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COMPARATIVE FIELD ADAPTABILITY OF SOME POTENTIAL CULTIVARS OF CIGAR TOBACCO IN HANZHONG, SHAANXI PROVINCE: GROWTH AND GAS EXCHANGE ATTRIBUTES

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Abstract

This study was aimed for high-quality planting and variety selection of cigar tobacco through the comparative analysis of the field growth adaptability and photosynthetic efficiency of cigar tobacco in Hanzhong of Shaanxi Province. This study comprised eight cigar tobacco varieties, Chuanxue No. 3, QX200, QX206, Haiyan 101, QX103, QX201, QX100 and QX204. These varieties were compared using different botanical traits, agronomic traits, disease resistance, chlorophyll SPAD values and photosynthetic characteristics. Cultivar Chuanxue No. 3 had the highest chlorophyll SPAD value, disease resistance, and net photosynthetic rate (*Pn*) compared to the other varieties used in the trial. Plant height, effective leaf number, maximum leaf length, and maximum leaf width of Haiyan 101 cultivated under shade were significantly greater than those of the other varieties. Disease resistance, chlorophyll SPAD value and *Pn* were higherin Chuanxue No. 3. The disease resistance, chlorophyll SPAD value and *Pn* of QX103 and QX201 were next to those of Haiyan101. The leaf shape of all varieties was long or wide elliptical; all had no petioles, and the leaves were flat or stead; the inflorescence was dense and the plant type and leaf size of most of the varieties met the quality requirements of the cigar industry raw materials The study indicated that in terms of field growth adaptability and photosynthetic efficiency, cvs. Chuanxue No. 3, Haiyan 101, QX103 and QX201 performed better so they could be considered as the main planting varieties in Mianxian County, Shaanxi province. Of all varieties tested here, Haiyan 101 is more suitable for shaded planting as a cigar wrapper variety.

Key words: Cigar leaves; Varieties; Field growth performance; Photosynthetic physiology.

Introduction

In recent years, with the rapid development of the national economy and the increasing consumption level of the residents, the cigar consumption market in China has rapidly expanded (Li *et al*., 2013), and multiple production areas have successively carried out research and development of cigar tobacco (Wang *et al*., 2009; Qin *et al*., 2012; Zhang *et al*., 2012; Li *et al*., 2013; Shi *et al*., 2013; Tan *et al*., 2013; Wang *et al*., 2014; Li *et al*., 2015; Lei *et al*., 2023). China has multiple cigar raw material production areas, located in Hainan, Shifang, Sichuan, Laifeng, Hubei, and Tongxiang, Zhejiang (Chen *et al*., 2019). However, the existing resources are far from meeting the current demand for cigar production. At present, cigar germplasm resources only account for 3% of China's tobacco germplasm resources (Li *et al*., 2012; Wang *et al*., 2020;). Xu *et al*., (2018) selected high-quality cigar coat varieties from imported cigar varieties, while Chen *et al*., (2009) selected cigar varieties that are resistant to PVY. However, due to the late start of cigar research in China, there is a significant difference in tobacco leaf quality compared to high-quality cigar leaves from foreign countries, and the majority of cigar varieties in China come from other countries, with significant differences between different cigar planting areas. Famous cigar producing countries such as Cuba produce cigars that adapt to local characteristics through regional planting and appropriate cultivation measures (Lewis *et al*., 2005; Zeng *et al*., 2009; Zhao *et al*., 2015; Ren *et al*., 2017). Therefore, we should adopt targeted introduction measures based on the ecological characteristics of each production area. Wang *et al*., (2023) conducted a comparative analysis of the climate similarity between Hunan cigar leaf planting areas and foreign high-quality cigar leaf producing areas. Yang *et al.*, (2017) studied the ecological conditions of the cigar smoking area in Wanyuan City, Sichuan, and analyzed and compared the adaptability of 13 introduced varieties in Wanyuan District, Sichuan. Yu *et al.*, (2021) analyzed the aroma components of cigars from different regions and explored their differences. Liu *et al.*, (2022) conducted a comprehensive evaluation of 11 cigar varieties introduced in Huaihua Tobacco District, Hunan. Shi *et al*., (2010) screened suitable varieties for planting in the tobacco growing area of Tongxiang, Zhejiang Province through field experiments on varieties such as ND1. Zhou (2015) conducted a study on three cigar leaf varieties introduced to the Shifang tobacco region and found that the KDL variety is suitable for planting in Shifang.

