STUDY OF SOME YIELD COMPONENTS IN DIFFERENT CULTIVARS OF STRAWBERRY

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Abstract. *The yield ability in strawberries is a very complex trait that relies on the influence and contribution of several components. Those components must be combined so as to ensure higher levels of yield and a high amount of marketable fruits. The studied biological material was represented by eight varieties with different ecological and genetic origin, which were analyzed in terms of: number of flowers and fruits number per plant, the percentage of ripening fruit, average fruit weight and yield per plant. The most pronounced differences between genotypes were recorded for fruit weight and number of flowers/plant, while in terms of the percentage of fruit ripening the studied cultivars showed similar and statistically undifferentiated values. Taking into account the inter-populations variability for the studied traits, depending on the way they are combined, can be selected cultivars with contrasting traits, in order to use them as genitors. Onda variety has the highest values of plant yield, number of flowers and number of fruits, associated with an average weight of the fruit. Depending on the yield components in different studied cultivars, in order to obtain an efficient yield, technological measures must be taken to foster the development of the traits with higher contributions to the achievement of plant yield.*

Key words: *strawberry, yield components, fruit traits.*

INTRODUCTION

Fragaria × *ananassa* (Duch.) is a natural hybrid of the South American *Fragaria chiloensis* (L.) and the North American *Fragaria virginiana* (Duch.). This intermingling of genetic characteristics has resulted in a fruit of great variety in size, shape, taste and color [9]. Strawberry is one of most popular, nutritious and lovely looking fruits in the world. The production and consumption of strawberry is increasing because of its food value and other importance [1].

Strawberry fruit is beneficial for human's health and cultivated for its juicy, red, succulent fruit nature which can be consumed fresh, frozen, added to dairy products and foods [3; 4; 7]. In present, strawberry comprises about 500 commercial cultivars grown worldwide [5; 8].

The yield ability in strawberries is a very complex trait that relies on the influence and contribution of several components. Those components must be combined so as to ensure higher levels of yield and a high amount of marketable fruits.

The objective of this study was to evaluate some yield components in different strawberry cultivars in order to establish their yield potential and the possibility of using them as genitors in breeding programs

MATERIAL AND METHODS

The studied biological material was represented by eight strawberry genotypes with different genetic and ecological origin: A1 (Romania); A2 (Romania), Alba (Italy), Clery (Italy), Marmolada (Italy), Mira (Canada), Onda (Italy), Elsanta (Netherlands). The genotypes in question were studied in a randomized blocks design with four replications on plots of three rows with 25 plants (75 plants per plot) grown at distances of 1m x 0.20 m. The experiment has been located in Topolavatu-Mare on an alluvial soil.

The plants in the experiment were in the second (2014) and third year of fruiting (2015). During the growing season the classic technological steps were applied (for organic farming) represented by the following measures: weed control and soil loosening by manually tilling between the plants and mechanized cultivation between rows, applying straw mulch, removal of runners during fructification, manual weeding, foliar calcium application (prevention of mildew). The crop was not irrigated and no chemical fertilizers were applied.

From each replication-plot were selected ten representative plants from the middle row. At these plants were carried out measurements relating to: number of flowers (FLN) and fruits number per plant (FRN), the percentage of ripening fruit (FRP), average fruit weight (FW) and yield per plant (PY).

Data were statistically analyzed using analysis of variance and least significant difference test [2]. The significance of differences was expressed based on letters, being considered as significant the differences between variants marked with different letters. To make possible the display in a single graph of the performance of each genotype for each of the five traits, the basic principle of the biplot technique developed by Gabriel (1971) and GGE biplot method developed by Yan et. al. (2000) was used.

RESULTS AND DISCUSSIONS

For most of the studied yield traits, from the ANOVA it appears that there are real and statistically ensured differences among the eight genotypes. Regarding the percentage of fruit ripening the studied cultivars showed similar values and significantly undifferentiated (Tab. 1). The most pronounced differences between genotypes were recorded for fruit weight and number of flowers per plant, respectively. The variability of the studied yield traits was not significantly influenced by the effect of replications.

Table 1.

