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Inheritance study of some morphological traits in castor (*Ricinus communis* L.)

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Abstract

The study revealed that green spike colour epistatic over sulphur white colour and trait being governed by a dominant inhibitory gene and another colour gene (Sulphur white). Monogenic nature of inheritance was observed for the other characters *viz.* nature of inter nodes, stem colour, and presence of bloom. Joint segregation for different pair of traits suggested independent segregation of all the traits studied and no evidence of linkage was detected.

Key words : Castor, inheritance, inhibitory epistasis, linkage

Introduction

Castor (*Ricinus communis* L.) has a number of contrasting characters like spike colour, nature of inter nodes, bloom etc. The morphological traits could be use as genetic marker. Traits like bloom provides natural protection against drought, cold and jassids. Despite the importance of morphological traits not much work on genetic study has been done. The available information on this aspect is scanty, quite old and no attempt has been made to study linkage. Thus present study was undertaken to generate information on inheritance of morphological traits and detection of linkage if any.

Materials and methods

Six parents *viz.* VP 1, MCP 2, RG 184, RG 125, RG 299 and 846 having diverse morphological traits (Table 1) were selected for present investigation. Hybridize parents on the basis of different morphological traits and five crosses i.e. VP 1 × RG 299, VP1 × RG 184, RG 184 × RG 299, MCP 2 × RG 125 and RG 125 × 846 were attempted in Kharif 1992. In season 1993 material for genetic study was prepared by selfing and back crossing (P_1, P_2, F_1, F_2, BC_1 and BC_2). During Kharif 1994 all six populations were planted to study inheritance pattern of spike colour (green-sulphur white), stem colour (green \ mahogany or red), nature of inter nodes (condensed \ elongated) and bloom (presence \ absence of bloom). In castor presence of waxy coating on plant parts is termed as bloom and absence of such coating is defined as non- bloom. Observation on 20 plants were recorded on parents and F_1s. The sample size in segregating generations varied in different crosses. The chi-square test was applied for the goodness of fit for different expected genetic ratios.

Table 1. Morphological characteristics of the parents

Parents	Node	Stem colour	Bloom	Spike colour
VP 1	Condensed	Green	Triple	Green
MCP 2	Elongated	Green	Double	Green
RG 125	Elongated	Red	No-bloom	Green
RG 184	Elongated	Mahogany	Triple	Green
846	Elongated	Green	Double	Green
RG 299	Elongated	Green	Double	Sulphur-white

Results and discussion

The inheritance of spike colour was studied in the two crosses namely VP 1 × RG 299 and RG 184 × RG 299. The parents, VP 1 and RG184 had all plants with green spike and RG 299 had sulphur-white spike colour. The F_1 population of both the crosses recorded green spike in all observed plants. The segregating population F_2 of these crosses indicated a good fit to the ratio of 13 green : 3 sulphur-white spike colour (Table 2). The back cross populations of F_1 (VP 1 × RG 299) × VP 1 and F_1 (RG184 × RG 299) × RG184 had all green spikes. While back cross population involving RG 299 (sulphur-white) as a recurrent parent had plants in the ratio of 1 green : 1 sulphur-white spike colour. Thus one dominant inhibitory gene and another colour gene (sulphur white gene) appeared to be responsible for the inheritance of this traits in this set of crosses. Gene governing green spike colour found to exhibiting inhibitory epistatic gene action over sulphur white spike colour gene. However Kulkarni and Ramanmurthy [1] reported segregation ratio of 15 green : 1 sulphur-white

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Table 2. Inheritance of spike colour in castor

Parent /generation	No. of plants observed	Spike colour		Expected ratio	χ^2 ratio	P-range
		Green	Sulphur -white			
Cross VP 1 × RG 299						
VP 1	20	20	-	-	-	-
RG 299	20	-	20	-	-	-
F_1	20	20	-	-	-	-
F_2	212	174	38	13:3	0.09	0.80-0.70
F_1 × VP 1	110	110	-	-	-	-
F_1 × RG 299	152	82	70	1:1	0.95	0.50-0.30
Cross RG 184 × RG 299						
RG 184	20	20	-	-	-	-
RG 299	20	-	20	-	-	-
F_1	20	20	-	-	-	-
F_2	177	140	37	13:3	0.54	0.50-0.30
F_1 × RG 184	78	78	-	-	-	-
F_1 × RG 299	93	50	43	1:1	0.52	0.50-0.30

spike colour in F_2 generation in different crosses of castor.

