

RESULTS OF EVALUATION ON AGRONOMIC CHARACTERISTICS AND DISEASE RESISTANCE OF NEW CHILI PEPPER MATERIAL IN GIA LAM DISTRICT, HA NOI CITY

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ABSTRACT

Among 40 chili pepper lines that were received from the World Vegetable Center (WorldVeg), there are 36 chili pepper lines, which germinated well (4 chili pepper lines did not germinate). They were evaluated for agronomic characteristics from August 2023 to March 2024 in a plastic house and open field in Fruit and Vegetable Research Institute, Gia Lam district, Ha Noi city, Vietnam. 7 promising chili pepper lines have been identified to had high potential yield highly potential yield, nice fruit appearance, and good disease resistance, in which there are 3 lines in pendant fruit type (AVPP2001, AVPP2005, AVPP1807) and 4 lines in erect fruit type (AVPP1609-022; AVPP0506; AVPP1609085; AVPP1345). These 40 WorldVeg chili pepper lines have grown on open fields without pesticides for disease resistance evaluation from November 2023 to May 2024. The AVPP1324 line (in pendant fruit type) was highly resistant to virus disease. Ten pendant fruit lines (AVPP2005, AVPP2007, AVPP22002, AVPP9909-S, AVPP9910-S, AVPP9606-S, VI047102, AVPP0024, AVPP1342, AVPP9910, AVPP1806, AVPP1807, AVPP1324) and 7 erect fruit lines (AVPP1609-022, AVPP1609-085, VI059328, AVPP0309, AVPP1812, AVPP2076, AVPP2077) were high resistant to *Stemphylium* spp. disease. VI037587 line (pedant fruit) and VI044930 line (erect fruit) were resistant to *Stemphylium* spp. disease. Thirty-seven chili pepper lines that were highly resistant to *Anthraco* disease. These WorldVeg pepper lines with good disease resistance, which are a great valuable germplasm resource for the chili pepper breeding program in Vietnam.

Keywords: Chili pepper, horticultural and disease resistance, WorldVeg, Gia Lam, Ha Noi.

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1. INTRODUCTION

Chili pepper (*Capsicum* spp.) is one of the oldest domesticated crops originating in the Americas [1]. Chili pepper, comprising around 17% of the global spice trade [2], is an essential ingredient contributing flavor and spiciness to numerous cuisines around the world [1]. Chili pepper production and consumption have increased

over the past three decades, especially for hot chili peppers and an estimated quarter of the world's population consumes chili peppers daily [3], rising from 1.4 to roughly 4.2 million tons of dried types and from 14 to 38 million tons of fresh types. Approximately 65% of chili pepper is produced in Asia [4] and being a high-value crop, chili pepper can have economic benefits for smallholder

farmers, greatly improving family income and socioeconomic mobility [5, 6].

Chili peppers have a significant economic value that compared to other agricultural products, with annual global trade worth \$35 billion. The Asia-Pacific region leads the global chili market, with China consistently ranking as the world's largest chili exporter. Key chili products include frozen fresh chili, dried chili, chili powder, and chili sauce.

Chili is one of the most important spices and indispensable in all people's daily meals in Vietnam. The cultivation of this crop has contributed significantly to the income of many farming households. As of the end of March, Vietnam exported 3,141 tons of chili peppers with worth US\$8.1 million, representing an increase of 17.6 percent in volume and 52.8 percent in value over the same period of 2023, according to data from the Vietnam Pepper Association (VPA). Last year, Vietnam's chili pepper exports reached a turnover of \$20 million with exported totaling 10,173 tons, marking a sharp increase of 107 percent year-on-year. Chili pepper was produced in an area of 37,030 ha with a production of 489,080 tons. The Mekong Delta is known as the "capital" of chili pepper cultivation in Vietnam, particularly in provinces such as Dong Thap, An Giang, Tien Giang, Soc Trang, Vinh Long, and Tra Vinh with a combined cultivation area of over 7,000 hectares and annual output of about 100,000 ton. In the Central Highlands, chili peppers are cultivated across a total area of 4,000 - 5,000 hectares with an output of about 60,000 tons a year [7]. Vietnam's demand for chili seeds is very large in 2020, reaching 10.3 tons of chili seeds, while hybrid seeds (F1) account for 95% and of which 90% are imported from other countries. Chili hybridization was first carried out in the 90s in Vietnam, from collecting, evaluating to local varieties, selecting and creating pure lines to create F1 hybrid varieties. Vietnam's demand for chili seeds is very

large in 2020, reaching to 10.3 tons of chili seeds, while hybrid seeds (F1) account for 95% and of which 90% are imported from other countries. Chili hybridization was first carried out in the 90s in Vietnam, from collecting, evaluating local varieties, selecting and creating pure lines to create F1 hybrid varieties.