Analysis of variance for some yield components in strawberry cultivars

Variation sources	DF	MS	F	Variation sources	DF	MS	F
Flowers number/plant				Fruit weight			
Replications	3	71.95	0.96	Replications	3	0.33	0.51
Cultivars	7	540.35	7.22**	Cultivars	7	10.49	16.15**
Error	21	74.85		Error	21	0.65	
Fruits number/plant				Plant yield.			
Replications	3	51.00		Replications	3	5708	0.79
Cultivars	7	251.43	0.99	Cultivars	7	37667	5.21**
Error	21	51.17	4.91**	Error	21	7223	
Fruits ripening percent							
Replications	3	58.88	0.62				
Cultivars	7	110.91	1.16				
Error	21	95.33					

Number of flowers per plant registered variation amplitude of 36.25, with a range from 25.75 for A2 to 62.00 for Elsanta, associated with a very high inter-genotypic variability (37.07%). Based on the multiple comparisons between cultivars it was found that the number of flowers in Onda was significantly superior to other cultivars, with relative increases of over 64%. Even if the other genotypes were not significantly differentiated in terms of this trait, they can be grouped into two classes, namely: Elsanta, Mira, Clery and Alba with 36 to 37.75 flowers/plant and respectively A1, Marmolada and A2 with 25.75 to 28 fruit/plant. The highest uniformity of this trait was found in varieties Clery and Mira while genotype A1 and cultivar Onda manifested high inter-individual variability.

Table 2

Mean values of flowers and fruit number, and fruits ripening percent in strawberry cultivars

No	Cultivar	Flowers number/pl		Fruits number/pl		Fruits ripening percent	
		$\bar{x} \pm s_{\bar{x}}$	s %	$\bar{x} \pm s_{\bar{x}}$	s %	$\bar{x} \pm s_{\bar{x}}$	s %
1	A1	28.25±5.12b	36.26	22.40±3.13bc	3.48	81.36±6.44ab	15.84
2	A2	25.75±1.18b	9.18	22.46±1.48bc	0.88	87.02±2.12a	4.87
3	Alba	36.25±4.48b	24.71	30.16±3.36b	2.03	83.79±2.18ab	5.20
4	Clery	36.00±0.71b	3.93	29.53±2.89bc	1.35	81.98±7.57ab	18.46
5	Marmolada	26.00±1.47b	11.32	19.36±1.59c	0.58	74.20±2.80ab	7.54
6	Mira	37.75±1.55b	8.20	31.93±3.46b	4.77	84.05±5.95ab	14.16
7	Onda	62.00±9.55a	30.80	44.80±7.58a	1.45	71.44±2.86b	8.02
8	Elsanta	37.25±2.25b	12.08	29.80±1.25bc	0.90	80.69±4.84ab	12.00
	Mean	36.16±2.37	37.07	28.80±1.74	34.26	80.57±1.73	12.12
	$LSD_{5\%}$	12.72		10.52		14.36	
	$LSD_{1\%}$	17.32		14.32		19.55	
	$LSD_{0.1\%}$	23.37		19.32		26.37	

Regarding the number of mature fruits per plant the studied cultivars showed an amplitude variation between 25.44 and 19.36 in Onda to 44.80 in Marmolada, associated with an inter-genotypic variability of 34.26%. As such, the plants of Onda cultivar have achieved a number of fruit significantly higher than other varieties. The number of harvested fruits in Alba and Mira varieties was significantly superior to that of Marmolada variety. In general, there is a high uniformity for the number of fruits between the plants of each cultivar, particularly in Marmolada, A2 and Elsanta.

In terms of fruits ripening percentage the studied cultivars presented values between 71.44 in Onda and 87.02 in A2, associated with a inter-genotypic variability (12.12%) lower than in the other traits. Thus, cultivar A2 stood out, registering a value of this trait significantly higher than the Onda variety, while the rest of the genotypes were not significantly differentiated for the ripening of fruit. The highest intra-population variability was recorded in Clery and A1 cultivars, while for the plants of A2 and Onda a very high uniformity of this character was observed.

Table 3

Mean values of fruit weight and plant yield in strawberry cultivars

No	Cultivar	Fruit weight (g)		Plant yield (g)	
		$\bar{x} \pm s_{\bar{x}}$	s %	$\bar{x} \pm s_{\bar{x}}$	s %
1	A1	8.00±0.31e	7.86	180.32±27.79c	30.82
2	A2	12.66±0.43a	6.86	282.39±8.69bc	6.15
3	Alba	11.51±0.09ab	1.61	347.22±38.70b	22.29
4	Clery	9.09±0.13de	2.79	268.80±28.52bc	21.22
5	Marmolada	9.97±0.44cd	8.73	193.00±18.07c	18.73
6	Mira	11.31±0.61b	10.73	366.23±56.98ab	31.12
7	Onda	10.49±0.42bc	8.05	473.10±84.54a	35.74
8	Elsanta	8.42±0.41	9.81	250.53±13.71bc	10.95
	Mean	10.18±0.30	16.56	295.20±20.88	40.01
	$LSD_{5\%}$	1.18		125.0	
	$LSD_{1\%}$	1..61		170.2	
	$LSD_{0.1\%}$	2.18		229.5	

