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Suitability of *Lupinus albus* L. Genotypes for Organic Farming in Central Northern Bulgaria

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Abstract: Cultivars suitable for organic production systems differ in many aspects from those adapted to a conventional one. The present study aimed to evaluate 23 white lupine genotypes for a range of traits: stability, biomass productivity and related parameters, tolerance to *Fusarium oxysporum*, and nutritional forage value. The goal was to identify white lupine genotypes suitable for organic production conditions in Central Northern Bulgaria. Among the genotypes, Solnechnii, Termis Mestnii, and Tel Keram exhibited the highest dry mass productivity, surpassing 14 t/ha. Solnechnii and Termis Mestnii showed no symptoms of *F. oxysporum* infection but were unstable in terms of forage yield. On the other hand, the genotypes Bezimenii 1, Barde, 17 Nahrquell, and WAT showed a satisfactory level of stability. Ranking according to basic parameters of biochemical composition, energy, and protein nutritional value determined ranks 1 and 2 for Pink Mutant and Kijewskij Mutant. A genotype with a good balance and complex suitability for organic conditions, considering stability, productivity, and tolerance to *F. oxysporum*, was identified as Bezimenii 1. This genotype exhibited both stability and productivity while demonstrating high resistance to *F. oxysporum* (infestation index of 7.18%).

Keywords: organic production; genotypes; lupine; suitability

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1. Introduction

Lupines serve various purposes as fodder and food crops, as well as ornamental plants, playing a crucial role in agriculture for the last 4000 years [1]. According to some researchers [2,3], the white lupine (*Lupinus albus* L.) holds a significant position among domesticated species, thanks to its valuable characteristics. The authors describe it as a "nutritional treasure" worthy of being harnessed. Its nutritional value is related not only to the high protein content of the seeds (35–48%) and green mass (18–23% dry matter) but also to the favorable amino acid ratio [4], the high-quality profile of fatty acids, and numerous health-promoting bioactive molecules [2,3].

According to Yakovenko et al. (2021) [4], the white lupine has the highest production potential of annual legumes (6–7 t/ha). It is relatively tolerant to drought, salinity, and soil acidity, which makes it a potential contributor to enhancing food security and the alleviation of malnutrition, particularly in the context of climate change [5]. Like other legumes, the white lupine actively fixes nitrogen through symbiosis with nodule bacteria; it binds 100 to 400 kg of molecular nitrogen per 1 ha of the crop [4], making it an excellent predecessor for non-legume crops. Additionally, white lupines could be used for phytoremediation [6]. These positive characteristics reveal the practicality and necessity of broader lupine utilization in agricultural production and the potential for biologizing the farming system [7].

Organic farming is a distinctive technique of production, focused on the preservation of the environment and biological diversity and the provision of healthy, high-quality nutrition [8]. Studies conducted by various scholars [9,10] highlight promising possibilities and prospects for cultivating white lupines within European organic systems. A crucial aspect of organic production systems is the selection of cultivars [11]. However, cultivars suitable for organic production systems differ in various aspects from those adapted to conventional ones [12,13].

The environmental conditions in organic farming are much more diverse than in conventional farming. Therefore, the varieties must be more adaptable, and yield stability is as important as its magnitude. Other significant criteria in the evaluation of cultivars suitable for organic agriculture include increased weed competitiveness, pest tolerance, and high quality regardless of low input levels [14,15].

The present study aimed to evaluate 23 white lupine genotypes for a complex of traits, including stability, biomass productivity and related parameters, tolerance to *Fusarium oxysporum,* and nutritional forage value, and to identify genotypes suitable for organic production conditions.

2. Materials and Methods

2.1. Field Experiment and Site Characteristics

The experimental activities were conducted at the Institute of Forage Crops (Pleven, Bulgaria) during the period 2017–2018. The objects of the study were 23 genotypes of *Lupinus albus* species originating from Poland—Kijewskij Mutant, Shienfield Gard, Amiga, Nahrquell, Astra, Ascar, BGR 6305, WAT, Hetman, Start; Russia—Bezimenii 1, Bezimenii 2, Tel Keram, Horizont, Pflugs Ultra, Solnechnii, Termis Mestnii, Pink Mutant, Barde, Manovitskii, Dega, Desnyanskii; and Ukraine—Garant. The randomized block method with three replications was used [16]. The sowing was carried out by hand at a rate of 35 seeds per m^2. The soil type was haplic loamy chernozem.

