

STUDY REGARDING THE QUALITATIVE AND YIELD CARACTERS VARIABILITY FOR SOME WHITE MUSTARD GENOTYPES

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Abstract. The purpose of this study was to obtain knowledge about the variability of the quantitative and qualitative traits for 9 genotypes of different genetic origin white mustard. This study was carried out for three years in the pedoclimatic conditions of the Agricultural Research and Development Station Lovrin. Ten parameters were taken into study, namely: silique length, number of branches/plant, number of grains/silique, number of silique/plant, number of seeds/plant, hectoliter weight, TSW, oil production and content. In order to determine the correlation coefficient, the data of the experiment were processed in Past 4 - statistical analysis software. The graphical representations were created in Microsoft Office Excel software. The results regarding the length of mustard siliques registered a high uniformity of plants. Regarding the number of branches/plant the variation amplitude was 1,18 branches/plant. The variability calculated for the number and the size of the seeds in the siliques was low except for the Lv-M9 genotype which recorded a medium variability. The number of silique/plant in the studied mustard genotypes recorded a variation amplitude of 616 silique/plant. The number of seeds per plant in the studied white mustard genotypes recorded an 2.198 seeds/plant amplitude of variation. HW of mustard genotypes ranged between 69 kg/hl and 73 kg/hl with a variation amplitude of 4 kg/hl. The weight of the seeds per plant recorded values between 13,76 g and 31,02 g with an amplitude of variation of 17,26 g. The TSW recorded values between 5,58 g and 6,85 g with a variability of 1,27 g. The oil content achieved values between 31,02 % and 33,35 % with a low variability. The effects of genotype factor had a very significantly positive influence on yield and a significant influence on TSW.

Keywords: mustard, genotypes, variability, quantitative and qualitative characters, correlations

INTRODUCTION

Sinapis alba L. cultivation brings important economical benefits to farmers being a tolerant crop to drought and manifesting resistance for diseases (Özcan, 2024). The importance of this crop is given by the usefulness of seeds in human and animal nutrition (Kloska, 2012), presenting a relative high protein content (28 % - 36 %), but also for various industrial applications due to its high oil content that ranges between 28% and 32% (Tyagi et al., 2007; Gadei et al., 2012). Another benefit of cultivating *Sinapis alba* L. plants is the improvement of soil quality that lacks organic matter using it as a green manure that produces large volumes of green matter and residual fibre (Krasnodębska-Ostręga et al., 2022; Padmavathiamma and Li., 2007; Petcu et al., 2021; Lungu et al., 2017).

Mustard oil is valuable due to its content of essential fatty acids (Sawicka et al., 2020; Khan et al., 2013), linoleic acid, oleic acid and linolic acids not only in food, but also in traditional medicine (Kaur et al., 2019) and industry due to its antimicrobial and anti-inflammatory properties (Fleming, 2000; Costin, 2017; Wendlinger et al., 2014).

Establishing and knowing the variability, correlations and hereditary transmission of different quantitative traits is a fundamental aspect of plant breeding (Bind et al., 2014) increasing the efficiency of breeding in order to create new varieties of mustard with high productivity and quality (Aragi et al., 2023; Lupașcu et al., 2017). The knowledge of quantitative and qualitative variability is of a major importance for choosing the best parental forms and the best crossing methods and increases the effectiveness of the selective breeding (Islam et al., 2024).

Starting from the need to acquire an extensive knowledge of the specific variability, quantitative and qualitative characteristics, the type of hereditary transmission and the intensity of the correlations between them, a series of research and biometric analyses were carried out in order to improve the selection methods and the breeding works of creating new varieties of mustard.

The results of the studies on the complex issue of variability of quantitative traits in mustard have highlighted the opportunity of differentiated research.

The researches aimed to study the mustard germplasm in terms of quantitative and qualitative characters variability, the selection of cultivars for the active mustard collection, but also their use in creating genetic variability in order to obtain new mustard varieties.

