

## Original Research Article

# Comparative Pest Resistance of Hot Pepper Hybrids in Organic Farming Systems

### ABSTRACT

The genetic basis of the hybrid and growing conditions can significantly affect the resistance to certain types of pests in environmental protection. Some hybrids have a thicker fruit skin, higher concentrations of capsaicin (the active ingredient in hot peppers) or that the fruit contains secondary metabolites that repel pests. This is very important in ecological agriculture and environmental protection, where conventional preparations are not used. The degree of resistance of hybrids can also differ according to which types of pests are dominant in the environment. This research examines pest resistance between two different hot pepper hybrids in organic production with identical agro-ecological conditions, nutrition and plant protection. The experiment was planted in the lowland part of Bosnia and Herzegovina at an altitude of 192 m in greenhouse. During a four-month study were monitored two type of hot peppers: hybrids Fortessa and Hungarian. The attack of the five most important pests of pepper were monitored: *Frankliniella occidentalis*, *Ostrinia nubilalis*, *Aphididae*, *Panonychus ulmi* and *Trialeurodes vaporariorum*. The resistance of the Fortessa hybrid was higher against all of the mentioned pests. Considering that the temperature was very high all trough the vegetation period and without a long period of rainfall, the attack of the mite - *Panonychus ulmi* was increased. The resistance of Fortesse to *Panonychus ulmi* is 31% higher compared to Hungarian pepper. The yield of the Fortessa hybrid is 0.52 kg higher per plant compared to Hungarian pepper. The use of genetically more resistant varieties and hybrids in organic production is the main preventive protection in the already limited possibilities of using plant protective products. Cultivation of hybrids in real conditions is the most reliable way to obtain data of plant resistance two different pepper hybrids.

**Key words:** Genetic basis, ecological agriculture, hybrid resistance, dominant pests

### INTRODUCTION

The origin of pepper is related to America, where it is grown as an autochthonous perennial plant in the southern parts of North and Central America [1]. In most cases, including Bosnia and Herzegovina, pepper is grown as an annual crop. It means that pepper is grown from seed every year, due to the climatic conditions prevailing in Bosnia and Herzegovina. Pepper (*Capsicum annuum* L.) is a vegetable crop, known for the high nutritional value of its fruit, rich in many phenolic substances, vitamins and antioxidants [2,3]. Because of the nutritional value of its fruits, which are an excellent source of a wide range of phytochemicals with well-known antioxidant properties. Major antioxidants include carotenoids, capsaicinoids and phenolic compounds, especially flavonoids, quercetin and luteolin [4,5]. Due to domestication, mass production and intensive cultivation, peppers are exposed to attacks by various pests. Commercially grown hot and sweet peppers have lost thrips resistance and become susceptible to several species of thrips, particularly *Frankliniella occidentalis* (western flower thrips) and *Thrips tabaci* (onion thrips) [6,7]. In Bosnia and Herzegovina besides of thrips attack, farmers often have a problems with mits in pepper production.

Differences in the degree of resistance of hot pepper hybrids to pests can be significant and depend on the genetic characteristics of each hybrid. Frequent and intensive use of chemical pesticides leads to the emergence of resistance among existing species of pests and sometimes to the development of new species [8]. The insecticides used are not always effective enough, therefore integrated pest management (IPM) practices have been implemented and combined with chemical and biological strategies to grow healthy crops [9,10].

The use of host plant resistance is one of the most effective management approaches to minimize damage from phytophagous pests [11]. Some hybrids have been developed to contain natural genes that make them less attractive to pests or make them more difficult to feed on. Hybrids with thicker fruit walls or stronger stems may be more resistant to damage caused by pests. Different hybrids can produce different natural pesticides, such as alkaloids

[12], which can repel or kill pests. Some hybrids are better able to tolerate stressful conditions, such as drought or high temperatures, which can reduce the risk of infestation [13].

In conventional agriculture, the rigorous use of chemical inputs in recent years has led to negative effects on soil microflora and reduced soil fertility [14].