The two experimental years differed in meteorological conditions. During the first year, the active vegetation period (April–June, until the stage BBCH 71–72) was characterized by a daily average air temperature of 18.2 °C, relative air humidity of 68%, and evenly distributed precipitation, the sum of which was 195 mm. The second year was characterized by relatively lower values. The precipitation amount was 15% lower than the previous year and distributed unevenly. Also, the relative air humidity and the average daily temperature were 10% and 1 °C lower, respectively.

2.2. Plant Measurements

Plants were grown for forage under organic farming conditions without the use of fertilizers and pesticides. Three measurements of the plant height were taken during the vegetation period (at budding, flowering, and pod development) to record the average daily growth rate (ADGR, cm/day). The plants were cut at the pod development stage (BBCH 71–72) and dry mass productivity (kg DM/ha) was recorded. Plant height (PH, cm) and aboveground biomass (AGB, g DM/plant) were recorded at the same stage.

2.3. Tolerance to Fusarium oxysporum f. sp. Lupini

The tolerance of lupine genotypes to *F. oxysporum* f. sp. lupini was assessed on a 5-point scale proposed by Ishikawa et al. [17] and modified by [18] Shaban et al. The infestation index was calculated using the formula by McKinney [19]. Based on the infestation index, genotypes were classified as immune (0%), highly resistant (0–25%), moderately resistant (>25–50%), weakly resistant (>50–75%), and susceptible (>75–100%).

2.4. Chemical Composition and Feeding Value

The general chemical composition of lupine herbage (stage BBCH 71–72) was determined as crude protein (CP), crude fiber (CF), and ash [20]. The energy value—gross energy (GE) and metabolizable energy (ME) in MJ/kg DM—was calculated on the basis of chemical composition and digestibility coefficient using empirical equations [21]. The energy feeding value was determined according to the French system (UFL-UFV, Feed units for milk, Feed units for growth) [22]. The protein feeding value was estimated by the

French system through the following parameters: TDP (Total Digestible Protein) and other digestible proteins in the ruminant small intestine—PDIN (Protein digestible in intestine depending on nitrogen) and PDIE (Protein digestible in intestine depending on energy) in g/kg DM [22].

2.5. Parameters of Ecological Stability and Statistical Analysis

Ecological stability is the ability of the plant population (variety) to keep its structure and functional features (including yield stability) under the influence of external and internal stress factors. The ecological stability of the yield of the studied lupine genotypes was performed using the following analyses and parameters: regression analysis according to Finlay and Wilkinson [23], where the regression coefficient (bi) was calculated; variance analysis through ecovalence (Wi) according to Wricke [24], and non-parametric analysis by the criterion KR of Kang [25]. For additional evaluation, the coefficient of variation (CVi, %) [26] was used. According to the Finlay–Wilkinson model, the formula of the regression equation is as follows:

$$\eta_{\mathbf{ij}} = \alpha_i + \beta_i w_j$$

where ij is the expected performance of the i-th genotype (i = 1, . . ., n) in the j-th year (j = 1, . . ., m), i and I are the intercept and slope for the i-th genotype, and jw is a latent effect of the j-th year. The slope i can be interpreted as a measure of sensitivity with small absolute values indicating stable responses over different years.

Variance component estimates for analyzed traits of each genotype and year over the two-year period were based on mean squares of the factor analysis of variance (two-factor ANOVA). As for the biochemical composition and nutritive value of biomass, the position of each genotype was evaluated by applying rank analysis.

All experimental data were processed statistically using MS Excel (2003) for Windows XP, the computer software GENES 2009.7.0 [27], and the computer software STATGRAPHICS Plus for Windows Version 2.1.

