Original Research Article

Examination of biological and economic characteristics of introduced walnut cultivars and recommendations for spreading

ABSTRACT

Plantation cultivation of grafted walnuts in Bosnia and Herzegovina did not exist until 6 years ago. Walnut seedlings (Juglans regia L) were mainly planted, which showed all the shortcomings related to the trees obtained from the seeds. In the last 5 years, there has been interest in planting grafted walnuts, so in this regard there was a need for controlled introduction of varieties suitable for this area.

Research was conducted during 2020 - 2021 at four walnut tree cultivars, Chandler, Franquette, Fernor i Fernette .

The aim of the research is to determine how certain varieties behave in agroecological conditions of the Majevica region and on that basis to give a proposal of the best variety for further spread in the area of this region. The research was conducted within the project number 02 / 9-712-1-5-3 / 21. The research was carried out at the Skakava Gornja site at an altitude of 192 m with a southwestern exposure (plot I) and a northeastern exposure at 172 m above sea level (plot II), with a terrain slope of 8%.

The research related to vegetative growth included counting and measuring the average, then the minimum and maximum growth during two years. Yield monitoring included counting and measuring fruit number, average fruit size and calculating average yield.

Generally the Chandler and Franquette varieties planted on the I plot had a stronger growth.

Taking into account the vegetative growth, the number and size of fruits as well as the yield in the observed period, the Chandler and Franquette varieties are recommended for further expansion.

Keywords: *walnut plantation cultivation, walnut varieties, introduction, vegetative growth.*

1. INTRODUCTION

There is no walnut plantation in Bosnia and Herzegovina. There is an interest of farmers / investors to get involved in raising larger plantations. In this regard, there is a dilemma of which varieties to recommend, which cultivation technology to apply, given the type of yield of walnuts.

Spontaneously some organizations imported walnut seedlings from various agro-ecological areas.

A particularly large number of seedlings were imported from Turkey. When choosing the assortment, science and profession were very little or not included, mostly imports were made for economic profit because such seedlings had a high price.

Cultivation and production of walnuts are limited by absolutely minimum temperatures, late and early frosts, frosts in the flowering phase, high summer temperatures and lack of precipitation, and few hours in winter with a temperature of 5-7 0C.Introdukcija vrlo često predstavlja najvažniji način uvođenja i širenja novog biljnog materijala iz jednog područja u drugo.

Foreign species and varieties are entering new natural ecosystems in different ways.[1,2]. Introduction was especially important in the early days of agricultural development. Some introduced plant species transferred to another area have adapted so much that their yield and production have increased significantly. There are many such examples, soybean cultivation in the United States after its introduction from China or the introduction of high-yielding Italian wheat cultivars to our production areas. In order to survive and bear fruit in a new habitat, species and varieties must be able to adapt in terms of the ability to change phenology and daily rhythm, the ability to change physiology in response to climatic and ecological conditions of cultivation [3] The introduction has two main goals. The first is the introduction of new plant material into production and the second is that the introduced material serves as a source of new genetic material. Many introduced cultivars served as the starting material in the development of domestic cultivars.

Of course, there are also problems related to the introduction, such as the potential danger of introducing pathogens and pests with the introduced material. The intake of dangerous diseases and pests is most often the result of ignorance, or carelessness.

From time to time, the introduced pests/pathogens have devastated crops and even created famine conditions in different parts of the world. The Ireland famine of 1845 was the result of an almost total failure of the potato crop due to the introduction of the late blight pathogen (*Phytophthora infestans*) from Central America [4]

The state determines the conditions of import and quarantine with its legal legislation. Plant quarantine is defined as the legal implementation of measures aimed at preventing the spread of pests or preventing their further reproduction in the event that they have already entered and settled in new restricted areas [5]. The introduction of species and varieties is done for two reasons: introduction for research purposes and introduction for production purposes. Introduction research involves pre-introduction and introduction. Pre-introduction is performed research on a small number of plants (5-10) and the research involves the examination of phenological, pomological and organoleptic characteristics of selected varieties. Production and variety research related to pomological and economic properties of varieties is carried out on promising and suitable varieties. This level of research is conducted on more than 100 seedlings [6].

For a successful introduction, it is necessary to know the climatic factors that have an impact on the adaptation and yield of walnuts. Walnut does not tolerate excess water and may be intolerant of floods [7,8].