The World Vegetable Centre is one of the organizations that research and develop chili pepper and sweet pepper gene sources, especially disease-resistant gene sources, which has achieved many excellent results. Therefore, accessing chili gene sources with good agronomic characteristics and disease resistance through international cooperative research programs is a good approach to supplement the source of materials for F1 hybrid chili breeding as well as quickly developing chili pepper varieties suitable for Vietnam's weather conditions.

2. MATERIALS AND METHODS

2.1. Materials

Forty (40) chili pepper lines were received on 27 March 2023 (Release code AVPP and VI) from the World Vegetable Center. Among them, there are six male sterile lines (AVPP9909-S; AVPP9910-S, AVPP9606-S, AVPP0711-S, AVPP9911-S and AVPP0309-S).

2.2. Methods

2.2.1. The first experiment was implemented in a plastic house

Forty WorldVeg chili pepper line seeds were sown on 2 August, 2023 and the seedlings were transplanted on FAVRI's plastic house on 10 September, 2023. The varietal trials were arranged without replications in green house. The experiment was sprayed with pesticides to control diseases and insects.

There were four chili pepper lines (VI047102, AVPP0024, AVPP1806, and VI044930) were died by fusarium in the nursery.

2.2.2. The second experiment was implemented on the open field

Forty WorldVeg chili pepper line seeds were sown on 2 November 2023 and the seedlings were transplanted on FAVRI field on 15 December 2023. The varietal trials were arranged without replications in an open field in FAVRI (Fruit and Vegetable Research Institute, Gia Lam district, Ha Noi city, Vietnam). The experiment was without insecticide spraying for screening of disease resistance.

* *Applying the chili pepper procedure of FAVRI*: The entire plot was mulched with plastic film to conserve soil moisture and control weeds. The plot size was 1.5 x 6.0 m² with 2 rows/plot and 24 plants/plot. NPK fertilizer at the rate of 120 - 90 - 120 kg/ha and manure fertilizer at 20,000 kg/ha.

These experiments were conducted in FAVRI (Fruit and Vegetable Research Institute, Gia Lam district, Ha Noi city, Vietnam).

Data were collected on:

- The agronomic characteristics: Day to open 50% flower (Days after transplanting - DAT); Days to first harvest (DAT); Average fruit weight (g); Plant height (cm); Canopy diameter (cm); Fruit length (cm); Fruit width (cm); Length of fruit peduncle (cm); Fruit type; Number of fruit/plant, Fruit weight (g); Fruit weight/plant (g).

- Disease damage (viral, *Stemphylium* spp. and Anthracnose): Pest and disease damage: Subscribe to the extent infected with diseases by the guidance of the World Vegetable Center (WorldVeg).

Disease Rating Score:

- + Score 0: No Symptom (High resistance).
- + Score 1: Light 1 - 10% leaf area infected (Resistance).
- + Score 2: Average 11 - 25% of leaf area infected (Moderate resistance).
- + Score 3: Heavy 26 - 50% of leaf area infected (Moderate susceptible).

+ Score 4: Very heavy 51 - 75% of leaf area infected (Susceptible).

+ Score 5: Serious 76 - 100% of leaf area infected (High susceptible).

Subscribe to the rate of viral infection by calculating the percent of plant damage:

$$\text{Disease} = \frac{\text{Number of damaged plant/plot}}{\text{Total number of plants/plot}} \times 100 (\%)$$

Analytical methods and data processing

The data were subjected to an analysis of variance using Excel.

3. RESULTS AND DISCUSSIONS

3.1. Growth periods and plant characteristics

Thirty six chili pepper varieties were divided into 2 fruit types, including 22 lines of the pendant fruit type and 14 lines of the erect fruit type. There are six male sterile lines (AVPP9909-S; AVPP9910-S, AVPP9606-S, AVPP0711-S, AVPP9911-S, and AVPP0309-S) that did not fruit setting.

