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Research

Economic Assessment of Scab-Resistant Apple Cultivars in Bulgaria

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Abstract: *The study was carried out during 2015-2018 in an apple plantation established in the spring of 2007 at the Institute of Agriculture - Kyustendil (Bulgaria) with fifteen scab resistant apple cultivars (nine foreign and six new Bulgarian), grafted on MM 106 rootstock. The tree productivity, fruit quality and economic indicators - management costs (euro ha⁻¹), gross output (euro ha⁻¹), net incomes (euro ha⁻¹), rate of profitability (%) and prime cost (euro t⁻¹) were established. The result showed that the most productive were cultivars Teser T219, Marlana, Siyana and Gorana - with cumulative yield between 99.3 and 122.4 kg tree⁻¹. The values of the economic indicators were influenced by the quantity and quality of the fruit and the production costs. Teser T219, Siyana, Marlana, Gorana, Florina and Besapara were the most effective cultivars from the economic point of view, with a rate of profitability above 180%.*

Keywords: yield, gross output, net incomes, rate of profitability, prime cost

Introduction

Although apples are predominantly cultivated in temperate zones, they adapt exceedingly well to different climatic conditions, which is why they are one of the world's most widely grown fruit species. Their perennial lifecycle facilitates their long-term exposure to potential accumulation, development, and mutation of pathogens. Therefore, the production of high-quality apple fruits requires increasingly more effort and costs incurred over the years. Moreover, the sustainability of conventional apple production systems have been increasingly raising concerns fostering a demand for chemical-free apple production at lower production costs, as well as lesser reliance on non-renewable resources, disturbance of biodiversity, water contamination, and soil degradation. Hence, a sustainable apple orchard is to generate acceptable yield, be profitable, and ensure sound environmental protection, resource conservation, socially responsible management (Reganold et al., 2001).

An alternative solution for adequate diseases control in apples is the cultivation of resistant cultivars, requiring much fewer fungicide applications, but such cultivars are still somewhat reluctantly accepted in large commercial orchards due to the potentially perceived inferiority in terms of fruit quality and economic performance (Büttner et al. 2000; Fischer, 2000; Fischer and Fischer, 2004;). That is why, in the last 1-2 decades, extensive research has been conducted on selection of resistant apple cultivars and their use in alternative production systems, aimed at the sustainable, environmentally friendly, and economically sound provision of appreciable and regular yields of high-quality fruits (Reganold et al., 2001; Beers et al., 2003; Grove et al., 2003; Norelli et al., 2003; Sandskar and Gustafsson, 2004; Cesa et al., 2006; Peil et al., 2008;). Meanwhile, apple production is considered to have high energy and cost inputs necessary for the commercial production of high-quality fruits with sizeable yields (Mouron et al., 2006; Akdemir et al., 2012).

The aim of this study was to perform a comparative economic assessment of scab resistant apple cultivars, grown under the conditions of Kyustendil region, Bulgaria.

Materials and Methods

The experimental orchard, which involved nine foreign and six new Bulgarian scab-resistant apple cultivars (Marlena, Besapara, Gorana, Martinika, Elegia and Siyana), was established in the spring of 2007. The trees were grafted on MM 106 rootstock, and planted at a distance of 4.5 x 2.5 m (890 trees ha⁻¹). Each cultivar was represented with five trees and each individual tree was treated as a repetition. The well-known and popular cultivar Florina was included in the evaluation as a control. The trees were trained as free-growing leader form. Growing - fertilizing, irrigation, pest, disease and weed control, pruning, and other care of the trees were maintained as recommended for commercial apple orchards.

Evaluation and characterization of the studied cultivars was performed in 2015-2018. Trees productivity and fruit quality were estimated in accordance with National Methodology for the study of plant resources in fruit plants (Nedev et al., 1979).

The yearly recorded parameters included average and cumulative yield (kg tree⁻¹) and fruit dimensions (mm) of 30 fruit from each experimental tree. Based on fruits diameter was determined their quality and they were separated into three classes – class ‘Extra’ (>65 mm), class I (55-65 mm) and class II (50-55 mm) in %.

The economic analysis was based on yield data and the fruit quality of each cultivar, management costs for mechanized and manual labor, and the materials needed. The production value was evaluated by realization prices. The calculation of the materials used

was done according to their prices in individual years. The production cost (euro/ha), gross output (euro/ha), net income (euro/ha), rate of profitability (%) and prime cost (euro t⁻¹) were calculated.

The significance of the differences between the variants was determined using the Duncan's test at level $p \leq 0.05\%$.

Results and Discussion

In the spring of 2017 significantly decrease in air temperatures were recorded on 22, 24 and 25 April, respectively -5°, -6° and -5°C at 2 m above the ground, for 3 to 5 hours. During this period the apple trees were in the end of blooming and these late spring frosts completely compromised the harvest of all cultivars

Over the remaining three years (2015, 2016 and 2018), the yield of studied cultivars was regular, relatively good and relatively constant, which is normal for apple trees in the period of full fruiting (9th -12th year). Only in Rubinola in 2016 an unsatisfactory yield was obtained (8.5 kg tree⁻¹). The highest average and cumulative yield per tree (40.8 kg, respectively. 122.4 kg) was harvested from trees of Teser T219 (Figure 1). The second most productive cultivar was Marlana, followed by Siyana and Gorana). Retina and Rubinola proved to be the least productive cultivars. The other cultivars were not significantly different from Florina, in term of their productive performance - the cumulative yield ranged between 80.2 - 90.6 kg tree⁻¹.

