase of technical maturity on the 26-29th day after sowing, in accordance with the methods of the Federal State Budgetary Institution State Commission for Variety Testing - RTG/02485/1; RTG/01/3 (OOS test methods). Reflectance spectra of leaves were recorded before harvesting using a miniature fiber-optic spectrometric system from Ocean Optics (USA). The following indices obtained as a result of contact spectroscopy were evaluated: chlorophyll index ChlRI, carotenoid to chlorophyll ratio index SIPI, photochemical index PRI [4, 5]. The PRI index in this work was used with the modification ((C1-PRI)*C2; C1=0.1; C2=10), hereinafter referred to as PRImod, and characterizes non-photochemical quenching. Statistical data processing was performed using the STATISTICA v.10.0 program (StatSoft Inc., USA).

RESULTS AND DISCUSSION

Plant mass is one of the features characterizing productivity for green crops. Under photoperiods of 12 and 16 hours, the production potential of garden cress samples was realized most fully – significantly higher mass values were noted than under a photoperiod of 14 hours (by 1.01 g and 1.34 g, LSD_{05}=1.01). Most of the optical parameters we used also changed significantly in plants grown under different photoperiods (Table 1).

The chlorophyll index value increased significantly with increasing photoperiod, indicating the accumulation of green pigments under longer illumination. Similar dynamics of an increase in the content of green pigments was previously obtained for other representatives of the *Brassicáceae* family under light

culture conditions [6]. Under the least favorable photoperiod of 14 hours for the accumulation of green mass, the SIPI index, representing the ratio of carotenoids to chlorophyll, increased. The growth of this ratio was caused by a significant increase in the amount of carotenoids, which is part of the adaptation to unfavorable conditions. No reliable differences in the PRI_{mod} index were noted, which is associated with high variability within the set of studied genotypes for this indicator.

Table 1. Productivity of garden cress (*L. sativum*) samples and some optical parameters, depending on the photoperiod

Indicator	Photoperiod, h			LSD_{05}
	12	14	16	
Mass of 1 plant, g	3,55±0,44	2,54±0,18	3,88±0,28	1,01
ChlRI	0,37±0,01	0,40±0,01	0,41±0,01	0,05
SIPI	1,00±0,00	1,01±0,00	1,00±0,00	0,01
PRI_{mod}	0,34±0,16	0,32±0,14	0,33±0,15	0,46

Note: n=16, mean ± SEM. LSD - Least Significant Difference.

As a result of the study, the most promising genotypes for growing in photoculture were also noted - samples k-112 (Local, Azerbaijan) and k-165 (Gartenkresse, Belgium). They demonstrated high mass values relative to the average for the studied samples under favorable photoperiods of 12 and 16 hours (Table 2).

Table 2. Average weight of 1 plant of isolated samples of watercress (*L. sativum*), compared with the average for the studied varieties, under different photoperiods

Samples	Photoperiod, h		
	12	14	16
k-112	6,04±0,35	3,19±0,13	5,64±0,58
k-165	5,91±0,32	3,00±0,16	5,45±0,33
Average across samples	3,60±0,46	2,54±0,18	3,88±0,28
LSD_{05}	1,17	0,66	1,29

Note: mean ± SEM. LSD - Least Significant Difference.

Both samples were resistant to early stem formation under light culture conditions under all studied photoperiods – the beginning of stem formation was not recorded by the end of the growing season (26-29 days).

The non-photochemical quenching index PRI_{mod} had an inverse dynamic with the mass of 1 plant trait in the selected samples. Thus, the values of the PRI_{mod} index in the genotypes selected by mass - k-112 and k-165 were below the average for the samples (the difference was from 0.45 to 0.79, with LSD_{05} from 0.09 to 0.12).

CONCLUSION

In this work, the productivity and optical indices of 17 garden cress (*Lepidium sativum* L.) accessions from the VIR collection grown under strictly controlled conditions were investigated for the first time. Photoperiods of 12 and 16 h were identified as the most favorable for growing garden cress accessions under light culture conditions. Garden cress accessions k-112 (Local, Azerbaijan) and k-165 (Gartenkresse, Belgium) were identified as having the highest productivity and resistance to early stemming under light culture conditions under all studied photoperiods. Based on the data obtained, it was established that some optical indices can be an effective non-invasive criterion for identifying the most optimal photoperiod duration for realizing the production potential of garden cress accessions, as well as predictors for determining the most productive accessions with traits of interest for further breeding work.

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