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FIELD EVALUATION OF AGRONOMIC PARAMETERS OF PROMISED-INTRODUCED TOMATO CULTIVARS (*Solanum Lycopersicon* Mill) IN WINTER-SPRING SEASON 2016–2017 IN THUA THIEN HUE, VIETNAM

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Abstract: The main objective of this study is to evaluate the growth ability and yield of promised-introduced tomato cultivars during winter-spring season 2016–2017 in Thua Thien Hue province. A total of eight cultivar treatments were used, namely GC171, GC173, CLN2001A, CLN5915, CLN1621L, Hawai7996, Cherry, and ThuanDien. Three promising cultivars (CLN2001A, CLN5915, and CLN1621L) were selected from two previous experiments. The field experiment was laid out in a randomized complete block design with three replications. Ten plants per replication were examined. The results show that CLN2001A, GC171, CLN1621L, CLN5915, and Hawai7996 have an early harvest period, ranging from 106 to 109 days, and their morphological and vegetative characteristics of are suitable under Thua Thien Hue conditions. Cultivars CLN5915, CLN1621L, and CLN2001A have a high actual yield with 15.7, 12.1, and 7.8 ton/ha, respectively. The Brix degree of high fruit quality ranges from 4.1 to 4.6 Bx. Therefore, these introduced cultivars can be considered as promising for tomato breeding and cultivation under the local conditions.

Keywords: tomato, agronomic characteristics, yield, Thua Thien Hue

1 Introduction

Tomato (*Solanum Lycopersicon* Mill) belonging to the Solanaceae family originates in western South America [1–3]. This crop is considered as one of the popular and second most consumed vegetables worldwide after potato [4, 5]. It is an important ingredient of the traditional Mediterranean diet as well as the other diets due to their abundant nutrients and secondary metabolites [6, 7]. Carbohydrates, fat, protein, vitamins, minerals, and other constituents (water, and lycopene) that support human health are found in raw red tomatoes [8]. Tomato lycopene and its role in the human being and chronic diseases are mentioned by Agarwal et al. [9]. In addition, the evidence of the role of nutritional values of tomato fruit is published in many papers. Frusciante et al. [6] reported the antioxidant nutritional quality of tomatoes. The evaluation of nutritional value and antioxidant activity of tomato peel extracts is reviewed by Elbadrawy and Sello [10]. On the other hand, tomato is widely consumed as a raw vegetable or

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processed products [11]. It is usually used to make a salad with other leafy vegetables and in sandwiches. It can be fried, stewed, and baked alone or in combination with other vegetables. It is an essential ingredient in pasta, hamburgers, pizzas, hot dogs, and other foods [4]. Potatoes are not just a food item in human diets, but they are also research materials in science [12]. Schumacher et al. [13] carried out an experiment on the *Lateral suppressor* (*Ls*) gene of tomato encoded with a new member of the VHIID protein family. A polypeptide from tomato leaves that induces wound-inducible proteinase inhibitor proteins was published by Pearce et al. [14].

In Vietnam, tomatoes are one of the oldest plants used as either a main fruit or a vegetable crop. Until present, it has been a crop prioritized for development in domestic agriculture. According to the statistics in 2013, the cultivation area was about 23.91 thousand hectares and mainly spread in the Red River Delta area such as Ha Noi, Hai Phong, Hai Duong, Thai Binh, Hung Yen, Bac Giang, Nam Dinh [15]. However, tomato has not been considered as the main crop in Thua Thien Hue. In 2011, the potato planting area was 4,144–4,500 hectares, mainly distributed in coastal sandy districts (Phu Vang, Phong Dien, Phu Loc), and alluvial areas (Hue City, Huong Tra, Quang Dien, Huong Thuy). A survey from 9 districts and Hue City shows that the structure of vegetables is still poor, containing mainly leaf vegetables such as water morning-glories, lettuces, and sweet potato buds. The cultivation area of tomato is small and scattered [16]. The currently cultivated tomatoes are the local cultivar or F1 line. The performance of the F1 line has proved to be unsuitable for climatic and soil conditions as well as cultivation techniques. Therefore, this cultivar is not widely applied in production. Besides, the change of weather conditions in the winter-spring season initiates many diseases, such as late blight *(Phytophthora infestans*) and bacterial wilt (*Ralstonia solanacearum*) [17, 18]. This is also one of the important reasons leading to low yield and low income for farmers. Truong et al. conducted two studies with tomatoes in two different seasons in Thua Thien Hue to select the appropriate tomato varieties for local conditions. One was in the 2014 spring-summer crop on sandy land, and the other was in the winter-spring crop of 2015–2016 [19, 20]. Therefore, the purpose of this study is to continue the evaluation of the agronomical characters of introduced-tomato cultivars under local field conditions.

