Scientific Papers. Series B, Horticulture. Vol. LXVIII, No. 2, 2024
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

NORTHERN BANANA OR PAW-PAW GROWN IN SOUTHERN ROMANIA SANDY SOILS

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Abstract

The Northern banana (Asimina triloba L.) or paw-paw is one of the fruit tree species belonging to the Annonaceae Family, which behaves very well in areas with a temperate climate and is considered here an exotic species. In Romania it was introduced in 1926, but until now there are no commercial orchards. In 2019, seven genotypes were planted at SCDCPN Dăbuleni, which were evaluated by the growth capacity, productive capacity, and fruit quality. Following the study, the Mary Foos genotype stood out with an average length of the annual shoots of 71 cm, an average fruit weight of 182 g/fruit and a fruit yield of 4.6 t/ha.

Key words*: shoots length, fruit quality, yield.*

INTRODUCTION

The Northern banana (*Asimina triloba* L.) is part of the Annonaceae family, the largest family in the *Magnoliales* order, with over 2300 species of trees and shrubs with tropical distribution. The fruits of some species of this family are eaten in the tropical areas of the world. An exception to the predominantly tropical and subtropical distribution of Annonaceae is the genus *Asimina*, the only genus of the family with species adapted to cold climates (Hormaza, 2014). *Asimina* includes at least eight species and several interspecific hybrids, all native to North America (Brannan, 2021) or pawpaw originates from the American continent, it is naturally propagated in an area starting from northern Florida to southern Ontario, and continued to eastern Nebraska. The modern literature provides information that this species dates back to the Eocene and the first ones that clearly resemble *A. triloba* in the Miocene (Brannan, 2012). The fruits of this species were an important source of food for the Native Americans before America was discovered, they were also appreciated by the European colonists, they were also a source of survival for American slaves, and they supplemented the increasingly low food rations of the American Civil War soldiers (Brindza, 2019). There is evidence that pawpaw was considered a delicacy by famous Americans such as the third US president Thomas Jefferson, Daniel Boone and the famous publicist Mark Twain. It was not until the beginning of the 20th century that the pawpaw attracted the interest of members of the American Horticultural Society as a fruit with promising potential, and studies and propagation practices were extended outside the areas where the species grew in wild flora (Ragan, 1888; Reich, 1991). Currently these fruits are consumed, especially in rural areas, as no marketing network has been developed (Brannan & Coyl, 2021).

In Europe, the first information about pawpaw comes from England, being mentioned in 1736, in a register from the Botanical Garden of the University of Cambridge, which even today has a collection of paw-paw with North American germplasm (Cambridge, Botanic Garden, 2021). In Italy, *Asimina triloba* was first planted in the Botanical Garden of Padua in 1801 (Mayer., 1959). More recently, in 1983, commercial paw-paw plantations were initiated in Faenza, and the Department of Horticulture of the University of Florence began to study this plant in 1990, focusing on breeding work (Bellini & Montanari, 1992). Here, in 2000, resulting in the largest orchard and variety collection (Bellini et al., 2003), in Europe, and efforts to marketing paw-paw fruit are still

ongoing. Research activity at the University of Turin on paw-paw has been focused on the biochemical composition and antioxidant activity of the fruit at different stages of ripening (Donno, 2014). Many of the studies carried out supported the increased interest in the promotion of paw-paw, which led to the appearance of several nurseries that offer paw-paw trees both for amateurs and for possible commercial plantations.

Research activity at the University of Turin on pawpaw has been focused on the biochemical composition and antioxidant activity of the fruit at different stages of ripening (Donno, 2014). Many of the studies carried out supported the increased interest in the promotion of papaw, which led to the appearance of several nurseries that offer paw-paw trees both for amateurs and for possible commercial plantations. In the 2000 year, Stănică F., has initiated an extensive research activity aimed at pawpaw germplasm, propagation techniques, orchard management, to USAMV Bucharest, in the fields of the Faculty of Horticulture, here the improvement activity led to obtaining the first genotype of Romanian paw-paw named "Asimina" (Stanica F., 2012). Also, a report with information about the accessions that resulted from the breeding activity, following six study year, provided valuable information about the morphology, phenology of the plants, in relation to the climate (Szilagvi et al., 2016b), with a special emphasis on the effects of climate change (Szilagvi et al., 2016a; 2017) in the Romania. The recent research has caracterized the paw-paw as one of the most exotic plants that has been adapted in Romania. As a result of research carried out at USAMV Bucharest, Romania is mentioned alongside Korea in a report carried out by Robert G. Brannan & Maria N. Coyl, in 2021, as future countries where paw-paw has the possibility of expansion in cultivation, in the same report China, Israel, Belgium and Portugal are mentioned as countries with cultivation potential.