MATERIAL AND METHODS

During the three experimental years of the study at the Agricultural Research and Development Station Lovrin, comparative cultures (Figure 1.) were sown with white mustard genotypes according to the randomized block method that contained 10 square meter dimension plots in 3 replicates (Ciulcă, 2006). This study highlights the behavior of 9 white mustard genotypes from Denmark, France, Austria, the Netherlands, Germany and Belgium.

The study was carried out on a typical chernozem soil, weakly gleized, epicalcic, clay - loam soil, with the following agrochemical characteristics (at a depth of 0-20 cm): pH(H₂O)= 6,60; humus content of 3,55 %; the N index of 3,07; mobile P content of 75,7 ppm; 205 ppm mobile K content; the degree of saturation in bases (V) of 80%.

Monthly weather data recorded during the three years of the study indicated a slight increase of the air temperature correlated with a reduced amount of precipitations, particularly in the spring months.

The sowing of the experimental plots was carried out with the Wintersteiger plot seeder. The harvesting of the plants was done manually and biometric measurements were carried out in the laboratory. The harvesting of the experimental plots was carried out with the Wintersteiger research plot combine harvester.



Figure 1. Experimental white mustard field (2023) at the Agricultural Research and Development Station Lovrin

A series of quality analysis and biometric assessments were carried out at the Agricultural Research and Development Station Lovrin, with the main purpose of improving the selection methods and breeding procedures, contributing to the creation of new varieties of white mustard by determining the specific variability, qualitative characteristics, productivity and the correlation between these characteristics.

The following measurements have been determined to a number of 25 plants per plot: the number of branches/plant, the number of silique/plant, the length of the siliques, the number of seeds/silique, the weight of the seeds/plant, the hectoliter weight, the thousand grain weight and the oil content.

The experimental data obtained were analyzed in the Polifact statistics software using the ANOVA test. The experimental data for the correlation coefficient were prepared and processed in Past4 statistical analysis software. Microsoft Office Excel was used to generate graphical representations.

RESULTS AND DISCUSSIONS

The studies have revealed that there is an adequate amount of genetic variability within white mustard genotypes. The results obtained during the three year study are discussed and presented below with the aid of the graphical representations.

The length of mustard siliques can influence yield by directly affecting the plants ability to produce and store seeds. More specifically, a longer silique may contain more seeds, which could lead to a higher total seed production per plant. For the analyzed genotypes, the siliques length was between 2,70 cm for the Lv-M4 mustard genotype and 3,06 cm for the Lv-M7 genotype with a variation amplitude of 0,36 cm. The LvM1 genotype showed a high uniformity of plants for this characteristic, while in the other varieties a medium-high

variability was recorded, the most accentuated heterogeneity being observed between the plants of the Lv-M4 genotype (Figure 2.).

The number of branches of the mustard plant can have a significant impact on seed production. The branching ability of the mustard plants directly influence the number of inflorescences and the number of siliques and seeds produced by the plant. Development of a significant number of branches leads to a larger leaf area, which means that the plant can capture more sunlight and produce more energy through photosynthesis to be used for the development of flowers and silique. Each inflorescence can produce a certain number of silique, so a higher number of inflorescences can lead to a higher seed production. The number of branches per plant for the mustard varieties registered a medium variability, except for the LvM9 mustard genotype, which showed low variability. The studied varieties achieved values of this character between 8,02 for Lv-M5 genotype and 9,20 for Lv-M7 genotype, with a variation amplitude of 1,18 branches/plant.

The number and the size of the seeds in the siliques can influence both the productivity and the quality of the seeds. The number of seeds/silique in this study for the mustard genotypes recorded values between 4,20 for the Lv-M5 genotype and 6,67 for the Lv-M1 genotype, with a variation amplitude of 2,47. The variability for this trait was generally low except for the Lv-M9 genotype which recorded a medium variability.