Inheritance of nature of internodes was studied in the two crosses VP1 × RG 299 and VP1 × RG 184. Both the crosses had elongated internodes in the F_1 generation. The F_2 of both crosses gave a good fit to the three elongated : one condensed node ratio (Table 3). The back cross population involving parent with condensed nodes indicated a good fit to 1 elongated: 1 condensed node ratio. The back cross population involving parent with elongated node as recurrent parent had all plants with elongated nodes indicating dominant nature of elongated nodes over

Table 3. Inheritance of nature of inter nodes in castor

Parent/ generation	No. of plants observed	Nature of inter nodes		Expected ratio	χ^2	P-range
		Elongated	Condensed			
Cross VP 1 × RG 299						
VP 1	20	-	20	-	-	-
RG 299	20	20	-	-	-	-
F_1	20	20	-	-	-	-
F_2	212	169	43	3:1	2.52	0.25-0.10
F_1 × VP 1	110	57	53	1:1	0.14	0.80-0.70
F_1 × RG299	152	152	-	-	-	-
Cross VP1 × RG 184						
VP 1	20	-	20	-	-	-
RG 184	20	20	-	-	-	-
F_1	20	20	-	-	-	-
F_2	62	51	11	3:1	1.75	0.25-0.10
F_1 × VP 1	109	46	63	1:1	2.65	0.25-0.10
F_1 × RG 184	61	61	-	-	-	-

Table 4. Inheritance of stem colour in castor

Parent/generation	No. of plants observed	Stem colour		Expected ratio	χ^2	P-range
		Re/mahogany	Green			
Cross RG 184×RG 299						
RG 184	20	20	-	-	-	-
RG 299	20	-	20	-	-	-
F_1	20	20	-	-	-	-
F_2	177	142	35	3:1	2.39	0.25-0.10
F_1 × RG184	78	78	-	-	-	-
F_1 × RG299	93	46	47	1:1	0.05	0.90-0.75
Cross VP 1 × RG184						
VP 1	20	-	20	-	-	-
RG 184	20	20	-	-	-	-
F_1	20	20	-	-	-	-
F_2	62	51	11	3:1	1.74	0.25-0.10
F_1 × VP1	109	60	49	1:1	1.1	0.30-0.20
F_1 × RG184	61	61	-	-	-	-
Cross MCP2 × RG 125						
MCP 2	20	-	20	-	-	-
RG 125	20	20	-	-	-	-
F_1	20	20	-	-	-	-
F_2	177	131	46	3:1	0.09	0.90-0.75
F_1 × MCP 2	144	64	80	1:1	1.77	0.28-0.10
F_1 × RG 125	110	110	-	-	-	-
Cross RG 125 × 846						
RG 125	20	20	-	-	-	-
846	20	-	20	-	-	-
F_1	20	20	-	-	-	-
F_2	253	182	71	3:1	1.76	0.50-0.28
F_1 × RG 125	148	-	-	-	-	-
F_1 × 846	70	33	37	1:1	0.22	0.75-0.50

Table 5. Inheritance of bloom in castor

Parent/ generation	No. of plants observed	Bloom type		Expected ratio	χ^2	P-range
		Bloom	No bloom			
Cross MCP 2 × RG 125						
MCP 2	20	20	-	-	-	-
RG 125	20	-	20	-	-	-
F_1	20	20	-	-	-	-
F_2	177	126	51	3:1	1.37	0.25-0.10
F_1 × MCP 2	144	144	-	-	-	-
F_1 × RG 125	110	47	63	1:1	2.32	0.25-0.10
Cross RG 125 × 846						
RG 125	20	-	20	-	-	-
846	20	20	-	-	-	-
F_1	20	20	-	-	-	-
F_2	253	184	69	3:1	0.70	0.50 0.25
F_1 × RG 125	148	66	82	1:1	1.69	0.25-0.10
F_1 × 846	70	70	-	-	-	-

condensed nodes. The results obtained were in agreement with those reported earlier [2-3].

The inheritance of stem colour was studied in the four crosses *viz.* RG 184 × RG 299, VP 1 × RG 184, MCP 2 × RG 125 and RG 125 × 846. The F_1s of all crosses had mahogany stem colour, it revealed the dominance of colour stem over green stem colour. Segregation pattern in F_2 generation in all crosses exhibited a good fit to the 3 coloured : 1 green ratio (Table 4). The back cross populations of (RG 184 × RG 299) × RG 184 and (RG 125 × 846) × RG 125 and the back cross populations of the crosses (VP 1 × RG 184) × RG 184 and (MCP 2 × RG 125) × RG 125 gave plants with all coloured stem. It confirmed the dominance of coloured stem. The back cross population of (RG 184 × RG 299) × RG 299, (VP 1 × RG 184) × VP 1, (MCP 2 × RG 125) × MCP 2

Table 6. Joint segregation for stem colour v/s spike colour (Cross RG 184 x RG 299) in castor

