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VARIABILITY IN *SIMMONDSIA CHINENSIS* UNDER SEMIARID CONDITIONS

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ABSTRACT

Jojoba (*Simmondsia chinensis*) being dioecious and polyploid is characterized by tremendous variability in yield as well as other morphological characters. Some highly fertile male and consistently high yielding female plants were selected and identified as erect, semierect and prostrate types. An effort was made to study the phenotypic variability existing in these various plant types which can be utilized for the economic improvement of the plant species. The study revealed that the erect type of male plants with high pollen fertility and long duration of flowering and prostrate type of female plants with high plant volume and seed yield must be used for further improvement of the crop.

Key words: *Simmondsia chinensis*, plant types, phenotypic variability.

Gentry [1] has reported the variability of morphological characters in jojoba. Such variations reflect on the diversity of habitates in which jojoba grows and several aspects of this genetic variability are of interest in the selection and improvement of the species. In the present study, various morphological as well as yield traits have been analysed to determine the extent of variability at interclonal level.

MATERIALS AND METHODS

A population of 1150 plants has been established on the coastal sand dunes in the semiarid region of Gujarat. Various morphological characters were measured to study the magnitude of variability in this population. Both male and female plants were classified into three categories on the basis of height and spread: i) plants with less than 1 m height and less than 3 m spread, ii) plants with 1-2 m height and 3-6 m spread and iii) plants with more than 2 m height and more than 6 m spread. Various statistical parameters of variability (SE and CV) were worked out to assess the extent of variability in 579 male and 571 female plants grouped in the above three categories.

Plants were further reclassified into three categories on the basis of spread (S) and height (H) ratio as follows: i) erect, with S/H ratio less than 1.5, ii) semierect, with S/H ratio between 1.5- 3.00 and iii) prostrate with S/H ratio above 3.00. The mean, range, SD and CV were calculated for plant height, plant spread, plant volume, internode length, pollen fertility, pollen grain size, and duration of flowering for 30 male plants; and plant height, plant spread, plant volume, internode length, seed size, seeds/plant, seed yield/plant, and 100-seed weight for 30 female plants in the three plant types separately. Plant volume (m^3) was calculated from the maximum crown diameter and height according to the following equation:

$$V = 0.67 \ \pi r^3 + \pi r^2 \ (h\text{-}r\text{-}0.35)$$

RESULTS AND DISCUSSION

The population raised from seeds exhibited marked variability in vegetative growth, especially in case of height and spread. Some of the plants were about 3 m high, while others grew only to the height of 40 cm. The plant spread also varied from 60 cm to more than 6 m (Table 1). Earlier, Yermanos [2] also reported considerable range for height and diameter in jojoba. Hoagan and Palzkill [3] stated that jojoba is one of the most heterozygous species which gives opportunities to make outstanding individual plant selections from seeded populations.

Amongst male plants, maximum variation was observed among the erect type plants for plant volume, plant spread, plant height and pollen fertility (Table 2). These plants showed maximum pollen fertility (96.8%), diameter of pollen grain (39.4 µm), and duration of flowering (31.8 days). The semierect plants showed sufficient variability for pollen diameter and duration of flowering only. The mean values of these traits in this group were the lowest as compared to other plant types.

Table 1. Variability for height and spread in various categories of male and female plants of *Simmondsia chinensis*

Category	Character	Plants in each category (%)		Range		Mean + SE		CV	
		male	female	male	female	male	female	male	female
0–1	Height	8.5	1.0	0.44–0.95	0.40–0.80	0.76 ± 0.02	0.71 ± 0.07	52.1	19.7
0–3	Spread	3.0	4.0	0.60–2.84	0.65–2.80	1.95 ± 0.11	2.14 ± 0.15	41.2	32.7
1–2	Height	75.4	76.8	1.10–2.00	1.00–1.90	1.84 ± 0.04	1.62 ± 0.26	20.1	81.4
3–6	Spread	39.8	30.8	3.22–6.00	3.40–5.86	4.55 ± 0.18	4.37 ± 0.08	23.1	26.5
>2	Height	16.1	10.0	2.20–2.90	2.11–2.90	2.56 ± 0.24	2.30 ± 0.40	15.4	9.7
>6	Spread	57.1	62.2	6.14–6.60	6.08–6.45	6.22 ± 0.10	6.35 ± 0.18	29.1	22.5

The prostrate plant type was intermediate between the two categories in most of the characters, although the means were high for plant spread (4.43 m) and plant volume (12.84 m^3), whereas pollen fertility (87.57%) and plant height (1.13 m) were the lowest in these plants.