Walnut also reacts unfavorably to the lack of moisture, so in connection with climate change research, they indicate that for southern Europe and the Mediterranean, an increase in the average annual temperature is expected, while precipitation is expected to decrease and thus

increase the risk of summer droughts. [9], [10]. Late spring frosts also have a great influence on the adaptation and yield of walnuts, so frosty areas should be avoided. Usually the damage from low temperatures occurs as a result of late spring frosts, research in California has shown that low temperatures in October and early November caused great damage to walnuts [11].
Frost injury to trees can occur in the autumn before they have cold-acclimated [12,13],
during winter dormancy or in the spring [14]
Walnut growing areas are more or less exposed to low temperatures, so protection from frost damage is a challenge every year for many growers. [15].
Walnut may be at a disadvantage due to its susceptibility to drought and frost injury in current growing regions given the projected increases in temperature and extreme climatic events[16].
Often, due to the lack of vacant production plots, production is reduced to unfavorable locations (areas of high groundwater and floodplain, frosty and arid areas). [17].
There are several measures to protect against frost damage, however all of them are applied just before or during a frosty night to prevent the formation of ice inside sensitive plant tissue [18].

2. MATERIALS AND METHODS

The walnut plantation was formed in December 2019 at the Skakava Gornja site on the altitude of 192 m with southwestern exposure (I plot) and northeastern exposure at 172 m above sea level (II plot), with a slope of 8%. Chandler and Franquette varieties were planted on the first plot, and Fernor and Fernette on the second.

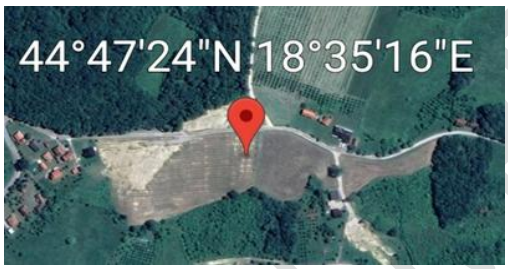

Figure 1 Location I plot

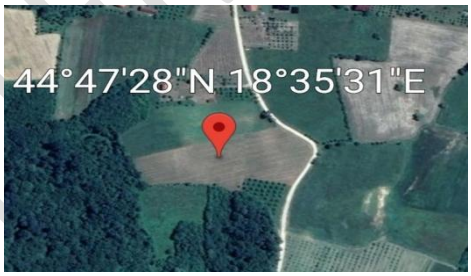

Figure 2 Location II plot

Before planting, undermining, calcification, fertilization and deep plowing were performed. In maintenance, agro-technical measures were applied, such as: mulching the grass in the inter-row space, hoeing seedlings, watering (5 times in the vegetation) and chemical protection. Varieties were grafted on seedlings of walnut (*Juglans regia L.*). The distance between the fruit trees is 8 x 7 m. The paper presents two-year data: the average vegetative growth in the first and second year of cultivation, the average number of vegetative growth and the average tree height. Yield monitoring included average fruit number, average fruit size and average yield.

Figure 3 Time of planting walnut

Figure 4 and 5 Walnut in I vegetation year

3. RESULTS AND DISCUSSION

Table 1 Vegetative growth in first year after planting in mm

Sort	Average growth I year	Min	Max
Chandler	275,3	70	720
Franquette	329,6	50	860
Fernor	285,3	100	810
Fernette	308. 3	100	900

The highest average vegetative growth in the first year after planting was in the Franquette variety (329.6 mm) while Chandler had the lowest average growth (275.3 mm). The lowest single growth was recorded in the variety Franquette (50 mm) and the variety Fernette had the highest single vegetative growth (900 mm)).

Table 2 Vegetative growth in the second year after planting in mm

Sort	Average growth II year	Min	Max
Chandler	121.83	74	213
Franquette	134.5	56	186
Fernor	85.5	16	131
Fernette	93.56	16	132

In the second year, the highest average vegetative growth was in the variety Franquette (134.5 mm), while in the second year Fernor gave the lowest average growth (85.5 mm).

This year, the varieties Fernor and Fernette planted on plot II gave on average less increments than the varieties Chandler and Franquette from plot I. The lowest single increment was also recorded in the cultivars Fernor and Fernette (16 mm), while the cultivar Chandler gave the highest single increment (213 mm).

Table 3 Average and total vegetative growth in mm

	Growth I year	Growth II year
Average growth	29.96	108.84
Total average gowth	119.85	435.39

Vegetative growth was in the reference values for Chandler and Franquette varieties, while in Fernor and Fernette varieties it was less expressed.

Table 4 Average number of growths

Sort	Average number of growths
Chandler	6.4
Franquette	4.1
Fernor	2.6
Fernette	4.2

Chandler showed the best overgrowth (6.4 increments) while Fernor showed the worst increments (2.6). Franquette and Fernette had uniform overgrowth (4.1 and 4.2).