Time from transplanting to 50% flowering ranged from 18 days (AVPP2007) to 30 days (AVPP0520, AVPP1324, AVPP2077) (Table 1). While the time from transplanting to first harvesting ranged from 75 to 82 days. AVPP2007 was earliest in flowering and also earliest in maturity (75 days). However, some lines as viz. AVPP9911, AVPP0520, AVPP1324, AVPP1342, and AVPP2077 were the latest in the mature (82 days after transplanting). Among the 36 chili pepper lines, there are 6 lines are CMS lines (AVPP9909-S, AVPP9910-S, AVPP9606-S, AVPP0711-S, AVPP9911-S, AVPP0309-S).

Plant height is an important growth characteristic in chili peppers. The yield of the crop was influenced by the vigor of the plant, where the plant height plays an important. The plant height ranged from 41.60 (AVPP2007) to 135.40 cm (AVPP0520) at full maturity. AVPP0711, AVPP0520, VI037587, AVPP1345, AVPP1245, and AVPP2077 lines have a plant height over 100 cm and the canopy diameters more than 70 cm.

Table 1. Growth periods and plant characteristics of WorldVeg chili pepper lines in a plastic house in winter crop 2023 - spring crop 2024 at Gia Lam district, Ha Noi city, Vietnam

No.	Lines	Days to 50% flowering (DAT)	Days to first harvesting (DAT)	Plant height (cm)	Canopy diameter (cm)
Pendant fruit type					
1	AVPP2001	21	78	83.60	66.65
2	AVPP2004	23	80	73.40	59.18
3	AVPP2005	21	78	85.00	66.62
4	AVPP2003	23	80	70.20	64.18
5	AVPP2007	18	75	41.60	50.20
6	AVPP22002	24	80	89.00	60.74
7	AVPP9909-S	24	-	44.80	41.26
8	AVPP9909	24	80	40.00	40.75
9	AVPP9910-S	24	-	87.40	66.84
10	AVPP9910	28	80	96.60	64.04
11	AVPP9606-S	26	-	67.40	57.50
12	AVPP9606	26	80	63.20	61.25
13	AVPP0711-S	26	-	98.60	72.62
14	AVPP0711	28	80	118.20	88.16
15	VI037587	28	80	121.20	92.12
16	AVPP0808	28	80	75.40	53.66
17	AVPP1808	24	80	82.20	64.28
18	AVPP1807	25	80	91.40	63.22
19	AVPP1345	26	80	112.60	77.36
20	AVPP1324	30	82	94.20	67.32
21	AVPP1342	28	82	87.40	76.78
22	AVPP1333	24	80	83.40	68.54
Erect fruit type					
23	AVPP2008	21	78	73.40	36.16
24	AVPP1609-022	24	78	67.40	51.52
25	AVPP0506	24	80	96.60	65.85
26	AVPP1609-085	24	80	71.60	54.67
27	AVPP9911-S	26	-	78.20	57.82
28	AVPP9911	28	82	81.40	53.34
29	AVPP0309-S	28	-	84.60	63.36
30	AVPP0309	28	80	78.20	57.66
31	AVPP0520	30	82	135.40	84.72
32	AVPP1812	24	80	65.60	57.45

33	VI059328	26	80	72.80	62.78
34	AVPP1245	24	80	113.20	77.62
35	AVPP2076	25	80	93.60	68.36
36	AVPP2077	30	82	112.40	74.41

3.2. Fruit characters

Fruit quality is an important criterion for hot pepper production.

For the pendant fruit group, the fruit length was usually large, ranging from 10.23 cm to 15.06 cm, except for VI037587 (at 7.64 cm), AVPP0808 (at 8.82 cm), and AVPP 1807 (at 6.66 cm). In the erect fruit group, the fruit length ranged from 3.48 cm to 8.45 cm.

Fruit diameter varied from 0.72 to 2.10 cm. Fruits of AVPP9606 had the largest fruit diameter (2.10 cm), smallest fruit diameter (0.72 cm) was recorded in AVPP2077. Overall, most of the pendant fruit-type lines had bigger fruit sizes than the erect fruit-type ones. The fruit peduncle length was not so different between the pendant fruit type and erect fruit type, it ranged from 2.02 to 4.84 cm.