The aim of the study is to examine the genetic resistance between two pepper hybrids and prove the importance of selecting a more resistant variety or hybrid in organic vegetable farming. Considering that preventive protection measures are the main and most important in organic agriculture, selecting a more resistant variety and healthy seeds/planting material have an important role. Besides to pest resistance, the aim of the work is to compare the difference in yield that will give farmers the economic justification for production. In addition to resistance, the research also monitored the difference in pepper planting material between container seedlings and ordinary seedlings. Objective was also to compare degree and rapidity of seedling rooting in the soil and the percentage of plant receptivity. The type of pepper planting material also has a big influence on the resistance of the plant, because a plant that doesn't have a well-developed root system can't resist pests well.

## MATERIALS AND METHODS

In this research were monitored influence of planting material and seed category on the resistance, quality and yield of hot pepper Fortessa F1 (hybrid) and Hungarian SS (standard seed) in organic production. Container planting material was used as planting material for Fortessa pepper, seedlings were used for Hungarian pepper. For the purpose of research, 100 Fortesse seedlings and 100 Hungarian seedlings were planted under foil with a drip irrigation system. The experiment was set up at the „Konjević polje“ location, at 192 m above sea level, in a greenhouse. The plants were transplanted on May 21, 2024. year, and nutrition and protection were applied at the same time, with the same means and in the same way (table 1, table 2). Used inputs are allowed in organic production by the certification body. The follow-up lasted 4 months or 120 days and included the analysis of several parameters: period of root scarring, resistance to insects, number of dead plants, yield and quality of fruits. During the research, the temperature of the air and soil and the period of leaf humidity were monitored by means of a meteorological station installed at that location (iMethos 3.3).



Picture 1. "Agrofood" Konjević Polje, Bratunac, 44°14'15"N 19°06'28"E

Organic fertilizers were used for fertigation, and preparations allowed in organic production were used to protect plant health. For plant protection were used available organic bio-pesticides on markets of Bosnia and Herzegovina. In comparison with the large and different amount of conventional pesticides (cypermethrin, emamectin benzoate, deltamethrin, lambdachallothrin, etc.[15]), the in organic agriculture inputs is limited. For the regulation of aphids and insects in general Oliveg was used - a preparation with a higher oil content that makes it difficult for insects to move. The composition of the Neem Azal preparation contains azadiractin, which acts as an inhibitor of the development of pests.

Table 1. – Records of fertilizer application

No.	Date of treatment	Name of fertilizer	Ingredients	Expected results of application	Type of application
1.	20.05.2024	Pelletized horse + cow + chicken manure	Organic matter + organic NPK	Provide an organic matter	Incorporation
2.	31.05.2024	Team F	Organic N-K fertilizer with organic acids	Better adaption after transplanting	Fertigation
3.	13.06.2024	Aminoton + Slavol	Organic N fertilizer with amino acids + mikrobiological fertilizer	Against stressful conditions (high temperatures)	Fertigation
4.	19.06.2024	Trazex	Microelements	Provide a microelements	Fertigation
5.	29.06.2024	Calcium	Ca fertilizer	Calcium fertilizer; prevention of end rot	Fertigation
6.	01.07.2024	Bacteria	Microbiological fertilizer	Against stressful conditions (high temperatures)	Fertigation
7.	19.07.2024	Calcium	Ca fertilizer	Calcium fertilizer; prevention of end rot	Fertigation
8.	31.07.2024	MYR K	K fertilizer	Potassium fertilizer; for better coloration and size of fruit	Fertigation
9.	10.08.2024	MYR K	K fertilizer	Potassium fertilizer; for better coloration and size of fruit	Fertigation
10.	20.08.2024	Barrier	Ca + Si fertilizer	Calcium and silicium fertilizer; for better strenght of fruit	Fertigation
11.	30.08.2024	Aminoton	Organic N fertilizer with amino acids	Against stressful conditions (high temperatures)	Fertigation
12.	15.09.2024	Team F	Organic N-K fertilizer with organic acids	Better plant growe	Fertigation
13.	20.09.2024	MYR Ca+B	Ca + B fertilizer	Calcium and boron fertilizer; for better blossoming	Fertigation
14.	10.10.2024	MYR K	K fertilizer	Potassium fertilizer; for better coloration and size of fruit	Foliar

