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Manipulation of castor bean (*Ricinus communis* L.) growth and its effect on some characteristics by pruning of lateral branches

Abdullah Hassanzadeh Ghorttapeh[1], Elnaz Taherifard[2*] and Farzad Gerami[2]

[1]Agricultural and Natural Resources Research Center of West Azerbaijan, Urmia, Iran
[2]Young Researchers Club, Mahabad Branch, Islamic Azad University, Mahabad, Iran

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ABSTRACT

The choice of a suitable system such as pruning is an important factor for achieving a profitable balance between labor costs and crop yield without loss of quality. A field trial was conducted for manipulation of castor bean growth by pruning and its effect on some characteristics at the Agricultural Research Station of Saatlo in Urmia, Iran, during 2010 growing season. The experiment was a split-plot design, arranged in randomized complete block with three replications. Main plots including four varieties of castor bean (i.e. 80-23, 80-29, 80-12-1, and 80-17), and sub plots including three types of pruning (i.e. no pruning, pruning of 2 lateral branches, and pruning of four lateral branches). The plant characteristics were studied in terms of number of capsules in primary raceme, secondary raceme length, number of branches per plant, weight of capsules per plant, days from planting to emergence of secondary raceme and oil percent. Results of the data review showed that, the effect of the varieties was significant on most of the traits and the effect of the pruning was significant just on the days from planting to emergence of secondary raceme trait. Also, the effect of interaction between two factors (variety and pruning) was significant on number of capsules in primary raceme and number of branches per plant. Based on our results, manipulation of castor bean growth showed different response on some characteristics.

Key words: capsule, lateral branches, oil percent, primary raceme, suitable system.

INTRODUCTION

During the recent decades, medicinal plants gained a substantial importance in agricultural production, pharmacy and exportation because of their use as a raw material for the pharmaceutical industry (1). Castor bean (*Ricinus communis* L., Family Euphorbiaceae, 2n = 20) is an important non-edible oilseed medicinal crop and its seed derivatives are often used in aviation oil, lubricants, nylon, dyes, inks, soaps, adhesive and biodiesel (15). Castor bean is a fast growing C_3 plant, known as castor oil bean, mole bean and wonder tree and also grown as an ornamental plant in many countries of Asia, America, Africa and Europe (5). Although castor is a low input-requiring crop and can be grown on marginal land, yet farmers are not inclined to grow it due to lack of suitable high yielding varieties that may fit in country's cropping system. New castor plant varieties (inbred lines or hybrids) that combine of high seed and oil yield and desirable morphological characteristics for mechanical harvesting have been developed over the past few years in the world. It is necessary to characterize the genetic diversity present across *R. communis* germplasm from different geographic regions to develop a genotyping scheme that links castor bean evidence to a particular source, geographic region, or batch (9). Although, the genus *Ricinus* is considered monotypic, castor bean varies greatly in its growth habit, color of foliage and stems, seed size and oil percent (12). Due to increased demand for castor bean in many countries, improvement of varieties is drawing great attention from breeders (16).

Pruning is one of the most important operations, next to plucking, which directly determines the productivity and quality of many crops. Lateral branches pruning is used to limit the number of raceme and reduce the competition to increase raceme mass. The main effect of pruning has been studied on carbohydrate movement to storage regions in lower parts of the plant (4). Pruning native plants can enhance seed dry weight, therefore leaf area would be increased which leads to more photosynthesis and seed storage materials (3). The number of stems per plant and planting density together affect the relationship between the number of fruits per surface unit area and the number of fruits per plant (7). Fruit pruning in per truss/cluster increased the fruit weight by 42 %, while the marketable yield reduced by 15 to 25 % (6).

This study was conducted for evaluation the manipulation of castor bean growth by pruning of lateral branches to get an optimum yield of this plant. Information presented herein, will help the breeder to develop high yielding castor bean varieties.

