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EVALUATION OF GERMPLASM RESOURCES AND SELECTION OF ELITE INDIVIDUALS OF *GARDENIA JASMINOIDES*

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Abstract

Gardenia jasminoides are widely cultivated in Fuding, Fujian Province and other places in China, but continuous large-scale reafforestation and multiple generations using a single clone, caused production instability and soil degradation. In this study, the germplasm resources of *G. jasminoides* were collected and evaluated, and the elite individuals and germplasm resources suitable for further cultivation were screened out. Variance analysis and comparison were conducted based on the fruit number, fruit weight, fruit length, tree height, tree diameter, and seed setting rate from 21 germplasm resources tested. The 11th and 9th germplasm resources (from central Jiangxi Province and Hunan Province), with excellent yield, tree height and crown width, and the geniposide content conforming to China Pharmacopoeia regulations, were selected as the most and the second optimal germplasm resources, and the 9th germplasm resources (Hunan Province) was selected as the second optimal germplasm resources. The analysis results showed that taking the fruit weight (yield) as the first index, and the geniposide content conforming to Chinese Pharmacopoeia regulations as the main indexs, 13 elite individuals were screened out, named as Min Lin Zhi No.1-13, respectively. The selection rate of elite trees was 5.9%. Compared with the population average, the fruit number, fruit weight, tree height (except No.4), ground diameter (except No.4) and crown width increased to over 248.23%, fruit weight increased to over 360.17%, tree height increased to over 151.47% (except Min Lin Zhi No.4), ground diameter increased to more than 119.65% (except Min Lin Zhi No.4), and crown width increased to more than 146.32%. Fruit weight, fruit number, tree height, ground diameter and crown width of all elite trees were higher than the control.

Key words: *Gardenia jasminoides*; Germplasm resources; Variance analysis; Germplasm resources evaluation; Elite individual selection.

Introduction

Gardenia jasminoides, also known as gardenia, yellow gardenia, mountain gardenia, and Haka called it as 'Huangguo', belongs to the Genus *Gardenia*, Family Rubiaceae. *G. jasminoides*is a shrub with 0.3-3 m height, growing at an altitude of 10-1500 m in the wildness, hills, valleys, hillsides, and stream side under the shrub or forest, distributed in the south of the Yangtze River basin in China. Its fruit tastes bitter for clearing heat, draining fire, cool blood for Chinese traditional medicine, and also contains yellow pigment, which can be extracted for natural pigment used as a food additive (Chinese Pharmacopoeia Commission, 2020a).

In the mountains of southern China, gardenia is a hardy plant tolerant of different soil conditions, requires little investment and produces quick economic returns. In the middle and late 1990s, the main producing areas of gardenia in Jiangxi, Sichuan, Guangxi, Hunan, Hubei and Henan provinces planted gardenia as a good project for comprehensive development of mountains and poverty alleviation. There were large-scale plantations of gardenia cultivation in Fuding, Fujian Province. In 2012, the fresh fruit output was more than 3200 tons in Fuding, and the price reached the highest level in history with an average of 9.2 RMB per kilogram for fresh fruit; The whole city was hot on gardenia planting in 2013 and 2014, the planting area exceeded 2,668 ha, and the surrounding counties together with Xiapu, Fu'an, Zherong, Shouning, Ningde and other places, the planting area reached more than 6,670 ha. In southern Zhejiang Province and eastern Fujian Province also introduced a large number of this species.

Fuding farmers adopted gardenia 'FenguanNo.1' (short name: FG1) as a large-scale promotion cultivar However, according to the latest Pharmacopoeia of China 2020 version described the characteristic length of gardenia fruit as 1.5-3.5 cm and diameter as 1-1.5 cm (Chinese Pharmacopoeia Commission, 2020a), the existing characteristic length of FG1 fruit is only 0.2 cm, resulting in a decline in market price. Nowadays, farmers produce seedlings of FG1 by cutting propagation, because of single clone and reafforestation caused serious problems, such as production instability, serious insect pests and diseases, soil degradation and economic benefit decline. it is a hot topic to develop more suitable gardenia varieties for multi-variety planting in the planting area.