Table2. – Records of application of bio-insecticide

No.	Date of treatment	Name of bio-insecticide	Reason for application bio-insecticide	Type of application
2.	13.06.2024	Oliveg	Preventive protection against aphids – big oil amount in the compostion makes movement difficult for aphids	Foliar
4.	26.06.2024	Neem Azal	Preventive protection against aphids and mites – azadiractin in the compostion acts as an insect growth regulator	Foliar
5.	10.07.2024	Oliveg	Preventive protection against aphids – big oil amount in the compostion makes movement difficult for aphids	Foliar
6.	15.07.2024	Sulfur	Preventive protection against mites – sulfur can have a positive effect in protection against mites [16]	Foliar
7.	20.07.2024	Neem Azal	Preventive protection against aphids and mites – azadiractin in the compostion acts as an insect growth regulator	Foliar
8.	30.07.2024	Sulfur	Preventive protection against mites – sulfur can have a positive effect in protection against mites	Foliar
9.	05.08.2024	Neem azal	Preventive protection against aphids and mites – azadiractin in the compostion acts as an insect growth regulator	Foliar
10.	15.08.2024	Sulfur	Preventive protection against mites – sulfur can have a positive effect in protection against mites	Foliar
11.	25.08.2024	Oliveg	Preventive protection against aphids – big oil amount in the compostion makes movement difficult for aphids	Foliar
12.	04.09.2024	Neem Azal	Preventive protection against aphids and mites – azadiractin in the compostion acts as an insect growth regulator	Foliar

13.	10.09.2024	Sulfur	Preventive protection against mites – sulfur can have a positive effect in protection against mites	Foliar
14.	20.09.2024	Sulfur	Preventive protection against mites – sulfur can have a positive effect in protection against mites	Foliar