MATERIALS AND METHODS

This research was carried out in the castor bean growth season 2010, at the Agricultural Research Station of Saatlo in Urmia, Iran, (37°44'18"N Latitude and 45°10'53"E longitude), at an elevation of 1338 m above mean sea level. Average rainfall in this growing season was 2.32 mm and average temperature was nearly 61.18°C. The soil type was Clay loam with pH 7.9 and 0.56 average organic matter concentration. Experimental design was a split-plot, completely randomized block design with three replications. Treatments consisted in varieties of castor bean (i.e. 80-23, 80-29, 80-12-1, and 80-17; list of studied castor bean varieties collected locations, as reported in Table I as a main plots, and three types of pruning (i.e. no pruning, pruning of two lateral branches, and pruning of four lateral branches) sub plots included. Planting as the row and each plot consisted of 4 rows, 6 m in length, interrow spacing was 100 cm and interplant spacing was 60 cm. Pruning operation was performed after primary raceme emergence and during the lateral branches production. To determine the effect of the treatments, 2 border rows in each plot were considered as sidelines, and the plants of middle 2 rows were harvested and the number of branches per plant was counted. Then after drying plants, racemes of plants were separated and sifter. Then the number of capsules in primary raceme, secondary raceme length and weight of capsules per plant was measured. Soxhlet method was used for extracting oil and the amount of oil percent was calculated with the following process. At first, we grounded some seeds sample and then weighted (W_1). Grounded samples immediately dried in drier at 85°C for 1.5 (W_2) and then transfer to desiccator for 35 min (W_3). After this process we used the following formula for measurement of oil percent:

Seed oil percent = $(W_1-W_3) / (W_2-W_3)$

The trial data were statistically processed using the single factor analysis of variance (ANOVA) and correlation analysis. Data were subjected to analysis by the SAS software and charts were drawn using Excel program. Duncan's multiple range test was used to separate the means when the ANOVA F-test indicated a significant effect of the treatment.

Table I. List of the 4 studied castor bean varieties collected from various location of Iran (8)

Code in gene bank	Location	Latitude	Longitude	Altitude (m)
80-23	Tafresh (Markazi State)	34º 24´	49º 43´	1735
80-12-1	Sahreza (Isfahan State)	32º 11´	51º 37´	1750
80-29	Toyserkan (Hamedan State)	36º 30´	48º 16´	1910
80-17	Ashtian (Markazi State)	32º 24´	50º 14´	1775

RESULTS AND DISCUSSION

Number of capsules in primary raceme

According to the results of Table II, number of capsules in primary raceme was showed significant difference among varieties of castor bean and variety × pruning interaction ($p < 0.05$). In contrast, different types of pruning had no significant effect on this trait in castor bean (Table II). The mean comparison showed that, 80-12-1 had highest number of capsules in primary raceme (75.22) due to genetic superiority produced stronger primary raceme, but minimum number of capsules in primary raceme (33.11) was observed in 80-29 (Table III). Also, mean comparison of treatments interaction (variety and pruning) indicated that, highest number of capsules in primary raceme achieved by 80-12-1 with pruning of 4 lateral branches whereas, lowest number of capsules in primary raceme was observed in 80-29 without pruning (Figure I). Pruning of 4 lateral branches in 80-12-1 variety had most effective on the primary raceme in this plant and the length and weight of this raceme increased. In castor bean

plant, the number of capsules in primary raceme is a major component in grain yield, and if this trait increases, the number of seeds in per plant increases too (11). Nabizadeh et al. (14) reported that 80-12-1 had highest seed weight in primary raceme. Also, they showed that 80-12-1 and pruning of 4 lateral branches had highest seed in primary raceme due to stronger primary raceme and high length of raceme.