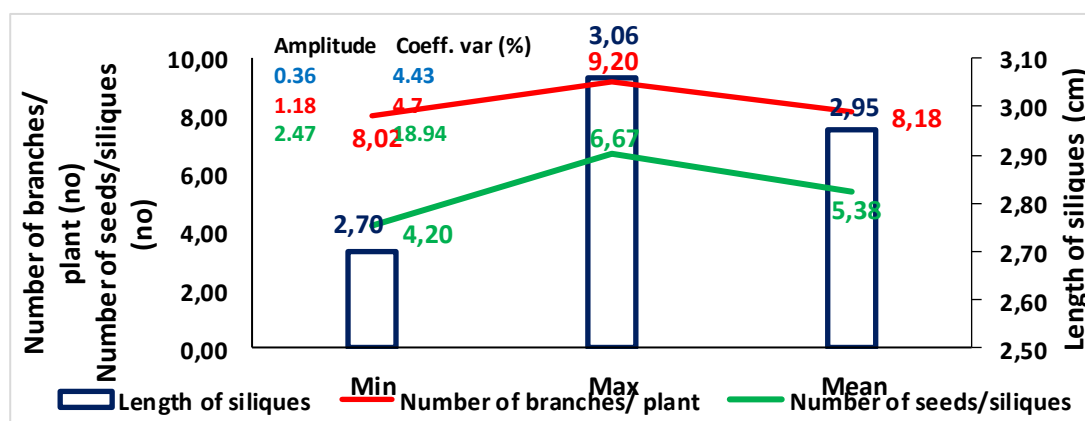


Figure 2. Summary statistics regarding the parameters length of siliques, number of branches and number of seeds/siliques for the white mustard genotypes during the 3 years of research

The number of silique/plant in the studied mustard genotypes recorded values ranging between 694 for the Lv-M6 genotype and 1310 for the Lv-M8 genotype, with a variation amplitude of 616 silique/plant. The studied genotypes variability recorded for the number of silique/plant was low for the Lv-M7 and Lv-M1 genotypes, respectively very high for the Lv-M3, Lv-M4 and Lv-M8 genotypes.

Mustard varieties have distinct genetic characteristics that may influence the number of seeds per plant. The number of seeds per plant in the studied white mustard genotypes recorded values between 1.571 for the Lv-M5 genotype and 3.769 for the Lv-M3 mustard genotype, with an amplitude of variation of 2.198 seeds/plant. The variability within the varieties was medium for the Lv-M6 genotype, medium-high for most genotypes except for the Lv-M9, Lv-M5 and Lv-M8 genotypes which recorded a very high variability.

Hectoliter weight (HW) is an indicator of seed density expressed in kilograms per hectolitre (kg/hl). This parameter is essential in assessing seed quality and has a significant impact on mustard yield. Hectoliter weight of mustard genotypes ranged from 69 kg/hl for mustard genotype Lv-M9 to 73 kg/hl for Lv-M6 with a variation amplitude of 4 kg/hl.

The results obtained during the 3 year study for the characters HW, number of silique/plant and number of seeds/plant are presented in the graphical representation below (Figure 3.).

