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Study of Variation in Certain Qualitative Characters of Castor (*Ricinus communis* L.)

by

S. VARISAI MUHAMMAD[1], N. SRINIVASALU[2], K. NAVAKODI[3], N. M. RAMASWAMY[4], P. SIVASUBRAMANIAN[5], M. STEPHEN DORAIRAJ[6] and K. S. PARAMASIVAN[7]

The scope of selection depends on the magnitude of variability in the material under selection and the extent to which the desirable characters are heritable. An appraisal of the variation and heritability of both qualitative and quantitative characters is therefore desirable to assess critically the value of the material under study for its further utilization either in selection or hybridization programme. Castor with its great multiplicity of forms and types, as it is grown under diverse agro-climatic conditions is subjected to such a study and the variations on the qualitative characters are presented. The standards are also fixed for describing these characters.

Materials and Methods: The study was undertaken with 154 inbred lines of castor, 68 indigenous and 86 exotic lines maintained for over three years in the homozygous condition at the Castor Research Station, Salem. The crop was raised under rainfed conditions between July and March during 1964–65 to 1967–68. The plants were raised in red loamy soil with a spacing of 90 cm × 90 cm. Observations on the qualitative characters were recorded on twenty plants selected at random in each of the lines. The colour grades were determined by referring to the British Colour Council Dictionary of Colour Standards.

Results and Discussion: While presenting the observations recorded in each of the qualitative characters, the variation observed by previous workers in the particular attribute and the significance of the character based on its heritability or otherwise are discussed.

i) *Stem colour:* The castor plant exhibited much variation in stem colour. Five distinct colour grades were recognisable at Salem and they are 1) *dark green* as in *R.c.* 1107, *R.c.* 1108 (Senegal), *R.c.* 1164 (Israel) and *R.c.* 1221 (U.S.A.), 2) *yellowish green* as in *R.c.* 820 (Russia), *R.c.* 1094 (Cimmorron), *R.c.* 833 (Egypt) and *R.c.* 913 (Namakkal), 3) *rose* as in *R.c.* 651/1 (Kanpur), *R.c.* 826 (Russia) and *R.c.* 830 (Egypt), 4) *mahogany* as in *R.c.* 1116 (Senegal) and *R.c.* 1092 (Italy) and 5) *purple* as in *R.c.* 1362 (Phillipines).

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1. Crop Specialist (oilseeds), 4. Ressarch Scholar, 5. Assistant in oilseeds, Department of Agricultural Botany, Tamil Nadu Agricultural University, Coimbatore. 2. Crop Specialist (Padday), Regional Agricultural Research Station, Aduthuari. 3. Assistant Crop Specialist (oilseeds), Kovilpatti. 6. Assistant Crop Specialist (oilseeds), Salem. 7. Post Graduate Student, Agricultural College, Madurai.

The above were the basic stem colours in which slight variation due to intensity of bloom and anthocyanin pigment could be seen. Observations on stem colour should be recorded just at the time of emergence of the main inflorescence, lest the colour got faded. The intensity of bloom also made the external expression deceptive, as could be seen in the appearance of the yellowish-green colour as green in the bloom types. White (1918) recognised five colour grades bright green, green with reddish blush on sunny side, carmine or rose-red, mahogany-red and purple or dark-red. Seshadri and Varisai Muhammad (1951) have reported four distinct stem colours, mahogany, red, red-blush and green. Stem colours varying from blood-red, red, green, pink to sulphur-white were distinguished at Himayatsagar (Kulkarni, 1959).

Stem colour has been recorded as a heritable character with a single factor pair difference in many cases (White 1918, Harland, 1922, Patwardhan, 1931, Kumar, 1938 and Kulkarni, 1959) and the operation of complementary factors in one instance (Seshadri and Varisai Muhammad, 1951). In view of the divergence and the heritability of this character, it was used as one of the bases for classifying castor varieties (Narain, 1958).

ii) *Surface of the stem:* The surface of the stem in castor may either be smooth or echinate. Seshadri and Varisai Muhammad (1951) have recorded that echinate nature was partially dominant with monogenic difference. Most of the inbred lines had smooth stem, while a few such as strain TMV3, *R. c.* 892 (Nandyal) and *R. c.* 902 (Ghodia) possessed the echinate stem. This is used as a marker gene in the breeding programme to maintain the purity of improved strains.

iii) *Bloom nature:* The waxy coating on the castor plant is of considerable significance, not only as a character for the identification of varieties, but also as a natural protection from extremes of weather and from certain insect pests. According to the presence or absence of bloom and its intensity, the nature of bloom is classified into four distinct categories.

