

EXPERIMENTAL PEPPER HYBRIDS AND THEIR MORPHOLOGICAL CHARACTERISTICS

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Abstract

Pepper (*Capsicum annuum* L.), as one of the most important vegetable crops, requires continuous work on the selection of new varieties and hybrids with greater genetic potential for fertility, and the introduction of new cultivation technologies, all to satisfy human needs. In the first year of research, after crossing two parental components based on sterile lines, hybrid seeds of experimental hybrids were produced. A comparative experiment was set up in the greenhouse of the Institute for Vegetable Crops Smederevska Palanka in 2023 to create new pepper hybrids, which are characterized by fruits for different purposes. Of the seven experimental hybrid combinations, one is selected (LPK027 x HM6) for its potential morphological features (fruit weight and number of fruits per plant) as the main components of yield and high content of dry matter and was reported to the Commission for the Recognition of New Varieties in 2024 under the name Katja F₁.

Key words: experimental hybrids, morphological characteristics, pepper, selection

Introduction

In Serbia, there are many varieties of peppers created by different selection methods for various purposes, but a very small number of hybrids. Considering that the process of creating a hybrid is much more difficult (whether it is a simple crossing of two pure lines or using *cms* – cytoplasmic male sterility or *ms* – nuclear male sterility lines) this is probably one of the main reasons. The selection of pure lines followed by crosses to create superior hybrids is one of the oldest strategies in crop breeding. The advantages of hybrids compared to varieties are multiple: occurrence of heterosis, precociousness, uniformity of fruits, resistance to plant pathogens, etc. Through different methods of the selection process, the goal is to create hybrids of different types and purposes (Victor et al., 2012; Basay, 2016; Lee

et al., 2018; Tudor et al., 2019; Vazquez-Espinosa et al., 2020). At the Institute of Vegetable Crops in Smederevska Palanka, wide varieties of peppers (more than 40) were created, and only one hot pepper hybrid, Sirena F₁, found wide application in production practice both in our country and abroad (Cvikić i sar., 2011). This resulted in a comparative examination of experimental pepper hybrids, in order to see their basic morphological characteristics and advantages compared to varieties. After the evaluation, as well as processing the obtained results, the main goal of these researches was to create new pepper hybrids with fruits for different purposes. The divergence of the shape and colour of the fruit, the size of the fruit, and the content of dry matter provide a great opportunity for breeders to create new and different

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pepper hybrids. In breeding programs, breeders usually focus on the following traits: earliness, fruit quality, yield, resistance to economically significant diseases, tolerance to abiotic stress, and plant morphology (Crosby, 2008). In order to fulfill the requirements set before the breeders, it is necessary to determine in advance the mechanisms of inheritance of the desired traits and, based on them, choose the directi-

ons of work on pepper selection. The research aims to create a hybrid pepper in the “kapia” type, which will stand out from the existing varieties in this type for the most important yield components, as well as to familiarize the expert public with the advantages of hybrids in a protected area taking into account the justification of production pepper hybrid from an economic aspect.

Material and methods

As material in this research, seven experimental pepper hybrids created by crossing *ms* line HM6 as the mother line and seven pure lines (LPK027, LPK042, LPK050, LPK062, LPK072, LPK080 and LPK092, pure homozygous lines of the Institute for Vegetable Crops Smederevska Palanka) used as the father lines. When creating pepper hybrids based on sterile lines (*ms* and *cms*), *ms* lines are generally used compared to *cms* lines, which are often unstable and much more difficult to maintain. In *ms* lines (nuclear sterility) there is a split into 50% sterile plants (which are used as a mother line for hybridization) and 50% fertile plants (which are used to maintain sterility). Such is the *ms* line HM6, which was used in these crossings as a mother line for obtaining experimental hybrids. A line obtained by *pedigree* selection from a foreign hybrid. After the crossing in 2022 between LPK027 x HM6, LPK042 x HM6, LPK050 x HM6, LPK062 x HM6, LPK072 x HM6, LPK080 x HM6 and LPK092 x HM6 hybrid seeds of seven experimental hybrids were produced. Next year, 2023, the seeds of the hybrid combinations were sown in mid-March

in 6x6 cm cups and seedlings were produced, and then the plants were planted in the greenhouse in May. The experiment was set up to a random block system in three replicates with 30 plants per replicate.