3. Results

3.1. Morphological Characteristics

The tested genotypes exhibited significant variation in plant height (Table 1). The tallest plants were produced by the genotype Shienfield Gard (87.1 cm), followed by the genotypes Bezimenii 2, Termis Mestnii, Nahrquell, and Bezimenii 1 (>75 cm). In terms of growth rate, the highest values were observed in Shienfield Gard (0.82 cm/day), Bezimenii 2 (0.75 cm/day), Solnechnii (0.74 cm/day), and Termis Mestnii (0.73 cm/day). Faster rates correlated with greater plant height (ranging from 41.7 to 87.1 cm, CV = 20%), revealing a robust correlation between the two variables (r = 0.991). The average growth rate in studied lupine accessions displayed substantial variation ranging from 0.43 to 0.82 cm/day (CV = 16%). Biomass accumulation values showed a strong variation (CV = 25%), from 12.77 to 46.50 g DM/plant. The top three positions were occupied by Solnechnii, Termis Mestnii, and Tel Keram, whose biomass weight/plant was 46.50, 46.00, and 41.68 kg DM/plant, respectively.

Table 1. Main morphological characteristics of white lupine genotypes in organic production conditions.

Genotypes	ADGR, cm/Day	PH, cm	AGB, g DM/Plant
Astra	0.70 hi	72.3 jk	37.76 l
Nahrquell	0.71 i	75.9 lm	31.00 g
Ascar	0.70 i	71.3 ij	33.41 h
BGR 6305	0.68 fg	69.9 h	35.85 jk
Shienfield Gard	0.82 l	87.1 n	34.40 hi
WAT	0.60 e	57.7 f	27.64 ef

Table 1. *Cont.*

Genotypes	ADGR, cm/Day	PH, cm	AGB, g DM/Plant
Kijewskij Mutant	0.59 e	57.2 f	21.68 b
Hetman	0.43 a	41.7 a	12.77 a
Start	0.50 c	48.2 c	28.35 f
Amiga	0.53 d	51.4 d	23.48 c
Garant	0.53 d	51.1 d	26.85 e
Tel Keram	0.69 gh	70.9 hi	41.68 m
Bezimenii 1	0.70 hi	75.2 l	35.90 k
Bezimenii 2	0.75 k	76.8 m	35.06 ij
Pflugs Ultra	0.69 gh	70.9 hi	36.08 jk
Termis Mestnii	0.73 j	76.1 lm	46.00 n
Horizont	0.68 fg	70.2 hi	31.66 g
Solnechnii	0.74 jk	72.9 k	46.50 n
Pink Mutant	0.67 f	65.9 g	36.62 kl
Manovitskii	0.54 d	52.3 d	23.80 c
Barde	0.59 e	55.4 e	28.82 f
Dega	0.47 b	45.3 b	25.31 d
Desnyanskii	0.44 a	42.5 a	24.41 cd
CV(%)	16	20	25

Different letters (a, b, c. . .) in the same column indicate a significant difference between treatments at $p < 0.05$; PH—plant height, ADGR—average daily growth rate, AGB—aboveground biomass, CV(%)—coefficient of variation.

The two-factor analysis of the variance of the data allows the evaluation of the strength of influence of the sources of variation—genotype, year, and genotype × year interaction (Table 2).

Table 2. ANOVA regarding main morphological characteristics of white lupine genotypes.

Source of Variation	df	Sum of Squares					
		PH	% of Total Variation	ADGR	% of Total Variation	AGB	% of Total Variation
Environment	1	11,897.79 **	66.0	0.99 **	69.2	4591.97 **	64.7
Genotype	22	498.93 **	30.4	0.034 **	26.2	191.79 **	29.7
Genotype × environment	22	29.13 **	3.6	0.003 ns	4.6	17.86 **	5.6

** significant at $p < 0.05/<0.01$; PH—plant height, ADGR—average daily growth rate, AGB—aboveground biomass.

Except for genotype × environment interaction regarding ADGR, the importance of genotype, environment, and their interaction was statistically significant ($p < 0.01$) for all three morphological traits. The determinant in these traits was the influence of environmental factors (from 64.7 to 66.0%), followed by genotype (26.2–30.4%) and the genotype × environment interaction (3.6–5.6%).

