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Research article

INHERITANCE STUDIES ON SEX EXPRESSION UNDER VARRYING ENVIRONMENTS IN CASTOR [*Ricinus communis* (L.)]

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ABSTRACT: Sex expression in castor for three qualitative characters viz., number of monoceious plant, number of interspersed plant and number of pistillate plant were studied under varying environments in kharif 2012-13. The experimental material consisted of four segregating F_2 populations for different characters. The results obtained from chi square test for genetics on sex expression in castor revealed that goodness of fit for all the characters, all environments and for all crosses under study bifurcated as 9:6:1 than normal dihybrid ratio. This ratio suggested the presence of polymeric gene interaction for this trait. Additional cycles of intermating in early segregating generation are suggested for the exploitation of such gene action. In both the environments sex expression was found to be governed by polymeric gene action irrespective of the nature of F_1 plants. However, number of interspersed staminate flowers (ISF) was found more in the irrigated environments (E_2) as compared to rainfed condition. Thus, irrigated condition might be proved helpful in maintaining plants with interspersed staminate flowers (ISF).
Key words: Sex expression, Monoecious, Pistillate, Interspersed and chi square

INTRODUCTION

Castor bean (*Ricinus communis* L.), a monotypic species in the spurge family (Euphorbiaceae) with 2n = 20 chromosomes, is an important non-edible oilseed crop. In India, Gujarat is leading castor growing state, which produces 82 per cent of total production. The productivity of castor is higher in Gujarat because more than 90 per cent cultivated areas are covered by castor hybrids under irrigated condition.

Being monoecious, it is anemophelous in nature and cross pollination ranges from 5 to 50 per cent. Due to this fact, it is difficult to maintain genetic purity in this crop. The exploitation of heterosis has been an important tool in castor which becomes feasible due to availability of 100% pistillate lines. A critical analysis of genetic and non genetic factors influencing sexual polymorphism in castor has enabled identification of three system of femaleness, viz., N, S & NES types. [1].

Sex expression in castor is highly influenced by environmental factors like, high day temperature, photoperiod, fertility, age of plant nutrition etc. [6, 7]. This information had been derived from the study of pistillate types only. However, information on genotype x environment interaction and stability analysis is totally lacking for sex related traits.

MATERIALS AND METHODS

The experimental material consisted of six parents (VP 1, VI 9, JI 35, 48-1, SH 72, and Geeta), four hybrids (GAUCH 1, GCH 2, GCH 4 and GCH 5) and four F_2 populations (Field evaluation in parents, hybrids and F_2 population) were evaluated in randomized block design replicated thrice under two environments created by manipulating sowing date, during *kharif* 2012-13 at Main Castor and Mustard Research Station and Centre for Watershed management, participatory research and rural engineering, S. D. Agricultural University, Sardarkrushinagar.

The observation were recorded for three qualitative characters *viz.,* number of monoceious plant, number of interspersed plant and number of pistillate plant. Genetics of sex expression were studied to test the significance of difference between observed and expected frequencies or ratios, for that Chi-square test (commonly known χ^2 test) Karl Pearson [4] was used. The general formula of χ^2 test was as follows:

$$\chi^2 = \frac{\sum(O-E)^2}{E}$$

Where,

$\sum$ = Summation,
O = Observed frequencies, and
E = Expected frequencies.

Arcsin Transformation

The primary, secondary and tertiary racemes were observed for per cent pistillate whorls. The number of whorls bearing male flowers and pistillate flowers were counted in each plant and expressed as per cent pistillate whorls.

$$\text{Percent Pistillate whorls} = \frac{\text{Number of Pistillate whorls (NPW)}}{\text{Total number of flowering whorls (TFW)}} \times 100$$

Where,
TFW = NPW + NMW
NPW = Number of Pistillate whorls
NMW= Number of staminate whorls (male)

The transformation formula is: = ASIN [SORT (A2/100)]* 180/PI ()

The mean values were converted into Arcsine transformation and used for statistical analysis. [5].

RESULTS AND DISCUSSION

Inheritance study on sex expression in cross I (VP 1 x VI 9) manifested all the plants in F_1 generation of this cross by monoceious nature. The F_2 population however, segregated in the ratio of 9 monoceious: 6 interspersed: 1 pistillate than normal dihybrid ratio (9:3:3:1) which suggested polymeric gene action controlling the interspersed flowers. The mode of inheritance of sex expression in inflorescence of cross II (VP 1 x JI 35) showed that, F_1 generation of this cross was found to have interspersed proportion of plants whereas in F_2 population polymeric gene interaction was observed with the ratio of 9:6:1 indicating that sex expression was governed by polymeric gene action.