During the growing season, regular agro-technical care measures were applied (irrigation, fertilization with top dressing, protection against plant diseases and pests). Harvesting was done when the fruits were fully biological maturity of the fruit (all harvested fruits were red). The length of the fruit, the width of the fruit, as well as, the properties of the fruits themselves (average weight of the fruit and thickness of the pericarp, number of fruits per plant, number of chambers) were determined by average values on samples of 10 fruits. The content of dry matter was determined by drying the fruits at 105 °C for 4 hours. An organoleptic sensory analysis was performed for the taste of the fruit. The obtained results were statistically processed (ANOVA) and tested with the LSD test in the program IBM SPSS Statistics, version 26.0. and presented tabularly and graphically.

Results and discussion

In the process of pepper selection, the most important characteristics are fruit weight, length and diameter (Smitha and Basavaraja, 2005; Bharadwaj et al., 2007). One of the most important roles in achieving the total yield is played by the morphological characteristics of the pepper fruit (fruit weight and number of fruits per plant). Based on the statistical analysis of the data (Table 1), we can see that there were

statistically significant differences between the hybrid combinations for the examined parameters. In the case of the hybrid combination LPK027 x HM6, a significant value of fruit mass was determined in relation to other combinations (Figure 1). For the overall height of the realized yield, the characteristic of the fruit mass (Figure 1) is of great importance and this hybrid combination shows the potential fertility

of the experimental hybrid. The investigated hybrids are characterized by fruits for different purposes (fresh consumption or processing) in the “kapia” types. For the industrial processing

of peppers, the agronomic characteristics of the fruit such as fruit weight, pericarp thickness and dry matter content stand out (Nascimento et al., 2014).

Table 1. Morphological characteristics of the investigated hybrid combinations

Tabela 1. Morfološke karakteristike ispitivanih hibridnih kombinacija

Hybrid combinations	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Pericarp thickness (mm)	Number of chambers	Number of fruits per plant	Dry matter content (%)
LPK027 x HM6	121.30**	16.60	4.28	4.20	2.00^{ns}	15.40*	10.50**
LPK042 x HM6	113.06	16.80	4.44	3.60	2.00	9.60	8.53
LPK050 x HM6	103.26	15.80	4.50**	4.20	2.00	12.40	8.40
LPK062 x HM6	101.50	19.00**	3.78	3.80	2.00	12.20	9.00
LPK072 x HM6	97.00	17.90	3.92	4.40^{ns}	2.00	12.00	8.70
LPK080 x HM6	84.46	17.10	3.88	4.00	2.00	13.80	7.60
LPK090 x HM6	81.60	15.60	4.16	3.60	2.00	14.60	9.80
Average	100.31	16.97	4.14	3.97	2.00	12.86	8.93
LSD 0.05	13.47	1.54	0.41	0.85	0.45	3.44	0.35
LSD 0.01	18.25	2.08	0.55	1.15	0.62	4.67	0.47

