RESEARCH ON THE VARIABILITY OF QUANTITATIVE AND QUALITATIVE TRAITS IN A POPULATION OF *RAPHANUS SATIVUS* L. VAR. *CAUDATUS* FOR BREEDING PUROPSES

CERCETĂRI PRIVIND VARIABILITATEA UNOR CARACTERE CANTITATIVE ŞI CALITATIVE ÎN CADRUL UNEI POPULAŢII DE *RAPHANUS SATIVUS* L. VAR. *CAUDATUS* ÎN SCOP DE AMELIORARE

OLTEAN Simona Laura, CORDEA Mirela, LUNG M. L., LAZAR M.
University of Agricultural Sciences and Veterinary Medicine
Cluj-Napoca, Romania

Abstract. *The study is done on several qualitative and quantitative traits of Raphanus sativus L. var. caudatus (rat-tail radish) to clarify the mechanisms of inheritance of these traits, for plant breeding purposes. Observations were perform on flower colour, presence/absence of anthocians on the stalks, color and length of the pods both in 2008 and 2009 using all the plants of this species obtained by sowing all the seeds obtained on open pollinated plants of the species population. The obtained data allowed the consideration of flower colour, presence/absence of anthocians on the stalk and pod color as alternative traits, while the length of pods presented a continuous variability characteristic for quantitative traits. Our results show that in the analyzed species the flower color, color of siliqua and the presence/absence of antocyans on stalks, as alternative characters, were inherited through Mendelian mechanisms while the length of siliqua proved to be a typical quantitative trait with a rather low heritability.*

Key words: *Raphanus sativus L.* var. *caudatus,* alternative/quantitative characters, segregation ratios.

Rezumat. *Studiul este făcut asupra unor caractere calitative şi cantitative ale speciei Raphanus sativus L. var caudatus menite să clarifice mecanismele de segregare a caracterelor în scop de ameliorare. Timp de doi ani, s-au făcut cercetări constând în observaţii şi intervenţii (autopolenizări) asupra plantelor din populaţia iniţială şi asupra plantelor aparţinând primei generaţii de consangvinizare. Caracterele urmărite au fost culoarea florilor, prezenţa sau absenţa antocianilor pe tulpini, culoarea şi lungimea silicvelor. S-au obţinut date care permit încadrarea modului de segregare a genelor, având ca punct de reper pentru culoarea florilor rezultatele cercetărilor făcute până în prezent asupra speciei înrudite, Raphanus sativus, şi recomandările literaturii de specialitate pentru celelalte caractere.Rezultatele obţinute arată că atât culoarea florii cât şi culoarea silicvei şi prezenţa/absenţa antocianilor pe tulpină sunt caractere alternative cu ereditate conform mecanismelor de segregare mendeliene în timp ce lungimea silicvei este un caracter cantitativ cu o ereditate slabă.*

Cuvinte cheie: *Raphanus sativus L.* var *caudatus,* caractere, segregare, culoarea florii

INTRODUCTION

In the contemporary period, due to globalization and the growing interest of people for a healthy diet, it is important to find new species with nutritional properties but also with high productivity and low requirements for environmental factors. *Raphanus* genus includes cultivated species worldwide, of which only two are known in Romania. Banga (1976) presented the history and evolution of four types of radishes grown today, as:

a. *Raphanus sativus* L. var. *radicula* (sin. *sativus*) - radish ;

b. *Raphanus sativus* L. var. *niger* - black radish;

c. *Raphanus sativus* L. var. *mougri* (sin. *caudatus*) - The rat-tail radish, which has a root rather unimportant as food, but it is grown as a vegetable in Southeast Asia for its edible foliage and pods used fresh, cooked or preserved;

d. *Raphanus sativus* L.var. D. *oleifera* – a radish type cultivated as fodder especially in northern Europe.

This paper tries clarifies some aspects of quantitative and qualitative inheritance of traits in a population of *R. sativus* L. var. *caudatus*. Analyses of these data are based on experimental results obtained in 2008 and 2009.

MATERIAL AND METHOD

Original material consists of a seed lot of *Raphanus sativus* L. var. *caudatus* purchased from India by a company representative of ALTozer Ltd, Cobham, United Kingdom. Examinations and measurements of the plants were made at the mentioned company. The qualitative characters analysed were the following: flower color, presence / absence anthocyans in pods and stem color, and of quantitative characters was observe only the pod length. To illustrate the consistency / deviation reports segregation obtained in the open-pollinated generation of theoretical reports expected under a particular model of action of genes, we used χ 2 test (Ardelean et al., 2007)

RESULTS AND DISCUSSIONS

Although specialized papers confirm the existence of four colors in the flowers of radish (Irwin et al., 2004, Strauss et al. 2004), we have identified only three colors: purple, pink and white. The yellow flowers, in the initial population, were missing.

The lack of yellow flowering plants could be explained by selection pressure that exerted when ruminants grazed the field where *Raphanus sativus* L. var. *caudatus* grew. According to data of Harder in 2006, the overwhelming majority of farm animals that feed on meadows with *Raphanus sativus* L. var.*caudatus* prefer plants with yellow flowers. This means that, as an allogamous plant, *Raphanus sativus* L. var. *caudatus* will be represented in the population especially by the other three colors and very seldom by the yellow colored flowers.

Adding to that the fact that the yellow flower is the double recessive homozygote (wwpp), it can be understood why in the population of *Raphanus sativus* L.var *caudatus* analyzed, the yellow color of the flower was missing.

