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THE FLOWERING AND POLLINATION STUDY ON OLIVE VARIETY ARBEQUINA GROWN IN MONTENEGRO CONDITIONS

SUMMARY

Arbequina, Spanish olive variety was introduced in Montenegro in the last decade. With small tree size, tolerant to low temperatures and self pollinated, Arbequina was well accepted by olive growers. New plantations were established in several locations on the Coast and in the area of Podgorica. Since there was no previous study of this variety in our ecological condition we set an aim to investigate its flowering and pollination ability. During two years (2014-2015) at two locations (Ulcinj and Podgorica) characteristics of flowering and yield potential were studied. The date and duration of flowering as well as the degree of flowering were assessed. Isolation of the branches with inflorescences for self- pollination was performed before flowering. At the same time branches were labelled for open pollination. Before bagging the number of inflorescences was counted. The structure of inflorescences was analyzed, counted the number of flowers and the number of perfect flowers. Flowering was lasting 12-13 days on both locations. Fruit set in open pollination was 1.45% in average and in self pollination plot 0.1%, respectively.

Keywords: *self pollination, open pollination, monovarietal orchards, inflorescence, self sterile, fruit set*

INTRODUCTION

Montenegro is a country with a small agricultural surface. In the relief structure dominates mountainous and hilly regions. Along the Montenegrin coast where are the traditional olive groves prevail slope areas at the foot of the Orjen, Lovcen and Rumija mountains. Of the total agricultural land in Montenegro, only 15% are flat surfaces (Markovic *et al.*, 2010). Available areas for new plantations are mainly on the coast in the vicinity of cities Ulcinj, Budva and Tivat, in terms of areas suitable for olive cultivation and in the hinterland around Podgorica. The area of Podgorica is exposed to appearance of excessively low temperatures and therefore risky for olive production. For this reason, and also the reasons of limited surface, it was necessary to choose a variety that is tolerant to low temperatures and with lower requirements in terms of living space.

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Popularity of growing olive trees in the intensive system of high density planting is resulted with increased interest of olive growers in planting variety Arbequina, to better utilize the existing relatively small areas. The variety Arbequina is represented worldwide in intensive plantations. Recommended as a variety of low vigour, early entry to the productive period, self fertile with high and regular yield, with high oil content in the fruit, which is of good quality. The first orchard of high density with this variety was planted in 2006 in the area of Podgorica, and since 2010 at several locations in the area of Podgorica and on the coastal area, mainly in monovarietal plantings. Spreading of Arbequina variety has continued in the area of Ulcinj in 2011 and 2012.

The aim of this study was to investigate the capacity or yield potential of Arbequina olive variety that is new in Montenegro and predominantly grown in monovarietal plantings.

MATERIALS AND METHODS

The trial was set up in olive orchards in two areas, the hinterland around Podgorica, where Arbequina variety was grown with other olive varieties, and on the coast in the vicinity of Ulcinj in more or less isolated monovarietal orchards. Studies were carried out in the period 2014-2015 year. At each of the two areas ten trees were marked. The following parameters were observed: the degree of flowering, determined on the basis of the presence of floral elements in relation to the crown (1-5); the duration of flowering, number of days from the beginning (5% open flowers) and the end of flowering (95% fallen flower petals); inflorescence length was measured on a sample of 40 inflorescences taken from the middle part of the annual twigs from all over the crown at the man height, according to the descriptor for the olive (Barranco *et al.*, 2000); number of flowers were counted in the inflorescence and the presence of imperfect flowers.

For the pollination trial, at each site five trees were selected for self-pollination (SP) and for free/open pollination (OP). For SP branches with inflorescences were isolated when the flowers were at the stage of the balloon; open flowers were manually removed. Flowering branches were isolated with paper bags. In all branches marked the number of inflorescences for self-pollination and open pollination were counted. Removal of the bags and counting of fruit set in self-pollination was carried out 45 days after the end of flowering. Based on the number of fruit set it was assessed the percentage of fruit set in relation to the number of inflorescences and the number of flowers.

The obtained results were statistically processed by analysis of variance (ANOVA), and the difference testing was performed by LSD test 0.05.

RESULTS AND DISCUSSION

In this study, over two years period (2014-2015), blossom characteristics, the ability to self-pollination and potential fruit set in open pollination in a variety Arbequina were studied.

Flowering and inflorescence characteristics

Flowering of Arbequina variety (Table 1) took place in the second half of May, almost simultaneously on both research sites, and lasted in average for 13 days, one day longer in the area of Ulcinj. The degree of flowering, however, differed significantly between the two areas (for 42%) and was higher in the area of Ulcinj, or in average 3.8.