3.2. Forage Yield and Ecological Stability

The dry mass yield data showed a high degree of variation among the tested lupine genotypes (VC = 25%) (Table 3). Three genotypes (Solnechnii, Termis Mestnii, and Tel Keram) achieved a productivity of over 14 tons DM/ha under the given experimental conditions. According to the linear regression coefficient (bi), genotypes Bezimenii 1 (bi = 1.01), Dega (bi = 0.98), Barde (bi = 0.90), Nahrquell (bi = 0.90), and WAT (bi = 0.90) closely approach the so-called "ideal" variety (bi ≈ 1) [28]. Bezimenii 1 can be considered valuable as it demonstrated a successful balance between stability (according to all stability parameters) and productivity, exceeding the group average by 14.6%.

Table 3. Forage yield and ecological stability of white lupine genotypes in organic production conditions.

Genotypes	Yield, t DM/ha		bi	Wi^2	KR	CVi
Astra	12.88	k	1.26	27.53	8	47.25
Nahrquell	10.65	g	0.90	3.81	5	41.13
Ascar	11.32	h	1.24	23.87	14	52.63
BGR 6305	12.27	ij	1.13	6.41	2	44.41
Shienfield Gard	11.96	i	0.74	26.72	14	30.45
WAT	9.44	ef	0.90	3.75	6	46.16
Kijewskij Mutant	7.34	b	0.83	12.05	19	53.86
Hetman	4.42	a	0.31	187.99	23	34.74
Start	9.87	f	0.60	62.83	20	30.07
Amiga	8.08	c	0.66	46.37	22	39.67
Garant	9.21	e	0.86	8.59	17	45.95
Tel Keram	14.23	l	1.37	53.98	12	46.37
Bezimenii 1	12.35	ij	1.01	0.06	1	39.82
Bezimenii 2	11.98	i	1.14	8.04	4	46.02
Pflugs Ultra	12.27	ij	1.26	27.31	10	49.41
Termis Mestnii	15.64	m	1.63	157.35	14	50.00
Horizont	10.92	gh	0.85	9.55	12	37.73
Solnechnii	15.95	m	1.39	62.05	10	42.37
Pink Mutant	12.54	jk	1.15	8.61	2	44.25
Manovitskii	8.17	cd	0.71	32.56	21	42.41
Barde	9.87	f	0.90	4.18	6	44.02
Dega	8.56	d	0.98	0.20	8	54.58
Desnyanskii	8.13	cd	1.17	12.05	18	67.93

Different letters (a, b, c. . .) in the same column indicate the significant difference between treatments at $p < 0.05$; Wi^2—ecovalence (Wricke, 1962) [24]; bi—regression coefficient (Finlay and Wilkinson, 1963) [23]; CVi—coefficient of variance (Francis and Kannenberg, 1987) [26]; KR—Kang's rank-sum (Kang, 1988) [25].

In terms of the ecovalence (Wi^2) of Wricke [24], varieties with lower values of this parameter are defined as more stable. In the present experimental conditions, these genotypes are Bezimenii 1 (0.06), Dega (0.20), WAT (3.75), Nahrquell (3.81), Barde (4.18), BGR 6305 (6.41), and Bezimenii 2 (8.04). Except for Bezimenii 1, all other genotypes in this group had low yields. The non-parametric analysis of Kang [25], in which the "KR" criterion was calculated, resulted in a similar assessment to the previous two parameters of the studied genotype with Bezimenii 1, BGR 6305, Pink Mutant, Bezimenii 2, Nahrquell, WAT, and Barde occupying the top positions. In contrast, Hetman exhibited instability to the greatest extent according to the values of KR and Wi^2.