As one of the high-quality flue-cured tobacco production provinces in China, Hanzhong, Shaanxi, belongs to a subtropical humid climate with abundant precipitation and sufficient sunlight. The ecological environment has suitable natural ecological conditions for planting cigar tobacco. Therefore, the introduction and trial planting of cigar tobacco in Hanzhong, Shaanxi has certain feasibility and ecological advantages. However, there are currently no reports on screening cigar tobacco varieties in the region. Therefore, a comparative study on the growth adaptability and physiological characteristics of 8 different cigar tobacco varieties was conducted in Mianxian County, Hanzhong, Shaanxi Province, in order to screen out suitable varieties for planting in Mianxian County, Hanzhong, Shaanxi Province, and provide scientific basis for the subsequent industrialization of cigar tobacco planting in the local area.

Material and Methods

The experiment was carried out in Chunfeng Village, Zhoujiashan Town, Mian County, Hanzhong City, Shaanxi Province in 2022, The physico-chemical characteristics of the trial site were: texture was sandy, the soil nutrient status 11.01 g/kg, the available nitrogen content 40.90 mg/kg, the available phosphorus content 7.13 mg/kg, the soil available potassium content 268 mg/kg, and the fertility level moderately uniform. Description of all eight varieties is presented in (Table 1).

A field trial was conducted in which each variety was treated as one treatment, and each treatment was repeated 3 times, among which the planting density was 1.1 m×42 cm, and the row spacing was 1.1×0.53 m. The design of each cell was 8 rows, each row being 10 m long, and the cell area was 88 m^2.

The experiment used wet seedlings, and the seedling management measures were according to the local seedling technology plan. The tobacco seedlings were transplanted on April 25, 2022, and the transplanting method was "well cellar" transplanting. The nitrogen application rate of eggplant core cultivars was 165 kg/hm^2, N: P_2O_5:K_2O was 1:1.2:2.5, whereas that of eggplant-coated varieties was 134.33 kg/hm^2, N: P_2O_5:K_2O was 1:1:2.3, and the ratio of base fertilizer and top dressing was 1:1. The application rates of the two top dressing were 30% and 20% of the total top-dressing amount, respectively. When applying base fertilizer, 150 kg/hm^2 of magnesium sulfate fertilizer was added. Superphosphate, calcium nitrate, ammonium sulfate and potassium sulfate were used to prepare the required fertilizer. The organic fertilizer was selected as vermicompost organic fertilizer (1500 kg/hm^2) + nano bio-organic fertilizer (750 kg/hm^2), and organic fertilizer was applied as the base fertilizer.

Agronomic parameters: According to the tobacco industry standard "Tobacco agronomic traits investigation and measurement method" (YC/T142-2010), 15 representative plants of each variety were selected to investigate and record the main agronomic traits, including plant height, effective leaf number, stem circumference, maximum leaf length and width, etc.

Natural diseases: Referring to the classification and investigation methods of tobacco diseases and insect pests (GB/T 23222-2008), the incidence and disease indices of different varieties of potato Y virus, tobacco mosaic virus, ring spot disease, wildfire disease, root rot and veined flowers and leaves were investigated at the maturity stage.

Chlorophyll SPAD value: The chlorophyll content (SPAD value) of tobacco leaves at maturity was determined using the CCM-200 chlorophyll meter (Opti-Sciences, USA), and all assays were completed by 10:00 am on the same day.

Photosynthetic characteristics: Using CI-340 portable photosynthetic instrument produced by CID Company of the United States, the effective photosynthetic radiation value was 1500-2200 mmol/(m^2·s) on a sunny day, and the net photosynthetic rate (*Pn*), transpiration rate (*Tr*), stomatal conductance (*Gs*), and intercellular CO_2 concentration (*Ci*) of tobacco leaves at the mature stage were determined.

Statistical analysis

The raw data of each parameter was subjected to SPSS 20.0 software for statistical analysis. All means followed SE values.

Results and Discussion

Comparative analysis of botanical traits: The leaf shape of all varieties was long or wide elliptical, except for QX100, QX201 and QX100, in which these traits were wide elliptical, and all othes were long elliptical. Except for cvs. QX200 and QX204, the leaf tips were tapering, whereas in rest of the the varieties they were sharp. All leaves had no petioles, and the leaves were flat or stead; the inflorescence was dense, and the auricle medium. Except for Chuanxue No. 3, the leaf color was dark green, the rest being light green or green, and the main vein thickness of each variety was medium. Except for QX204 and Chuanxue No. 3 being with microwave leaf margin, the other varieties had smooth leaf margin (Table 2).