The diameter of the fruit is an important indicator when determining their quality. According to an Ordinance No 108/2006 of the Ministry of Agriculture and Food (Bulgaria), the fruits are classified into three classes - class of 'Extra' with a diameter over 65 mm, Class I - from 60 to 65 mm, and Class II - 55-60 mm.

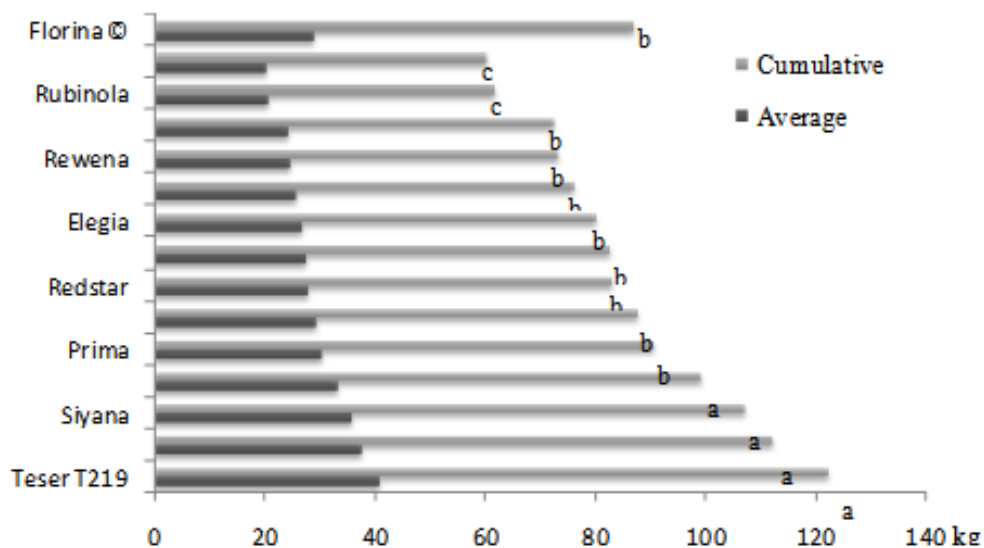


Figure 1. Cumulative and average yield of apple cultivars (kg tree⁻¹)

Distribution of fruit to classes according to diameter established that Teser T219, Florina, Redstar, Retina, Rubinola and Besapara produced fruit the highest class ('Extra') - over 90% of the fruit, average for the studied period (Table 1). Cultivars Martinika, Prima and Elegia have formed the highest percentage fruit of class I. The quantity of fruit in class II was not essential - between 4 and 23%, and for substantial part of the cultivars even lacked such fruit.

Table 1. Distribution of fruit to classes according to their diameter (%), average for 2015-2018.

Cultivar	Class 'Extra', > 65mm	Class I, 60-65 mm	Class II, 55-60 mm
Reglindis	85	15	-
Retina	92	8	-
Rewena	52	34	14
Rubinola	92	8	-
Redstar	93	7	-
Topaz	84	10	6
Teser T219	98	2	-
Marlena	62	20	18
Besapara	91	9	-
Gorana	72	24	4
Martinika	12	78	10
Elegia	22	63	15
Siyana	75	25	-
Prima	12	65	23
Florina	96	4	12

The values of the economic indicators were influenced by the average yield per trees, respectively per unit plantation area, fruit quality and the production costs. The average annual management costs (for materials, for mechanization and workers costs) for the studied cultivars varied from 3003.92 euro/ha for Retina to 3339.35 euro/ha for Teser T219 (Figure2).

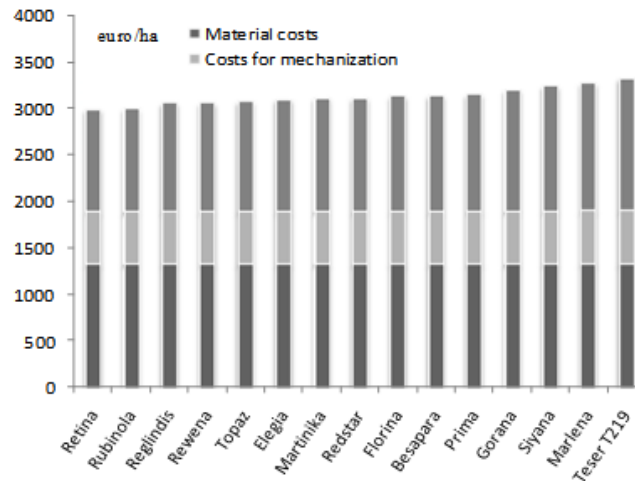


Figure 2. Management costs (euro/ha).