In 2019 year, researchers from SCDCPN Dăbuleni initiated research on some pawpaw genotypes in search of fruit tree species that can requers sandy soils for they grow. In this paper, the productivity and quality characteristics of pawpaw genotypes will be analyzed, under the conditions of sandy soils in Southwestern Romania.

MATERIALS AND METHODS

In 2019 year, to SCDCPN Dăbuleni, an experimental lot was established with 7 genotypes of paw-paw, as: Ithaca, Rebecca, Mary Foos, Sunflower, Prima, PT and PTS. The planting distance is 5 m between rows and 2.5 m between plants per row, on raised beds, mulched with agrotextile and irrigated with a drip irrigation system. Until the 3rd year after planting, the plants were shaded with corn plants planted on either side of the paw-paw row at a distance of 0.25 m from the row of paw-paws. To evaluate the growth capacity, the growth dynamics of the shoots (cm) were evaluated monthly; and to evaluate the quality of the fruits was measured: the average weight of the fruits (g); fruit diameter (mm); fruit height (mm); fruit color indices measured in the CIEL* system, where L*= brightness; a*= red shade + or green -; b*= yellow + or blue-. The fruits of the paw-paw genotypes ripen in stages, at each time of fruit harvesting, the fruits were analysed in the laboratory to determine the skin and pulp color. The color parameters were measured using a Minolta CR-400 colorimeter (Osaka, Japan) with mode L*, a*, b* and indices C* (defines color saturation) = (a*x1000)/(L*x b*) (after Minelkis, 2019), and h° (hue) = tan-(b*/a*) (Abbott, 1999), is defined as the hue angle on the colour wheel (0° = red/purple, 90° = yellow, 180° = green and 270° = blue).

The skin colour indices were measured on the diameter of the fruit, then the skin was removed with a knife on a 1 cm^2 portion and the values for the pulp of the fruit were read. The determinations of the biochemistry of the fruit were carried out, such as: soluble solids (% Brix); the total dry matter (%), the water content (%), the C vitamin content (mg %); the glucides content (%).The obtained results were calculated and statistically interpreted with the analysis of variance (ANOVA) Duncan test at $p \leq 0.5$, and the bars in each column of the figures represent the standard deviation, the letters accompanying the values in the figures represent the significance according to the Duncan test.

RESULTS AND DISCUSSIONS

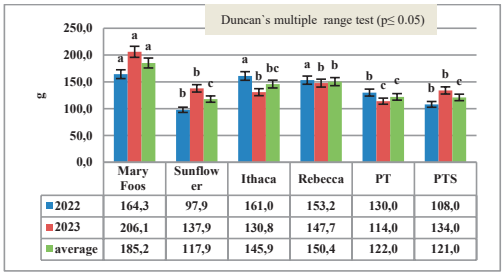
The dynamics of annual shoot growth. The analysis of the data in the Table 1 shows that all the studied varieties grew with a monthly increment of 5 to 20 cm until the second decade of August, after this period the growth increment was much reduced.

Table 1. The dynamics of paw-paw annual shoot growth

Cultivar	Date					Media
	20. V	20. VI	20. VII	20. IX	5. X	
Mary Foos	13.0b	28.30c	51.8a	112.13a	108.43a	69.8a
Rebecca	10.0c	24.3d	43.7 b	69.46c	73.3c	47.3c
Sunflower	13.2b	35.83a	51.7 a	104.13a	108.0a	68.1a
Ithaca	15.26a	24.3d	35.8 c	46.5e	47.8e	35.73e
Prima	10.3c	31.83b	31.83b	86.13b	88.5b	57.2b
PT	7.70d	15.7f	20.66d	29.43f	31.8f	21.73f
PTS	10.0c	21.2e	37.0 c	58.0d	59.8d	42.26d

On average over the entire study period, the Mary Foos variety recorded an average shoot growth length of 69.8 cm, and the lowest average annual shoot length was recorded for the PT genotype, respectively 21.73 cm (Table 1).