Chart 1. – Air temperature per day

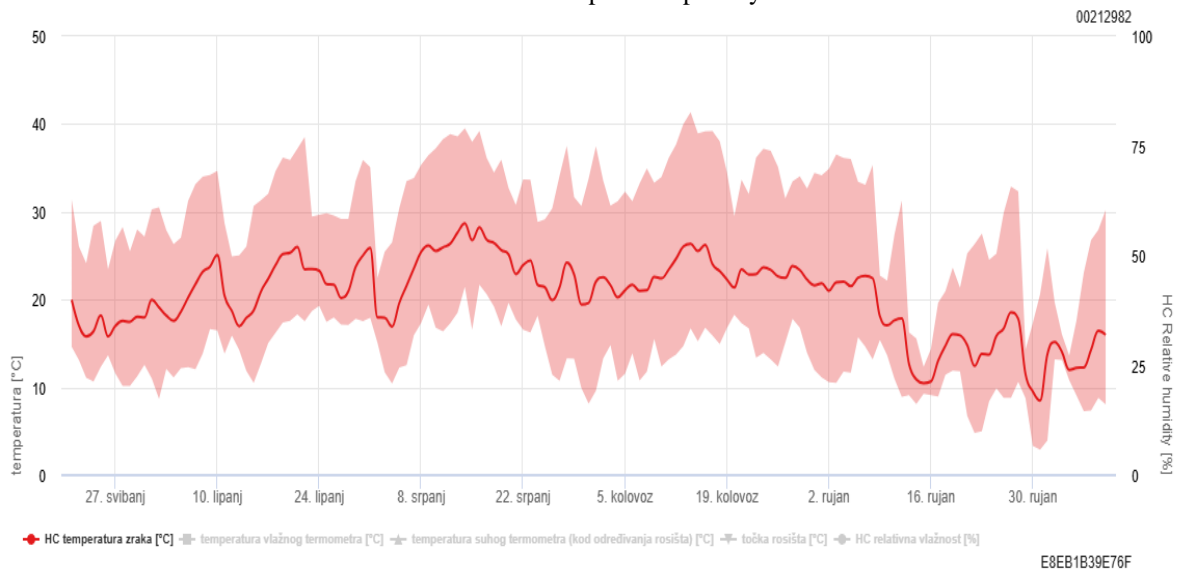
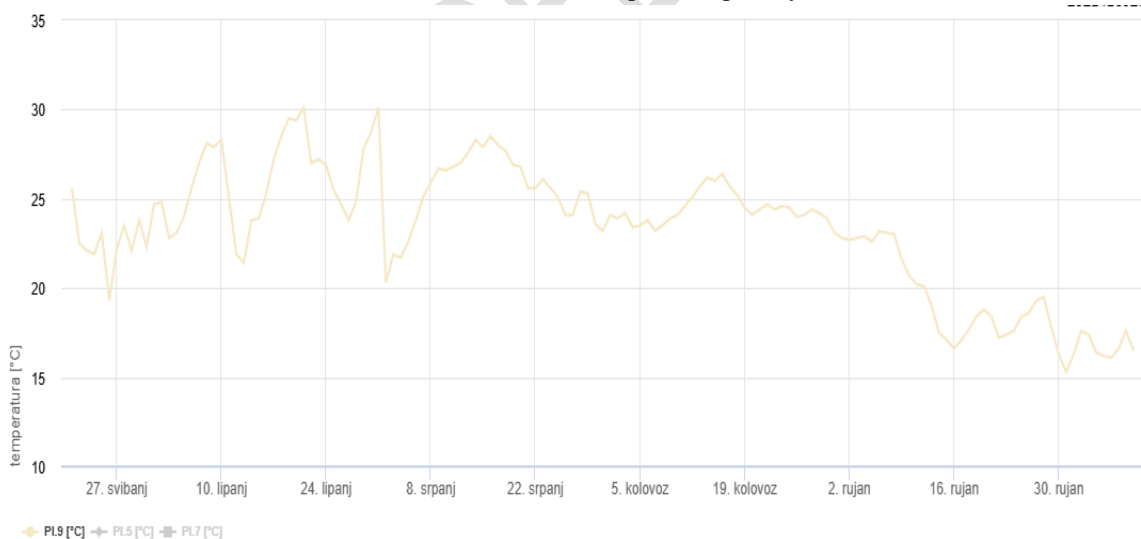
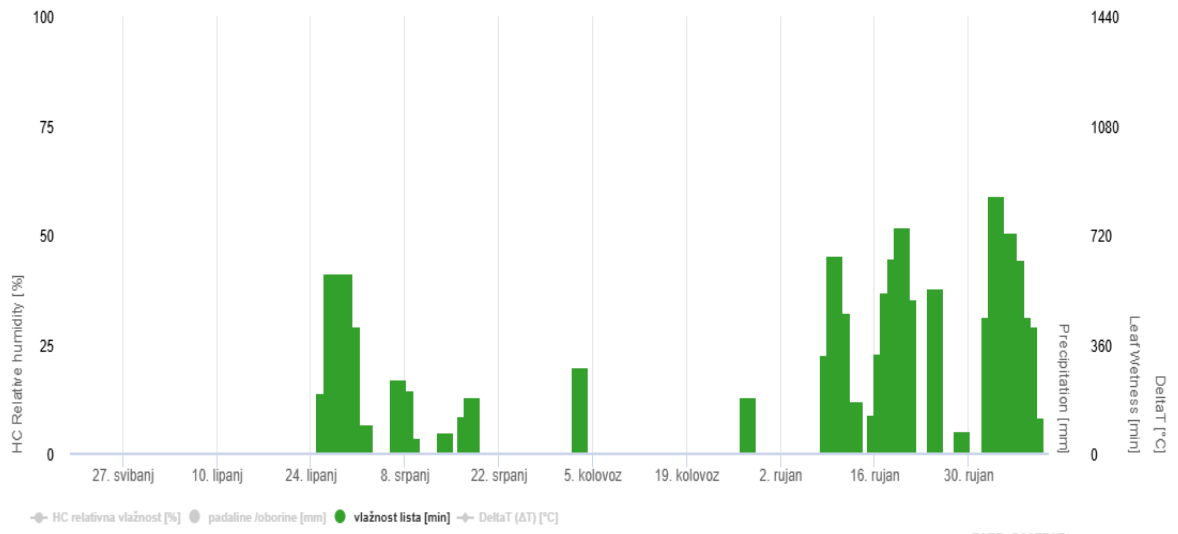


Chart 2. – Soil temperature per day



According to the data from charts 1, 2 and 3, we can conclude that it was a very hot summer, that the air temperatures were between 35-41 °C, and in the greenhouse the temperatures were even higher. Leaf moisture was also at a low level concluding to data from chart 3. The soil temperature in the greenhouse was an average of 23°C. Air and soil temperature as well as relative humidity indicate the agro-ecological conditions of which we could carry out preventive plant protection. Agro-ecological conditions are very important and dictate the development of certain pests. It is to be expected in such warm days that there is an increased attack of mites. The reproduction and development of the female mite *Panonychus ulmi* takes 9.35 days at a temperature of 29-31° C [17].