Stability assessment was also carried out according to the method by Francis and Kannenberg [26] employing the variation coefficient (CVi), which reflects the plasticity of a given genotype in a certain environment. In general, Shienfield Gard and Start displayed the lowest coefficient of variation; therefore, they can be categorized as relatively stable. On the other hand, Desnyanskii was in a highly variable genotype. It is noteworthy that the differences in stability assessments are due to the fact that different methods are based on different concepts of stability.

3.3. Tolerance to Fusarium oxysporum

The studied 23 genotypes exhibited varying susceptibility to *F. oxysporum* (Figure 1). Hetman (36.67%), Ascar (27.50), and Amiga (26.79) demonstrated a high infestation index and were categorized as moderately resistant according to the scale of Shaban et al. [18]. Nevertheless, 11 genotypes (Astra, Shienfield Gard, Start, Garant, Tel Keram, Bezimenii 1, Bezimenii 2, Horizont, Manovitskii, Barde, Desnyanskii) displayed high resistance with an infestation index ranging from 4.17 to 19.55%. In the conditions of the study, nine genotypes (Nahrquell, BGR 6305, WAT, Kijewskij Mutan, Pflugs Ultra, Termis Mestnii, Solnechnii, Pink Mutant, Dega) did not exhibit any symptoms of *F. oxysporum*, leading to their classification as immune.

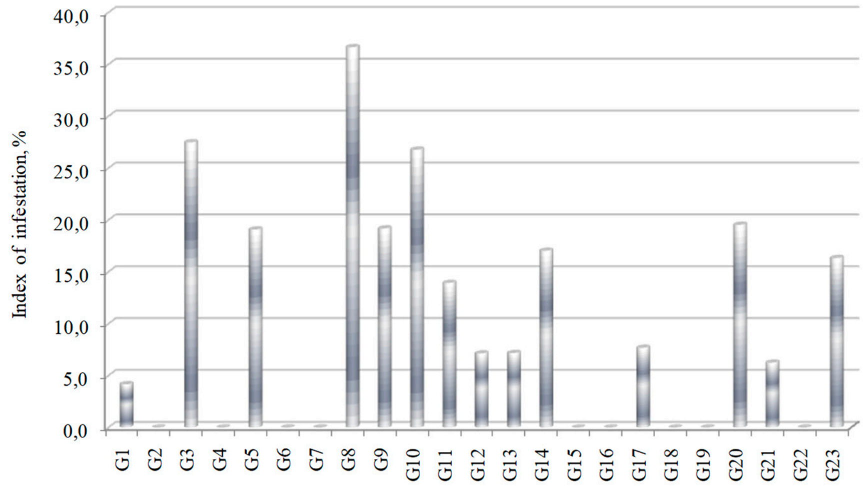

Figure 1. Index of infestation of *Fusarium oxysporum* f. sp. lupini in white lupine genotypes. G1, Astra; G2, Nahrquell; G3, Ascar; G4, BGR 6305; G5, Shienfield Gard; G6, WAT; G7, Kijewskij Mutant; G8, Hetman; G9, Start; G10, Amiga; G11, Garant; G12, Tel Keram; G13, Bezimenii 1; G14, Bezimenii 2; G15, Pflugs Ultra; G16, Termis Mestnii; G17, Horizont; G18, Solnechnii; G19, Pink Mutant; G20, Manovitskii; G21, Barde; G22, Dega; G23, Desnyanskii.

3.4. Chemical Composition and Feeding Value

The primary chemical composition is key for the assessment of nutritional value and the efficient utilization of feed. The data presented in Table 4 show the main biochemical composition, energy, and protein nutritional value in the studied genotypes. The contents of CP, CF, and ash were within the range of 143.2–199.8 g/kg DM, 164.1–244.1 g/kg DM, and 68.70–91.0 g/kg DM, with CVs of 14.7, 18.9 and 6.3%, respectively. High protein content was observed in Manovitskii, followed by Kijewskij Mutant and Tel Keram, with values surpassing the group average of 12.2%. Kijewskij Mutant also stood out with the highest mineral content of 91.0 g/kg DM. Pink Mutant, Horizont, Hetman, Barde, and Manovitskii demonstrated favorable CF content, registering values below 200 g/kg DM.