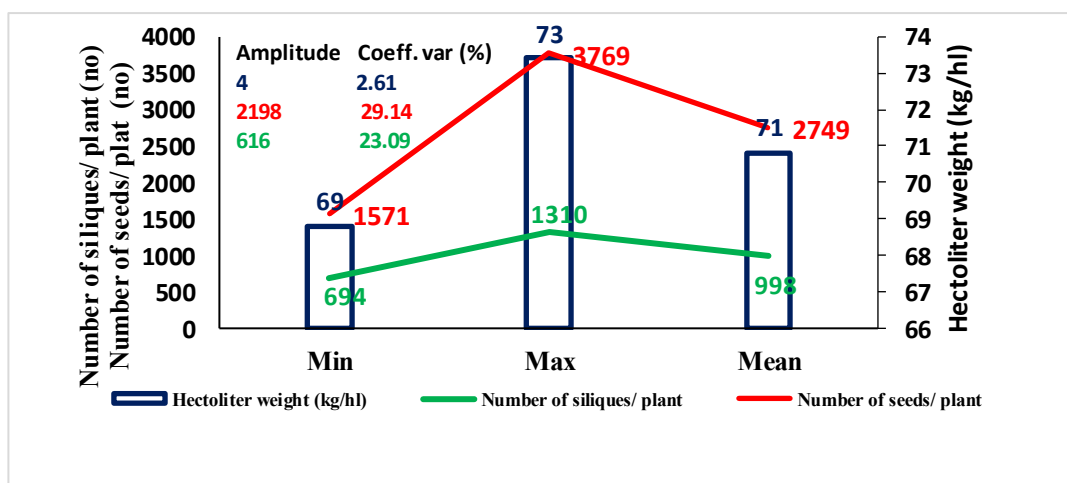


Figure 3. Summary statistics regarding the parameters number of siliques/plant, number of seeds/plant and hectoliter weight for the white mustard genotypes during the 3 years of study

The weight of the seeds is often correlated with their size and quality. To maximize mustard production, it is important to select plant varieties that produce high-quality seeds. Plant selection and genetic improvement contribute to increasing grain weight and total production. The weight of the seeds per plant in the studied varieties from the mustard collection recorded values for this character between 13,76 g for the Lv-M9 mustard genotype and 31,02 g for the Lv-M3 genotype with an amplitude of variation of 17,26 g.

The thousand seed weight (TSW) of the tested mustard genotypes recorded values between 5,58 g for the Lv-M5 genotype and 6,85 g for the Lv-m3 genotype recording a variability of 1,27 g. Within the assessed varieties, the variability of this character was low for the Lv-M7, Lv-M9, Lv-M6, Lv-M4 genotypes, medium for the Lv-M1 and Lv-M3 genotypes, high at the Lv-M8 genotype and very high at Lv-M5.

The results obtained during the 3 year study for the characters yield, grain weight and TSW are presented in the graphical representation below (Figure 4.).

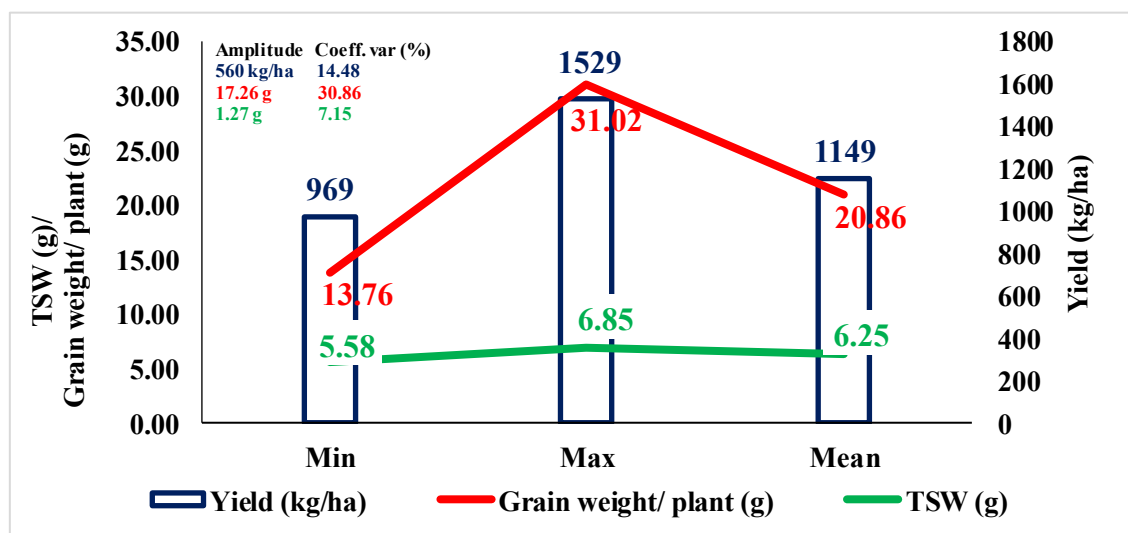


Figure 4. Summary statistics of grain weight/plant, TSW and yield of white mustard genotypes tested during the 3 year study

The phenotypic correlation between different quantitative traits provide useful informations for the breeding processes by obtaining statistical differences between two or more traits.