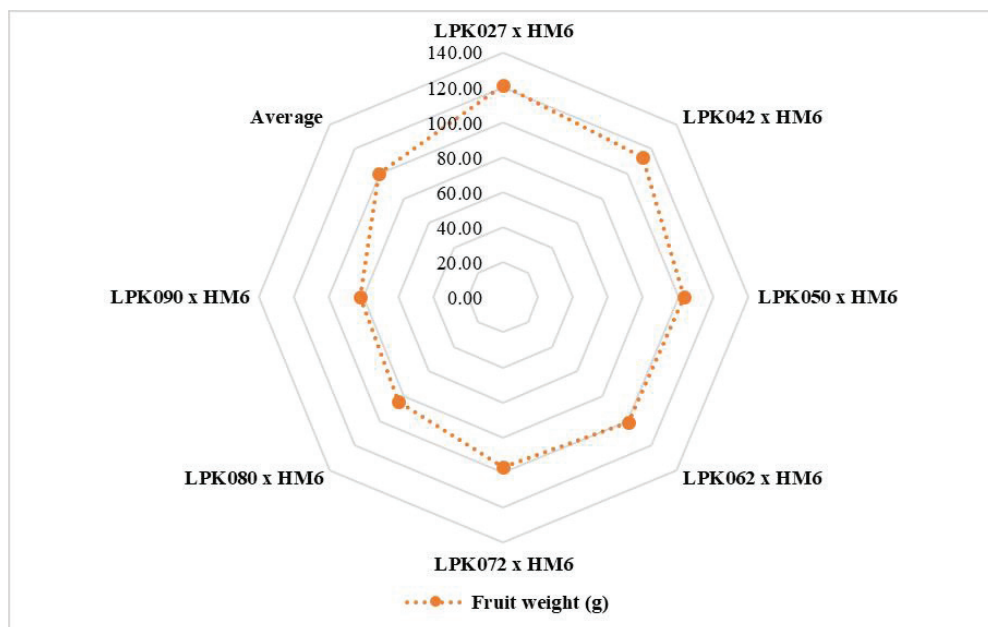


Figure 1. Average values of fruit mass (g) of experimental hybrids

Grafikon 1. Prosečne vrednosti mase ploda (g) eksperimentalnih hibrida

Danojević et al. (2018) analyzed over 250 pepper fruits in their research and measured the largest fruit weight, which was up to 295 g. The hybrid combination LPK027 x HM6 showed statistically significant differences in the values of the examined parameter, the number of fruits per plant, which was 15.40, which is significantly higher than that recorded in other experimental hybrids. Good results were also achieved by the experimental hybrid LPK090 x HM6, where the number of fruits per plant was 14.60 (Figure 2). The advantage of the LPK027 x HM6 hybrid combination is that it showed a heterotic effect for the characteristics of fruit mass, number of fruits per plant and the content of dry matter in the fruit, the values of which are significant in comparison to other tested hybrids. In the research on pepper lines,

the occurrence of heterosis in hybrids of the F_1 generation for the same morphological traits was also determined by other scientists. Rezende Naves. et al. (2022) research, shows how an adequate combination of parental genotypes and the optimal crossing direction can cause phenomena such as heterosis, yield and fruit morphology. Selection of lines from segregating generations and breeding hybrids to exploit heterosis or heterobeltiosis is an effective tool for improving economically important traits in the genus *Capsicum*, and based on the estimates of general combining ability values of the parents and heterosis of the progenies, it is concluded hybridization would be the most appropriate genetic improvement method to increase both yield and the number of fruits for the plant. (Rodríguez-Llanes et al., 2023).