Table 4. Main chemical composition (g/kg DM), energy, and protein feeding value of *Lupinus albus* genotypes.

Genotypes	CP	CF	Ash	GE	ME	UFL	UFV	PBD	PDIN	PDIE
		g/kg DM		MJ/kg DM		Feed units			g/kg DM	
Astra	171.2	206.6	78.30	11.583	6.489	0.855	0.768	127	108	98
Nahrquell	143.2	228.2	76.60	11.446	6.397	0.849	0.764	100	90	93
Ascar	165.3	227.9	77.60	11.546	6.327	0.816	0.724	122	104	95
BGR 6305	192.0	211.1	86.90	11.675	6.403	0.82	0.726	148	121	101
Shienfield Gard	166.2	233.2	72.80	11.546	6.419	0.836	0.747	122	104	96
WAT	182.3	226.8	82.20	11.627	6.352	0.811	0.717	138	115	98
Kijewskij Mutant	194.2	209.7	91.00	11.689	6.380	0.814	0.719	150	122	101
Hetman	185.3	193.9	90.00	11.647	6.357	0.817	0.723	141	116	100
Start	176.6	215.1	86.60	11.582	6.398	0.833	0.743	128	108	98
Amiga	155.9	224.1	73.40	11.501	6.247	0.803	0.710	112	98	92
Garant	187.7	202.1	81.70	11.651	6.508	0.849	0.760	143	118	102
Tel Keram	192.3	244.1	80.20	11.670	6.039	0.727	0.619	148	121	95
Bezimenii 1	159.8	221.4	76.30	11.520	6.339	0.824	0.733	116	100	94
Bezimenii 2	177.9	222.6	68.70	11.595	6.693	0.895	0.815	133	112	102
Pflugs Ultra	174.0	227.5	77.60	11.585	6.333	0.811	0.718	130	109	96
Termis Mestnii	174.8	202.8	71.70	11.584	6.290	0.802	0.707	130	110	95

Table 4. *Cont.*

Genotypes	CP	CF	Ash	GE	ME	UFL	UFV	PBD	PDIN	PDIE
Horizont	163.9	177.7	71.30	11.535	6.541	0.875	0.793	120	103	98
Solnechnii	161.5	234.2	73.00	11.525	6.312	0.813	0.721	118	101	94
Pink Mutant	156.5	164.1	71.60	11.502	6.409	0.843	0.756	113	98	94
Manovitskii	199.8	199.9	85.90	11.709	6.608	0.871	0.785	155	125	105
Barde	159.0	196.3	74.20	11.515	6.441	0.851	0.766	115	100	96
Dega	180.6	201.5	78.30	11.616	6.512	0.855	0.767	136	113	100
Desnyanskii	186.1	221.7	82.10	11.644	6.452	0.836	0.746	142	117	100
Min	143.2	164.1	68.70	11.446	6.039	0.727	0.619	100	90	92
Max	199.8	244.1	91.00	11.709	6.693	0.895	0.815	155	125	105
Mean	174.2	212.7	78.60	11.587	6.402	0.831	0.740	130	109	98
CV, %	14.70	18.90	6.30	0.10	0.10	0.03	0.04	14.40	9.30	3.40
$LSD_{0.05}$	26.21	31.04	9.02	0.21	0.25	0.06	0.07	23.66	16.53	5.76

CP—Crude protein, CF—Crude fiber, GE—Gross energy, ME—Metabolizable energy, UFL—Feed units for milk, UFV—Feed units for growth, PBD (TDP)—Protein Brute Digestible (Total Digestible Protein), PDIN—Protein digestible in intestine depending on nitrogen, PDIE—Protein digestible in intestine depending on energy (The determination of energy and protein feeding values was conducted by prof. Y. Naydenova).

