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RE-EVALUATION OF THE PRODUCTIVITY AND STABILITY OF WINTER BARLEY CULTIVAR "NEDA" ACROSS DIFFERENT ENVIRONMENTS

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Abstract: *Long-term cultivation may lead to changes in varietal performance due to environmental pressure, seed quality deterioration, or interactions with biotic and abiotic stress factors. Therefore, the re-assessment of existing cultivars under present-day conditions is necessary to determine their current suitability for agricultural practice.*
The current study aims to re-evaluate the stability, productivity, and adaptive response of the Bulgarian winter barley cultivar "Neda" based on historical (2010, 2011) and recent (2024, 2025) multi-environment trials. The results of the analyses conducted over various environmental conditions reveal that Neda clearly stands out as having a higher yield compared to the standard varieties ("Obzor", "Emon," and "Kaskadior 3" within the system of Executive Agency of Variety Testing, Field Inspection and Seed Control) and exhibits a high degree of adaptability to the environment and resilience to climatic fluctuations. Neda is a two-row barley variety owned by Agrodimex Ltd., characterized by high lodging resistance and very good winter hardiness. Grain protein content is around 12%, and the 1000-grain weight: 50-53 g. Hectoliter weight: 66 kg; yield: 693-801 kg/dka.

Keywords: *barley, Hordeum vulgare L., Neda, plant breeding, re-evaluation, yield stability*

•Introduction

•The most effective factor in ensuring high yields and high-quality produce under intensive farming conditions is the crop variety (Ahmar et al., 2020). The diverse soil and climate regions of Bulgaria require a differentiated approach to crop cultivation technology (Sevov and Georgieva, 2025).
•It is well known that there are no universal varieties (Dimova et al., 2024). Therefore, to achieve the maximum economic benefit from their introduction into production, varieties must be tested in the main production regions of the respective crops, and based on the data obtained, the most suitable regions for their distribution must be identified (Creissen et al., 2016). Newly developed varieties can replace previously regionalized and propagated varieties only if they demonstrate significant superiority in terms of yield and/or product quality (Krishnan et al., 2021; Lawrence, 2025).
•The varietal structure of cereal crops in Bulgaria shows marked differences among species. National breeding has a dominant role in barley and triticale, whereas wheat includes a substantial share of foreign cultivars, and rice remains highly dependent on external genetic resources. This pattern reflects the adaptive value of locally developed varieties, but it also highlights the need to preserve and expand domestic breeding capacity. In the context of climate variability and increasing production challenges, strengthening national breeding programs remains strategically important for ensuring long-term agroecological resilience and stable barley production amid climate variability (OSL, 2026).

•Material and method

•Field experiments were conducted during two experimental periods. The first period was within the official testing system of the Executive Agency for Variety Testing, Field Inspection and Seed Control (IASAS) in 2009 and 2011. The IASAS trials included six locations representing major agro-ecological zones in Bulgaria: Burgas, Radnevo, Chepintsi (Southern Bulgaria), and General Toshevo, Pordim, Selanovtsi (Northern Bulgaria).
•The second stage was conducted under experimental conditions in 2024 and 2025 growing seasons at the Agricultural University of Plovdiv and the seed production fields of Agrodimex Ltd., Dragoevo (Shumen region).

•Experimental conditions
•The experimental sites covered a wide range of soil types, including leached and calcareous chernozems, alluvial-meadow soils, and grey forest soils. Soils in Northern Bulgaria were predominantly chernozemic with moderate humus content and good potassium supply but limited available phosphorus. The Plovdiv site was characterized by Mollic Fluvisols with favorable structure, moderate humus content (~3.7%), slightly alkaline pH, and good nutrient availability. The Dragoevo site was represented by grey forest soils with silty texture and high calcium content, influencing nutrient dynamics.
•The climate is temperate and continental with Mediterranean influence during winter. Weather conditions during the study period were generally favorable for crop development. Winter temperatures occasionally decreased to -18°C, but no significant frost damage was observed. Rainfall distribution varied between years, with higher precipitation in autumn and late spring in some seasons, affecting sowing and harvesting conditions (Figure 1).