Period of flowering in Arbequina in Podgorica coincides with the blooming of other foreign varieties, eg. Leccino variety flowered from 20-29.05. in average (unpublished data), with 3 days delay when compared to the coastal area of Bar (Lazovic *et al.*, 2004), and also lasts two days longer. Also, the indigenous variety Zutica, which predominates on the coast specifically in the area of Ulcinj, and the most potential pollinator for variety Arbequina, flowered in period from 19-31. May or in average of 12 days (Miranović, 1976) and possibly 1-5 days earlier (Lazovic, 2000; Lazovic and Adakalic, 2012).

Generally speaking, Arbequina variety shows uniform characteristics of flowering period on both studied areas. The same can be said for the structure of inflorescence (Table 1), the capacity to produce fruit or the potential for satisfactory fruit set in productive plantations, respectively. Inflorescence length was significantly higher in the area of Ulcinj (3.04 cm). Number of flowers in inflorescence was in average 17.80, and slightly, but not significantly higher (about 4%) in the area of Ulcinj. Number of flowers in Arbequina variety is much higher than in the domestic variety Zutica (Lazovic, 2000), as well as in Spanish variety Cornicabra (Rojo *et al.*, 2015) and some other Spanish and Italian varieties (Ferrara *et al.*, 2007; Aguilera and Ruiz, 2012), including Arbequina (13.4 flower/inflorescence) in conditions of Puglia, Italy (Ferrara *et al.*, 2007). This implies a greater capacity for fruit set in Ulcinj. However, this advantage is reduced in Arbequina in the area of Ulcinj due to higher number of imperfect flowers which was about 18% higher than in the area of Podgorica.

Table 1: Flowering and inflorescence characteristics of Arbequina variety in Montenegro (2014-2015)

Locality	Flowering			Degree of flower.	Flower. lasting (days)	Inflorescence characteristics		
	Begin.	Full	End			Length (cm)	No. of flowers	Imperfect flowers (%)
Podgorica	19.05.a ^(q)	23.05.a	31.05.a	2.8b	13a	2.58b	17.42a	16.97a
Ulcinj	19.05.a	24.05.a	30.05.a	4.8a	12a	3.04a	18.17a	20.44a
<i>p</i> -value ^(r)	0.4112ns	0.5021ns	0.0501ns	0.0000**	0.3784ns	0.0228**	0.5204ns	0.1667ns
LSD _{0.05}	1.4420	1.1784	1.2381	0.3508	1.1205	0.1404	0.8611	3.7911

^(q) Values of traits marked with different letter in same column are statistically significant on the level $p < 0.05$ (LSD test)

^(r) *p*-values are highly significant (**), significant (*) or not significant (ns)

Inflorescence length, number of flowers and number of imperfect flowers in Arbequina variety is slightly above the value characteristic for autochthonous variety Zutica (Lazovic, 2000; Lazovic and Adakalic, 2012), and is well above

the value for the variety Leccino in Podgorica (unpublished data), or data for the variety Arbequina and Leccino in the area of Puglia, Italy (Ferrara *et al.*, 2007). This indicates that the productive potential of Arbequina varieties is satisfactory for good yields, to which contributes the relatively low level of imperfect flowers. However, the amount of fruit per tree is not dependent on the percent of male flowers, as only 1-3 flowers per inflorescence set fruit (Lavee, 2007). Although, the olive pollen production is influenced by weather conditions, regulated at first by temperature, water availability and solar radiation (Rojo *et al.*, 2015).

The fruit set

Fruit set in self and open pollination (Table 2 and 3) was observed at the studied sites in the two years of research. For about one third more flowers were marked for open pollination in the area of Ulcinj, and just above the number for self-pollination in the area of Podgorica. All data obtained were statistically highly significant.

Open pollination

Around 20% more inflorescences were marked for OP (Table 2) in the area of Ulcinj, or about 33% more flowers. However, the number of fruit set was significantly higher in Podgorica (1585) in relation to the area of Ulcinj (1214). Percentage of fruit set in relation to the isolated inflorescence was higher in Podgorica area (32.45%) as well as in relation to the number of isolated flowers (1.86%). According to the findings of Moutier (2002), fruit set below 33% compared to the number of inflorescences in hybridization represents the presence of the pollen of poor pollinators. On the other hand, the number of fruit set of 1-3%, compared to the number of flowers can be regarded as sufficient for a quality yield (Lavee, 2007), what we have recorded in the area of Podgorica.