In terms of fruit weight, the studied cultivars presented values ranging from 8 g in A1to 12.66 g in A2, due to a medium inter-genotypic variability of 16.56%. Thus, cultivar A2 particularly stood out, registering an average fruit weight that was significantly superior to other varieties except Alba, who in his turn presented fruit significantly bigger than A1, Clery

and Marmolada. The highest intra-population variability was recorded for Mira's fruits, while Clery and Alba's fruits showed a very high uniformity for this trait.

The yield per plant registered an amplitude variation of 292.78 g, with the range from 473.10 g for Onda up to 180.32 g for A1, associated with a very high inter-genotypic variability (40.01%) and superior to the traits presented above. Based on the multiple comparisons it was found that the plants of Onda variety achieved yields significantly higher to most other genotypes (with the exception of Mira), with relative gains of over 68%. Mira recorded significantly increases of yield than A1 and Marmolada. The greater uniformity for this trait was observed in A2' plants while the Elsanta, Mira and Onda cultivars showed high inter-individual variability.

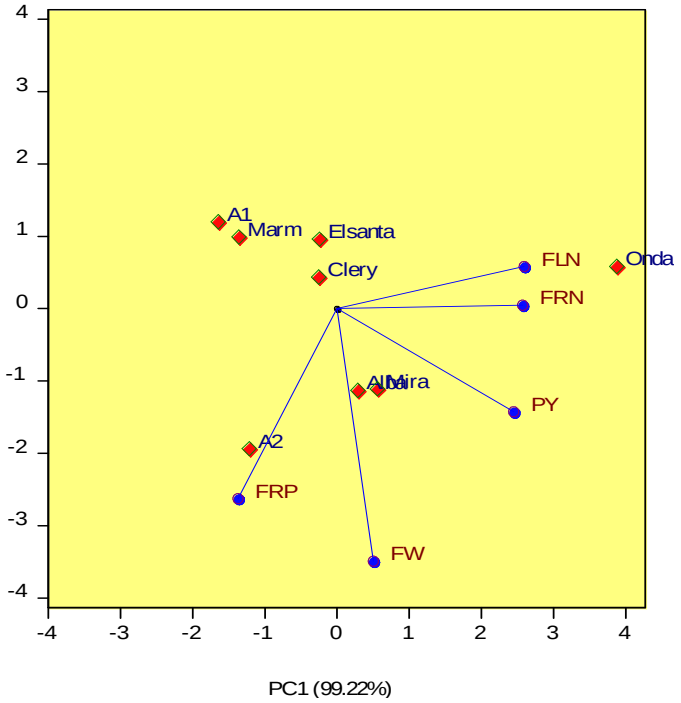

Fig. 1. Biplot for some yield components in the eight strawberry cultivars

The biplot achieved by the first two principal components express almost the entire variability of the yields traits (99.88%) between the eight strawberries cultivars. Given the genotypes performance, expressed based on their position from the vectors of various traits, it was observed that Onda variety has the highest yield/plant, number of flowers and number of fruit values, associated with an average weight of the fruit.

The above average yields of Alba, A2 and Mira's are due to higher values for fruit weight and a high percentage of fruits maturing, associated with average values for the number of flowers and fruit per plant. A1, Marmolada, Elsanta and Clery genotypes had a low potential of plant yield, registering lower levels for its components.

CONCLUSIONS

1. The most pronounced differences between genotypes were recorded for fruit weight and number of flowers/plant, while in terms of the percentage of fruit ripening the studied cultivars showed similar and statistically undifferentiated values.

2. Taking into account the inter-populations variability for the studied traits, depending on the way they are combined, can be selected cultivars with contrasting traits, in order to use them as genitors.

3. Onda variety has the highest values of plant yield, number of flowers and number of fruits, associated with an average weight of the fruit.

4. The above average yields of Alba, A2 and Mira cultivars, are due to higher values for fruit weight and a high maturing percentage, associated with average values for the number of flowers and fruits /plant.

5. Depending on the yield components in different studied cultivars, in order to obtain an efficient yield, technological measures must be taken to foster the development of the traits with higher contributions to the achievement of plant yield.

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