Table 5 Average yields per tree

Sorta	Average yield per tree	Average fruit size	Average number of fruits per tree
Chandler	960	12.60	76.19
Franquette	720	11.20	64.29
Fernor	270	13.70	19.71
Fernette	220	12.10	18.18

Yield monitoring included average fruit number, average fruit size and average yield. Fruit size was within the standard variety sizes.

4. CONCLUSION

The cultivation of introduced varieties Chandler, Franquette, Fernor and Fernette in the Majevica region has shown that it is possible and that there is no special danger of low temperatures, but the use of irrigation in the growing season is mandatory. The amount of precipitation is optimal, but the distribution of precipitation is not good. In addition to this, for successful cultivation of walnuts, it is necessary to do undermining and abundant fertilization with organic matter, because in this region there are heavy soils with an impermeable layer after 30-40 cm.

Based on vegetative growth, number and size of fruits as well as yield in the observed period, Chandler and Franquette varieties are recommended for further expansion.

REFERENCES

1. Drake J.A., Mooney H.A., di Castri F., Groves R.H., Kruger F.J., Rejmanek M., Williamson M., (1989), Biological Invasions; a global perspective (John Wiley & Sons, New York).
2. Nentwig W. (2007), Biological invasinons, Springer, Heidelberg, Germany.
3. Bellard C., Bertelsmeier C., Leadley P., Thuiller W., Courchamp F., (2012), Impacts of climate change on the future of biodiversity, Ecology Letters 15: 365–377,
4. Nath R., (1991), Plant Quarantine - International Board for Plant Genetic Resources Regional Office for South and Southeast Asia,New Delhi.
5. P. Karuppuchamy and Sheela Venugopal (2016), Integrated Pest Management, Ecofriendly Pest Management for Food Security, Book 2016, Pages 651-684.

6. Vujević P., Milinović B., Jelačić T., Halapija Kazija D., Čiček D.,(2011), Sorte voćnih vrsta, Zavod za vinogradarstvo, vinarstvo i voćarstvo Zagreb.
7. Mapelli S, Lombardi L, Brambilla I, Lulini A, Bertani A (1997) Walnut plant selection to hypoxic soil resistance. Acta Hortic 442:129–136
8. Winter M-B, Wolff B, Gottschling H, Cherubini P (2009) The impact of climate on radial growth and nut production of Persian walnut (Juglans regia L) in Southern Kyrgyzstan. Eur J For Res 128:531–542.
9. Christensen J.H., Hewitson B., Busuioc A., Chen A., Gao X., Held I., Jones R., Kolli R.K., Kwon W-T., Laprise R., Magaña Rueda V., Mearns L., Menéndez C.G., Räisänen J., Rinke A., Sarr A., Whetton P., (2007) Regional Climate Projections. In: Solomon S, Qin D., Manning M., Chen Z., Marquis M., Averyt K.B., Tignor M., Miller H.L. (eds) Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.Cambridge University Press, Cambridge, pp 847–940.
10. Bréda N.., Huc .R, Granier A, Dreyer E., (2006), Temperate forest trees and stands under severe drought: a review of ecophysiological responses, adaptation processes and long-term consequences. Ann For Sci 63:625–644
11. Claypool L.L., Paul E., (1956), Frost Damage to Walnut Kernels, California agriculture.
12. Smith, M.W.; Reid, W.; Carroll, B.; Cheary, B. Mechanical fruit thinning influences fruit quality, yield, return fruit set, and cold injury of pecan. HortScience 1993, 28, 1081–1084.
13. Cade, J.C., (2001), The Relationship between Fatty Acid Content and Pecan Cold Hardiness; Mississippi State: Starkville,MS, USA.
14. Malstrom, H.L.; Jones, J.R.; Riley, T.D., (1982), Influence of freeze damage on fruitfulness of the pecan. Pecan Q.,16, 13–17.
15. Battany, M. C., (2012): Vineyard frost protection with upward-blowing wind machines. Agric. For. Meteor., 157**,** 39–48,
16. Martin-Michel G., Douglass F. J.,(2011), Walnut (Juglans spp.) ecophysiology in response to environmental stresses and potential acclimation to climate change, Annals of Forest Science, Springer Verlag, 68 (8), pp.1277-1290.
17. Koprivnjak M.,(2021), Utjecaj niskih temperatura na izmrzavanje lijeske na području Baranje, Josip Juraj Strossmayer University of Osijek, Faculty of Agrobiotechical Sciences Osijek
18. Ribeiro, A. C., J. P. De Melo-Abreu, and R. L. Snyder, (2006), Apple orchard frost protection with wind machine operation. Agric. For. Meteor., 141, 71–81