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RESEARCH ARTICLE

Productivity of *Brassica napus* L. agrocenoses under the implementation of biologization elements in various moisture supply conditions of the south of Ukraine

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Abstract

The aim of the research was to study the impact of biopreparations at different application times on the formation of structural parameters, seed productivity, and sowing qualities of winter rapeseed under varying moisture supply conditions in the south of Ukraine. The formation of the crop's seed productivity was evaluated under different moisture supply conditions: Rainfed (without irrigation) and irrigated (factor A). To ensure the biological protection of the crops against diseases, biopreparations developed by the Engineering and Technology Institute (ITI) 'Biotechnica (BT)' of National Academy of Agrarian Sciences of Ukraine (NAAS) were applied: Ampelomycin BT, Planriz BT, and Trichodermin BT (factor B). Double and triple treatments of the crops were carried out during the following growth stages: Rosette formation+stem elongation+budding; stem elongation+budding (factor C). The maximum values of germination energy (92.90%) and seed germination (94.35%) were achieved under irrigation and triple application of Planriz BT.

Keywords: Winter rapeseed, Seeds, Irrigation, Biological preparation, Application timing, Seed productivity, Sowing qualities

Introduction

The concept of development for the rapeseed production industry should be aimed at establishing regional zones of concentrated winter rapeseed cultivation. According to data from the ministry of agrarian policy and food of Ukraine and the state statistics service, the gross harvest of winter rapeseed in our country during favorable seasons (particularly in 2023-2024) has already crossed the 3.4-4.1 million tons mark due to the expansion of sown areas to 1.3-1.4 million hectares (State Statistics Service of Ukraine, 2024).

The realization of the biological potential of *Brassica napus* L. through the implementation of biologization elements in its cultivation technology is an important direction for ensuring sustainable agricultural production. The use of biological methods in rapeseed cultivation involves the integration of natural growth stimulants, microbiological preparations, and other ecologically safe agents (Bunas, et al. 2024, Balabash, et al. 2026, Panfilova, et al. 2023, Tkachuk, et al. 2024, Zabarnyi, et al. 2024). Under current conditions, stable seed production of *Brassica napus* L. is largely achieved through the use of irrigation (Maliarchuk, et al. 2018).

Materials and Methods

During the 2023-2026 period, research and observations were conducted on the peculiarities of growth, development, water consumption, yield formation, and sowing qualities of winter rapeseed seeds depending on agrotechnical elements. Field experiments were carried out under the conditions of the private enterprise 'HSP' (GSP), located in the village of Shyriaieve, Berezivka (formerly Shyriaieve) district, Odesa region (47°14'21" N, 30°11'22" E). A three-factor field experiment was laid out using a split-plot design with randomized block placement in four replications. Factor A represented moisture supply conditions (rainfed/without irrigation; irrigated); factor B represented biopreparation (control/without application; Ampelomycin BT; Planriz BT; Trichodermin BT); factor C represented application timings (rosette formation+stem elongation+budding; stem elongation+budding). The basic seeds (elite) of the winter rapeseed variety 'Chornyi veleten' were used as the starting material for the research.

Results and Discussion

The analysis of the structural parameters of the winter rapeseed yield, averaged over 2024-2026, proved the high and mathematically confirmed (by Least Significant Difference (LSD₀₅)) effectiveness of all studied factors (Tab. 1).

Table 1. Structural indicators of the winter rapeseed harvest depending on the studied factors (in the conditions of Private Enterprise (PE) "HSP", average for 2024-2026).

Factor A, moisture supply conditions	Factor B, biological preparation	Factor C, application timings	Plant density before harvesting, plants/m2	Number of pods per plant	Number of seeds per pod	1000-seed weight, g
Rainfed/without irrigation	Control/without application	I	51.9	125.0	19.5	3.08
		II	51.2	121.9	19.2	3.07
	Ampelomycin BT	I	53.4	130.7	20.2	3.18
		II	53.1	125.6	19.8	3.16
	Planriz BT	I	54.8	135.3	20.3	3.21
		II	54.5	129.9	20.1	3.19
	Trichodermin BT	I	54.2	131.2	20.0	3.17
		II	53.9	127.8	19.8	3.15
Irrigated	Control/without application	I	65.7	154.1	25.6	4.09
		II	65.3	150.5	25.4	4.13
	Ampelomycin BT	I	67.9	163.0	26.1	4.24
		II	67.4	158.9	25.8	4.28
	Planriz BT	I	69.1	181.2	26.7	4.40
		II	68.7	175.7	26.4	4.48
	Trichodermin BT	I	68.6	178.3	25.9	4.37
		II	68.2	172.6	25.6	4.45
Assessment of the materiality of partial differences LSD05		A	2.10	4.23	0.91	0.43
		B	0.67	1.96	0.78	0.25
		C	0.43	1.25	0.45	0.12