Germplasm resources evaluation and elite individual selection have been successfully achieved for *Betula alnoides* (Chen *et al*, 2020; Fang, 2022; Yin, 2020), *Xanthoceras sorbifolium*, kiwifruit, *Hydrangea* and *Keteleeria fortune* var. *cyclolepis* (Chang *et al*., 2021; Ren *et al*., 2021; Jiang *et al*., 2022; Wei *et al*., 2022; Xu *et al*., 2022) and *Cyclocarya paliurus* were observed (Lan *et al*., 2022) in China, but the systematic collection and

evaluation of germplasm resources of gardenia have not been reported in Fujian Province. Thereby in this study, its germplasm resources were collected and evaluated, the germplasm resources and elite individuals suitable for cultivation in Fuding and Fujian Province were selected.

Material and Methods

Experimental site: The experimental site is located at the nursery of Fuding Forestry Bureau, Bailin Town, Fuding City, Fujian Province. It is a subtropical marine monsoon climate zone with a warm and humid climate, abundant rainfall, short winter and long summer, and a frost-free period of 270 days. The annual average temperature is 18.5°C, the extreme maximum temperature is 40.6°C, the extreme minimum temperature is -4.3°C, and the average temperature of the coldest month in January is 8.6°C. The average temperature in July, the hottest month, is 28.3°C, the average annual precipitation is 1668 mm, and the average annual rainfall days are 172 days. The parent rock was Basalt, and the soil was acidic red soil. Site quality was grade II. Gardenia and white tea were the pillar industries of local agriculture and forestry.

Germplasm resources: 21 germplasm resources of gardenia were collected from Fujain Province and other places since 2019, mainly came from Fuzhou (Gushan, Minhou, Jin'an District), Sanming (Qingliu), Longyan (Xinluo), Nanping (Yanping and Jian'ou), Zhangzhou (Zhangpu), Ningde (Jiaocheng and Fuding), and Jiangxi, Chongqing, Guangxi, Hunan and other provinces.

Experimental design: The experiment was designed with 21 treatments (germplasm resources), 3 repeats and a randomized block arrangement. FG1 was used as control. There were 30 trees in each plot, planted in March 2020.

The experimental site was nursery landed, cleared by a hook machine and deep-turned. The row and spacing of the planting plants was 1.5 m ×1.5 m, and the height of the seedlings was 25-35 cm.

Tending management: In 2020-2021, comprehensive weeding was adopted for the first time in April, combined with compound fertilizer application of 50 g/tree and calcium magnesium phosphate fertilizer 25 g/tree; comprehensive weeding was adopted for the second time in June and the third time in October, combined with compound fertilizer application 50 g/tree; In March 2022, the first comprehensive weeding combined with a compound fertilizer application of 100 g/tree, the second comprehensive mowing in June, and the third comprehensive mowing combined with a compound fertilizer application of 100 g /tree in September. Use beta-cypermethrin and imidacloprid to control pests.

Measure items: Each tree of the experimental site was investigated in October 2022, including tree height (m), tree ground diameter (mm), crown width (cm), fruit number (number), fruit diameter (mm), fruit length (mm), fruit weight (g), seed setting rate (%), diseases and pests, and growth status. The content of geniposide in fruit was determined (Gao & Pei, 2010; Chinese Pharmacopoeia Commission, 2020a; Chinese Pharmacopoeia Commission, 2020b; Huang *et al*., 2022) by high-performance liquid chromatography (HLPC).

Data analysis: EXCEL and SPSS17.0 software were used to classify, arrange and analyze variances among the measure items.