Comparative analysis of agronomic traits: In the long term, cv. Haiyan 101-Y plant height was the highest, followed by that of QX204. Of the eggplant core varieties, QX206 plant height was the highest, and that of Haiyan 101-X the lowest, but the plant height of that other varieties had been between 53~65.4 cm. The stem circumference of cv. QX206 was significantly larger than that of the other varieties, whereas that of the other varieties had been between 6.38~7.50 cm. The pitch of cv. QX103 was the smallest, and there was no significant difference between the pitches of the other varieties; QX200 had the largest number of effective leaves, with 12 pieces, and the plant height and maximum leaf width of QX200 were the largest of those of all other varieties. The effective leaf number of the other varieties was in the range of 8~10. The maximum leaf width of Chuanxue No. 3, Haiyan 101-X and QX201 was small, and there was no significant difference among them. The maximum leaf length was highest in cv. QX206, and the maximum leaf width was at the second position in cv. QX200. The maximum leaf length of cvs. QX200 and QX206 was about 40 cm, that of Chuanxue 3 and Haiyan 101-X as 35 cm, and of QX103 and QX201 37 cm. Among the eggplant-coated varieties, the maximum leaf length and maximum leaf width of Haiyan 101-Y were the largest, and the maximum leaf length of cv. Haiyan 101-Y was the largest among all varieties. The stem circumference, pitch and effective leaf number of cv. QX204 were the largest. The plant height, stem circumference, pitch, maximum leaf length and maximum leaf width of cv. QX100 were the smallest (Table 3).

In the maturity stage, the highest plant height was in cv. Haiyan 101-Y, which is consistent with the wang period, however, cv. Chuanxue No. 3 was the lowest in this trait. The plant height of the other varieties had been between 112~134 cm; cv. Haiyan 101-Y had the smallest stem circumference and the largest pitch; cv. QX206 had the largest stem circumference. The pitch of Haiyan 101-X was the smallest, and the pitch of other varieties had been between 6.41~8.16 cm. For the same variety, shade cultivation and unshaded cultivation, there was no significant difference in the effective number of leaves, being consistent with the law of the strong period. The effective number of leaves of the other varieties was 12~14. Among the eggplant core varieties, cv. Chuanxue No. 3 had the largest leaf length and maximum leaf width. The largest leaf width of cv. Haiyan 101-X was the smallest. Cultivar QX200 had the smallest maximum leaf length. Among the eggplant-coated varieties, cv. Haiyan 101-Y had the largest leaf length. The maximum leaf width was highest in cv. QX100.The maximum leaf length and maximum leaf width were the smallest in cv. QX204. Cultivar QX204 had the smallest maximum leaf length and maximum leaf width (Table 4).

When tobacco plants grew to peak period, the plant height, effective leaf number, stem circumference, pitch, maximum leaf length and maximum leaf width of shade cultivated tobacco plants of a same variety were greater than those of unshaded tobacco plants. At maturity, the plant height, pitch, maximum leaf length and maximum leaf width of shade-cultivated tobacco plants were greater than those of unshaded tobacco plants, and the stem circumference was smaller than that of unshaded tobacco plants.

On the whole, the plant type and leaf size of most of the varieties of cigar tobacco planted in Mian County are suitable for the raw materials of the cigar industry.

Table 1. Name and source of cigar tobacco leaf varieties.

	Variety name	Source
Cigar filler variety	Chuanxue No. 3	China National Tobacco Corporation Sichuan Provincial Company
	QX200	Oingzhou Tobacco Research Institute of China National Tobacco Company
	QX206	Oingzhou Tobacco Research Institute of China National Tobacco Company
	Haiyan 101-X	China National Tobacco Corporation Hainan Provincial Company
	QX103	Shandong Tobacco Company Weifang City Company
	QX201	Shandong Tobacco Company Weifang City Company
Cigar wrapper variety	QX100	Oingzhou Tobacco Research Institute of China National Tobacco Company
	Haiyan 101-Y	China National Tobacco Corporation Hainan Provincial Company
	QX204	Shandong Tobacco Company Weifang City Company

Table 2. Comparison of botanical traits.