The oil content of the tested white mustard genotypes achieved values between 31,02 % for the Lv-M5 genotype and 33,35 % for the Lv-M3 genotype, with a small variability (var. coefficient = 2,12 %) (Figure 5.).

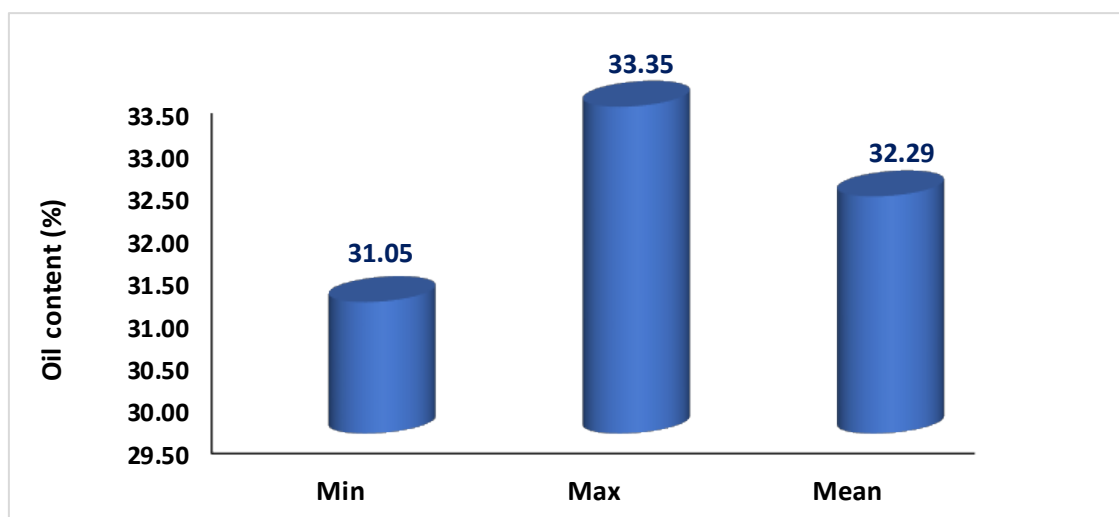


Figure 5. Summary statistics for the oil content of the mustard genotypes seeds tested during the 3 year experiment

Based on the Pearson's correlation coefficient (Figure 6.) recorded by assessing ten traits of agronomic importance for the white mustard crop, the yield is closely correlated with: the number of branches/plant ($r=0.89$), the number of siliques/plant ($r=0.73$); the number of seeds/plant ($r=0.82$) and the TSW ($r=0.76$). A very high positive statistical correlation ($r=0.94$) was established between the number of seeds/plant and the size of the seeds. Negative correlation was recorded between oil content and TSW ($r = -0.67$).