Results and analysis

Selection of optimal germplasm resources: The fruit number, weight, diameter, length and seed setting rate of 21 tested germplasm resources of gardenia were analyzed by variance and comparison by SPSS software (Table 1 and Fig. 1). The main purpose of this experiment is in accord with medicinal utilities; thus the total fruit weight (yield) was used as the main index; that is, the total fruit weight (yield) must reach the "A" level in the comparison. The results showed that in terms of fruit weight, the germplasm resources No. 9 (from Hunan Province), with the average yield per tree reached 23.33 g (Aa) with the highest yield, the average fruit diameter reached 19.08 mm, the average fruit length reached 42.12 mm, exceeded the latest Chinese pharmacopoeia 2020 edition described the character length of gardenia as 1.5-3.5 cm, 1-1.5 cm in diameter. While the germplasm resources No. 11 (from central Jiangxi Province) ranked second, with the average yield of 14.33 g per tree (ABb), average fruit diameter of 13.00 mm and average fruit length of 24.64 mm; The third germplasm resource was germplasm No. 12 (from Fuzhou, Fujian Province), with the average yield of 12.27 g per tree (BCbc), average fruit diameter of 11.03mm and average fruit length of 21.0 6mm; The fourth germplasm resource No. 5 (also from northwest Jiangxi Province), the average yield per tree reached 10.37 g (BCDbcd), the average fruit diameter reached 13.00 mm, the average fruit length reached 23.78 mm. The 3 germplasm resources met the range of the latest Chinese Pharmacopoeia 2020 edition.

The fruit weight (yield) per tree of the 5 germplasm resources, No. 9, 11, 12, 5, were 3.86, 2.37, 2.03 and 1.72 times compared to the population average weight of 6.04 g, and 3.22, 1.98, 1.69 and 1.43 times compared to the FudingFG1 control of 7.24 g, respectively.

When the tree height and crown width were used as the main indexes (Table 2 and Fig. 2), in term of tree height, germplasm resources No. 11had the highest growth rate; the average tree height reached 88.42 cm (Aa), the average ground diameter reached 15.28 cm (ABab), the average crown width reached 53.22 cm (ABab), and all reached the best (A). The second germplasm resources, No. 8 (from central Jiangxi Province), had the highest tree height (ABab), ground diameter (ABab), and crown width (Aa), reaching 81.76 cm (ABab), and all reached the best (A). The third germplasm resource No. 9, with an average tree height of 80.15 cm (ABabc), average ground diameter of 15.32 cm (ABab), and average crown width of 48.17 cm (ABCabc), also reached the best (A). The indexes of tree height, ground diameter and crown width of the other germplasm resources were close to the population average.

Table 1. Comparison of different *G. jasminoides* germplasm resources fruits.