Table 1

Types of flower color in *Raphanus sativus* L. var. *caudatus* plants observed in field to open-pollinated variety

Lot	Number of plants	Flower color			
		Purple	Pink	White	Yellow
1	55	28	14	13	0
2	53	19	19	15	0
3	55	41	12	2	0
4	52	20	8	24	0
5	56	38	6	12	0
TOTAL	**271**	**146**	**59**	**66**	**0**
Expected segregation 9:3:3:1		153	51	51	17
χ^2		11,6			
Comparison χ^2 for DF_3		11,6 > 7,8			

χ^2 for $P_{5\%}$ and DF_3 = 7,81

Data presented in table 1 correspond to the segregation model of open-pollinated populations for the four colors analyzed even if there were no yellow flowers. It is clear that most plants should have purple flowers (W_P_) because these genotypes takes 9:16 of the total segregants possible while plants with pink and white flowers represent only 3:16 of the total possible recombination.

Calculated value of χ^2, greater than the theoretical 11,6 for DF = 3 is very close to the lack of significance since the small deviation could be induced by the 17 plants with yellow flowers that ought to exist in the population and that in fact there were missing.

Pod length, analyzed in the open-pollinated population, is shown in table 2, according to four dimensions, taking into account the nature and objectives to obtain offspring with pods over 20 cm and between 6-7 cm.

In the initial population, we observed a high variability on the pod length (6.9 ÷ 16.1 cm). The data presented in table 2 reveals that large and very large pods were most frequently presents on the plants.

Of the 271 plants analyzed, 232 had pods with length over 11 cm. This means that in this population of *Raphanus sativus* L. var *caudatus*, long and very long dimensions of pods are very likely determined more by the effects of dominance of polygenes and less by the additive effects.

Table 2

Pod length (cm) of open-pollinated plants of *Raphanus sativus* L. var. *caudatus* observed in field

Lot	Number of plants	Pod length (cm)			
		≤7	7÷10	11÷15	≥16
1	55	1	9	40	23
2	53	0	7	33	7
3	55	1	10	34	15
4	52	0	4	24	4
5	56	0	7	52	0
TOTAL	**271**	**2**	**37**	**183**	**49**

The presence of anthocyanins in plant stems of open pollinated variety is a trait that affects less the pods and seed quality but more the quality of fodder obtained.

Table 3

Presence/absence of anthocyanin on stem pollinated plants of *Raphanus sativus* L. var. *caudatus* observed field

Lot	Number of plants	Anthocyanins on the stem	
		Absent	Present
1	55	13	31
2	53	12	51
3	55	21	45
4	52	22	22
5	56	16	38
Total	**271**	**84**	**187**
Expected segregation 3:1		68	203
χ^2		2,52	
Comparison with χ^2 for DF_1		2,52 < 3,84	

χ^2 for $P_{5\%}$ and $DF_1 = 3,84$

Generally, most authors who have dealt with this problem (Harder, 2006; Irwin et al., 2004; Strauss et al., 2004) agree that plants with anthocyanin stems are less preferred by the ruminants, probably because of the astringent taste given by the compounds containing of anthocyanins.

The ratio of segregation observed for the presence/absence of anthocyans on the stems in the original population, suggest that, this is a qualitative trait

determined by a single major gene that is dominant for the presence of anthocyanin over the absence of it.

In table 3, it is noted that the population of open pollinated plants with stem with anthocyanins predominated over the green stem, report being very close to 3:1 segregation. The value of χ 2 calculated is less than the theoretical value for P = 5%, which shows that the actual distribution of color classes is identical to the theoretical one.

The pod color is a qualitative trait determined by a single major gene that is dominant for the green pods over the purple pods. Pod color is more important in esthetic terms. Although the taste is sourer due to the presence of anthocyans, purple pods have a more attractive appearance.

Table 4

Color of pod to open-pollinated plants of *Rapanhus sativus* L. var. *caudatus* observed in field

Lot	Number of plants	Pod Color	
		Purple	Green
1	55	13	51
2	53	12	44
3	55	17	38
4	52	10	47
5	56	6	33
TOTAL	**271**	**58**	**213**
Expected segregation 3:1		68	203
χ^2		1,96	
Comparison with χ^2 for DF_1		1,96<3,87	

χ 2 for $P_{5\%}$ and DF_1 = 3,84

The presence of anthocyanins on the stem is not correlated with their presence on the pods. In table 4, there can be seen that the plants with green pods prevailed in the initial population, giving a segregation ratio very close to 3:1. The computed of χ^2, value is less than the theoretical value for P = 5% and DF = 3, which shows that the observed color distribution is identical to the theoretical one for the pods color.

CONCLUSIONS

1. The plants with yellow flowers did not occur in the initial population that we analyzed. Regarding the accurate assessment of color flower is recommended to be done in inbreeding generations and to use a color spectrum analyzer to avoid any doubt on the intensity of petal color.

2. Regarding the length, of pods, the initial population had a large variability. From the 271 plants analyzed, the majority were with pods size over 11 cm, which shows that this trait is determined more by the effects of dominance of polygenes and less by the additive effects.

3. According to the segregation ratio of the presence/absence of anthocyanins on the stem, we concluded that this is an alternative character determined by a single major gene, where the presence of the anthocyanin is dominant over its absence.

4. A single major gene determines pod color, which interested both aesthetically and qualitatively, that this time, green is dominant over purple color. The rate of segregation of this character in the initial population is 3:1, identical with the expected segregation ratio

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