Table 2. Fruit characters of WorldVeg chili pepper lines in a plastic house in winter 2023 – spring crop 2024 at Gia Lam district, Ha Noi city, Vietnam

No.	Lines	Fruit length (cm)	Fruit diameter (cm)	Fruit peduncle length (cm)
Pendant fruit type				
1	AVPP2001	14.30	1.44	3.76
2	AVPP2004	11.28	0.93	3.18
3	AVPP2005	12.31	1.30	3.37
4	AVPP2003	11.83	1.09	3.17
5	AVPP2007	11.72	1.20	2.36
6	AVPP22002	14.06	1.52	3.46
7	AVPP9909-S	-	-	-
8	AVPP9909	12.88	1.16	3.36
9	AVPP9910-S	-	-	-
10	AVPP9910	11.42	1.48	4.36
11	AVPP9606-S	-	-	-
12	AVPP9606	12.22	2.10	3.86
13	AVPP0711-S	-	-	-
14	AVPP0711	15.06	1.41	4.84
15	VI037587	7.64	0.94	3.78
16	AVPP0808	8.82	0.96	2.92
17	AVPP1808	10.23	1.27	4.44
18	AVPP1807	6.66	1.22	2.02

19	AVPP1345	13.53	1.21	3.48
20	AVPP1324	12.44	0.82	4.26
21	AVPP1342	14.07	1.45	3.74
22	AVPP1333	11.40	1.25	2.92
Erect fruit type				
23	AVPP2008	5.00	0.96	2.96
24	AVPP1609-022	5.82	1.16	2.02
25	AVPP0506	7.60	1.00	3.18
26	AVPP1609-085	8.45	0.96	2.86
27	AVPP9911-S	-	-	-
28	AVPP9911	5.81	1.82	3.06
29	AVPP0309-S	-	-	-
30	AVPP0309	7.85	0.85	2.62
31	AVPP0520	4.43	1.04	4.22
32	AVPP1812	6.45	0.86	2.98
33	VI059328	3.82	0.76	3.42
34	AVPP1245	6.26	0.78	3.17
35	AVPP2076	8.44	0.87	3.26
36	AVPP2077	3.48	0.72	3.46

3.3. Yield and yield components

The number of fruits per plant is one of the most important yields attributing characteristics of chili pepper. The number of fruits per plant remarkably varied among all lines.

For the pendant fruit group with large fruit size, the number of fruits/plants is often lower than the erect fruit group. AVPP 0711 line had the lowest number of fruits per plant (4.60 fruits), AVPP2004 line had the highest number of fruits per plant at 67.0 fruits/plant. For erect fruit type, AVPP9911 line had the lowest number of fruits per plant (31.60 fruits), AVPP1245 line had the highest number of fruits per plant at 189.40 fruits/plant. Such variation in chili genotypes for several fruits per plant [8 - 10].

Most of the fruit weight of the pendant fruit type group is bigger than the fruit weight of the

erect fruit type group. However, there are five chili pepper lines as AVPP2004, VI037587, AVPP0808, AVPP1807 and AVPP1324 are belong to small fruit size with the lowest fruit weight range from 3.3 cm to 4.4 cm. AVPP22002 line gave the highest fruit weight at 23.6 g and followed by AVPP9606 line with at 18.6 g. The other rest lines gave fruit weight ranging from 7.2 - 14.4 g.

For erect fruit type, most of the chili pepper lines gave fruit weight ranging from 1.1 - 4.6 g, only AVPP9911 line gave big fruit with fruit weight at 7.6 g.

Therefore, depending on the goal of breeding chili peppers with fruit sizes such as length, diameter, and weight, we can choose chili pepper parent lines with characteristics suitable for the oriented goal.

Fruit weight/plant was different between entries. Fruit weight/plant ranged from 40.6 to 762.6 g in the pendant fruit type group, and ranged from 48.2 - 470.6 g in the erect fruit type group. The results were in accordance with findings on

the previous research of Kumari and al; Arya and al [10 - 13].

Therefore, depending on the objectives of the chili pepper breeding program, criteria such as length, diameter, fruits/plant, and fruit weight are considered to select suitable parent lines.