Germ-plasm resources No.	Fruit weight/ (g)	Fruit number/ (piece)	Average weight of single fruit/ (g)	Average fruit diameter/ (cm)	Average fruit length/ (mm)	Fruiting rate/ (%)
1.	6.77 ± 2.484 ^{BCDbcde}	3.13 ± 0.885^{Bbc}	1.96 ± 0.162^{Cc}	14.08 ± 0.335^{BCDbc}	26.15 ± 0.568^{BCc}	16.73 ± 4.298 ^{Bbcd}
2.	0.8 ± 0.173^{De}	1 ± 0Bc	0.8 ± 0.173^{FGh}	11.1 ± 0.733^{DEFefghi}	18.61 ± 1.461^{EFGghi}	3.70 ± 3.703 ^{Bd}
3.	7.83 ± 0.677^{BCDbcde}	3.29 ± 0.421^{Bbc}	1.85 ± 0.127^{CDEcd}	13.23 ± 0.449^{BCDcd}	23.71 ± 1.118^{CDEFcdef}	36.93 ± 8.617 ^{ABbcd}
4.	2.1 ± 0.289^{CDde}	2 ± 0^{Bc}	1.05 ± 0.144^{EFGfgh}	10.7 ± 0.638^{DEFhij}	19.6 ± 1.195^{CDEFGfghi}	1.94 ± 0.980 ^{Bd}
5.	10.37 ± 3.090^{BCDbcd}	5.30 ± 0.977^{ABbc}	1.63 ± 0.227^{CDEFcdef}	13.00 ± 0.722^{BCDcdef}	23.78 ± 1.052^{CDEFcdef}	35.32 ± 8.596 ^{ABbcd}
6.	4.97 ± 0.833^{BCDcde}	1.68 ± 0.104^{Bc}	3.04 ± 0.445^{Bb}	15.22 ± 0.217^{Bb}	30.83 ± 3.999^{Bb}	31.37 ± 7.885 ^{ABbcd}
7.	4.7 ± 1.328^{BCDcde}	3 ± 0.577 ^{Bbc}	1.48 ± 0.159^{CDEFGcdefg}	11.69 ± 0.165^{CDEdefghi}	21.22 ± 0.266^{CDEFGdefghi}	1.59 ± 1.587 ^{Bd}
8.	2.2 ± 0.127^{CDde}	2 ± 0.058^{Bc}	1.1 ± 0.058^{DEFGefgh}	8.94 ± 0.514^{Fj}	22.14 ± 1.276^{CDEFGcdefgh}	0 ± 0 ^{Bd}
9.	23.33 ± 3.948^{Aa}	4.6 ± 0.643^{ABbc}	5.02 ± 0.384^{Aa}	19.08 ± 0.426^{Aa}	42.12 ± 1.943^{Aa}	78.09 ± 11.421 ^{Aa}
10.	1.7 ± 0.098^{CDe}	2.5 ± 0.144 ^{Bbc}	0.76 ± 0.046^{Gh}	9.79 ± 0.566^{EFij}	16.46 ± 0.953 ^{Gi}	27.01 ± 8.154 ^{Bbcd}
11.	14.33 ± 4.247^{ABb}	7.5 ± 1.195^{ABab}	1.71 ± 0.300^{CDEcde}	13 ± 0.821^{BCDcdef}	24.64 ± 1.435 ^{CDEcde}	45.63 ± 14.166 ^{ABabc}
12.	12.27 ± 8.141^{BCbc}	10.31 ± 6.344^{Aa}	1.16 ± 0.116^{CDEFGefgh}	11.03 ± 0.352^{DEFfghi}	21.06 ± 1.204^{CDEFGdefghi}	49.50 ± 24.947 ^{ABab}
13.	2.65 ± 0.260^{CDde}	2.98 ± 0.465^{Bbc}	0.86 ± 0.072^{FGgh}	10.8 ± 0.456^{DEFghij}	17.49 ± 0.606 ^{FGhi}	42.52 ± 17.974 ^{ABabc}
14.	3.65 ± 1.576^{BCDde}	2.84 ± 1.059^{Bbc}	0.82 ± 0.185^{FGh}	10.67 ± 0.641^{EFhij}	17.53 ± 1.117 ^{FGhi}	15.19 ± 12.510 ^{Bbcd}
15.	3.3 ± 0.191^{CDde}	3 ± 0.173 ^{Bbc}	1.1 ± 0.064^{DEFGefgh}	11.26 ± 0.652^{DEFdefghi}	20.18 ± 1.166^{CDEFGefghi}	15.00 ± 7.638 ^{Bbcd}
16.	7 ± 0.404 ^{BCDbcde}	4.5 ± 0.260 ^{ABbc}	1.31 ± 0.075^{CDEFGdefgh}	11.32 ± 0.652^{DEFdefghi}	23.11 ± 1.334 ^{CDEFcdefg}	10.00 ± 10.000 ^{Bcd}
17.	4.73 ± 0.561^{BCDcde}	3.22 ± 0.266^{Bbc}	1.3 ± 0.082^{CDEFGdefgh}	11.97 ± 0.331^{CDEdefgh}	21.78 ± 0.501^{CDEFGcdefgh}	42.11 ± 5.263 ^{ABabc}
18.	2.57 ± 0.384 ^{CDde}	1.59 ± 0.109^{Bc}	1.55 ± 0.140^{CDEFGcdef}	12.81 ± 0.417^{BCDcdefg}	23.24 ± 0.724 ^{CDEFcdefg}	42.94 ± 9.565 ^{ABabc}
19.	4.77 ± 1.785 ^{BCDcde}	2.71 ± 1.191 ^{Bbc}	1.92 ± 0.162^{Ccd}	13.1 ± 0.866^{BCDcde}	25.72 ± 2.634 ^{BCDcd}	17.28 ± 10.169 ^{Bbcd}
20.	3.83 ± 0.546 ^{BCDde}	2.79 ± 0.448^{Bbc}	1.35 ± 0.038^{CDEFGcdefgh}	13.01 ± 0.777^{BCDcdef}	20.43 ± 0.688^{CDEFGefghi}	45.17 ± 7.960 ^{ABabc}
21.	2.63 ± 1.538^{CDde}	2.71 ± 1.063 ^{Bbc}	0.81 ± 0.172^{FGh}	10.97 ± 1.075^{DEFfghi}	19.27 ± 0.583^{DEFGfghi}	44.71 ± 20.747 ^{ABabc}
Average	6.04 ± 0.794	3.51 ± 0.382	1.55 ± 0.124	12.22 ± 0.290	22.78 ± 0.739	28.7 ± 3.222