1. *No bloom* (absence of bloom in any part of the plant) as in *R. c.* 1072 and *R, c.* 1066 (ornamental types extracted from a cross). 2. *Single bloom* (presence of bloom on stem, petiole and peduncle as in *R c.* 822 (Russia), *R. c.* 539/1 (Egypt), *R. c.* 1133 (I. A. R. I.) and *R..c.* 686/1 (Nagpur). 3. *Double bloom* presence of bloom on stem, petiole peduncle and lower surface of the lamina as in *R. c.* 895 (Nandyal), *R. c.* 834 (Rajampet) and *R. c.* 830 (Egypt) and 4. *Triple bloom* (presence of bloom on stem, petiole, peduncle and both the surfaces of the lamina as in *R. c.* 826, *R. c.* 827 (Russia) and *R. c.* 880 (Rajampet). Most of the inbreds available at Salem possessed double or single bloom. In the double and triple bloom inbreds, the intensity of waxy coating differed. In the no bloom group, rose-stemmed plants were not met with, while all the mahogany stemmed plants were without bloom.

Besides the four groups enumerated above, Narain (1952, 1961) has recorded two new characters one with light smoky bloom and the other where the bloom was restricted only to the inflorescence. The inheritance of bloom nature has been studied by many workers and a simple monogenic factor was found to operate by White (1918), Harland (1920) and Patwardhan (1931), while Peat (1926) recorded two non-allelic factors B and C together producing the double bloom with segregation of 9 double bloom : 3 single bloom : 4 no bloom in the F_2 of a cross between double and no bloom plants. Kumar (1938) observed the bloom characters to be inherited in a complex manner. Narain (1961) encountered the full bloom, bloomless and light smoky bloom forming an allelic series, the order of dominance being $B>b>b^b$. In view of the heritable nature of the character, there is scope to utilize the bloom nature for distinguishing the varieties and also in the classification of castor varieties.

iv) *Colour of the nectary gland:* Of the 154 inbreds studied, only two inbreds *R. c.* 826 (Russia) and *R. c.* 894 (Nandyal) possessed red nectary glands, while all others had yellow glants. The yellow glands were found in all the inbreds irrespective of stem colour, while the presence of red glands was always associated with the red colour of the stem and petiole. Seshadri and Varisai Muhammad (1951) found the red colour described by them as crimson, to be dominant due to a single factor.

v) *Colour of the stigma:* In castor, the colour of stigma was either crimson or yellow in colour. The crimson stigma exhibited slight variation in intensity in different inbreds. The yellow stigma in its early stage of development appeared as greenish-yellow and hence described so by Seshadri and Varisai Muhammad (1951). The authors found the crimson to be dominant over yellow with a single factor difference.

Most of the inbreds such as *R.c.* 822 (Russia), *R.c.* 830 (Egypt), *R.c.* 1125 (Senegal), *R.c.* 1221 (U.S.A.), to quote a few, possessed crimson stigma, while only a few green stemmed inbreds such as *R.c.* 873/1 (Egypt), *R.c.* 1115 (Senegal), *R.c.* 1098 (Baker-U.S.A.), *R.c.* 1194 (Kanpur) and *R.c.* 834 (Rajampet) had yellow stigma. The yellow stigma was always associated with green stem and never seen on any of the inbreds with stems of other colours.

vi) *Nature of the surface of fruit:* The epicarp of the fruit of castor was either spiny or non-spiny. The former had spiny protuberances on the surface of the fruit and this was common in the castor inbreds. The non-spiny epicarp was either smooth or warty. In the warty type represented by inbreds *R.c.* 552/2 (Nagpur) and *R.c.* 651/1 (Kanpur), the surface of the epicarp was rugged as against the smooth surface met with in *R.c.* 1168/2 (Senegal), *R.c.* 1077 (South Africa) among others. In general, the non-spiny varieties possessed non-shattering capsules.

The character has been found to be inherited in monomendelian factor ratio with the spiny nature incompletely dominant over spineless and wartiness over smoothness (Peat, 1926; Harland, 1928; Kumar, 1938; Reddi, 1939; Seshadri and Varisai Muhammad, 1951 and Kulkarni, 1959).

vii) *Colour of capsule:* Though most of the inbreds possessed green capsules, other colours were also met with. The colour of the capsule was to a certain extent inhibited by the intensity of bloom. The capsule colours observed in the collection at Salem were green as in *R.c.* 820 (Russia), *R.c.* 835 (Kanpur), *R.c.* 719/1 (Egypt), purple as in *R.c.* 1362 (Phillipines), mahogany as in *R.c.* 1066, rose as in *R.c.* 1068, pink as in *R.c.* 1067, yellow as in *R.c.* 1073 and creamy yellow as in *R.c.* 1071, the inbreds possessing mahogany to creamy yellow capsules being extracted from a cross.