2 Materials and method

2.1. Materials

The study uses eight tomato cultivars, namely GC171, GC173, CLN2001A, CLN5915, CLN1621L, Hawai7996, and two control cultivars Cherry and Thuan Dien (Table 1).

Table 1. Lists of tomato cultivars in the experiment

No.	Name of cultivar	Place of collection
1	GC171	National Institute of Horticultural and Herbal Science, Korea
2	GC173	National Institute of Horticultural and Herbal Science, Korea
3	CLN2001A	The World Vegetable Center
4	CLN5915	The World Vegetable Center
5	CLN1621L	The World Vegetable Center
6	Hawai7996	The World Vegetable Center
7	Cherry (Control 1)	Phu Nong Seeds Co., Ltd, Vietnam
8	ThuanDien (Control 2)	Thuan Dien Seed Company Limited, Vietnam

2.2. Experimental design

A field experiment was conducted during the winter-spring season from December 2016 to April 2017 in an open field at Institute of Development Studies, University of Agriculture and Forestry, Hue University, located at Huong Van, Huong Tra, Thua Thien Hue province. The experiment was laid out in a random complete block design with three replications. Each replication has ten plants. The spacing of 50 cm × 100 cm was applied in this study. Planting and nursing techniques were based on QCVN 01-63:2011/BNNPTNT guidelines [21].

2.3. Agronomy characteristics

The data were assessed according to QCVN 01-63:2011/BNNPTNT [21] and 10TCN 557-2002 [22]. The growth time was recorded from transplanting to the point when 50% of the plants give flowers and to the first and last harvesting. The morphological and vegetative characteristics of stems, leaves, flowers and fruits were also investigated. The stem includes the number of nodes from foot to the first flower (node), height from foot to the first flower (cm), plant height (cm), and growth type. Leaf parameters were directly obtained in adult leaves. The leaf length was measured from the top of the leaf to the petiole; the leaf width is the widest area of the leaf; the leaf color depends on the intensity of the green color, and the leaf shape was assessed on the division of the lobe of leaflets. Flower indicators include the number of flowers per inflorescence, the number of main stem inflorescences, the inflorescence type, the characteristics of blooming, and the percentage of fruiting (%). The fruit morphological traits were assessed when fruits are ripened. The color of the fruit shoulder was determined on the basis of the green color of the shoulder compared with the rest of the fruit. The color of the ripened fruit was observed when the fruit is fully ripened; the fruit diameter (cm) is the widest part of the fruit; the fruit height (cm) is the largest height of the fruit; the thickness of flesh fruit (cm) and number of locules/fruit (locule) were collected. The theoretical yield and actual yield were calculated according to Eqs. (1) and (2)

$$\text{Theory yield (tons/ha)} = \frac{\text{number of fruit}}{\text{number of plants}} \times \text{fruit weight} \times \text{plant density} \quad (1)$$

$$\text{Actual yield (tons/ha)} = \frac{\text{yield of experiment plot (tons)}}{\text{plot area (m}^2\text{)}} \times 10^4 \quad (2)$$

Fruit quality was assessed as the height/diameter ratio ($I = H/D$), firmness, wetness (flesh), taste, and Brix degree at harvesting. The late blight disease was recorded using the scoring method. The other diseases were evaluated from transplanting to harvesting according to Eq. (3)

$$\text{Rate of disease (\%)} = \frac{\text{number of diseased plants}}{\text{total number of monitored plants}} \times 100 \quad (3)$$

2.4 Weather conditions

The weather conditions during the experiment are presented in Table 2. From December to February, the plants were affected by a low mean temperature (20.5–21.4 °C), and a high number of rainy days (17–30 days). From March to April, although the sunny hours were highest (120–143 h), the low rainfall led to the obstacles of the fruit development.