Variety	Leaf shape	Petiole	Leaf tip	Auricle	Leaf surface	Leaf margin	Leaf color	Main vein thickness	Field regularity	Growth potential
Chuanxue No. 3	Long elliptical	no	sharp	medium	flat	microwave	dark green	medium	neat	well
QX200	Long elliptical	no	tapering	medium	flat	smooth	green	medium	neat	well
QX206	Long elliptical	no	sharp	medium	flat	smooth	light green	medium	neat	well
Haiyan 101-X	Long elliptical	no	sharp	medium	flat	smooth	green	medium	neat	well
QX103	Wide elliptical	no	sharp	medium	flat	smooth	green	medium	neat	well
QX201	Wide elliptical	no	sharp	medium	flat	smooth	light green	medium	neat	well
QX100	Wide elliptical	no	sharp	medium	flat	smooth	light green	medium	neat	well
Haiyan 101-Y	Long elliptical	no	sharp	medium	flat	smooth	light green	medium	neat	well
QX204	Long elliptical	no	tapering	medium	flat	microwave	green	medium	neat	well

Table 3. Comparison of agronomic traits (fast-growing stage).

Variety	Plant height (cm)	Stem girth (cm)	Pitch (cm)	Effective leaf number	Maximum leaf length (cm)	Maximum leaf width (cm)
Chuanxue No. 3	53.00 ± 3.03bc	6.38 ± 0.12b	3.70 ± 0.75b	9.40 ± 0.49ab	35.80 ± 1.17c	24.90 ± 1.11c
QX200	65.40 ± 8.01a	6.62 ± 0.82b	3.70 ± 0.24b	12.20 ± 1.17a	40.40 ± 1.85ab	32.20 ± 3.25a
QX206	66.02 ± 4.84a	7.88 ± 0.95a	3.44 ± 0.57b	8.20 ± 4.12b	41.30 ± 1.33ab	30.78 ± 1.24ab
Haiyan 101-X	45.20 ± 4.84c	7.06 ± 0.08ab	2.94 ± 0.12b	9.40 ± 0.49ab	35.90 ± 1.69c	25.20 ± 1.72c
QX103	54.00 ± 3.42bc	6.56 ± 0.57b	2.84 ± 0.21b	9.20 ± 0.75ab	37.78 ± 2.26bc	27.88 ± 0.47bc
QX201	55.40 ± 2.80b	6.90 ± 0.46ab	2.96 ± 0.33b	10.00 ± 0.63ab	37.30 ± 1.66bc	24.80 ± 1.17c
QX100	60.00 ± 8.32ab	7.06 ± 0.34ab	3.10 ± 0.49b	9.00 ± 0.63ab	40.80 ± 2.64ab	29.80 ± 3.60ab
Haiyan 101-Y	67.20 ± 5.71a	7.42 ± 0.12ab	3.60 ± 0.37b	9.60 ± 0.80ab	44.40 ± 3.72a	30.80 ± 2.32ab
QX204	66.20 ± 1.17a	7.50 ± 0.14ab	6.58 ± 0.15a	11.60 ± 0.49ab	44.00 ± 0.63a	29.80 ± 0.75ab

Note: Different letters indicate that there is a significant difference between treatments at the probability level of 0.05. The same should be considered for the remaining tables

Table 4. Comparison of agronomic traits (maturity stage).

Variety	Plant height (cm)	Stem girth (cm)	Pitch (cm)	Effective leaf number	Maximum leaf length (cm)	Maximum leaf width (cm)
Chuanxue No. 3	97.47 ± 28.60e	9.16 ± 1.14a	7.24 ± 1.37cd	12.36 ± 2.62c	64.56 ± 8.03a	36.58 ± 5.44ab
QX200	124.87 ± 3.77bc	7.64 ± 1.50de	7.35 ± 1.94cd	13.24 ± 2.61cd	51.00 ± 10.12e	33.56 ± 8.07bc
QX206	134.78 ± 16.39b	9.51 ± 1.12a	8.16 ± 0.92ab	14.87 ± 2.30a	53.51 ± 5.29cde	35.00 ± 4.31b
Haiyan 101-X	112.58 ± 21.49d	8.30 ± 1.16bc	6.27 ± 0.79e	15.29 ± 2.30a	55.02 ± 6.37bcd	32.82 ± 4.93c
QX103	117.91 ± 13.40b	8.62 ± 1.13b	6.82 ± 0.76de	14.84 ± 1.68a	52.62 ± 5.13ce	33.53 ± 3.67bc
QX201	120.27 ± 21.87cd	8.00 ± 0.97cd	6.41 ± 1.29e	14.71 ± 1.42a	52.90 ± 6.90ce	34.31 ± 9.06bc
QX100	118.53 ± 11.19cd	7.85 ± 0.66cde	7.62 ± 0.58bc	13.27 ± 1.16cd	56.53 ± 2.56bc	39.67 ± 2.53a
Haiyan 101-Y	172.00 ± 10.08cd	7.45 ± 0.55e	8.27 ± 1.01a	14.70 ± 1.47a	57.83 ± 2.10b	35.65 ± 1.52bc
QX204	112.33 ± 10.61d	8.60 ± 1.27b	7.63 ± 0.62bc	13.53 ± 1.60b	53.80 ± 4.84cde	33.23 ± 4.08c