Character	Ratio observed	Generation	Number of plants				χ^2	P-range
			Mahogany & Green	Mahogany & Sulphur-white	Green & Spike colour green	Green & Sulphur-white		
Spike colour	13:3 (G) (SW)	F_2	(O) 114	28	29	6	2.70	0.50-0.25
			(E) 107.8	24.9	35.9	4.0		
			Ratio 39:	3:	13:	3		
Stem colour	3:1 (M) (G)	BC_1	(O) 78	-	-	-	-	-
			(E) 78.0					
		BC_2	(O) 24	22	26	21	0.63	0.90-0.75
			(E) 23.2	23.2	23.2	23.2		
			Ratio 1:	1:	1:	1		

G = Green, SW = Sulphur-white, M = Mahogany; O = Observed frequency; E = Expected frequency

Table 7. Joint segregation for stem colour v\s bloom in castor

Character	Ratio observed	Generation	Number of plants				χ^2	P-range
			Red & bloom	Red & no bloom	Green & bloom	Green & no bloom		
Cross MCP 2 × RG 125								
Stem colour	3:1 (R) (G)	F_2	(O) 95	36	31	15	1.98	0.75-0.50
			(E) 99.6	33.2	33.2	11.1		
			Ratio 9:	3:	3:	1		
Bloom	3:1 (B) (NB)	BC_1	(O) 64	-	80	-	1.77	0.25-0.10
			(E) 72.0		72.0			
			Ratio 1 :		1			
		BC_2	(O) 47	63	-	-	2.32	0.25-0.10
			(E) 55.0	55.0				
			Ratio 1:	1				
Cross RG 125 × 846								
Stem colour	3:1 (R) (G)	F_2	(O) 133	49	51	20	2.03	0.75- 0.50
			(E) 142.3	47.4	47.4	15.8		
			Ratio 9:	3:	3:	1		
Bloom	3:1 (B) (NB)	BC_1	(O) 66	82	-	-	1.72	0.50-0.25
			(E) 74.0	74.0				
			Ratio 1:	1				
		BC_2	(O) 33	-	37	-	0.22	0.75-0.50
			(E) 35.0	-	35.0			
			Ratio 1:	1				

R = Red, G = Green. B = Bloom, NB = No bloom; O = Observed frequency and E = Expected frequency

Table 8. Joint segregation for spike colour v\s nature of inter nodes (cross VP1 × RG299) in castor

Character	Ratio observed	Generation	Number of plants				χ^2	P-range
			Green & elongated	Sulphur-white & elongated	Green & condensed	Sulphur-white & condensed		
Spike colour	13:3 (G) (SW)	F_2	(O) 138	31	36	7	2.65	0.50- 0.25
			(E) 129.2	29.8	43.0	9.9		
			Ratio 39 :	3:	13:	3		
Nature of inter nodes	3:1 (EL) (C)	BC_1	(O) 57	-	53	-	0.14	0.75-0.50
			(E) 55.0	-	55.0			
			Ratio 1 :		1			
		BC_2	(O) 82	70	-	-	1.00	0.50-0.25
			(E) 76.0	76.0				
			Ratio 1:	1				

G = Green, SW = Sulphur white, EL = Elongated nodes, C = Condensed nodes
O = Observed frequency and E = Expected frequency

and (RG 125 × 846) × 846 segregated in the ratio 1 green : 1 coloured stem ratio. The present finding confirmed the earlier reports [4-6].

The crosses studied for inheritance of bloom had all plants with bloom in the F_1 generation (Table 5). In the F_2 all crosses gave a good fit to the 3 bloom: 1 no bloom ratio, indicating that bloomness is determined by a single dominant gene. The back crosses (MCP 2 × RG 125) × MCP2 and (RG 125 × 846) × 846 had all plants with bloom. It confirmed dominance of bloom over no bloom. The back crosses (MCP 2 × RG 125) × RG125 and (RG 125 × 846) × RG125 had bloom and no bloom plants in the 1 : 1 proportion. These results were in agreement with those reported earlier [4, 7, 8]. In castor plant variation for bloomness consists of no bloom (absence of waxy coating on all parts of plant), single bloom (presence of waxy coating on stem only), double bloom (presence of waxy coating on stem and dorsal side of leaves) and triple bloom (presence of waxy coating on stem and ventral as well as on dorsal sides of leaves). However, in present study observation on plants was recorded for presence or absence of bloom. To study complete inheritance of bloomness observations on the basis of single bloom, double bloom, triple bloom and no bloom is essentially required.

Joint segregation for different traits *viz.* spike colour and stem colour, stem colour and bloom, spike colour and nature of inter node in different crosses were studied (Tables 6-8). The results suggested that all the four characters segregated independently of each other and no evidence of linkage was observed among spike colour, nature of inter nodes, stem colour and bloom.

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