Table 2. Weather conditions recorded in winter-spring season 2016–2017

Month	Temperature (°C)			Humidity (%)		Rainfall		Total sunny hour (h)
	T_{mean}	T_{max}	T_{min}	H_{mean}	H_{min}	NRD (day)	$R_{mean\ (mm)}$	
December	21.1	27.5	16.3	98	71	30	1211.8	21
January	21.4	29.1	16.8	93	58	21	241.7	80
February	20.5	30.2	15.2	94	49	17	205.1	101
March	23.5	32.8	16.4	92	66	10	47.3	143
April	28.2	38.2	18.1	88	48	8	28.4	120

T: temperature; H: humidity; R: rain; NRD: number of rainy days.

Source: Center for Hydrometeorology Forecast of Thua Thien Hue Province.

2.5 Statistics analysis

The raw data were analyzed using Excel 2010, while the differences in the mean values of the growth ability, yield and yield components among the treatments were compared using Duncan's test at $p < 0.05$.

3 Results and discussion

3.1 Time of growth

The growth time of tomato cultivars ranges around 110 days (Table 3). This parameter is an important factor to determine the crop season and apply appropriate techniques. The time from sowing to flowering among cultivars ranges from 18 to 22 days. CLN5915 and Hawai7996 have the earliest flowering time (18 days), followed by GC171 and CLN2001A (19 days). GC173 and CLN1621L have the same flowering time with 20 days. The flowering time of the controlled checks is 21 days for Cherry and 22 days for ThuanDien. The harvesting period depends on many factors, such as variety characteristics, weather conditions, and planting techniques. Both CLN2001A and CLN1621L have the shortest harvesting time (83 days), while control check 1 has the longest harvesting time (88 days). Almost all cultivars have the last harvest at 110 days, whereas control check 1 and control check 2 last longer with 115 days and 116 days, respectively. The data of the last harvest in this study are similar to those reported by Truong et al. [19, 20] in Thua Thien Hue province during a trial conducted on tomato varieties, which ranged from 101 to 120 days in the early spring-summer crop of 2014 and from 106 to 113 days in the winter-spring crop of 2015–2016.

Table 3. Growth time of tomato cultivars

Cultivar	Time (days) from transplanting to:		
	Flowering	Harvesting	
		First	Last
GC171	19	84	108
GC173	20	87	110
CLN2001A	19	83	106
CLN5915	18	84	109
CLN1621L	20	83	108
Hawai7996	18	84	109
Cherry (Control 1)	21	88	115
ThuanDien (Control 2)	22	87	116

3.2 Morphological and vegetative characteristics of plants

Stem

The highest number of nodes from foot to the first flower is observed with CLN1621L (10.0 nodes), and the lowest is with CLN2001A (7.4 nodes). The other cultivars have from 8.1 nodes (GC171) to 9.5 nodes (CLN5915 and Hawai7996). The height from foot to the first flower is determined by the length of each node. GC171 has the largest height (31.7 cm), and a significant difference is found between GC171 and the other cultivars (Table 4).

The plant height is one of the morphological indicators used to assess the growth, development, and yield. They are controlled by genetics but also influenced by environmental factors such as temperature, sunlight, soil nutrition, and cultivation techniques. The largest plant height is observed in control check 1 (85.1 cm), followed by control check 2 and CLN1621L with 55.4 cm and 51.1 cm, respectively. The smallest height is observed in CLN5915 (19.4 cm). The difference between the control checks and the remaining cultivars is statistically significant at the 95% confidence level. The growth type of cultivars is also different. Control check 1 and Hawai7996 have indeterminate growth; GC171 and GC173 have semi-determinate growth, and the other cultivars represent determinate growth. Furthermore, the growth type of CLN2001A, CLN5915, and CLN1621L in this study is the same as that published by Truong et al. [19, 20].