Table 3. Yield and yield components of WorldVeg chili pepper lines in a plastic house in winter crop 2023 – spring crop 2024 at Gia Lam district, Hanoi city, Vietnam

No.	Lines	Fruits/plant	Fruit weight (g)	Fruit weight/plant (cm)
Pendant fruit type				
1	AVPP2001	52.2 ± 7.36	14.4 ± 0.26	751.7 ± 38.44
2	AVPP2004	67.0 ± 16.06	4.1 ± 0.16	274.7 ± 4.94
3	AVPP2005	54.4 ± 15.55	11.0 ± 10.60	598.4 ± 4.05
4	AVPP2003	65.6 ± 8.05	7.4 ± 0.10	485.4 ± 5.41
5	AVPP2007	31.6 ± 4.58	9.1 ± 0.08	287.6 ± 0.36
6	AVPP22002	18.6 ± 4.04	23.6 ± 0.45	439.0 ± 0.90
7	AVPP9909-S	-	-	-
8	AVPP9909	22.6 ± 5.68	7.4 ± 0.03	167.2 ± 3.74
9	AVPP9910-S	-	-	-
10	AVPP9910	24.7 ± 8.14	11.1 ± 0.45	274.2 ± 4.42
11	AVPP9606-S	-	-	-
12	AVPP9606	41.0 ± 5.29	18.6 ± 0.65	762.6 ± 5.63
13	AVPP0711-S	-	-	-
14	AVPP0711	4.6 ± 2.07	14.4 ± 1.37	66.2 ± 1.30
15	VI037587	12.3 ± 5.13	3.3 ± 0.57	40.6 ± 0.55
16	AVPP0808	46.0 ± 7.00	3.4 ± 0.10	156.4 ± 3.31
17	AVPP1808	35.7 ± 10.97	7.2 ± 0.05	257.0 ± 1.41
18	AVPP1807	20.7 ± 3.51	3.8 ± 0.10	78.7 ± 0.70
19	AVPP1345	54.3 ± 9.60	11.4 ± 9.06	619.0 ± 7.30
20	AVPP1324	23.3 ± 8.20	4.4 ± 0.10	102.5 ± 0.86
21	AVPP1342	38.0 ± 6.00	11.7 ± 0.76	444.6 ± 2.19
22	AVPP1333	21.0 ± 2.64	7.2 ± 0.72	151.2 ± 1.68
Erect fruit type				
23	AVPP2008	41.3 ± 14.97	2.2 ± 0.10	90.9 ± 0.10
24	AVPP1609-022	42.0 ± 8.17	3.7 ± 0.10	155.4 ± 0.10
25	AVPP0506	110.5 ± 31.05	3.8 ± 0.01	419.9 ± 0.77
26	AVPP1609-085	102.3 ± 29.68	4.6 ± 0.05	470.6 ± 8.52

27	AVPP9911-S	-	-	-
28	AVPP9911	31.6 ± 7.09	7.6 ± 0.15	240.2 ± 4.41
29	AVPP0309-S	-	-	-
30	AVPP0309	117.0 ± 17.62	2.9 ± 0.10	339.3 ± 2.35
31	AVPP0520	113.3 ± 17.09	2.3 ± 0.57	260.6 ± 1.11
32	AVPP1812	42.8 ± 14.0	3.8 ± 0.02	162.6 ± 1.75
33	VI059328	53.7 ± 7.37	1.2 ± 0.10	64.4 ± 1.03
34	AVPP1245	189.4 ± 70.2	2.2 ± 0.10	416.7 ± 1.28
35	AVPP2076	106.0 ± 27.22	3.2 ± 0.18	339.2 ± 1.36
36	AVPP2077	43.8 ± 11.18	1.1 ± 0.14	48.2 ± 1.63

3.4. Disease resistance

Table 4. Disease resistance of WorldVeg chili pepper lines in a plastic house in winter crop 2023 – spring crop 2024 at Gia Lam district, Ha Noi city, Vietnam