Gross energy (GE) and metabolizable energy (ME) values ranged between 11.446 and 11.709 and between 6.039 and 6.693, respectively, with the highest values found in Manovitskii and Bezimenii 2 for GE and ME, respectively. The calculated energy nutritional values according to the French system highlighted Bezimenii 2 as the one with the highest energy nutritional value (UFL-UFV: 0.895–0.815), followed by Horizont and Manovitskii. On the other hand, the protein nutritive value calculated on the basis of Total Digestible Protein (TDP), and the protein digestible in the small intestine dependent on nitrogen (PDIN) and energy (PDIE) is important for the assessment of the nutritional value of forages. Manovitski secured the top position based on the values of TDP, PDIN, and PDIE (155, 125, and 105, respectively). To sum up, the overall evaluation of the primal parameters of biochemical composition (CP, CE, GE, and TDP) positioned Manovitskii at rank 1, followed by Kijewskij Mutant at rank 2 (Table 5).

Table 5. Ranks of parameters of chemical composition and feeding value of Lupinus albus genotypes.

Genotypes	CP	CF	GE	PBD	ARS	R
Astra	14	9	11	12	46	10
Nahrquell	23	20	17	20	80	18
Ascar	16	19	12	13	60	13
BGR 6305	4	11	3	3	21	3
Shienfield Gard	15	21	12	13	61	14
WAT	8	17	7	7	39	6
Kijewskij Mutant	2	10	2	2	16	2
Hetman	7	3	5	6	21	3
Start	11	12	11	11	45	9
Amiga	22	16	16	19	73	17
Garant	5	7	5	4	21	3
Tel Keram	3	23	4	3	33	5
Bezimenii 1	19	13	15	16	63	15
Bezimenii 2	10	15	9	9	43	8
Pflugs Ultra	13	18	10	10	51	11
Termis Mestnii	12	8	11	10	41	7
Horizont	17	2	13	14	46	10
Solnechnii	18	22	14	15	69	16
Pink Mutant	21	1	16	18	56	12
Manovitskii	1	5	1	1	8	1
Barde	20	4	15	17	56	12
Dega	9	6	8	8	31	4
Desnyanskii	6	14	6	5	31	4

CP—Crude protein, CF—Crude fiber, GE—Gross energy, PBD (TDP)—Protein Brute Digestible (Total Digestible Protein), ARS—Arithmetical rank sum, R—Ranks (Lowest R—Highest forage quality).

4. Discussion

Weed control poses a significant threat to organic farming [29,30]. Management strategies for weed control include tillage, crop rotation, seeding density, utilization of competitive cultivars, etc. Morphological traits determining the plant competitiveness against weeds include fast ADGR, increased PH, and early accumulation of AGB [31]. According to Paolini and Faustini [32], cultivars with greater height "capture" a higher percentage of photosynthetically active radiation and accumulate dry mass faster. This means they are more effective in weed suppression compared to shorter cultivars. In the current research, four genotypes displayed the highest values in terms of PH and ADGR (and significant differences compared to the rest of the collection). Three genotypes stood out in terms of AGB. Termis Mestnii was the sole genotype exhibiting high, significant differences regarding all three morphological characteristics. In our previous study, seven vetch varieties were estimated under organic growing conditions. The results showed that the Moldavian variety Liya was distinguished by a higher ADGR (1.04 cm/day), greater PH (70.4 cm), and amount of AGB formed (by 55.0% above the average of the studied varieties) [33]. In another experiment conducted under organic conditions, five pea varieties were tested. The Bulgarian variety Pleven 4 displayed a greater height, total biomass (aboveground and root), leaf area, and average daily growth rate (by 27.8, 17.3, 22.9, and 32.5% on average) compared to the other four introduced varieties (Glyans, Svit, Kamerton, Modus). These parameters determined higher competitiveness against weeds as well as enhanced nutrient uptake and assimilation [34]. Similarly, Olle et al. [35] reported that when testing pea cultivars under organic conditions, three of them (Ambassador, Greenshaft, Jaguar, Zelda, DS8903) that grew fast and formed a large amount of biomass were better at competing with weeds.