Table 4. Morphological and vegetative characteristics of the stem of tomato cultivars

Cultivar	No. of nodes from foot to 1st flower (node)	Height from foot to 1st flower (cm)	Plant height (cm)	Growth type
GC171	8.1^{cd}	31.7^{a}	37.1^{e}	S-D
GC173	8.8^{bc}	22.4^{bc}	36.6^{e}	S-D
CLN2001A	7.4^{d}	21.4^{bcd}	27.6^{f}	D
CLN5915	9.5^{ab}	21.3^{bcd}	19.4^{g}	D
CLN1621L	10.0^{a}	20.8^{cd}	51.1^{c}	D
Hawai7996	9.5^{ab}	19.2^{cd}	45.6^{d}	I
Control 1	8.8^{bc}	25.6^{b}	85.1^{a}	I
Control 2	9.1^{abc}	17.2^{d}	55.4^{b}	D
$LSD_{0.05}$	1.1	4.5	4.0	–

I = indeterminate, S-D = semi-determinate, D = determinate; Letters a–g mean that different letters in each column indicate significant difference at $\alpha = 0.05$.

Leaf

Leaf area was assessed by the length and width. Control check 2 has the largest length (30.7 cm), followed by Hawai7996 (29.8 cm) and CLN5915 (29.2 cm), and there is a significant difference between these cultivars and the others (Table 5). The width of leaves ranges from 9.0 cm (CLN2001A) to 20.3 cm (Hawai7996). Each cultivar has different morphological characteristics, and they are used to identify and distinguish the cultivars. The leaf color changes from light green to dark green. GC171, GC173, and CLN1621L come up with light green; CLN2001A, CLN5915, Hawai7996 and control check 2 turn into green, whereas dark green is observed in control check 1 only. All cultivars have the same regular leaf shape without any deformities.

Table 5. Morphological and vegetative characteristics of the leaf of tomato cultivars

Cultivar	Leaf length (cm)	Leaf width (cm)	Leaf color	Leaf shape
GC171	24.8^{bcd}	15.8^{c}	Light green	Regular leaf
GC173	23.9^{cd}	10.5^{d}	Light green	Regular leaf
CLN2001A	25.6^{bc}	9.0^{d}	Green	Regular leaf
CLN5915	29.2^{a}	18.5^{ab}	Green	Regular leaf
CLN1621L	22.8^{d}	14.8^{c}	Light green	Regular leaf
Hawai7996	29.8^{a}	20.3^{c}	Green	Regular leaf
Control 1	26.2^{b}	10.4^{d}	Dark green	Regular leaf
Control 2	30.7^{a}	16.3^{bc}	Green	Regular leaf
$LSD_{0.05}$	2.1	2.2	–	–

Letters a–d mean that different letters in each column indicate significant difference at $\alpha = 0.05$.

Flower

While the number of flowers per inflorescence of GC171, GC173, Hawai7996, and control check 2 is fewer than 8.0 flowers, the remaining cultivars have above 9.0 flowers (Table 6). There is a significant difference between GC171 and the other cultivars. The lowest number of inflorescences per main stem is six in CLN5915, and the highest is observed with control check 1 (11.8). GC173 and CLN1621L have the same number of inflorescences (11.1), followed by Hawai7996, CLN2001A, control check 2, and GC171 with 10.4, 8.9, 8.8, and 8.7, respectively.

All cultivars have the same inflorescence type (simple inflorescence). Blooming takes place synchronously and asynchronously. The synchronized type is CLN2001A, CLN5915, CLN1621L, and control check 1; meanwhile, GC171, GC173, Hawai7996, and control check 2 belong to the asynchronous blooming type. The percentage of fruiting is an important determinant of the yield. The lowest percentage is observed in CLN5915 with 52.0%, followed by CLN1621L, and control check 1 with 54.1%, and 59.1%, respectively. GC171 has the highest yield (72.0%). The remaining cultivars have a higher yield than control check 2. There is a significant difference among CLN5915, CLN1621L, and GC171. The percentage of fruiting of the CLN2001A, CLN5915, and CLN1621L cultivar in this study is higher than that reported by Truong et al. [19] where the resultant data ranged from 52 to 61%, those in another research in 2015–2016 [20] ranged from 46.93 to 57.72%.