Note: Different uppercase English letters in the same column indicate a significant difference, and lowercase English letters in the same column indicate a significant difference, the same below

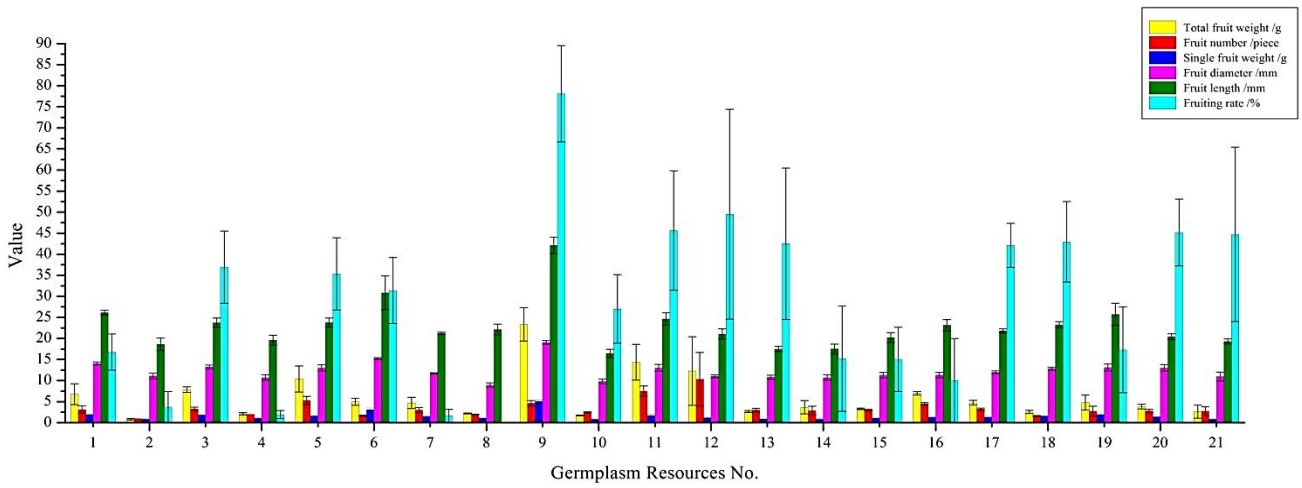

Fig. 1. Comparison of various quality resources of *G. jasminoides* fruits.