The inheritance study of sex expression in monoceious, interspersed and pistillate plant was studied in the cross III (VP 1 x 48-1). All the plants in F_1 generation of this cross were interspersed plant. In F_2 population 9 monoceious: 6 interspersed: 1 pistillate ratio indicating the role of polymeric gene in the expression of this trait. In cross IV (Geeta x SH 72), the F_1's was found to have interspersed nature of the trait. The F_2 population indicated a good fit to the polymeric ratio of 9 monoceious: 6 interspersed: 1 pistillate plant. Thus irrespective of monoceious or interspersed nature in F_1 generation, all the crosses showed same genetic ratio indicating involvement of polymeric gene action in these traits. The result of the present study thus, indicates that polymeric type of interaction was observed for all the crosses in rainfed condition, suggesting the complex nature of inheritance for this trait. The results found in this environment for all crosses are similar of goodness of fit for sex expression. Similar results were also found by Lavanya and Gopinath [3], whereas, contradictory results were observed for gene expression as reported by Lavanya [2]. The inheritance pattern of genetics of sex expression was studied in castor using four cross combinations for number of monoceious, number of interspersed and number of pistillate plant inirrigated condition also. In cross (VP 1 X VI 9) all F_1 plants derived from this cross were monoceious. Segregation in the F_2 gave 51 monoceious, 41 interspersed and 6 pistillate plants, which fitted to 9 monoceious: 6 interspersed: 1 pistillate ratio (Table 2), suggesting polymeric gene ratio. Cross VP 1 X JI 35, exhibited all the plants in F_1 generation with interspersed nature, and it was segregated in the F_2 population as 9 monoceious: 6 interspersed: 1 pistillate plants.

In cross III (VP 1 x 48-1), all the plants in F_1 generation of this cross were interspersed. The F_2 population however, segregated in the ratio of 9 monoceious: 6 interspersed: 1 pistillate (50 monoceious: 38 interspersed: 5 pistillate), which suggested polymeric gene responcible for interspersed flower. The mode of inheritance of sex expression in inflorescence of castor in cross IV (Geeta x SH 72) revealed F_1 generation of this cross was found to have interspersed nature proportion of plants with monoceious, interspersed and pistillate flowers in F_2 population closely fitted in the ratio of 9:6:1 indicating that sex expression was governed by polymeric gene interaction.

Table 1. Genetic analysis of sex expression in segregating population of castor and test of goodness of fit to the expected ratio in E-I.

Environment - I Rainfed Condition							
Cross	Generation	No. of plants observed				Expected ratio	χ^2 value
		Total	Monoceious	Interspersed	Pistillate		
I	GAUCH-1 (VP-1 × VI-9)	75	42	29	4	9:6:1	0.127
II	GCH-2(VP-1 × JI-35)	85	46	35	4	9:6:1	0.699
III	GCH-4 (VP-1 ×48-1)	80	45	32	3	9:6:1	0.933
IV	GCH-5 (Geeta × SH-72)	77	41	31	5	9:6:1	0.287

Table 2. Genetic analysis of sex expression in segregating population of castor and test of goodness of fit to the expected ratio in E-II.

Environment - II Early sown irrigated condition							
Cross	Generation	No. of plants observed				Expected ratio	χ^2 value
		Total	Monoceious	Interspersed	Pistillate		
I	GAUCH-1 (VP-1 × VI-9)	98	51	41	6	9:6:1	0.801
II	GCH-2 (VP-1 × JI-35)	97	52	40	5	9:6:1	0.667
III	GCH-4 (VP-1 × 48-1)	93	50	38	5	9:6:1	0.495
IV	GCH-5 (Geeta × SH-72)	91	48	37	6	9:6:1	0.458

In both the environment I and environment II, genetic architecture for the sex expression was same but numbers of interspersed plants were comparatively more in E_2 than E_1. It may be due to irrigated condition of environment II and rainfed condition may be enhancing the number of monoceious plants than irrigated condition. In timely sown irrigated condition (E_2) polymeric type of interaction was also observed for the expression of this trait. In such, situation simple pedigree method of selection alone is in effective. The results are found in this environment for all crosses are similar for sex expression. Similar results are also found by Lavanya and Gopinath (2008), whereas, contradictory results are found by Lavanya [2].

In both the three environments sex expression was found to be governed by polymeric gene action irrespective of the nature of F_1 plants. However, number of interspersed staminate flowers (ISF) was found more in irrigated environment (E_2) as compared to rainfed condition. Thus, irrigated condition might be proved helpful in maintaining plants with interspersed staminate flowers (ISF). From the fore going result and discussion on gene action for sex expression in castor, it was cleared that duplicate gene interaction was important for the expression of this trait in all the crosses in all the environments. In such, condition simple pedigree method of selection would not be appropriate. To exploit such variation additional cycles of intermating in early segregating generation are suggested.

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