Chart 3. – Leaf humidity per minutes and percentage



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UNDER PEER REVIEW

## 1. RESULTS AND DISCUSSION

**Table 3. –Experiment labels**

Crop	Label in text	Seed category	Category of planting material	Number of plants
Hot pepper Fortessa	P-F	F1 hybrid	Container seedlings	100
Hot pepper Hungarian	P-H	Standard seed– SS	Seedlings	100

In the experiment, the resistance of hot pepper to the appearance of pests was examined, where the Fortessa hybrid and the Hungarian variety were taken. Both experiments had protection and nutrition in accordance with the Law on Organic Production, which is stated in tables 1 and 2.

**Table 4. – The appearance of the pepper pest monitored through experiment**

No.	Name of microorganisms / pest	Label in text
1.	<i>Frankliniella occidentalis</i>	FO
2.	<i>Ostrinia nubilalis</i>	ON
3.	<i>Aphididae</i>	A
4.	<i>Panonychus ulmi</i>	PU
5.	<i>Trialeurodes vaporariorum</i>	TV

**Table 5. –Rooting of plants after planting**

Label	Number of planted plants	10days after planting	20 daysafterplanting
		% rooted plants	% rooted plants
P-F	100	70%	98%
P-H	100	35%	90%

Trough this research were monitored the appearance of the most economically significant pepper pests in the territory of Bosnia and Herzegovina (table 4). A special problem that farmers have in the locality where the trial is set up (and its surroundings) is the attack of *Panonychus ulmi*, *Frankliniella occidentalis* and *Aphididae*. In addition to the resistance between the two pepper varieties, the influence of the planting material on scarring and the condition of the plants in the subsequent growing season was also monitored. Table 5 shows the degree and speed of rooting between the container seedling of the hybrid Fortessa and the seedling of Hungarian. After 10 days, when the first monitoring was carried out, 70% of the Fortessa seedlings took root in the soil and continued with vegetation, and in the second monitoring after 20 days, 98% of the seedlings or 98 plants took root, while two died. On the other hand, the percentage of Hungarian seedlings that survived is 35%, 10 days after planting, or 90%, 20 days after planting. It is clearly seen that the percentage of seedlings survival is better and faster with container seedlings and that this certainly further affects the condition of the plant and its immunity.

**Table 6. –Results of monitoring pest attacks in the days after planting**

Label	Disease-label	15 days	30 days	45 days	60 days	75 days	90 days	105 days	120 days
		% pest attack							
P-F	FO	0	0	0	0	0	0	0	0
P-H		0	0	0	0	0	0	0	0
P-F	ON	0	0	0	0	0	0	0	0
P-H		0	0	0	0	0	0	0	0
P-F	A	11	17	17	0	0	0	0	0
P-H		18	25	25	0	0	0	0	0
P-F	PU	0	0	7	15	22	31	37	41
P-H		0	0	12	28	35	48	64	72
P-F	TV	0	0	0	0	0	5	8	20
P-H		0	0	0	0	11	23	28	34

Table 7. – Number of plants that died due pest attacks

Label	Disease - label	15 days	30 days	45 days	60 days	75 days	90 days	105 days	120 days
		Number of died plants							
P-F	A	0	0	0	0	0	0	0	0
P-H		0	0	0	0	0	0	0	0
P-F	PU	0	0	0	0	0	0	0	0
P-H		0	0	0	0	5	21	30	37
P-F	TV	0	0	0	0	0	0	0	0
P-H		0	0	0	0	0	0	0	0