No.	Lines	Virus (%)	<i>Stemphylium</i> spp. (%)	No.	Lines	Virus (%)	<i>Stemphylium</i> spp. (%)
	Pendant fruit type				Pendant fruit type		
1	AVPP2001	0.00	16.67	20	AVPP1324	0.00	25.00
2	AVPP2004	0.00	16.67	21	AVPP1342	0.00	16.67
3	AVPP2005	0.00	8.33	22	AVPP1333	0.00	25.00
4	AVPP2003	0.00	16.67		Erect fruit type		
5	AVPP2007	0.00	25.00	23	AVPP2008	33.33	50.00
6	AVPP22002	25.00	66.67	24	AVPP1609-022	0.00	8.33
7	AVPP9909-S	0.00	58.33	25	AVPP0506	0.00	0.00
8	AVPP9909	0.00	25.00	26	AVPP1609-085	0.00	8.33
9	AVPP9910-S	0.00	33.33	27	AVPP9911-S	25.00	33.33
10	AVPP9910	25.00	33.33	28	AVPP9911	0.00	50.00
11	AVPP9606-S	0.00	58.33	29	AVPP0309-S	22.22	25.00
12	AVPP9606	0.00	33.33	30	AVPP0309	0.00	33.33
13	AVPP0711-S	0.00	16.67	31	AVPP0520	0.00	16.67
14	AVPP0711	0.00	50.00	32	AVPP1812	0.00	33.33
15	VI037587	9.09	8.33	33	VI059328	0.00	16.67
16	AVPP0808	0.00	25.00	34	AVPP1245	0.00	41.67
17	AVPP1808	20.00	16.67	35	AVPP2076	0.00	16.67
18	AVPP1807	0.00	8.33	36	AVPP2077	0.00	25.00
19	AVPP1345	8.33	0.00				

For the experiment conducted in greenhouse conditions, which limited disease vectors, most of chili lines were not infected with the virus. However, 3 pendant fruit type lines (AVPP22002, AVPP9910, and AVPP1808) and 3 erect fruit type lines (AVPP2008, AVPP9911-S, and AVPP0309-S) were infected with the virus at a rate of 20.00 - 33.33%.

Most of the pepper lines in this experiment were attacked by *Stemphylium* spp., except for two lines AVPP1345 (pedant fruit) and AVPP0506 (erect fruit) which were not infected by *Stemphylium* spp. so they are considered high resistance. Three lines in pedant fruit as AVPP2005, VI037587 and AVPP1807 and two erect fruits as AVPP 1609-022 and AVPP9911-S, which

are considered resistant with *Stemphylium* spp. disease. Other rest lines were attacked by *Stemphylium* spp. with high incidence from 16.67 - 66.67%.

In addition to evaluating the agrobiologically characteristics and disease resistance of chili pepper lines under greenhouse conditions, evaluating the natural disease resistance in the field to identify and select resistant lines is very important for breeders. Forty chili pepper lines imported from the World Vegetable Center were arranged on open-field experiments without spraying pesticides to eliminate viral disease vectors as well as without fungicides to eliminate fungal spores. The results were shown in the table 5.

Table 5. Disease infection of WorldVeg chili pepper lines on open field in winter crop 2023 – spring crop 2024 at Gia Lam district, Ha Noi city, Vietnam

No	Lines	Non - sprayed pesticides					
		<i>Stemphyliu m</i> spp. (%)	<i>Stemphylium</i> spp. (Score)	Virus (%)	Virus incidence (score)	Anthracnose (%)	Anthracnose incidence (Score)
	Pedant fruit type						
1	AVPP2001	15.0	2	11.0	2	0	0
2	AVPP2004	60.0	3	24.0	2	0	0
3	AVPP2005	0	0	52.0	4	0	0
4	AVPP2003	25.0	2	15.0	2	0	0
5	AVPP2007	0	0	51.0	4	0	0
6	AVPP22002	0	0	55.6	4	12.5	2
7	AVPP0309-S	12.5	2	40.1	3	0	0
8	AVPP9909-S	0	0	42.4	4	0	0
9	AVPP9910-S	0	0	86.1	5	0	0
10	AVPP9606-S	0	0	58.4	4	0	0
11	AVPP0711-S	12.5	2	21.3	2	0	0
12	AVPP1345	11.1	2	40.2	3	0	0
13	VI037587	0	1	81.3	5	0	0
14	VI047102	0	0	84.6	5	0	0