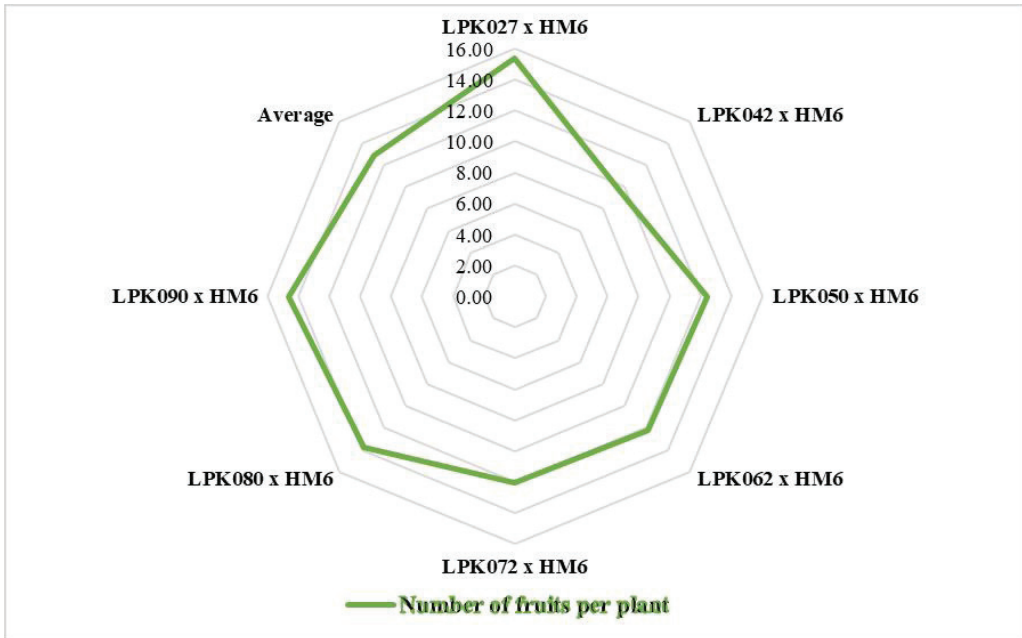


Figure 2. Average values number of fruits per plant of experimental hybrids
Grafikon 2. Prosečne vrednosti broja plodova po biljci eksperimentalnih hibrida

The hybrid combination LPK062 x HM6 had significant values in this research for the characteristic fruit length, while for fruit width the highest values were measured with LPK050 x HM6 (Figure 3). The property of pericarp thickness did not have statistically significant

differences in the tested hybrids, the highest value was measured in the experimental hybrid LPK072 x HM6 and was 4.40 mm, while in LPK027 x HM6 and LPK050 x HM6, it was measured at 4.20 mm. Cvikić et al. (2007) recorded a pericarp thickness of 4.40 mm in F_1 hybrids.

Danojević et al. (2018) state that plants with a thicker pericarp had a higher fruit mass in the research they conducted, and the results of their previous research indicated a positive correlation between fruit mass and pericarp thickness (Danojević et al., 2016). In their works, Lama et al. (2020) point out that fruits with a higher percentage of dry matter have an advantage in terms of canning because they have smaller losses in fruit mass. The hybrid combination that stands out for its dry matter content (10.50%) is

an experimental hybrid, LPK027 x HM6, which was selected and reported to the Variety Recognition Commission. During fruit ripening, the content of dry matter in it also increases and reaches its highest value at biological maturity. There is no statistically significant difference in the number of chambers for the trait, and in all combinations, it was 2 chambers in the fruit. All experimental hybrids after the organoleptic sensory analysis of the fruits are characterized by a sweet taste.