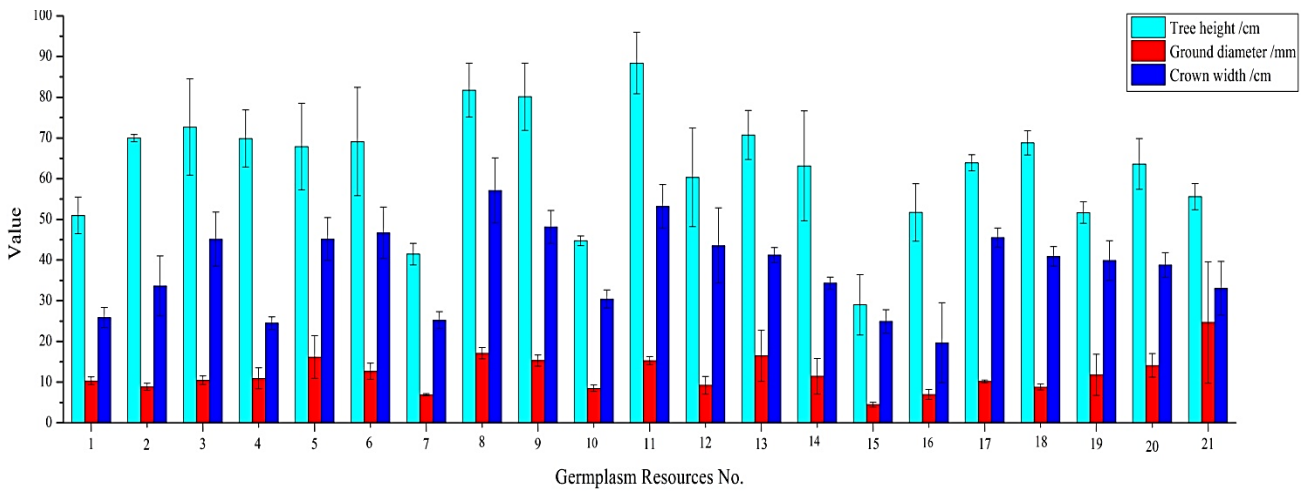

Fig. 2. The growth indexes comparison of *G. jasminoides* germplasm resources.

Fig. 3. The elite individuals screened
N.B.: a. The plant of Min Lin Zhi No.8; b. The plant of Min Lin Zhi No.10

Table 2. The growth indexes of different *G. jasminoides* germplasm resources.

Germplasm resources No.	Tree height /cm	Ground diameter /mm	Crown width /cm
1.	50.96 ± 4.500^{BCDdefg}	10.32 ± 0.971^{ABb}	25.88 ± 2.451^{CDde}
2.	70.00 ± 0.864^{ABCabcde}	8.87 ± 0.827^{ABb}	33.64 ± 7.360^{ABCDcde}
3.	72.70 ± 11.822^{ABCabcd}	10.49 ± 1.035^{ABb}	45.16 ± 6.662^{ABCabc}
4.	69.88 ± 7.030^{ABCabcde}	10.95 ± 2.571^{ABab}	24.52 ± 1.517^{CDde}
5.	67.90 ± 10.644^{ABCabcde}	16.16 ± 5.231^{ABab}	45.19 ± 5.258^{ABCabc}
6.	69.13 ± 13.317^{ABCabcde}	12.70 ± 1.981^{ABab}	46.72 ± 6.306^{ABCabc}
7.	41.46 ± 2.655^{CDfg}	6.94 ± 0.278^{ABb}	25.20 ± 2.103^{CDde}
8.	81.76 ± 6.618^{ABab}	17.10 ± 1.375^{ABab}	57.12 ± 7.993^{Aa}
9.	80.15 ± 8.272^{ABabc}	15.32 ± 1.380^{ABab}	48.17 ± 4.045^{ABCabc}
10.	44.76 ± 1.184 ^{CDefg}	8.52 ± 0.797^{ABb}	30.42 ± 2.200^{BCDcde}
11.	88.42 ± 7.574^{Aa}	15.28 ± 1.018^{ABab}	53.22 ± 5.385^{ABab}
12.	60.36 ± 12.137^{ABCDabcdef}	9.25 ± 2.161^{ABb}	43.58 ± 9.252^{ABCabc}
13.	70.76 ± 6.033^{ABCabcde}	16.48 ± 6.297^{ABab}	41.24 ± 1.874^{ABCDabcd}
14.	63.17 ± 13.508^{ABCabcdef}	11.47 ± 4.374^{ABab}	34.35 ± 1.478^{ABCDcde}
15.	29.01 ± 7.394^{Dg}	4.49 ± 0.599^{Bb}	24.92 ± 2.852^{CDde}
16.	51.72 ± 7.063^{BCDdefg}	6.97 ± 1.234^{ABb}	19.66 ± 9.834^{De}
17.	63.88 ± 1.992 ^{ABCabcdef}	10.201 ± 0.361^{ABb}	45.55 ± 2.358 ^{ABCabc}
18.	68.82 ± 2.979 ^{ABCabcde}	8.80 ± 0.722^{ABb}	40.91 ± 2.397^{ABCDabcd}
19.	51.70 ± 2.643 ^{BCDdefg}	11.82 ± 5.061^{ABab}	39.91 ± 4.866^{ABCDabcd}
20.	63.63 ± 6.235^{ABCabcdef}	14.12 ± 2.896^{ABab}	38.78 ± 3.053^{ABCDbcd}
21.	55.60 ± 3.218^{ABCDabcdef}	24.67 ± 14.884^{Aa}	33.08 ± 6.557^{BCDcds}
Average	62.66 ± 2.232	11.95 ± 0.937	37.96 ± 1.582