Reviewing the performance of 30 selected female plants of jojoba under semiarid conditions, more or less similar values of CV were obtained for plant height and plant spread amongst the three types while considerable variation was observed for plant volume for all the seed characters (Table 3). The CV values for yield and its contributing characters were high in the semierect group, especially for seed size and seeds/plant, while the prostrate plants exhibited maximum variability for 100-seed weight and seed yield per plant. Wide range of variation was recorded for seeds/plant in all the three categories. The overall range for this trait 101–3051 seeds/plant, but the maximum variability (500–3051 seeds/plant) was recorded in the group of prostrate plants. The CV for this attribute was maximum in the semierect group (74.36), although maximum average seed number (1257.70) was recorded in the prostrate group of plants. Thus, this character may be helpful in the improvement of this plant species.

Table 2. Variability in some morphological and phenological characters in various plant types of selected male plants of *Simmondsia chinensis*

Character	Erect			Semierect			Prostrate		
	mean	range	CV, %	mean	range	CV, %	mean	range	CV, %
Plant height (m)	2.07	0.7–3.0	34.6	1.64	0.8–2.2	32.3	1.13	0.6–1.7	32.9
Plant spread (m)	2.57	0.7–4.4	44.1	4.27	2.0–5.5	27.1	4.43	2.0–5.5	24.7
Plant volume (m^3)	5.08	0.7–14.1	105.4	12.09	2.5–23.8	58.9	12.284	9.7–16.5	39.3
Internode length (cm)	3.04	2.5–3.5	9.6	2.82	2.4–3.3	9.8	2.91	2.4–3.3	10.4
Pollen fertility (%)	96.85	82.9–98.0	5.3	94.14	90.8–97.7	2.9	87.57	81.8–94.2	4.3
Pollen grain size (μm)	39.44	34.0–44.2	6.7	33.45	23.5–40.9	13.9	34.22	29.9–39.3	9.7
Flowering duration (days)	31.80	22.8–36.0	7.7	29.40	28.0–34.0	8.22	30.50	29.0–34.0	5.1

The seed yield per plant also exhibited a wide range of variability ranging from 50.5 g to 1794.9 g, and the maximum yield/plant was obtained in the group of prostrate plants (Table 3). The average seed yield/plant was also highest (771.43 g) in this group and minimum (109.09 g) in the erect group of plants. The average 100-seed weight was minimum (56.42 g) in the erect group of plants, and maximum in the semierect group (67.06 g), followed by the prostrate plants (64.67 g). The overall range for this character in all the three types was 38.35–99.85 g. Weiss [4] also reported that 100-seed weight in jojoba can vary from 40 g to 80 g and occasionally much higher. It is clear that the extent of morphological variation was maximum in the group of plants, whereas prostrate group showed better performance in yield characters.

Table 3. Variability in some morphological and yield characters of various plant types of 30 selected female plants of *Simmondsia chinensis*

Character	Erect			Semierect			Prostrate		
	mean	range	CV, %	mean	range	CV, %	mean	range	CV, %
Plant height (m)	1.99	1.0–2.8	29.1	1.80	0.9–2.9	28.9	1.71	1.4–2.9	25.7
Plant spread (m)	2.22	1.1–3.2	29.3	3.86	1.9–5.1	23.3	5.62	4.3–8.8	24.6
Plant volume (m^3)	7.38	0.4–13.8	61.1	11.53	0.8–35.6	84.1	14.22	4.8–67.3	127.9
Internode length (cm)	3.00	2.0–3.7	19.7	2.7	1.9–3.7	21.0	2.80	2.5–3.2	8.1
Seed size (cm)	1.62	1.5–1.9	7.4	1.66	1.4–2.5	18.1	1.58	1.3–1.7	8.6
Seeds per plant	180.70	101.0–396.0	50.7	780.70	236.0–1929.0	74.4	1257.70	500.0–3051.0	60.1
100-seed weight (g)	56.42	42.24–78.5	20.1	67.06	38.3–82.5	17.3	64.67	47.1–99.9	21.8
Seed yield/plant (g)	109.09	50.5–300.6	70.3	512.14	194.63–1302.6	77.8	771.43	348.3–1794.9	55.4

The male as well as female plants of all the three types showed considerable variation for the attributes studied. Morphological as well as phenological variability exhibited by the erect type of male plants can be utilized in further improvement of the crop. In case of female plants, the prostrate type proved to be better, exhibiting maximum plant spread and plant volume, ultimately giving maximum seed yield. Therefore, selection must be made for these plant types for further improvement. Though 100-seed weight was maximum in the semierect group, the prostrate plants gave highest yields due to large number of seeds. The studies made so far on phenotypic and yield characters revealed that the male plants with erect growth, high pollen fertility, and long duration of flowering should be selected for commercial plantation, while female plants with high plant volume, plant spread, and high yield should be selected for commercial cultivation.

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