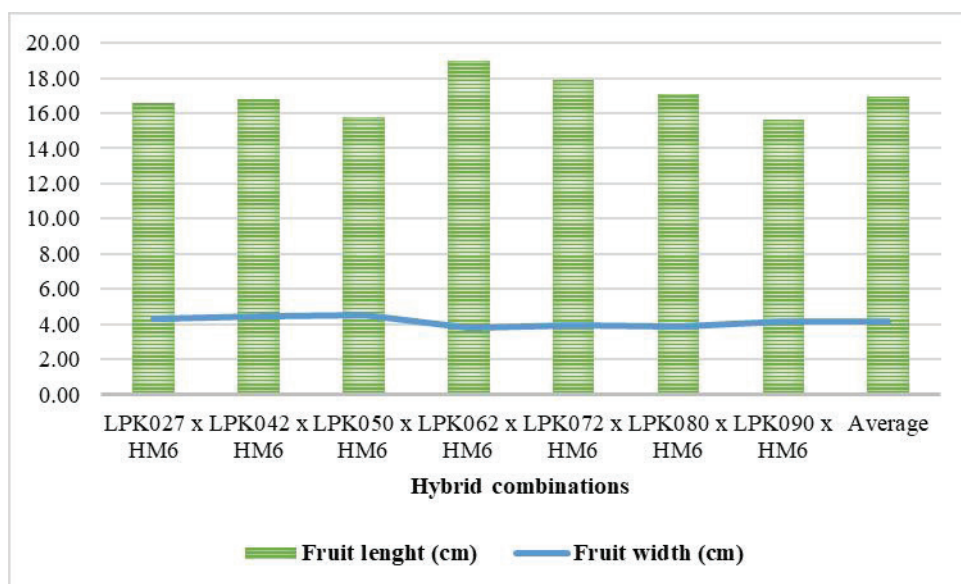


Figure 3. Average values of length and width of fruits (cm) of experimental hybrids

Grafikon 3. Prosečne vrednosti dužine i širine plodova (cm) eksperimentalnih hibrida

Conclusion

The research showed that the experimental hybrid LPK027 x HM6 exhibited heterosis for the investigated characteristics of fruit weight, number of fruits per plant and dry matter content in the fruit. In this hybrid combination, the largest fruit weight was measured, which was 120.30 g, and the largest number of fruits per plant was recorded at 15.40. The characteristic dry matter content (10.50%) showed significant values in relation to other hybrid combinations. This feature is very important

in the vegetable processing industry, which affects the manipulation and storage of fruits. Comparing the varieties that are present on the market concerning the hybrids, which are very few, based on the results of this work, we can conclude the superiority of hybrids for growing in a protected area with a justified economic effect. The advantage of hybrids compared to varieties is precisely those morphological characteristics of the pepper fruit, which determine the total yield, as one of the main reasons the

experimental hybrid LPK027 x HM6 was selected and reported to the Commission for the Recognition of New Varieties under the name Katja F₁. It is characterized by large fruits, with

a yield per plant of about 2 kg, bright red in biological maturity, which are uniform in the "kapia" type, with a pleasant and sweet taste.

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Author contribution

Conceptualization, D.C and B.Š.; Formal analysis, B.Š.; Investigation, V.P., B.Š., J.S., I.T. and I.Ž.; Resources, D.C., I.Ž. and J.S.; Supervision, D.C, B.Š. and M.B.; Visualization, M.B.;

Validation, D.C., B.Š., I.T. and M.B.; Roles/ Writing - original draft, B.Š. and D.C.; Writing - review & editing, V.P.

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EKSPERIMENTALNI HIBRIDNI PAPIRIKE I NJIHOVE MORFOLOŠKE KARAKTERISTIKE

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Izvod

Paprika (*Capsicum annum* L.), kao jedna od najznačajnijih povrtarskih kultura zahteva kontinuiran rad na selekciji novih sorti i hibrida sa većim genetskim potencijalom za rodnost, uvođenje novih tehnologija gajenja, a sve u cilju zadovoljavanja ljudskih potreba. U prvoj godini istraživanja, nakon ukrštanja dve roditeljske komponente na osnovu sterilnih linija, proizvedeno je hibridno seme eksperimentalnih hibrida. U plasteniku Instituta za povrtarstvo Smederevska Palanka tokom 2023. godine postavljen je komparativni ogled sa ciljem stvaranja novih hibrida paprike, koji se odlikuju plodovima za različite namene. Od sedam eksperimentalnih hibridnih kombinacija, jedna je odabrana (LPK027 x HM6) zbog svojih potencijalnih morfoloških karakteristika (najveće vrednosti mase ploda i broja plodova po biljci) kao glavne komponente prinosa i visokog sadržaja suve materije i prijavljena je Komisiji za priznavanje novih sorti u 2024. godini pod nazivom Katja F_1 .

Ključne reči: eksperimentalni hibrid, morfološke karakteristike, paprika, selekcija

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