Table 6 shows the results of monitoring pest attacks in the days after planting with the percentage of attacks. The attack percentage actually refers to the number of attacked plants in relation to the total planted number. The experiment did not have any attacks by the corn moth and the California thrips. At the beginning of the growing season, aphids appeared on a few plants, but over time their number stagnated and completely stopped, partly due to high temperatures and partly due to the protection that was implemented. The white shield fly started to cause damage at the end of production, more so on the Hungarian pepper trial, but these damages were not economically significant. Finally, the biggest attack was by the red fruit spider, which started its attack in the middle part of the vegetation and eventually caused great economic damage. As many as 72% of plants of the Hungarian variety were attacked by mites, in contrast to Fortesse where the attack was 41%. Also, the intensity of the attack was different, as can be seen in Table 7, where in the P-SS trial, as many as 37 plants died due to the mite attack. In contrast to the P-SS trial, the pepper trial with the Fortessa hybrid was far more resistant. The attack was also present there, but the plants, with the help of the bio-protection listed in Table 2, did not die, but their yield was only reduced.

Table8. – Plant yield in kg

Label	I class yield	II class yield	Total yield	Yield per plant
P-F	103	29	132	1,32
P-H	45	25	70	0,70

Finally, table 8 shows the total yield and yield per plant in kilograms. Fortessa pepper had a yield of 1.32 kg per plant, while Hungarian pepper had 0.70 kg per plant, which is 47% less. According to research data on the cultivation of hot peppers with different fertilizer additions, the average yield of Don Diego hot peppers was 1.54 kg per plant [18]. This is a difference of 0.22 kg per plant compared to Fortessa and 0.84 kg compared to Hungarian. Also, the first-class yield of Fortessa peppers was 78%, while Hungarian had 60%. A higher first-class percentage means a higher product price and a greater economic benefit. Second-class fruits referred to deformed and smaller fruits that can be sold at a lower price or used in processing. If we convert this data to a larger area, this would mean that the yield of Fortessa peppers under these conditions would be 40.92 t/ha, but with a first-class yield of 31.91 t/ha. While Hungarian peppers would have 21.7 t/ha, but with a first-class yield of 13.02 t/ha. Ultimately, these are big differences.

In addition to the fact that the Hungarian pepper did not have the reproductive potential of the Fortessa pepper and a good initial start of planting material, it suffered a large attack of mites. The mite reduced the yield in two ways: 1. by the death of the plants so that in the end those plants could not produce any results, 2. the diseased plants focused all their energy on defending against the attack of the mite, as a result of which they rejected the fruits. In organic farming, in addition to bio protection and frequent treatment with preventive means, we must choose more resistant varieties and hybrids that will be able to resist diseases and pests. Also, we must have good and healthy

planting material that will allow the plants to quickly adapt to the new environment so that they can focus their energy on development and fruiting.

## CONCLUSION

Based on the scientific research work, we draw the following conclusions:

1. The selection of quality planting material plays an important role in strengthening the natural immunity of the plant. Those plants adapted faster to the new environment and have a better developed root system. Container seedlings of Fortessa pepper had 70% of seedlings rooted a 10 days after planting unlike ordinary seedlings Hungarian pepper where this percentage was 35%. Ultimately, they needed more time to develop.
2. There was no economically significant attack by *Frankliniella occidentalis*, *Ostrinia nubilalis*, Aphididae and *Trialeurodes vaporarum*, but the attack by *Panonychus ulmi* (mite) caused economically significant damage.
3. The resistance of the Fortessa hybrid to mites was 31% higher compared to Hungarian pepper.
4. Although Fortessa pepper was also attacked with mites, the plants didn't die but the yield was reduced because the plant struggled to survive. On the other side, Hungarian pepper had 37% of dead plants by the end of the vegetation which directly reflected in lower yields. The plants couldn't cope with the mites attack.
5. The yield of Fortessa pepper was 1.32 kg/plant while Hungarian yield was 0.70 kg/plant. Ultimately, this is a difference of 0.52 kg/plant, or 19.22 t/ha when we converted it to larger areas.
6. The research above has proven that the selection of healthy and high-quality planting material, resistant varieties/hybrids, regular organic nutrition and using of biopesticides can give positive results in organic pepper cultivation with economic justification. Selecting resistant hybrids for cultivation is a primary task in organic cultivation.

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