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15	AVPP0024	0	0	52.3	4	0	0
16	AVPP0808	33.3	3	23.3	2	0	0
17	AVPP1342	0	0	45.3	3	0	0
18	AVPP9909	20.0	2	38.4	3	0	0
19	AVPP9910	0	0	35.6	3	0	0
20	AVPP9606	50.0	3	28.3	2	0	0
21	AVPP0711	20.0	2	10.0	2	0	0
22	AVPP1808	25.0	2	32.4	3	0	0
23	AVPP1806	0	0	36.2	3	0	0
24	AVPP1807	0	0	25.8	2	0	0
25	AVPP1324	0	0	0.0	0	0	0
26	AVPP1333	25.0	2	35.6	3	0	0
	Erect fruit type						
27	AVPP2008	40.0	3	33.4	3	0	0
28	AVPP1609-022	0	0	35.1	3	0	0
29	AVPP0506	50.0	3	62.4	4	0	0
30	AVPP1609-085	0	0	33.1	3	70.0	4
31	AVPP9911-S	50.0	3	52.1	4	0	0
32	AVPP0520	25.0	2	45.6	3	0	0
33	VI059328	0	0	20.6	2	0	0
34	VI044930	10.0	1	48.3	4	0	0
35	AVPP0309	0	0	32.6	3	0	0
36	AVPP9911	87.5	3	35.3	3	0	0
37	AVPP1812	0	0	40.2	3	41.6	3
38	AVPP1245	20.0	2	25.1	2	0	0
39	AVPP2076	0	0	22.1	2	0	0
40	AVPP2077	0	0	28.3	2	0	0

Screening of leaf spot (*Stemphylium* spp.) disease

There are 13 pendant hot pepper lines such as AVPP2005, AVPP2007, AVPP22002, AVPP9909-S, AVPP9910-S, AVPP9606-S, VI047102, AVPP0024, AVPP1342, AVPP9910, AVPP1806, AVPP1807, and AVPP1324 and 7 erect fruit lines such as AVPP1609-022, AVPP1609-085, VI059328, AVPP0309, AVPP1812, AVPP2076, AVPP2077 were highly resistant to *Stemphylium* spp.

Resistant to *Stemphylium* spp. included VI037587 (pendant fruit) and VI044930 line (erect fruit).

Moderately resistant to *Stemphylium* spp. included nine lines of pendant fruit as AVPP2001, AVPP2003, AVPP0309-S, AVPP0711-S, AVPP1345, AVPP9909, AVPP0711, AVPP1808, AVPP1333 (pendant fruit) and two lines of erect fruit as AVPP0520, AVPP1245.

The other rest hot pepper lines were moderately susceptible with *Stemphylium* spp.

Screening of virus disease

Only AVPP1324 line (pendant fruit) was highly resistant to virus diseases.

There are 8 pendant fruit lines (AVPP2001, AVPP2004, AVPP2003, AVPP0711-S, AVPP0808, AVPP9606, AVPP0711, AVPP1807) and 4 erect fruit lines (VI059328, AVPP1245, AVPP2076, AVPP2077) were moderately resistant to virus disease. The other rest lines were susceptible and high susceptible to virus. These results are relevant for the study of current situation, breeding strategies and future prospects for the management of virus on peppers (*Capsicum* spp.) [14].

Screening of Anthracnose disease

Most of the pepper lines were not infected with Anthracnose disease except for three lines as AVPP22002 (at score 2), AVPP1812 (at score 3 and AVPP1609-085 (at score 4).

The results of evaluation and selection for disease-resistant chili pepper lines are very valuable for chili pepper breeders, especially in breeding disease-resistant F1 hybrid chili pepper varieties.



Figure 1. Pictures of WorldVeg promising chili pepper lines in winter crop 2023 – spring crop 2024

4. CONCLUSION

Through the results of the evaluation of agronomic characteristics and disease resistance, we determined seven lines (AVPP2001, AVPP2005, AVPP1609-022; AVPP0506; AVPP1609-085; AVPP1807; AVPP1345) which had highly potential yield, nice fruit appearance and good disease resistance.

AVPP1324 line was highly resistant to virus disease.

Thirteen pendant fruit lines (AVPP2005, AVPP2007, AVPP22002, AVPP9909-S, AVPP9910-S, AVPP9606-S, VI047102, AVPP0024, AVPP1342, AVPP9910, AVPP1806, AVPP1807, AVPP1324) and seven erect fruit lines (AVPP1609-022, AVPP1609-085, VI059328, AVPP0309, AVPP1812, AVPP2076, AVPP2077) were high resistant to *Stemphylium* spp. disease.