In organic farming, it is crucial to determine to what extent the varieties retain their productive potential in the absence of production inputs and to evaluate the stability of their yield [15,31]. However, it has long been established that high-productive varieties often exhibit low stability levels [36,37], a correlation also confirmed in the present study. The less productive genotypes like Bezimenii 1, Dega, Barde, Nahrquell, and WAT (with yields between 8.56 and 12.35 t DM/ha) demonstrated better stability (bi is between 0.90 and 1.01) compared to the most productive but unstable genotypes Solnechnii, Termis Mestnii, and Tel Keram (yields between 14.23 and 15.95 t DM/ha) (bi is between 1.37 and 1.63). Bezimenii 1 exhibited stability across all parameters while surpassing the average value of the group in terms of productivity. Similarly, in a study involving 12 white lupine accessions (varieties and hybrids) [38], Shcherbyna et al. found that the Chabansky variety and hybrids 247/6, 824/34, and 122/6 were less productive (2.33–2.43 t/ha), yet displayed high plasticity (bi = 1.027–1.092) and low standard deviation (0.005–0.064), which are indicators of their high stability. In an evaluation of the adaptive capacity and stability of 121 common bean accessions under organic cultivation, Kazydub et al. [39] identified five cultivars with high genotypic stability: Biichanka, Sibakovskaya-100, Rubin, Nerussa, and Petukh.

Some authors [40–42] have pointed out *F. oxysporum* as the most injurious and widespread disease in white lupines. The spread of the disease is associated with a considerable negative effect on vegetative and generative plant development, leading to serious economic losses [43]. An integral approach in the control of *F. oxysporum* is the identification of cultivars with pronounced resistance to the pathogen [44]. According to the author, lupine cultivars resistant to *F. oxysporum* in some areas are often susceptible in others. Therefore, cultivar evaluation should be carried out in specific soil–climatic conditions and under various environmental conditions. In our experimental conditions, eleven genotypes showed high resistance to *F. oxysporum*, while nine genotypes were immune, suggesting their potential for organic farming. In a comparative test of newly developed varieties of white lupine, Yagovenko et al. [7] identified Alyi parus, Mitchurinskiy, and Pilgrim as tolerant to *F. oxysporum*, with an infestation index below 13%. In a similar experiment involving three Egyptian lupine cultivars, Zian et al. [43] found that Dijon-2 displayed the lowest susceptibility to *F. oxysporum*. This cultivar produced the highest percentage of healthy plants and had the lowest disease severity score (48% and 1.8, respectively), followed by Giza-1 (44% and 2.0) and Giza-2 (24% and 3.0). According to the authors, the variation in the responses of *L. albus* to *F. oxysporum* is attributed to the physiological and mechanical resistance of the cultivars.

In the conditions of the present study, the average protein content was 196.3 g/kg DM, a value closely aligned with the one of 190 g/kg DM reported by Fraser et al. [45]. CF content is also a vital factor in assessing the forage quality and nutritional value [46]. Feed low in protein and high in fiber content has low digestibility and voluntary feed intake [47]. According to Petkova et al. and Bozhanova et al. [48,49], the contemporary assessment of forage quality is primarily based on the nutritional energy value and defined by milk and growth units.

5. Conclusions

In the presented experimental conditions, three genotypes (Solnechnii, Termis Mestnii, and Tel Keram) demonstrated dry mass productivity of over 14 t/ha, surpassing the average value of the parameter by 41.6%. Solnechnii and Termis Mestnii did not show any symptoms of *Fusarium oxysporum infestation* and were thus categorized as immune.

According to the main stability parameters, a satisfactory level of stability was found in Bezimenii 1, Barde, Nahrquell, and WAT. Manovitskii and Kijewskij Mutant showed the highest evaluation regarding biochemical composition, energy, and protein nutritive value.

The Bezimenii 1 genotype possessed a good balance and complex stability for organic conditions, according to the main characteristics such as stability, productivity, and tolerance to *F. oxysporum.* It exhibited good stability (bi = 1.01, Wi^2 = 0.06, KR = 1) with productivity exceeding the group average (by 14.6%) and high resistance to *F. oxysporum* (infestation index of 7.18%).

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