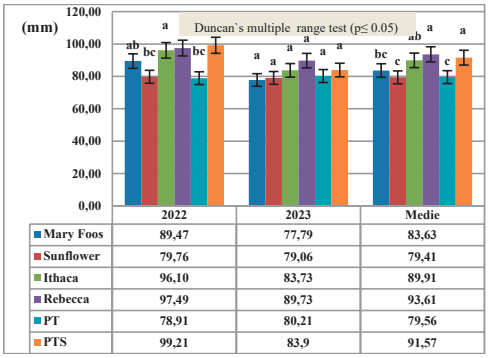
Average fruit weight, illustrated in Figure 2, shows that the evaluated genotypes recorded an average fruit weight that varied from one year to another, with differences between the two years of study between 41.8 g in the case of the Mary variety Foos, and only 4.4 g in the case of the Prima variety. On average over the two years of the study, the highest values of the average fruit weight were recorded in the Mary Foos genotype (185.2 g) and the lowest value of the average fruit weight was recorded in the Sunflower genotype (117.9 g).



	Mary Foos	Sunflower	Ithaca	Rebecca	PT	PTS
2022	164,3	97,9	161,0	153,2	130,0	108,0
2023	206,1	137,9	130,8	147,7	114,0	134,0
average	185,2	117,9	145,9	150,4	122,0	121,0

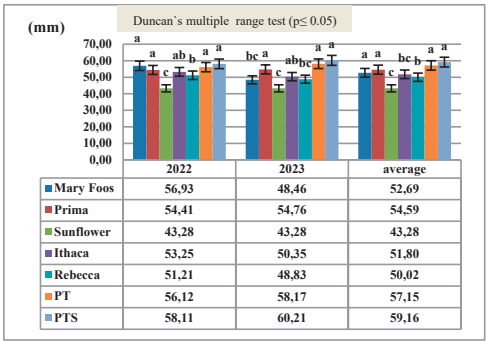
Figure 1. The fruits weight, during the study period

The average length of the fruits is one of the biometric characteristics of the quality of the fruits, which, together with the diameter of the fruits/their thickness, can be the basis of the adjustments of the future machines for conditioning and preserving the fruits of this species, which is why the two characteristics were evaluated annually and represented graphically in Figures 2 and 3.



	2022	2023	Medie
Mary Foos	89,47	77,79	83,63
Sunflower	79,76	79,06	79,41
Ithaca	96,10	83,73	89,91
Rebecca	97,49	89,73	93,61
PT	78,91	80,21	79,56
PTS	99,21	83,9	91,57

Figure 2. The paw-paw fruits length, during the study period



	2022	2023	average
Mary Foos	56,93	48,46	52,69
Prima	54,41	54,76	54,59
Sunflower	43,28	43,28	43,28
Ithaca	53,25	50,35	51,80
Rebecca	51,21	48,83	50,02
PT	56,12	58,17	57,15
PTS	58,11	60,21	59,16

Figure 3. The paw-paw fruits thickness, during the study period

Thus, it can be seen that the Rebecca and PTS genotypes recorded the highest values of the average length of the fruits, it is shows that from the statistically point of view this genotypes versus the other studied genotypes had recorded differences statistically assured (Figure 2) for this quality characteristic. Regarding the average fruit thickness over the two years of the study, the highest values were recorded for the PTS genotype (59.16 mm) which shows statistically assured differences only from the Sunflower genotype which recorded the lowest average fruit thickness value of only 43.28 mm.

The colour of the fruit. The analysis of the brightness of the fruit skin (L*) to the seven

northern banana genotypes studied highlighted the Mary Foos genotype with the highest values (69.19), with statistically assured differences compared to the values recorded by the genotypes: PT, Rebecca and PTS (Figure 4). In the case of the brightness of the fruit pulp between the seven evaluated genotypes, no differences statistically assured were recorded, but it should be highlighted that the highest value was recorded for the PT genotype (Figure 5).

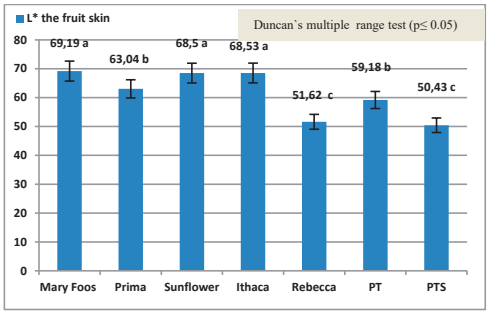


Figure 4. The skin brightness of the paw-paw fruits

In the case of the brightness of the fruit pulp between the seven evaluated genotypes, no differences statistically assured were recorded, but it should be highlighted that the highest value was recorded for the PT genotype.