VI037587 line (pendant fruit) and VI044930 line (erect fruit) were resistant to *Stemphylium* spp. disease.

Thirty-seven chili pepper lines that were highly resistant to *Anthraco* disease. The WorldVeg chili pepper lines are available germplasm resources for the Vietnam chili pepper breeding program in general and particular in FAVRI. Special, 6 male sterile chili pepper lines (AVPP9909-S; AVPP9910-S, AVPP9606-S, AVPP0711-S, AVPP9911-S, and AVPP0309-S) are very valuable genetic resources in F1 hybrid breeding and F1 hybrid seed production.

REFERENCES

1. Bosland P. W., Votava E. J. (2012). Vegetable and Spice Capsicums (*Wallingford, UK: CABI*). doi: 10.1079/978184593 8253.0000.
2. Ahmed J., Shivhare U. S., Raghavan G. S. V. (2000). Rheological characteristics and kinetics of colour degradations of green chili puree. *J. Food. Eng.* 44, 239 - 244. doi: 10.1016/S0260-8774 (00)00034-0.
3. Halikowski-Smith S. (2015). In the shadow of a pepper - centric historiography: Understanding the global diffusion of Capsicums in the sixteenth and seventeenth centuries. *J. Ethnopharmacol.* 167, 64 - 77. doi: 10.1016/j.jep.2014.10.048.
4. FAOSTAT. (2022). Food and agriculture organization of the United Nations. Available at: <http://www.fao.org/faostat/en/>.
5. Weinberger L., Lumpkin T. A. (2007). Diversification into horticulture and poverty reduction: a research agenda. *World Dev.* 35(8), 1464 - 1480. doi: 10.1016/j.worlddev. 2007.05.002.
6. Kahane R., Hodgkin T., Jaenicke H., Hoogendoorn C., Hermann C., Keatinge J. D. H., et al. (2013). Agrobiodiversity for food security, health and income. *Agron. Sustain. Dev.* 33 (4), 671 - 693. doi: 10.1007/s13593-013-0147-8.
7. General Statistics office of Vietnam (2023). Statistical Yearbook 2022. *Statistical Publishing House*, Ha Noi.
8. Smitha, R. P. and N. Basavaraja. (2006). Variability and Correlation Studies in Chilli (*Capsicum annum* L.). *Karnataka Journal of Agricultural Sciences*, 19(4): 888 - 891.
9. Chattopadhyay, A. A., A. A. Sharangi, N. Dai and S. Dutta. (2011). Diversity of genetic resources and genetic association analyses of green and dry chilies of Eastern India. *Chilean Journal of Agricultural Research*, 71(3).
10. Kumari, V., J. Singh, D. Sharma and M. M. Sunidhi. (2017). Evaluation of chili genotypes for growth and fruit yield attributing traits under Chhattisgarh Plains conditions. *International Journal of Current Microbiology and Applied Sciences*, 6(11): 3478 - 3483.

11. Gupta, A. M., D. Singh and A. Kumar. (2009). Genetic variability, genetic advance and correlation studies in chili (*Capsicum annuum* L.). *Indian Journal of Agricultural Sciences*, 79: 221 - 223.
12. Amit, K., I. Ahad; V. Kumar and S. Thakur. (2014). Genetic variability and correlation studies for growth and yield character in chili (*Capsicum annuum* L.). *Journal of spice and Aromatic Crops*, 23(2): 170 - 177.
13. Arya, V. K., S. Bhandari and A. C. Mishra. (2018). Evaluation of variability for growth, seed yield and its contributing characters in Chili genotypes. *International Journal of Current Microbiology and Applied Sciences*, 7(10): 1118 - 1125.
14. Manoj Kumar Nalla, Roland Schafleitner, Hanu R Pappu, Derek W Barchenger. (2023). Current status, breeding strategies and future prospects for managing chili leaf curl virus disease and associated begomoviruses in Chili (*Capsicum* spp.). *Front Plant Sci*, 2023 Oct 23:14:1223982. doi: 10.3389/fpls.2023.1223982.