Table II. Results of analysis of variance (mean squares) treatments in castor bean

Source of variation	d.f.	Number of capsules in primary raceme	Secondary raceme length	Number of branches per plant	weight of capsules per plant	Days from planting to emergence of secondary raceme	Oil percent
Rep	2	1305.19 ^{ns}	27.52 ^{ns}	0.19 ^{ns}	1487.5 ^{ns}	1.77 **	15.24 ^{ns}
Varieties	3	2978.76 *	228.83 *	1.22 ^{ns}	5902.11 *	606 **	39.83 ^{ns}
Error (a)	6	376.15	29.52	2.52	1031	0.0004	11.27
Pruning	2	185.36 ^{ns}	2.09 ^{ns}	0.44 ^{ns}	53.79 ^{ns}	48.44 **	22.49 ^{ns}
V×P	6	230.43 *	35.06 ^{ns}	2.55 *	187.38 ^{ns}	0.002 ^{ns}	40.54 ^{ns}
Error (b)	16	67.08	26.71	0.77	268.38	0.44	24.73
CV (%)		14.92	22.74	22.35	14.6	0.92	9.54

**, **, ns, Significant at P = 0.05, P = 0.01 and non-significant, respectively. d.f. degree of freedom.*

Table III. Mean comparison of varieties of castor bean and pruning on traits

Treatments	Number of capsules in primary raceme	Secondary raceme length (cm)	Number of branches per plant	weight of capsules per plant (g)	Days from planting to emergence of secondary raceme	Oil percent (%)
Varieties						
80-23	62.77 b	23.44 a	3.44 a	134.27 a	73.11 b	52.18 a
80-29	33.11 d	26.27 a	4.33 a	95.16 b	68.11 c	49 a
80-12-1	75.22 a	25.77 a	4 a	133.83 a	83.11 a	53.05 a
80-17	48.33 c	15.38 b	4 a	85.33 b	64.11 d	54 a
Pruning types						
No pruning	51.66 b	22.75 a	4.16 a	111.16 a	70 c	50.51 a
Pruning of 2 lateral branches	53.66 ab	22.29 a	3.83 a	110.70 a	72.33 b	52.71 a
Pruning of 4 lateral branches	59.25 a	23.12 a	3.83 a	114.58 a	74 a	53.03 a

In each section, means followed by the same letter within columns are not significantly different (p≤0.05) according Duncan test.

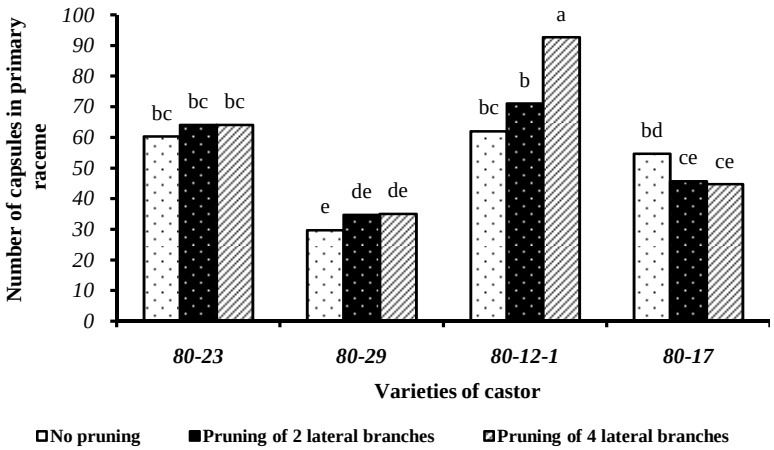

Figure I. Comparison of interaction of castor bean varieties and pruning on number of capsules in primary raceme

Secondary raceme length

Secondary raceme length showed significant difference between varieties ($p < 0.05$). The main effect of pruning and interaction (variety and pruning) had no significant effect on this trait in castor bean (Table II). The mean comparison showed that, maximum length of the secondary raceme (26.27 cm) was observed in 80-29 variety because of genetic superiority in connection with this trait, and minimum length (15.38 cm) was observed in 80-17 variety (Table III). According to the comments of Tongoona (17), variety has highly significant difference effect on all traits in castor bean plant. Generally, the raceme length, which caused non-uniformity in seed handling, can be increased to 100 cm (10).