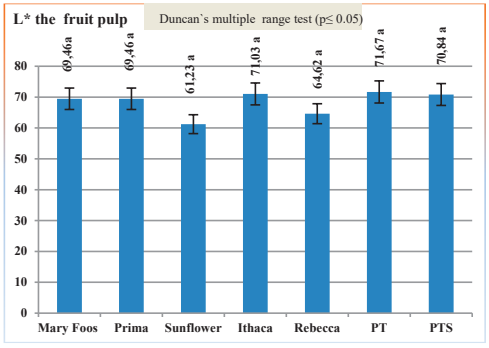


Figure 5. The brightness of the paw-paw fruit pulp

The evaluation of the colour hue angle of the fruits skin and the flesh (h^0) it did not reveal differences statistically assured (Figures 6 and 7), between the seven studied genotypes, but the highest value of the colour hue angle for the skin of the fruit being recorded for the Ithaca genotype, and in the case of the the pulp the highest value being recorded for the Mary Foos genotype.

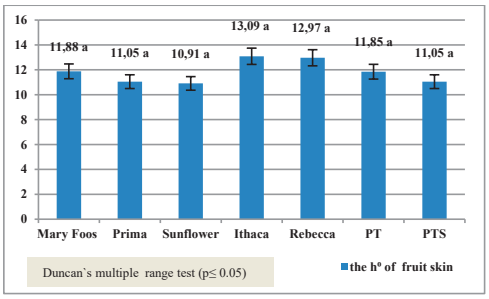


Figure 6. The hue angle of the fruits skin

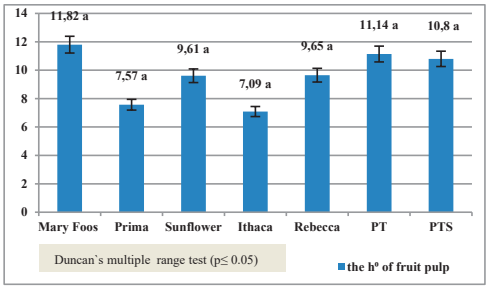


Figure 7. The hue angle of the paw-paw fruits pulp

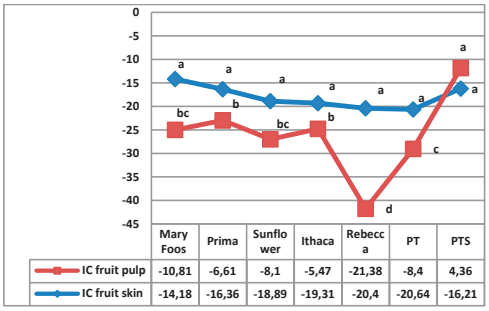


Figure 8. The chroma index to the paw-paw fruits to the studied genotypes

Table 2. Fruit yield, during the study period

The genotype	Yield (kg/tree)			Estimated fruits yield (tons/hectar) (800 trees/ha)
	2022	2023	Average yield	
Mary Foos	5.48	6.14	5,81	4.6
Rebecca	1.08	2.36	1.72	1.3
Sunflower	1.26	1.31	1.28	1.0
Ithaca	1.23	5.66	3.45	2.7
Prima	1.09	1.22	1.16	0.92
PT	0.91	3.22	2.06	1.6
PTS	0.87	3.02	1.94	1.5
Media	1.7	3.27	2.49	1.9

The analysis of the chromatic index (color saturation) of the fruit skin (Figure 9), recorded values between -14.18 (Mary Foos) and -20.64

(PT) with differences that are not statistically ensured between the genotypes studied. In the case of the same index, the values recorded on the pulp for the studied genotypes divide them into three statistical classes, the highest value being recorded by the PTS genotype, and the lowest value by the Rebeka genotype (Figure 8).

The evaluation of the production capacity to the studied genotypes revealed an average production per tree that increased from one year to another, and the average of the two years of the study was between 1.16 kg/tree (Prima) and 5.81 kg/tree (Mary Foos) (Table 2).

CONCLUSIONS

Following the study, it was found that from the point of view of the vegetative growth capacity, the evaluated genotypes developed normally, recording annual increases that varied between 21 and 71 cm average length of the annual shoots.

It is necessary to deepen the research regarding the establishment of the technical moment of harvesting, in this study the optimal moment of harvest could not be established, the fruit were collected only when they downed from the tree branches.

During the entire study period, the studied paw-paw genotypes recorded an average yield in the fourth year from planting of 1.22 to 6.14 kg/tree, which represents an estimated production per hectare of up to 4.0 t/ha.

It is recommended to continue research to determine the suitability of this species in the southern area of Romania.

ACKNOWLEDGEMENTS

The study presented in this paper was suported by the project ADER 6.3.2 "Contributions to the efficiency of natural resources in areas subject to aridification by introducing some exotic plant species into culture" founded by the Ministry of Agriculture and Rural Development.

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