Comparative analysis of natural field morbidity: As can be seen from (Table 5), potato Y virus was the main disease, followed by mosaic disease. Cultivar Chuanxue No. 3 was not infected with potato Y virus. The cultivars with the most severe occurrence of potato Y disease were cv. QX200, with a disease index of 12.0, and cross-infected mosaic disease, followed by cvs. QX206 and QX204, with a disease index of 11.1, and cv. QX200 with cross-infected mosaic disease. Cultivar Haiyan 101 was mildly infected with potato Y virus and was not infected with mosaic disease during shade cultivation. Cultivars QX103 and QX201 were both infected with potato Y virus with a similar disease index of 7.5, and QX103 was infected with mosaic disease and ring spot disease, and QX201 was not infected with the mosaic disease. Cultivar QX100 was infected with potato Y virus with a disease index of 8.7, which was higher than that of QX201 and QX103, but it was not infected with mosaic disease.

Comparative analysis of chlorophyll SPAD values: There was no significant difference among the varieties in the SPAD value of upper chlorophyll. Among the eggplant core varieties, Chuanxue No. 3 leaves had the highest chlorophyll SPAD value. The chlorophyll SPAD value of the upper and middle leaves of Haiyan 101-X was at the second position after that of Chuanxue No. 3, and the chlorophyll SPAD value of the lower leaves was medium. There was no significant difference between QX103 and Haiyan 101-X in chlorophyll SPAD values. The QX200 leaves had lower chlorophyll SPAD values. Among the eggplant-coated varieties, the chlorophyll SPAD value of the upper and lower leaves of Haiyan 101-Y was the highest, and that of the middle leaf was at the second position after QX204. The QX100 leaves had the lowest chlorophyll SPAD value. In the same variety, the chlorophyll SPAD values of the upper leaves and lower leaves of shade-cultivated tobacco plants were greater than those of tobacco plants cultivated without shade, and the chlorophyll SPAD values of the middle leaves of the tobacco plants cultivated in shade cultivation were lower than those of tobacco plants cultivated without shade (Table 6).

Comparative analysis of photosynthetic properties: The net photosynthetic rate (*Pn*) often directly affects the accumulation of organic matter in tobacco leaves. The *Pn* of Chuanxue No. 3, Haiyan 101, QX103 and QX201 was significantly higher than that of other varieties, and the *Pn* of tobacco plants without shade cultivation was greater than that of tobacco plants cultivated in shade. The *Pn* of cvs. QX200 and QX204 was minimal, but there was no significant difference between the two cultivars (Table 7).

Table 5. Comparison of natural field incidence (%).

Variety	Mosaic disease		Potato virus		Ringspot disease		Wildfire disease		Root rot		Vein band mosaic virus	
	Disease rate	Disease index	Disease rate	Disease index	Disease rate	Disease index	Disease index	Disease index	Disease rate	Disease index	Disease rate	Disease index
Chuanxue No. 3	4	1.3	-	-	-	-	2	0.7	-	-	2	1.1
QX200	2	0.7	28	12.0	-	-	-	-	-	-	-	-
QX206	-	-	24	11.1	-	-	-	-	-	-	2	1.1
Haiyan 101-X	2	0.7	2	0.7	-	-	-	-	2	0.7	-	-
QX103	2	0.7	16	7.5	4	1.3	-	-	-	-	-	-
QX201	-	-	16	7.5	2	0.7	-	-	-	-	2	0.7
QX100	-	-	18	8.7	-	-	-	-	-	-	-	-
Haiyan 101-Y	-	-	2	0.7	-	-	-	-	-	-	-	-
QX204	-	-	4	11.1	-	-	-	-	-	-	-	-

Table 6. Comparison of chlorophyll SPAD values.