Table 6. Morphological and vegetative characteristics of the flower of tomato cultivars

Cultivar	No. of flowers per inflorescence	No. of main stem inflorescences	Inflorescence type	Characteristic of blooming	Percentage of fruiting (%)
GC171	4.9[d]	8.7[c]	SI	Asynchronous	72.0[a]
GC173	6.9[c]	11.1[ab]	SI	Asynchronous	64.0[abc]
CLN2001A	10.6[ab]	8.9[c]	SI	Synchronized	66.1[ab]
CLN5915	11.3[a]	6.0[d]	SI	Synchronized	52.0[c]
CLN1621L	9.8[b]	11.1[ab]	SI	Synchronized	54.1[c]
Hawai7996	7.9[c]	10.4[b]	SI	Asynchronous	64.5[abc]
Control 1	9.6[b]	11.8[a]	SI	Synchronized	59.1[abc]
Control 2	7.4[c]	8.8[c]	SI	Asynchronous	62.1[abc]
$LSD_{0.05}$	1.3	1.2	–	–	13.3

SI = Simple inflorescence; a–d means that different letters in each column indicate significant difference at $\alpha = 0.05$.

Fruit

The color of the fruit shoulder is a characteristic morphology of variety and reflects the quality of ripened fruits. A light green color appears in GC171, GC173, and CLN2001A, while CLN5915, CLN1621L, Hawai7996, and control check 2 have a green shoulder; and control check 1 has a dark green shoulder (Table 7). The color of ripened fruits is also different among cultivars. GC171 and CLN5915 are red-orange, and the remaining cultivars are bright-red. The fruit diameter ranges from 2.2 cm (control check 1) to 5.2 cm (control check 2), and there is a significant difference between control check 2 and the other cultivars. The largest fruit height is also observed in control check 2 (6.7 cm), followed by CLN5915, CLN1621L, CLN2001A, and Hawai7996 ranging from 3.8 to 4.1 cm, while the remaining cultivars have a smaller fruit height. A statistically significant difference in the fruit height is found among these three groups. The thickness of fruit as the thickest fruit fresh is observed in control check 2 (0.7 cm). The number of locules per fruit of GC171, GC173, and the control checks is the same (2.1), and the other cultivars have from 2.4 locules (CLN1621L) to 3.1 locules (Hawai7996).

Table 7. Morphological and vegetative characteristics of the fruit of tomato cultivars

Cultivar	Color of fruit shoulder	Color of ripened fruit	Fruit diameter (cm)	Fruit height (cm)	Thickness of flesh fruit (cm)	No. of locules/ fruit (locule)
GC171	Light green	Red-orange	2.8^{cd}	2.9^{c}	0.4^{d}	2.1^{c}
GC173	Light green	Bright red	3.3^{bc}	2.8^{c}	0.3^{e}	2.1^{c}
CLN2001A	Light green	Bright red	3.6^{bc}	4.1^{b}	0.5^{e}	2.6^{bc}
CLN5915	Green	Red-orange	3.6^{bc}	3.8^{b}	0.5^{cd}	2.5^{bc}
CLN1621L	Green	Bright red	3.7^{b}	3.8^{b}	0.5^{bc}	2.4^{bc}
Hawai7996	Green	Bright red	4.0^{b}	4.1^{b}	0.5^{b}	3.1^{a}
Control 1	Dark green	Bright red	2.2^{d}	3.0^{c}	0.4^{e}	2.1^{c}
Control 2	Green	Bright red	5.2^{a}	6.7^{a}	0.7^{a}	2.1^{c}
$LSD_{0.05}$	–	–	0.8	0.2	0.1	0.5

Letters a–e mean that different letters in each column indicate significant difference at $\alpha = 0.05$.