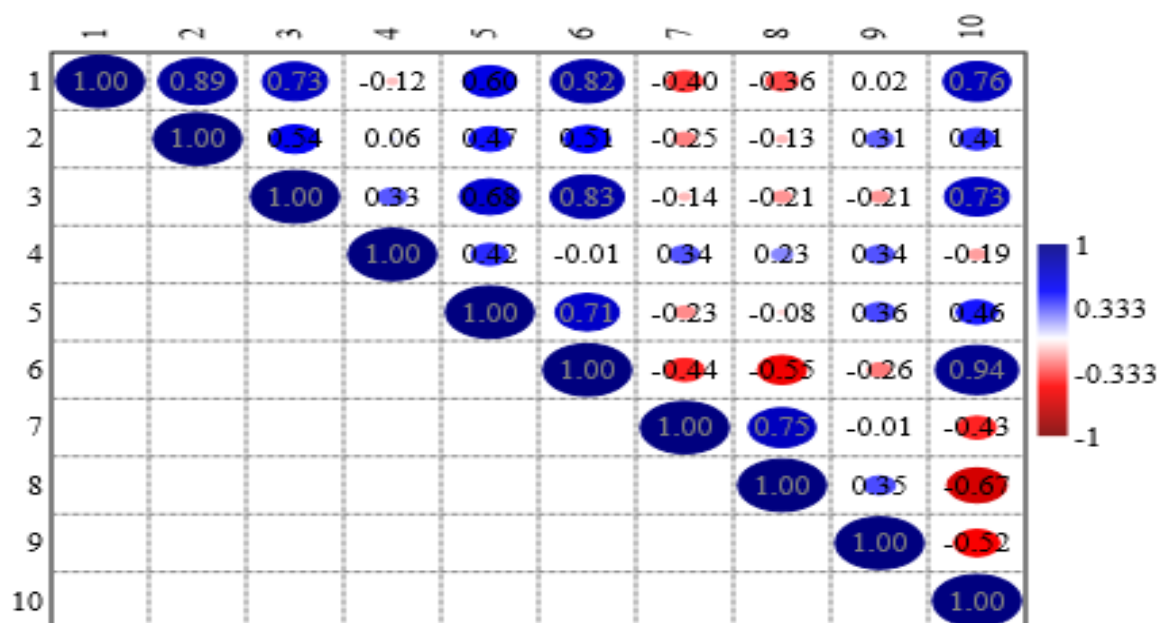


Figure 6. The correlogram representing the Pearson correlation coefficient matrix between the studied traits (1 - yield; 2 - number of branches/plant; 3 - number of siliques/ plant; 4 - length of siliques; 5 - number of seeds/siliques; 6 - number of seeds/ plant; 7 - grain weight/plant; 8 - oil content; 9 - hectoliter weight; 10 - TSW)

The genotype had a very significantly positive influence on yield and a significant influence on TSW (Table 1). The yields obtained at the Lv-M2 genotype (1453 kg/ha) registered a very significantly positive difference (288 kg/ha ***) compared to the average production of the 9 genotypes studied. In terms of TSW and oil content, there were no significant differences recorded compared to the average of the experience (Table 1).

Table 1. The effects of genotype factor on yield, TSW and oil content traits during the years of research

Factor Mustard genotype	Yield (kg/ha)	Diff.	Significance	TSW (g)	Diff.	Significance	Oil content (%)	Diff.	Significance
Lv – M1	1215	49.19	ns	6.85	0.6	ns	31.50	-0.79	ns
Lv – M2	1453	288	***	6.69	0.44	ns	32.10	-0.19	ns
Lv – M3	1039	-127	ns	5.63	-0.63	ns	33.35	1.06	ns
Lv – M4	1173	8	ns	6.35	0.09	ns	32.75	0.46	ns
Lv – M5	1190	25	ns	6.62	0.37	ns	31.05	-1.24	ns
Lv – M6	1165	-0.15	ns	6.10	-0.16	ns	32.55	0.26	ns
Lv – M7	1051	-144	ns	6.09	-0.16	ns	32.50	0.21	ns
Lv – M8	1207	42	ns	6.38	0.13	ns	32.60	0.31	ns
Lv – M9	996	-169	0	5.58	-0.67	ns	32.25	-0.04	ns
Average	1165	0	Control	6.25	0	Control	32.29	0	Control
DL(p 5 %)		141			0.81			1.56	
DL (p 1%)		194			1.12			2.15	
DL (p 0.1 %)		267			1.54			2.96	
ANOVA (genotype)		***			*			ns	

CONCLUSIONS

Selection for the silique length plays an important role in the breeding program improving both the production and quality of mustard grains.

The number of branches is an important factor affecting seed production in mustard plants. Choosing the right genotype can optimize this parameter and increase yields.

The number of grains in mustard siliques is an important indicator of total production and its optimization can lead to increased yield and efficiency in mustard production.

The hectoliter weight of mustard seeds is a valid indicator of their quality and directly influences production through the impact on germination, plant vigor and final crop yield.

Selection and genetic improvement of plants can also contribute at the breeding processes by increasing grain weight and yield.

The existing variability within the analyzed germplasm and the existence of positive correlations hence the breeding program processes by identifying valuable progenitors.

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