Kulkarni (1959) recognised four capsule colours, mahogany, pink, sulphur white and green. Patwardhan (1931) in a cross between varieties with green and pink capsule colours and Seshadri and Varisai Muhammad (1951) in a cross involving parents with rose-red and green capsules encountered a segregation ratio of 3 : 1 with the dominance of green colour. At Himayatnagar, crosses between pink and green and also between green and sulphur white showed the dominance of green colour and a segregation of 15 : 1 in the F_2 (Kulkarni, 1959).

Green capsules were found in all the inbreds with different coloured stems, while purple capsules were recognised in purple-stemmed plants and mahogany and pink capsules in mahogany-stemmed ones. Rose capsules were associated with rose stem. The yellow and creamy yellow capsules were found only in green-stemmed inbreds.

viii) *Shape of capsule:* Even though distinct shapes of the capsules are met with, they have not been recognised by previous workers. In the inbred lines studied at present, the capsules were ovate as in *R.c.* 831/1 and *R.c.* 869/1 (Egypt), round as in *R.c.* 1243 (Nebraska) and strain CO 1 and oblong as in *R.c.* 1345 (Israel). The ovate shape was predominant in most of the inbred lines, while the oblong shape was found only in one Israel variety.

ix) *Dehiscence of capsule:* The capsule when attains maturity may dehisce shattering the seeds from the locules in certain of the varieties. Such dehiscent types were found in *R. c.* 1092 (Italy), *R. c.* 1118 (Senegal), *R.c.* 1170/1 (South Africa), *R. c.* 1163 (Vijayapur), *R. c.* 843 (Cuddapah) and strain TMV3 to site a few. In certain other inbreds such as *R. c.* 852 (B. Diveli), *R. c.* 1166 (Israel), *R. c.* 962 (Solur), *R. c.* 1098 (U. S. A.), *R. c.* 822 (Russia) and strain TMV2, among others, the fruits did not dehisce even after maturity. Among the dehiscent types, there are a few in which the capsules dehisce with greater force, thereby dispersing

the seeds over a great distance. Such types are described as "poppers" and a South African inbred *R. c.* 1170/1 had this characteristic feature.

Non-dehiscence of capsule is an economic character in castor which is a predominantly rainfed crop, where the harvest of raceme is done at intervals. This character also assumes greater importance in view of the fact that the castor plants alone are left in the fields when the other crops in the mixed cropping programme are harvested earlier, so that the farmer can gather the mature racemes without any loss of produce.

x) *Shape of the mature receme:* The shape of the raceme is determined by the arrangement of the capsules on the peduncle, the length of pedicel and the proportion of pistillate and staminate flowers on the raceme. Generally, the following three shapes were found to be predominant; 1) cylindrical where the mature raceme was more or less like a narrow cylinder with uniform diameter as in *R.c.* 539/1 (Egypt), *R.c.* 1290 (U.S.A.), *R.c.* 879/1 (Rajampet), *R.c.* 1164 (Vijayapur) and strain TMV 3 (Tindivanam). 2) conical in which the fruit cluster was broad at the base and progressively narrow towards the top as in *R.c.* 1073 (Horticulture type) and strain TMV 1 (Tindivanam) and 3) globose, where the raceme was short and the length of the pedicel varied at different positions of the raceme giving a round shape to it as in *R.c.* 1298 (U.S.A) and *R.c.* 1168/2 (South Africa). Most of the inbred lines have the conical shape.

Kulkarni (1959) recognised long cylindrical and long conical shape in the mostly female types and certain shapes were discernible but not so conspicuous in the partially female types.

xi) *Compactness of the raceme:* The disposition of the fruits on the raceme and their relative density gives the measure of compactness. In the inbreds studied, the degree of compactness of the raceme could be grouped into (1) compact as in *R.c.* 895 (Nandyal), *R.c.* 1163 (Vijayapur), *R.c.* 1223 (U.S.A.), *R.c.* 1197 (Kanpur) and *R.c.* 1289 (U.S.S.R.). 2) semi-compact as in *R.c.* 1168/2 (South Africa), *R.c.* 833 (Egypt), strains TMV 1 and TMV 3 and 3) sparse as in *R.c.* 882 (Rajampet), *R.c.* 872 (Egypt), *R.c.* 1227 (U.S.A.) and strains TMV 2 and CO 1. In the compact raceme, the capsules were set so close together touching each other that there was no interspace between capsules. The stalks of the capsules were also not visible outside. In the sparse types, there was more space between capsules, while in the semi-compact type, the capsules were quite close to one another, but there was some interspace between capsules.