Number of branches per plant

According to the results of Table II, variety and pruning factors had no significant effects on number of branches per plant. In contrast, number of branches per plant was showed significant difference between variety × pruning interactions ($p < 0.05$). Mean comparison of treatments interaction (variety and pruning) indicated that, highest number of branches per plant achieved by 80-29 without pruning and lowest number of branches per plant was observed in 80-23 with pruning of 4 lateral branches (Figure II). The difference between number of branches per plant in various varieties depends on the genetic characteristics and environmental conditions of experiment location such as: latitude and longitude, altitude of origin and planting place of castor bean. Many lateral branches in castor bean plant caused to increase maturity period and mechanized harvest can be difficult. Koutroubas et al. (11) reported that lower number of branches in castor bean plant with three racemes resistant to shedding is suitable for new varieties.

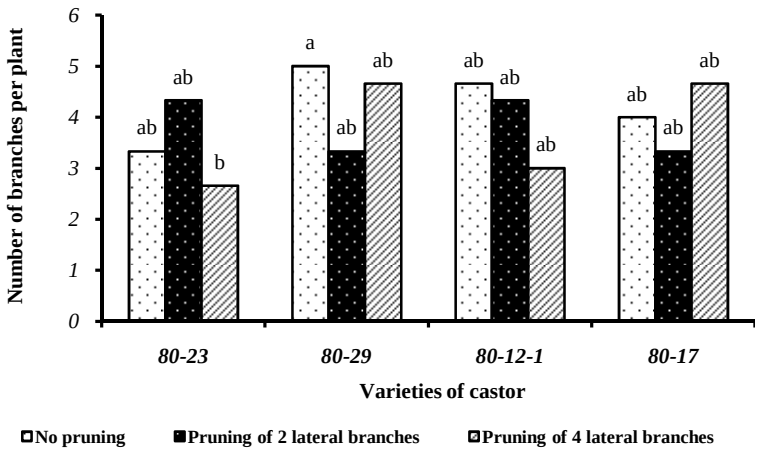

Figure II. Comparison of interaction of castor bean varieties and pruning on number of branches per plant

Weight of capsules per plant

Variety factor showed significant difference for weight of capsules per plant ($p < 0.05$). In contrast, pruning and variety × pruning interactions had no significant effect on weight of capsules per plant in castor bean (Table II). Mean comparison effect of variety on this trait indicated that, maximum weight of capsules per plant (134.27 g) obtained in 80-23, due to genetic superiority among the different varieties, and minimum weight (85.33 g) was in 80-17 variety (Table III). Weight of capsules per plant of different varieties, depending on genetic characteristics and weather conditions can be different (10). Usually yield of early varieties and so weight of seed in capsule and weight of capsule in racemes is less than the late varieties (2).

Days from planting to emergence of secondary raceme

Analysis of variance showed that, the variety and pruning factors had significant difference on days from planting to emergence of secondary raceme ($p < 0.01$), but interaction of variety and pruning on this trait had no significant effect (Table II). The mean comparison showed that, maximum period (83 days) was in 80-12-1 variety, and minimum period to emerge secondary raceme (64 days) was in 80-17 variety (Table III). Mean comparison effect of pruning on this trait indicated that, maximum period (74 days) obtained for pruning of 4 lateral branches, and minimum period to emerge secondary raceme (70 days) obtained for no pruning (Table III). In this experiment, the 80-12-1 variety in compared with other varieties of castor bean was late season and because of that, secondary raceme emergence was delayed. But 80-17 variety in compared with other varieties in this study, was early maturing and secondary raceme emergence was quickly. Also pruning lateral branches increased growth period in this plant. Alyary and Shekary (2) stated that, usually the yield of early varieties is less than the late varieties.

Oil percent

According to the results of Table II, variety and pruning factors had no significant effects on oil percent. Also, interaction of variety and pruning on this trait had no significant effect (Table II). Although not being significant effect on variety factor, maximum oil percent (54 %) obtained in 80-17 variety, and minimum oil percent (49 %) obtained in 80-29 variety (Table III). The amount of oil in castor bean seeds is a genetic trait, but is affected by the environmental conditions, agricultural operations and harvesting time. Difference latitude is one of the influencing climatic factors on oil percent (13). Small grains have less percent of skin and therefore containing more oil percent

(18). In this study, 80-17 variety compared to the other varieties of castor bean, was produced smaller grains and had the highest oil percent because of the less percent of skin.

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