Assessment of the materiality of average (main) effects LSD ₀₅	A	0.74	1.50	0.32	0.15
	B	0.34	0.98	0.39	0.12
	C	0.22	0.63	0.23	0.06

Note: I: Rosette formation+stem elongation+budding; II: Stem elongation+budding, LSD₀₅: Least Significant Difference at the 5% significance level (P=0.05)

Irrigation (factor A) was the main factor influencing the formation of yield structure elements, radically improving plant architecture compared to rainfed variants. Due to the optimization of the water regime, crop density before harvesting increased by 25-27% (up to 65.3-69.1 plants/m²), the number of pods per plant increased by 23-34%, and the number of seeds per pod reached 25.4-26.7 pcs. The moisture supply conditions had the most pronounced effect on the formation of 1000-seed weight, which increased by 30-40%-from 3.07-3.21 g on rainfed plots to 4.09-4.48 g under irrigation. Among the studied biopreparations (factor B), Planriz BT provided the highest agronomic efficiency. Its application allowed for obtaining the maximum parameters of the yield structure under all moisture conditions; Trichodermin BT showed slightly lower effectiveness, while Ampelomycin BT demonstrated a moderate increase relative to the control. The evaluation of application timings (factor C) proved the advantage of triple preparation application ('rosette formation-stem elongation-budding') over double application.

An early start of biopreparation application optimized the initial development of the crop, which ensured plant survival and increased the number of reproductive organs. However, under irrigation conditions with double application, biological compensation was recorded: the formation of fewer pods led to the redistribution of nutrients and caused a slight increase in 1000-seed weight (up to 4.45-4.48 g). The highest indicators of the yield structure were formed under the combination of irrigation and triple application of the preparation Planriz BT, which is the optimal technological solution.

It was established that under the influence of agrotechnical practices, the seed productivity of winter rapeseed, on average for 2024-2026, varied from 1.57 to 2.89 tons per hectare (Tab. 2). It was revealed that the most significant factor for crop optimization is factor A (moisture supply conditions), as the use of artificial irrigation contributed to obtaining the highest average seed productivity of 2.66 t/ha and ensured a substantial yield increase of 0.98 t/ha.

Table 2. Seed productivity of winter rapeseed depending on the studied factors, t/ha (under the conditions of Private Enterprise (PE) 'HSP', average for 2024-2026).

Factor A, moisture supply conditions	Factor B, biological preparation	Factor C, application timings	Average seed yield			
			t/ha	By the factor		
				A	B	C
Rainfed/without irrigation	Control/without application	I	1.59	1.68	2	2.22
		II	1.57			2.11
	Ampelomycin BT	I	1.74		2.17	
		II	1.62			
	Planriz BT	I	1.83		2.29	
		II	1.7			
	Trichodermin BT	I	1.77		2.22	
		II	1.65			
Irrigated	Control/without application	I	2.42	2.66		

	II	2.4
Ampelomycin BT	I	2.74
	II	2.59
Planriz BT	I	2.89
	II	2.73
Trichodermin BT	I	2.81
	II	2.66
Assessment of the materiality of partial differences	LSD05, t/ha A=0.08; B=0.05; C=0.07	
Assessment of the materiality of average (main) effects:	LSD05, t/ha A=0.25; B =0.02; C=0.03	
Note: I: Rosette formation+stem elongation+budding; II: Stem elongation+budding		

The evaluation of the impact of factor B (biopreparation) proved the high technological efficiency of all studied variants compared to the untreated control (2.00 t/ha). The best result was achieved with the preparation Planriz BT, under the application of which the average seed yield reached 2.29 t/ha. The investigation of factor C (application timing) revealed the smallest share of influence on the final yield of winter rapeseed (0.8%). Under triple biopreparation application during the rosette formation, stem elongation, and budding phases, the highest average yield value for this factor was obtained at 2.22 t/ha, which was 6.7% or 0.11 t/ha higher compared to the application timing during the stem elongation and budding phases. The studied factors indicate a minimum seed productivity level of 1.57-1.59 t/ha under rainfed conditions in the control, whereas the maximum yield of 2.89 t/ha was achieved under irrigation combined with a triple application of the biopreparation Planriz BT.

Conclusion

To minimize the chemical impact on agroecosystems, improve the phytosanitary state of crops, and create favorable conditions for yield formation, the efficacy of fungicidal biopreparations was studied, and their application timings were optimized to more fully unlock the productive potential of winter rapeseed under irrigated and rainfed conditions in the south of Ukraine. The use of biopreparations in the cultivation technology of *Brassica napus* L. under various moisture supply conditions in the south of Ukraine demonstrates their high efficiency in improving yield structure, increasing seed productivity, and enhancing the quality properties of the sowing material. The maximum seed productivity of winter rapeseed at 2.6 t/ha and the best structure elements were achieved through the combination of irrigation and a triple application of the biostimulant Planriz BT during the rosette, stem elongation, and budding phases, which is 44.4% higher than the control indicators.

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