Note: Different uppercase English letters in the same column indicate a significant difference, and lowercase English letters in the same column indicate a significant difference, the same below

The average tree height of the 3 germplasm resources, No. 11, 8, 9, were 1.42, 1.31 and 1.29 times compared to the population average height of 62.22 cm, and 1.75, 1.61 and 1.58 times compared to the FudingFG1 control of 50.67 cm; The average ground diameter of the 3 germplasm resources were 1.28, 1.43 and 1.28 times compared to the population average ground diameter of 11.95 mm, and 1.40, 1.50 and 1.27 times compared to the FudingFG1 control of 50.67 cm; The average crown width of the 3 germplasm resources were 1.28, 1.43 and 1.28 times compared to the population average crown width of 37.96 mm, and 1.44, 1.55 and 1.31 times compared to the FudingFG1 control of 36.91 cm;

The content of geniposide in germplasm resources No. 11 and No. 9 was 3.5% and 4.4%, respectively, which was in line with the latest Chinese Pharmacopoeia 2020 edition, and 0.8%-1.4% higher than FudingFG1 control of 2.7%.

In summary, germplasm resources No. 11 was selected as the best germplasm resource with excellent yield, tree height and crown width, and germplasm resources No. 9 was selected as the second-best germplasm resource.

Selection of elite individual germplasm: The data of fruit weight, number, diameter, length, tree height, ground diameter and crown width of sexually propagated were analyzed by variance and comparison (Table 3). The main purpose of this experiment was to select and breed for medicinal fruits, and the total fruit weight (yield) as the main index; indication that the total fruit weight (yield) must reach an "A" level in the comparison. Using fruit weight as the first index, 13 elite individuals were screened (Fig. 3), named as Min Lin Zhi No.1-13. Their fruit weight (yield) ranging from 41.6-94.7 g, fruit diameter from 11.89-17.24 mm, and fruit length from 22.63-29.80 mm, which were in line with the latest Chinese Pharmacopoeia 2020 edition standard range. The selection rate of elite individuals was 5.9%. Compared with the population average, the number of fruits increased to more than 248.23%, the average fruit weight increased to 360.17%, the tree height increased to more than 151.47% (except No.4), the ground diameter increased to more than 119.65% (except No.4), and the crown width increased to more than 146.32%. Fruit weight, fruit number, tree height, ground diameter and crown width of all elite individuals were higher than that of FudingFG1 control.

Except No.11 with the geniposide content of 1.3%, the geniposide content of remaining 12 elite individuals were more than ≥1.5%, which was in line with the latest Chinese Pharmacopoeia 2020 edition standard range.

Conclusions and Discussion

Phenotypic traits are stable and heritable formed by plants adapting to external environmental conditions for a long time, and the variation of phenotypic traits is the external manifestation of genetic variation. gardenia is widely distributed ranging in Zhejiang and Shandong in the eastern China, Yunnan in the western China, Hebei and Gansu in the northern China, and Hainan in the southern. Outside China, it is distributed in Japan, Korea, Vietnam, Laos, Cambodia, India, Nepal, Pakistan, Pacific Islands and North America, with wild or cultivars (Editorial Board of Flora of China, 1999). Previous studies have found significant differences in growth traits among different provenances of gardenia, and there are significant differences in the geniposide content (Chen *et al*, 2016; Jiao *et al*., 2017).

Table 3. Comparison of the elite individuals.