Variety	Upper leaves	Middle leaves	Lower leaves
Chuanxue No. 3	50.33 ± 9.29a	61.77 ± 6.81a	63.87 ± 2.49a
QX200	45.40 ± 7.98a	42.20 ± 8.7b	36.63 ± 11.47cd
QX206	44.17 ± 7.17a	47.77 ± 3.64ab	50.00 ± 2.06b
Haiyan 101-X	45.93 ± 2.83a	49.60 ± 7.14ab	47.77 ± 6.68bc
QX103	48.83 ± 6.24a	49.47 ± 6.35ab	49.07 ± 5.51bc
QX201	45.10 ± 7.18a	39.27 ± 7.76b	46.40 ± 4.62bcd
QX100	41.97 ± 5.00a	39.53 ± 1.16b	34.10 ± 2.55bcd
Haiyan 101-Y	51.10 ± 3.48a	47.43 ± 0.41b	53.53 ± 1.53b
QX204	45.93 ± 4.89a	49.60 ± 9.48ab	47.77 ± 8.57d

Table 7. Comparison of photosynthetic properties.

Variety	Net photosynthetic rate (P_n/μmol CO_2 m^{-2} s^{-1})	Stomatal conductance (G_s/mol CO_2 m-^{2} s^{-1})	Intercellular CO_2 concentration (C_i/μmol mol^{-1})	Transpiration rate (T_r/mmol m^{-2} s^{-1})
Chuanxue No. 3	12.67 ± 0.47a	0.11 ± 0.06cd	286.33 ± 6.24c	6.07 ± 0.24a
QX200	8.00 ± 0.82e	0.37 ± 0.01abc	322.00 ± 17.25cde	5.10 ± 0.62ab
QX206	10.00 ± 0.82cd	0.40 ± 0.22ab	231.33 ± 19.60c	5.87 ± 0.40a
Haiyan 101-X	12.34 ± 0.47a	0.24 ± 0.03bcd	334.33 ± 20.93cd	4.73 ± 0.47b
QX103	11.38 ± 0.47abc	0.37 ± 0.08abc	243.67 ± 10.61de	5.70 ± 0.50ab
QX201	11.40 ± 0.82abc	0.17 ± 0.04bcd	190.67 ± 0.56e	5.77 ± 0.56ab
QX100	11.34 ± 0.94bc	0.04 ± 0.05d	479.33 ± 10.53b	1.59 ± 1.01c
Haiyan 101-Y	12.00 ± 0.82ab	0.34 ± 0.01d	264.33 ± 34.37a	6.03 ± 0.62d
QX204	8.67 ± 0.47de	0.24 ± 0.27a	334.33 ± 8.98cd	4.73 ± 0.45a

The yield and quality of cigar tobacco are mainly influenced by a type of variety, cultivation techniques, and ecological environment (Wang *et al*., 2013), and a variety is the key internal factor affecting tobacco yield and quality. Variety selection is a prerequisite and foundation for planting high-quality cigar tobacco. Different varieties under the same ecological conditions and the same variety under different ecological conditions all exhibit different quality characteristics and aroma styles (Zhou *et al*., 2005; Li *et al*., 2009; Geng *et al*., 2013). However, the current demand for cigar leaves in China has mainly relied on imports for a long time, which seriously restricts the development of the cigar industry. It is of great significance to introduce new varieties in specific tobacco areas and compare and analyze their growth adaptability and physiological characteristics (Liu *et al*., 2022). Yang *et al*., (2018) found that the plant type and leaf growth of 13 introduced cigar tobacco varieties meet the requirements of high-quality cigar tobacco, and there are no serious diseases. The cigar aroma style is significant, and 6 varieties are suitable for promotion as cigar core varieties in Wanyuan Tobacco District, and 5 varieties are suitable for promotion as cigar core varieties in Wanyuan Tobacco District. Shi *et al*., (2010) conducted field comparative experiments on ND1, ND2, ND3, ND4, ND5, American variety, Cuban variety, Indonesian variety, etc. From the analysis of agronomic and physicochemical traits, it was found that Indonesian varieties, ND2, and ND5 are suitable for planting in Tongxiang tobacco area, Zhejiang Province. In the current investigation, the growth performance of different varieties in the field varied significantly. The results of this experiment show that among the eggplant core varieties, cv. QX206 had the highest plant height, stem circumference, and maximum leaf length. Cultivar QX200 had the most effective leaves, with the highest plant height and maximum leaf width. Among the eggplant varieties, Haiyan 101-Y and QX204 showed better overall agronomic traits. Each variety grew neatly in the field and had good growth momentum. Natural field morbidity is the main characteristic indicator of the ecological adaptability of varieties (Liu *et al*., 2022). The results of this trial showed that Chuanxue No. 3 was not infected with potato Y virus. Haiyan 101 had a strong anti-potato Y virus ability, since the disease index was only 0.7, and there was no mosaic disease infection during unshaded cultivation. Cultivar QX201 showed cross-infection potato Y virus, ring spot disease and veined flower leaves; QX103 also showed cross-infection mosaic disease, potato Y virus and ring spot disease. QX200 was the weakest against potato Y virus. The occurrence of diseases in tobacco fields was relatively mild and had little impact on cigar leaf production.