Kulkarni (1959) recorded the racemes to be firmly compact, compact, loose and very loose. White (1918) studying the inheritance of the character found semicompact F_1s when loose and compact raceme plants were crossed and all the different types were available in the segregating population.

The breeder always selects a semi compact type, since compact racemes allow heavy infestation of the castor capsule borer, *Dichocrocis punctiferalis* Guen.

xii) *Colour of seed coat:* The crustaceous seed coat of castor is variously coloured with an overlay of mottling. The ground colour of seed varied from white to purple and in the inbred collections, ten distinct ground colours were recognised. They were 1) *White-R. c.* 1108 (Senegal), *R. c.* 1237 (U. S. A.), Co.1. 2) *dull white-R. c.* 686/1 (Nagpur). 3) *light grey-R. c.* 1077 (South Africa). 4) *dark grey-R. c.* 1098 (Baker-U. S. A,), *R. c.* 1073 (Horticultural type). 5) *light brown-R. c.* 1094 (Cimmorron-U. S. A.), *R. c.* 820, *R. c.* 822 (Russia), strain TMV1. 6) *brown-R. c.* 865 (Namakkal). 7) *red brown-R. c.* 1092 (Italy), *R. c.* 539/1 (Egypt), *R. c.* 847 (Vinukonda), strains TMV2, TMV3. 8) *red-R. c.* 1243 (U. S. A.), 9) *light purple-R. c.* 1196 (Kanpur), *R. c.* 1241 (U. S. A.) and 10) *purple-R. c.* 1225, *R. c.* 1230 U. S. A.).

Kulkarni (1959) reported red, white, grey, faint chocolate, deep chocolate and purple seed coat colours in castor.

xiii) *Mottling of the seed:* A great variation was seen in the mottling or presence of coloured speckles on the ground colour of the seed coat. It ranged from complete absence of mottling to very thick mottling. The latter sometimes made it difficult to distinguish between the ground colour and the mottling. The colour of mottling was either white, brown or dark brown, the latter two being predominant in many inbred lines.

Among the qualitative characters of castor discussed above, colour of stem, nectary glands, stigma and capsules, smooth or echinate nature of stem and petiole, nature of bloom, spiny or non-spiny nature of fruit and compactness of raceme were all determined to be heritable characters. Further, the presence of bloom, capsule dehiscence and compactness of raceme are economically important attributes that contribute directly or indirectly to yield of beans

Summary: One hundred and fiftyfour inbred lines of castor, 68 indigenous and 86 exotic lines maintained at the Castor Research Station, Salem for over three years were utilized for the study of variation in certain qualitative characters and for fixing standards for the purpose of description by plant breeders. The characters included colour of stem, nectary gland, stigma and capsule, smooth or echinate nature of stem and petiole, nature of bloom, spiny or non-spiny nature of fruit and compactness of raceme which were determined to be heritable characters, besides capsule dehiscence, shape of the capsule, shape of mature raceme, colour of seed coat and mottling on the seeds. The mode of inheritance of the characters and their economic importance are indicated.

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REFERENCES

Anon. 1951. *The British Colour Council Dictionary of Colour Standards.*

Harland, S. C. 1920. Inheritance in *Ricinus communis* L. Part I. *J. Genet.*, **10** : 207–18.

———. 1922. Inheritance in *Ricinus communis* L. Part II. *J. Genet.*, **12** : 251–53.

———. 1928. The genetics of *Ricinus communis* L. *Biblio. Genetica*, **4** : 171–77.

Kulkarni, L. G. 1959. *Castor* – Indian Central Oilseeds Committee Publn.

Kumar, L. S. S. 1938. *Annual Rep. Dep. Agric. Bombay Province*, 1937–38 : 21.

Narain, A. 1952. Bloom character in castor oil plant, *Ricinus communis* L. *Curr. Sci.*, **21** : 166.

———. 1958. Thesis, Section of the Economic Botanist to Government U. P. (Millets, Oilseeds and Pulses).

———. 1961. Inheritance of bloom in castor. *Indian J. Genet.*, **21** : 136–141.

Patwardhan, G. W. 1931. A preliminary note on inheritance of castor. *J. Indian bot. Soc.*, **10** : 100–109.

Peat, J. E. 1926. Genetic studies in *Ricinus communis* L. *J. Genet.*, **19** : 373–389.

Reddi, P. H. R. 1939. *Rep. Operation Dep. Agric. Madras Presidency* 1938–39.

Seshadri, C. R. and S. Varisai Muhammad. 1951. Study of inheritance of certain characters in castor. *Proc. Ist Scientific Workers Conf. Coimbatore.*

White, O. E. 1918.* Inheritance studies on castor beans. *Brooklyn Bot. Garden Mem.* **1** : 513–21.

* Original not seen