The analysis of the management cost structure showed that the cost of materials was greater than those for mechanization and workers costs (Fig. 2). The differences among cultivars are determined by the quantity of the yields and the related harvesting costs. Higher costs were established for Teser T219, Marlana, Siyana and Gorana. Cultivars are grown under the same technology, so the value of materials was the same for all of them - 1337.5 euro/ha. In the case of mechanization costs, no significant differences were found. Their variation ranged from 563.3 to 572.9 euro/ha. Workers costs were within 36.7 - 42.8% of total management costs.

The value of gross output fluctuated widely and was dependent on both the quantity and quality of the obtained fruits. This indicator was the highest for Teser T219, followed by Siyana and Marlana - respectively 12637, 10326 and 9786 euro/ha, and the lowest for Elegia - 6107 euro/ha (Figure3). The net incomes followed the trend of change in gross output and ranged from 2996.2 to 9297.2 euro/ha. The rate of profitability varied over a wide range too - from 96% for Elegia to 278% for Teser T219.

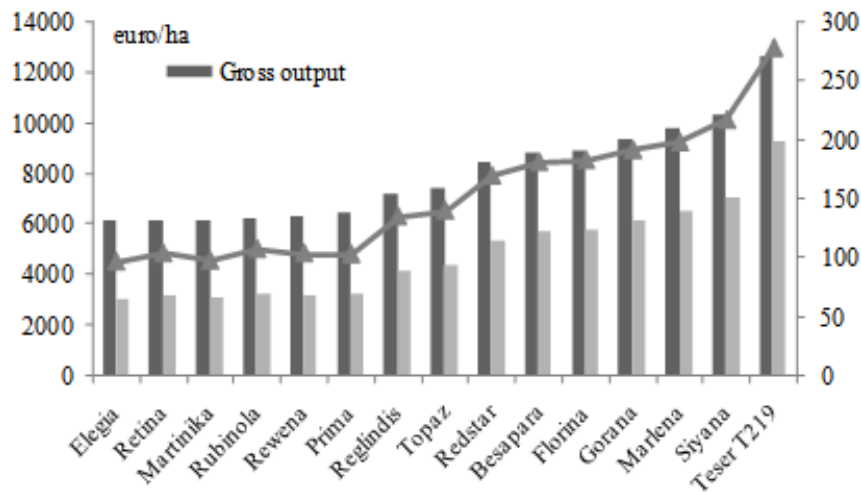


Figure 3. Economic indices for apple cultivars, average for 2015-2018.

The price of output is one of the main indicators for assessing the efficiency of a given production and a mandatory element in determining its profitability. Its reduction reflects the savings of raw materials, working hours, etc., accelerates the re-use of the working capital and requires less financial resources to carry out the reproduction process. On the other hand, the cost reduction is one of the most important factors in forming a lower cost of production. In the studied cultivars the prime cost was the lowest for Teser T219 - 90 euro/t, while in the other cultivars it has grown gradually and reached 170 euro/t for Retina (Figure 4). Similar economic results were also obtained for other apple cultivars grown in Bulgaria (Manolova, 2005).

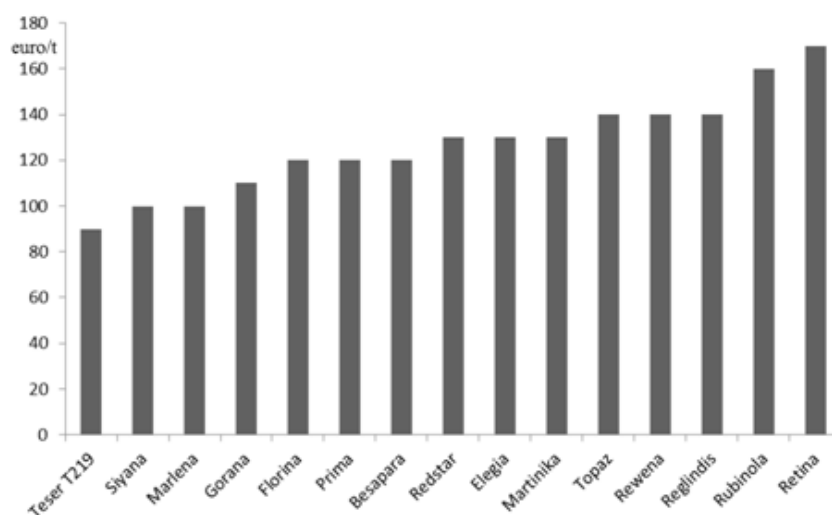


Figure 4. Prime cost (euro t⁻¹)

Conclusions

The studied cultivars have good biological and economic qualities, ecological plasticity and resistance to the most important disease in the apple. The most successful, from economic point of view, were Teser T219, Siyana, Marlana, Gorana, Florina and Besapara with a rate of profitability above 180%. With their wider application in the practice, as high-productivity, with high-quality, and resistant to scab, they will lead to substantial savings in money for materials and labor, as well as to increased profitability of the apple plantations created with them.

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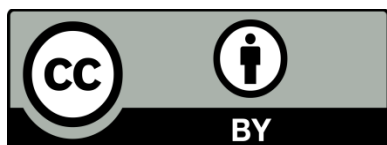
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