Natural field incidence rate is the main characteristic index of ecological adaptability of varieties (Ren *et al*., 2022). The results of this experimental study indicate that Chuanxue 3 was not infected with Potato Y virus. Cultivar Haiyan 101 had a strong resistance to potato virus Y, with a disease index of only 0.7, and was not infected with mosaic disease when cultivated without shade. CultivarQX201 was cross infected with potato virus Y, ring spot disease, and vein stripe mosaic, while cv. QX103 was cross infected with mosaic disease, potato virus Y, and ring spot disease. The two varieties were equally infected with potato virus Y. Cultivar QX200 had the weakest resistance to potato virus Y. The overall disease occurrence in the tobacco field was relatively mild, and it had little impact on the production of cigar tobacco.

The adaptability of cigars to the ecological environment is closely related to their photosynthetic intensity. There could be differences in the response of different varieties of cigars to light intensity (Wang, 2011). In addition, cultivation methods can also have an impact on the photosynthetic process. Shading cultivation is a key technology for producing high-quality cigar coated tobacco leaves (Zhao, 2017). Zhao's research shows that moderate shading cultivation affects the photosynthesis and growth and development of cigars. Shi *et al*., (2006) also showed that shading cultivation can improve the adaptability of cigars to the environment. Shading can reduce the net photosynthetic rate and water use efficiency of cigar coated tobacco leaves and reduce the accumulation of photosynthetic products (Shi *et al*., 2006). Research by Lin (2013) also shows that the leaves of cigar coated tobacco produced by shading cultivation are thinner. The results of this experimental study indicate that the net photosynthetic rate (*Pn*) of cv. Chuanxue 3 was significantly higher than that of the other varieties, and the chlorophyll SPAD value of the leaves was the highest. There is no significant difference in the chlorophyll SPAD value of the upper leaves of each variety. Among eggplant core varieties, cvs. QX206 and QX200 had higher chlorophyll SPAD values in their leaves. Among eggplant varieties, Haiyan 101-Y and QX204 had higher chlorophyll SPAD values in their leaves. When cultivated under shade, the chlorophyll SPAD values of the upper and lower leaves were higher. As a variety of eggplant core, when cultivated without shade, the chlorophyll SPAD values of the upper and middle leaves were higher. There was no significant difference in net photosynthetic rate between shaded and unshaded tobacco plants. The chlorophyll SPAD value of QX201 leaves was lower, while the QX103 leaves had a higher chlorophyll SPAD value than that of the QX201 leaves. The *Pn* of Chuanxue 3, Haiyan 101, QX103, and QX201 were significantly higher than that of the other varieties.

Conclusion

Through the comparative analysis of the botanical and agronomic traits, natural diseases, chlorophyll values and photosynthetic characteristics of eight cigar tobacco varieties planted, Chuanxue No. 3, Haiyan 101, QX103 and QX201 had a strong field adaptability and photosynthetic ability and could be cultivated as varieties for industrial planting of cigar tobacco leaves in Shaanxi. Haiyan 101 shade cultivation has a stronger ecological adaptability than that of unshaded cultivation and is suitable for planting as an eggplant-coated variety in the tobacco area of Mian County.

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