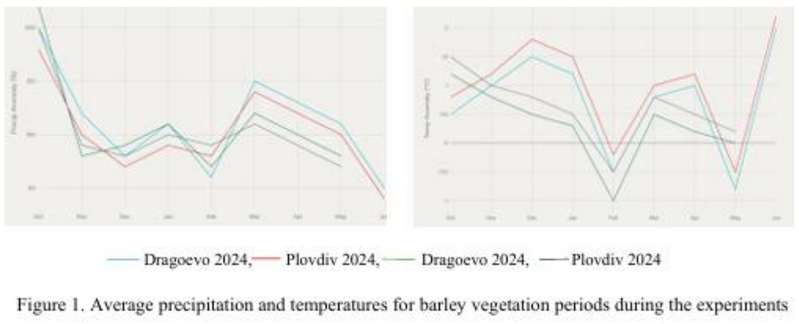

Figure 1. Average precipitation and temperatures for barley vegetation periods during the experiments

•Experimental design and crop management

•Field trials in Plovdiv and Dragoevo were conducted using a randomized block design with four replications and a plot size of 10 m^2. Sowing was performed within the optimal period (early to mid-October) at a seeding rate of 450 viable seeds m^2. Standard agronomic practices were applied during the growing season, including weed control according to infestation level.
•Traits and data collection:
•The following traits were evaluated according to UPOV methodology (www.upov.int): grain yield (kg/dka, at 13% moisture), vegetation period and heading date, thousand kernel weight (g), hectoliter weight (kg hl^{-1}), plant height and lodging resistance, productive tillering (number of fertile stems m^2), overwintering (%)
•Disease resistance to *Pyrenophora teres*, *Erysiphe graminis f. sp. hordei*, *Rhynchosporium commune*, *Puccinia hordei*, and *Fusarium head blight* were assessed under natural infection conditions using standard scoring scales. In this scale values were 1 = resistant, 9 = highly susceptible.
•Grain quality parameters, including extract content, protein content, and germination capacity, were determined in accredited laboratories.
•Statistical analysis
•Experimental data were processed using analysis of variance (ANOVA), and the significance of differences was determined using Duncan's multiple range test at $P \leq 0.05$.

•Results and discussions

Variety "Neda" - breeding line 68903597 /Winter two-rowed, *Hordeum vulgare L. subsp. distichum (L.) Korn.*/ (Figure 1).

•Figure 1. Neda (https://agrodimex.com/)

Neda demonstrated superior yield performance across IASAS historical trials and all four environment-year combinations in recent trials, achieving up to 18% compared to the average standard (Av. St.). Significantly outperforming it in Dragoevo (750-801 kg/dka) vs. Plovdiv (639-704 kg/dka), (Table 1). Neda maintained competitive crop density (785-801 stems/m^2 in Plovdiv, 811-930 in Dragoevo) comparable to standards, with excellent lodging resistance (score 9 across all sites/years), indicating strong culm stability under wet spring conditions prevalent in 2024-2025. Plant height remained moderate (84-97 cm), balancing yield potential with resistance to lodging (Table 2).
Neda's brewing quality parameters were competitive, with superior 1000-grain weight (50.2-52.8 g, highest alongside Obzor) and acceptable uniformity (96.3-94.5% Class 1), though extract content was lowest (70.5-78.5%). Compared to standards, Neda offers balanced physical quality suitable for brewing, with heavier kernels compensating for moderate extract potential (Table 3). Neda recorded the lowest nitrogen (1.68-1.89%) and grain protein (10.5-11.79%) levels, potentially advantageous for malting (reduced modification risk) but lower than standards (12.5-16.88%). Carbon content was consistent across varieties (~44-45%). This profile suggests Neda produces high-yield, low-protein grain ideal for brewing under intensive management, though producers targeting feed markets may prefer higher-protein standards like Obzor (Table 4).