3.3 Yield and yield components

Yield and yield components are the indicators to evaluate the adaptability of each cultivar under external conditions. The yield and yield components are shown in Table 8.

The number of fruits per plant ranges from 10.1 fruits (CLN2001A) to 23.5 fruits (control check 1). The highest mean fruit weight is observed in control check 2 (65.2 g), followed by Hawai7996 and CLN5915 with 40.0 g, and 29.5 g, respectively. There is a significant difference among CLN5915, CLN1621L, Hawai7996, and the controls.

The theoretical yield ranges from 5.0 ton/ha (CLN2001A) to 23.9 ton/ha (Hawai7996). A statistically significant difference is found between Hawai7996 and the other cultivars. The highest actual yield is recorded in CLN5915 (15.7 ton/ha), followed by Hawai7996 (12.1 ton/ha), CLN1621L (10.8 ton/ha), and CLN2001A (7.8 ton/ha). The actual yield of CLN5915, CLN1621L, and CLN2001A in this research is lower than that reported previously by Truong et al. [19], which ranged from 13.5 ton/ha (CLN5915) to 17.25 ton/ha (CLN1621L), and in another research in 2015–2016 [20] from 38.7 ton/ha (CLN1621L) to 41.9 ton/ha (CLN2001A).

Table 8. Yield and yield components of tomato cultivars

Cultivar	No. of fruits/ plant (fruit)	Mean fruit weight (g)	Theory yield (tons/ha)	Actual yield (tons/ha)
GC171	17.8^{ab}	19.6^{de}	9.8^{bcd}	6.9^{bc}
GC173	13.8^{bc}	19.3^{de}	7.7^{cd}	7.6^{bc}
CLN2001A	10.1^{c}	21.7^{de}	7.8^{d}	5.0^{bc}
CLN5915	19.5^{bc}	29.5^{c}	15.7^{bc}	12.6^{a}
CLN1621L	19.3^{ab}	23.2^{d}	16.5^{b}	10.8^{abc}
Hawai7996	21.8^{a}	40.0^{b}	23.9^{a}	12.1^{a}
Control 1	23.5^{a}	17.1^{e}	11.4^{bcd}	4.3^{c}
Control 2	13.6^{bc}	65.2^{a}	13.6^{bc}	7.7^{bc}
$LSD_{0.05}$	6.4	5.6	7.1	7.3

Letters a–e mean that different letters in each column indicate significant difference at $\alpha = 0.05$.

3.4 Fruit quality

Fruit quality is an important factor to increase the fruit value. It is expressed as the ratio height/diameter, firmness, wetness, tastiness, and Brix degree. Table 9 represents the fruit quality of the tomato cultivars. Most of the cultivars have round-shaped fruits, except the control checks which have a long round shape. The firmness and wetness of fruit flesh are related to each other. Medium firmness is observed in Hawai7996 and control check 1; the remaining cultivars have firm flesh. The wetness of fresh fruits is indicated as wet and mild-dry. GC171, GC173, CLN2001A, and CLN1621L are wet, while the CLN5915, Hawai7996 and the controls are mild-dry.

The tastiness is different among the cultivars. A sour taste is observed in most of the cultivars. Hawai7996 and control check 1 are tasteless. The taste of CLN2001A, CLN5915, and CLN1621L in this study is the same as that reported by Truong et al. [20]. The Brix degree is one of the indicators to evaluate the fruit quality of tomatoes. The less sour cultivar has a higher Brix value. Control check 1 has the highest Brix (5.3 Bx); followed by GC171 and control check 2 with 5.2 Bx. The lowest Brix degree is observed in CLN2001A with 4.1 Bx. There is a statistically significant difference between GC171, GC173, the control checks and the other cultivars at the 95% confidence level.