Elite tree No.	Fruit number/piece		Total fruit weight/g		Average single fruit weight/g		Average fruit diameter/mm		Average fruit length/mm		Tree height/cm		Ground diameter/mm		Crown width/cm	
	Original data	Improved value/ (%)	Original data	Improved value/ (%)	Original data	Improved value/ (%)	Original data	Improved value/ (%)	Original data	Improved value/ (%)	Original data	Improved value/ (%)	Original data	Improved value/ (%)	Original data	Improved value/ (%)
Min Lin Zhi No.1	35	620.57	94.7	819.91	2.71	152.25	15.24	114.59	28.94	117.45	104	148.61	23.14	192.67	95.0	250.46
Min Lin Zhi No.2	32	567.38	76.6	663.20	2.39	134.27	13.94	104.81	29.8	120.94	106	151.47	14.37	119.65	55.5	146.32
Min Lin Zhi No.3	24	425.53	76.0	658.01	3.17	178.09	16.6	124.81	29.01	117.74	153	218.63	21.78	181.35	97.0	255.73
Min Lin Zhi No.4	34	602.84	73.7	638.10	2.17	121.91	13.58	102.11	25.85	104.91	73	104.32	12.88	107.24	60.0	158.19
Min Lin Zhi No.5	19	336.88	69.5	601.73	3.66	205.62	16.98	127.67	30.81	125.04	119	170.05	19.74	164.36	72.5	191.14
Min Lin Zhi No.6	17	301.42	66.5	575.76	3.91	219.66	17.24	129.62	31.97	129.75	168	240.07	21.57	179.60	84.0	221.46
Min Lin Zhi No.7	23	407.80	62.9	544.59	2.73	153.37	15.3	115.04	25.73	104.42	113	161.47	21.61	179.93	85.0	224.10
Min Lin Zhi No.8	35	620.57	58.6	507.36	1.67	93.82	11.89	89.40	27.68	112.34	106	151.47	19.33	160.95	68.0	179.28
Min Lin Zhi No.9	21	372.34	57.3	496.10	2.73	153.37	13.73	103.23	33.79	137.13	128	182.91	19.72	164.20	110.0	290.01
Min Lin Zhi No.10	28	496.45	55.0	476.19	1.96	110.11	14.41	108.35	28.52	115.75	131	187.20	21.08	175.52	88.5	233.32
Min Lin Zhi No.11	24	425.53	45.3	392.21	1.89	106.18	12.95	97.37	27.16	110.23	114	162.90	17.78	148.04	65.0	171.37
Min Lin Zhi No.12	23	407.80	44.0	380.95	1.91	107.30	14.73	110.75	22.63	91.84	114	162.90	16.02	133.39	73.5	193.78
Min Lin Zhi No.13	14	248.23	41.6	360.17	2.97	166.85	13.24	99.55	28.56	115.91	128	182.91	21.41	178.27	100.0	263.64
Population mean (no control)	5.64		11.55		1.78		13.3		24.64		69.98		12.01		37.93	
Control	7.24		15.86		2.12		14.23		27.49		50.84		10.71		38.89	

Multi-index selection means using multiple indexes for comprehensive evaluation, analysis and screening to obtain superior germplasm resources (Yu & Fu, 2004). In order to obtain superior germplasm resources with the maximum medicinal health care and economic value, it is necessary to consider the yield of a single plant comprehensively. Yu *et al*., (2018) combined the growth index with medicinal components' content and comprehensively evaluation on the superior leaf-used *Ginkgo biloba*.

In this study, through the analysis of variance and comparison of the fruit number, fruit weight, fruit diameter, fruit length and seed setting rate of 21 germplasm resources of gardenia, the main purpose of this experiment was to select superior germplasm resources with medicinal utilities by considering the total fruit weight (yield) as the main index, that is, the total fruit weight (yield) must reach "A" level in this comparison. Other indexes such as fruit number, weight, diameter, length and seed setting rate were combined together. Using SPSS software to analyze for selection by multi-index is more meaningful than principal component or cluster analysis. Germplasm resources No. 11was selected as the best germplasm resources with high yield, tree height and crown width, and the content of geniposide reached the latest Chinese Pharmacopoeia 2020 edition standard range. Germplasm resources No. 9 (Hunan) was selected as the secondary one. From the fruit weight as the first indicator and the content of geniposide as a reference index, 13 elite individuals were screened out.

In the next step, germplasm resources No. 11 and No. 9 should be propagated for pilot and extension tests. Based on the obtained reproductive technique, 13 elite individuals should be propagated by cutting and tissue culture techniques (Chen *et al*., 2023), and pilot and extension tests should be carried out.

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