Table 1. Grain yield obtained from variety trials

Location/ year	Plovdiv 2023/2024						Dragoevo 2023/2024			Plovdiv 2024/2025		
Variety	kg/dka	kg/dka	GD	%	GD	%	kg/dka	GD	%	kg/dka	GD	%
Av. St	669	704		100		100	639		100,0	707,8		100,0
Obzor	726	651	000	92,2	+	109	656	-	103,1	701	-	97,54
Emon	624	748	+++	106	o	93	601	-	94,09	741	-	103,3
Kaskadior 3	656	704	-	101	-	98	654	-	102,8	712	-	99,16
Neda	693	801	+++	116	-	104	750	+++	118	666	ooo	92,55

Table 2. Assessment of crop density and lodging severity

Variety, year	Number of productive stems /m^2/		Stem height /cm/		Lodging* /score/	
	Plovdiv	Dragoevo	Plovdiv	Dragoevo	Plovdiv	Dragoevo
	2023-2024					
Obzor, 24	785	1100	100	98	8	9
Emon, 24	778	930	89	99	8	9
Kaskadior 3, 24	737	889	78	87	9	9
Neda, 24	785	930	84	88	9	9
	2024-2025					
Obzor, 25	797	811	102	97	8	9
Emon, 25	744	784	97	95	8	9
Kaskadior 3, 25	752	790	84	88	9	9
Neda, 25	801	817	97	90	9	9

Table 3.
Average data on the brewing qualities of the genotypes studied

Variety	Weight of 1,000 grains/g/			Uniformity: Class 1		Extract /%/		Moisture /%/		Germination /%/
	Plovdiv	Dragoevo	Dragoevo	Plovdiv	Dragoevo	Plovdiv	Dragoevo	Plovdiv	Dragoevo	Plovdiv
Obzor	50.5	93	52.0	98.4	99.1	76.6	78.0	12.1	12.3	92
Emon	49.5	92	51.8	99.8	89.3	75.9	77.5	12.3	12.2	94
Kaskadior 3	46.7	90	48.9	96.7	92.2	76.1	78.2	12.1	12.8	92
Neda	50.2	92	52.8	96.3	94.5	70.5	78.5	12.1	12.3	90

Table 4.
Nitrogen, carbon, and crude protein content (%), average for the 2024, 2025 period

Variety	nitrogen /%/		carbon /%/		grain protein /%/	
	Plovdiv	Dragoevo	Plovdiv	Dragoevo	Plovdiv	Dragoevo
Obzor	2.70	2.05	44.72	45.33	16.88	12.8
Emon	2.45	1.90	44.29	44.98	15.30	11.7
Kaskadior 3	2.00	2.00	44.41	45.01	12.51	12.5
Neda	1.89	1.68	44.28	44.87	11.79	10.5

•Conclusions

•The re-evaluation trials confirm that winter barley cultivar "Neda" maintains superior productivity and environmental adaptability across historical (2010, 2011 by IASAS) and recent (2024, 2025) conditions in Plovdiv and Dragoevo, outperforming standards ("Obzor," "Emon," and "Kaskadior 3") in yield (e.g., 750-801 kg/dka vs. 639-704 kg/dka average; 4-18% relative) despite climate variability. Neda exhibits high stability, with consistent performance under warmer/wetter recent years (e.g., record 2024 heat, excessive fall rain), good overwintering, lodging resistance (score 9), and disease tolerance (powdery mildew 5-6, no infection by rust pathogens was observed). Quality traits remain reliable (1000-grain weight 50.2-52.8 g, hectoliter weight ~66 kg, protein ~10.5-12.4%), though slightly lower protein in recent trials suggests minor environmental influence. Multi-environment analysis reveals low genotype × environment interaction for Neda, positioning it as broadly adapted.