Table 9. Fruit quality of tomato cultivars

Cultivar	Ratio height/ diameter (*I* = *H*/*D*)	Firmness	Wetness (flesh)	Tasty	Brix
GC171	1.1^{b}	Firm	Wet	Sour	5.2^{a}
GC173	1.1^{b}	Firm	Wet	Sour	5.1^{a}
CLN2001A	1.1^{b}	Firm	Wet	Sour	4.1^{c}
CLN5915	1.1^{b}	Firm	Mild dry	Sour	4.2^{c}
CLN1621L	1.1^{b}	Firm	Wet	Sour	4.6^{b}
Hawai7996	1.1^{b}	Medium	Mild dry	Tasteless	4.4^{bc}
Control 1	1.3^{a}	Medium	Mild dry	Tasteless	5.3^{a}
Control 2	1.3^{a}	Firm	Mild dry	Sour	5.2^{a}
$LSD_{0.05}$	0.1	–	–	–	0.3

$I < 0.6$: flat shape; $0.6 < I < 0.9$: flat round shape; $0.9 < I < 1.1$: round shape; $1.1 < I < 1.3$: long round shape; $I > 1.3$: long shape. Letters a–c mean that different letters in each column indicate significant difference at $\alpha = 0.05$.

3.5 Diseases

The disease is an important factor, and it significantly reduces the yield and quality of tomatoes. Some serious diseases in tomato appeared and their level was recorde**d** (Table 10). From the flowering to harvesting stage, the disease of late blight occurs with high intensity. *Phytophthora infestans* is observed in all cultivars, ranging from level 2.3 (Hawai7996) to level 6.7 (control check 2). Control check 1 is also seriously damaged (level 5.7); followed by GC173 with level 4.3; GC171, CLN5915, and CLN1621L are damaged at the same level 3.7; CLN2001A is affected at level 3.3. The damage score of *Phytophthora infestans* of CLN2001A, CLN5915, and CLN1621L in this study is higher than that reported by Truong et al. [19] and lower than that in another study reported by the same authors [20].

Bacterial wilt caused by *Ralstonia solanacearum* occurs in many important crops worldwide. However, bacterial wilt does not affect the studied cultivars (0%). The control checks are also less infected by tomato yellow leaf curl than the others. The damage by southern blight is different with different cultivars. The highest is recorded with control check 1 and 2 with 36.7% and 20%, respectively. The damage level by *Sclerotium rolfsii* with CLN2001A (16.7%), CLN5915 (16.7%) and CLN1621L (0.0%) in this study is also higher than that provided bt Truong et al. [19] which is 0.0%; it is also lower than the damage level reported in another study in the 2015–2016 crop, which ranges from 2.38 to 16.67% [20].

Table 10. Diseases incidence of tomato cultivars

Cultivar	Late blight (*Phytophthora infestans*)	Disease incidence (%)		
		Bacterial wilt (*Ralstonia solanacearum*)	Tomato yellow leaf curl (Tomato yellow leaf curl virus)	Southern blight (*Sclerotium rolfsii*)
GC171	3.7	0	23.3	13.3
GC173	4.3	0	33.3	0.0
CLN2001A	3.3	0	56.7	16.7
CLN5915	3.7	0	43.3	16.7
CLN1621L	3.7	0	40.0	0.0
Hawai7996	2.3	0	6.7	16.7
Control 1	5.7	0	0.0	36.7
Control 2	6.7	0	0.0	20.0

1 = not infected; 3 = Leaf stem area infected (<25%); 5 = Leaf stem area infected (25–50%); 7 = Leaf stem area infected (51–75%); 9 = Leaf stem area infected (76–100%)

4 Conclusions

The experiment of tomato cultivars was used to evaluate the agronomical and morphological features concerning the growth time, stem, leaf, flower, and fruit. The results show that there is a significant difference in all indicators of some cultivars. Three tomato cultivars (CLN2001A, CLN5915, and CLN1621L) show high actual yield performance compared with the others in three seasons in Thua Thien Hue. The accepted Brix content is also one of the favorable features of CLN2001A, CLN5915, and CLN1621L. It ranges from 3.52 to 3.88 Bx in the first season [19], and from 2.9 to 4.2 Bx in the second season [20]. These cultivars could be used as a material for potential breeding sources of tomatoes in the local region. The other cultivars in this study need to be investigated further in the next seasons so that they could adapt local conditions.

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