Table 2: Fruit set of Arbequina variety in open pollination in Montenegro (2014-2015)

Locality	No. of isolated inflorescences	No. of isolated flowers	No. of fruit set	% of fruit set in relation to number of inflorescence	% of fruit set in relation to the number of flowers
Podgorica	4884 b ^(q)	85079.3 b	1585 a	32.45 a	1.86 a
Ulcinj	6081 a	110491.8 a	1214 b	19.96 b	1.10 b
<i>p</i> -value ^(r)	0.0065**	0.0047**	0.0007**	0.0039**	0.0033**
LSD _{0.05}	471.42	8317.9	44.142	3.6637	0.2041

^(q) Values of traits marked with different letter in same column are statistically significant on the level $p < 0.05$ (LSD test)

^(r) *p*-values are highly significant (**), significant (*) or not significant (ns)

Higher number of fruit set in the OP in area of Podgorica could be due to better pollination in the plantation with mix of varieties (11 varieties), suggesting

presence of suitable pollinator. However, the topic of possible pollinators for varieties Arbequina in Montenegro needs further consideration and research.

Self pollination

From a total of 14,695 inflorescences, or approximately 261,916 flowers isolated on both studied areas for self pollination of Arbequina variety (Table 3), a total of 273 fruit was registered, almost equally to both studied areas (144 and 124), which is an average of 0.11% in relation to the number of flowers.

About 1,100 inflorescences or about 25,352 flowers were more isolated in the area of Ulcinj. However, the number of fruit set was 18% higher in the area of Podgorica. The percentage of fruit set in relation to the number of inflorescences and of isolated flowers was 2.12% and 0.12% respectively.

Table 3: Fruit set of Arbequina variety in self-pollination trial in Montenegro (2014-2015)

Locality	No. of isolated inflorescences	No. of isolated flowers	No. of fruit set	% of fruit set in relation to no. of inflorescence	% of fruit set in relation to the no. of flowers
Podgorica	6790 b ^(q)	118281.8 b	144 a	2.12 a	0.12 a
Ulcinj	7905 a	143633.9 a	124 b	1.57 b	0.09 b
<i>p</i> -value ^(r)	0.0070**	0.0044**	0.0136**	0.0114**	0.0299**
LSD _{0.05}	456.04	8011.8	12.170	0.2989	0.0304

^(q) Values of traits marked with different letter in same column are statistically significant on the level $p < 0.05$ (LSD test)

^(r) *p*-values are highly significant (**), significant (*) or not significant (ns)

The reason for the appearance of the fruit set in the SP may be the presence of airborne pollen or pollen already present on the branches and inflorescences before bagging (Diaz de la Guardia *et al.*, 2003; Rojo *et al.*, 2015).

However, the results indicate almost complete incompatibility of varieties Arbequina in monovarietal plantings. Similar results were obtained in earlier research (Moutier, 2002; Diaz *et al.*, 2006; Marchese *et al.*, 2016).

Influence of the study year

In 2014, the colder weather (data not shown) with the rain during flowering (Table 1), especially evident in the area of Podgorica resulted with significantly lower fruit set per inflorescence compared to the area of Ulcinj (67.9%) (Table 4). In addition, in the area of Ulcinj where monovarietal plantations of Arbequina are situated, the presence of pollen from traditional varieties in the vicinity is assumed to have contributed to a better fruit set. In 2015, lack of flowering in traditional varieties in Ulcinj area, resulted with lower fruit set in comparison to the area of Podgorica.

The fruit set in 2015 in area of Podgorica was above 33% of isolated inflorescences that indicates possible presence of partially good pollinators (Moutier, 2002) among varieties in the mixed plantation.

Table 4: Percentage of the fruit set under open and self pollination of Arbequina in Montenegro during two years

Locality (A)	Year (B)	Open		Self	
		Fruits per inflor. (%)	Fruits per flower (%)	Fruits per inflor. (%)	Fruits per flower (%)
Podgorica	2014	17.25 c ^(q)	0.99 b	0.17 bc	0.01 c
	2015	37.7 b	2.16 a	2.88 a	0.15 a
Ulcinj	2014	67.9 a	3.77 a	2.84 ab	0.15 ab
	2015	12.36 c	0.72 b	0.10 c	0.05 bc
<i>p</i> -value ^(r) (A x B)		0.0002**	0.0110**	0.0120**	0.0106**
LSD _{0,05}		11.865	2.4489	2.6233	0.1476

^(q) Values of traits marked with different letter in same column are statistically significant on the level $p < 0.05$ (LSD test)

^(r) *p*-values are highly significant (**), significant (*) or not significant (ns) for AxB

Further studies on pollination in Arbequina variety in Montenegro is necessary moreover because the varieties mentioned in the previous studies as potential pollinators for Arbequina (Moutier, 2002; Diaz *et al.*, 2006; Marchese *et al.*, 2016) are not grown in Montenegro.

CONCLUSION

Olive variety Arbequina shows uniform characteristics of flowering period on both studied areas. However, our study showed that Arbequina variety is not self fertile, inducing a high concern for the productivity of single variety orchards. The research should be continued towards study on the acceptable pollinators for this variety in Montenegro.

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