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The Characterization of Castor (*Ricinus communis* L.) Genotypes for Morphological Traits

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A B S T R A C T

Twenty six genotypes were characterized based on their morphological characters as per DUS guidelines of castor *viz.*, stem color, bloom, seed shape, plant type, leaf shape, type of internode, spike type, inflorescence spike type, seed coat color, branching habits, spike shape and capsule type. The characters triple bloom nature, medium plant type, elongated internode, conical spike shape, divergent branching pattern and oval seed shape were dominant in nature whereas, spike types, stem colour, capsule type, type of internode, inflorescence spike type showed more than one class of F_1's from all the cross combinations, which indicated involvement of more than one gene and epistatic type of gene interaction for the inheritance of the character and expression of the character was also influenced by different genetic background of parents. The germplasm has shown great extent of morphological variability for all the traits observed.

Introduction

Castor (*Ricinus communis* L. 2n = 2X = 20) resides to mono specific genus *Ricinus* of Euphorbiaceae family and one of the most important non-edible oilseed crop (Chaudhari *et al.*, 2019). It has cross pollination up to the extent of 50 per cent due to its monoecious nature.

Morphological characters like stem color, bloom, seed shape, plant type, leaf shape, types of internodes, spike shape, inflorescence spike shape, seed coat color, branching habits, spike types and capsule type are important markers used for distinctness, uniformity and stability (DUS) tests in castor under different environments (Lavanya and Gopinath, 2008).

Morphological characterization of seed, seedling and plant would generally be considered for varietal identification. Introduction of Plant Variety Protection under General Agreement on Trade and Tariff (GATT) necessitated the need is precise genotypic characterization with clear Distinctiveness (D), Uniformity (U) and Stability (S). The concept of DUS was fundamental for the characterization of the variety as a unique creation. It is essential to

secure Plant Breeder's Rights (PBR's) and it also generates official description of a variety. Information on DUS characters generated in castor is not documented until now. Hence, there is a need to characterize castor genotypes.

Materials and Methods

The main objective of the investigation was to characterize the castor germplasm to assess their potential to contribute to future crop improvement programmes. The twenty six castor genotypes including advanced parental lines and hybrids were evaluated at Castor-Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in Randomized Block Design in three replications with inter and intra row spacing of 120 x 60 cm. Need based agronomic and plant protection measures were taken up for good crop growth. Data was collected at various growth stages of castor plant.

Results and Discussion

Three types of stem colors were observed *viz.*, green, mahogany and red. Five genotypes and three hybrids had green stem color, while fifteen (7 genotypes + 8 hybrids) had mahogany stem colour, remaining three genotypes had red stem color (Table 1). Bloom or waxy coating in castor is an important morphological marker and serves as a natural protection against drought, cold, jassids etc., (Lavanya and Gopinath, 2008). Based on presence of bloom on combination of plant parts, genotypes in castor were usually classified as single bloom (stem + petiole + capsule stalks), double bloom (stem + petiole + capsule + lower side of the leaf) and triple bloom (all the above parts + upper side of the leaf).The sixteen genotypes (7 genotypes + 9 hybrids) had triple bloom while, nine genotypes (7 genotypes + 2 hybrids) had double bloom and JI-65 had zero bloom. Seven hybrids and twelve genotypes had spiny capsule, while four had semi spiny and GEETA, 48-1 and SKI-215 had non spiny. Out of 26 genotypes, 23 genotypes had elongated type of internodes, whereas three genotypes had condensed type of internodes. Three types of leaf shape, flat, semi-deep and deep-cup were observed. Twenty three genotypes had flat leaf shaped, remaining two genotypes *viz.*, VP-1 and SKP-84 had deep-cup leaf shaped and GCH-7 had semi-deep leaf shaped.

In spike shape all the twenty-six genotypes had conical spike shape. Four types of spike were observed like loose, semi-loose, semi-compact and compact. Genotypes, GNCH-1, GEETA, 48-1 and JI-96 had loose type spike whereas; seven genotypes had semi-loose spike and five genotypes had semi-compact of spike whereas, ten genotypes had compact spike type. In branching habit, out of 26 genotypes, 24 genotypes had divergent branching habit while, VP-1 and SKP-84 had convergent branching habit. Three types of inflorescence spike were observed; monoecious, interspersed and pistillate. Out of 26 genotypes nineteen genotypes had interspersed inflorescence spike, while GAUCH-1, JI-96 and VI-9 had monoecious inflorescence spike. Remaining four genotypes *viz.*, VP-1, GEETA, SKP-84 and JP-65 had pistillate types of inflorescence. The photographs of all the qualitative characters have been shown in the figure 1-4.

Twenty six genotypes were categorized in to three different groups as: dwarf plant type viz., (VP-1 and SKP-84), medium plant type (viz., GAUCH-1, GCH-2, GCH-4, GCH-6, GCH-7, SHB-1005, SHB-1018, SHB-1019, SHB-1029, GNCH-1, JP-65, VI-9, SKI-352, SKI-370, SKI-372, SKI-373, DCS-94) and tall plant type (GCH-5, GEETA, JI-35, 48-1, SH-72, JI-96 and SKI-215). In seed shape 24

genotypes had oval seed shape, while genotype GEETA and JI-35 had round seed shape. Two types of seed coat color were observed; dark brown and light brown. Genotypes GAUCH-1, GCH-2, GCH-4, GCH-5, SHB-1005, SHB-1018, SHB-1019, SHB-1029, GNCH-1, VP-1, GEETA, JP-65, SKI-84, VI-9, JI-35, SH-72 JI-96, SKI-215, SKI-370, SKI-373 and DCS-94 had dark brown seed coat color and remaining genotypes GCH-6, GCH-7, 48-1, SKI-352 and SKI-372 had light brown seed coat color. The results are in accordance with findings of Solanki and Joshi (2001), Lavanya and Gopinath (2008), Bhanu (2009), Elena and Edilyng (2009), Gourishankar *et al.*, (2010), Sakure *et al.*, (2010), Gupta and Aggarwal (2012), Rao (2014) and Rukhsar (2017) which showed that morphological characterization helps in identification of genotypes easily.

The pattern of expression of stem colour indicated that mahogany stem colour was controlled by nuclear genes and dominant in nature over green and red. Crosses of red × green, green × mahogany and mahogany × mahogany stem color, all F_1's were mahogany whereas, in case of green × green stem color all F_1's produced green stem color, but in case of red × mahogany, all F_1's were green in color. In most of the genotypes, mahogany stem was observed with varying range from green to red which could be due to different genetic background of parental genotypes influencing the expression of gene/s. With regards to bloom, most of the genotypes were triple bloom in nature, which indicated its dominant nature. The triple bloom nature was dominant over double bloom and zero bloom; whereas, double bloom nature was dominant over zero bloom.

Regarding capsule type, when the crosses were made between spiny × non spiny, all F_1's were semi spiny. It is the indication of spiny capsule type nature was co-dominant over non-spiny capsule. Dwarf plant type had a condensed internode. When condensed parents crossed with elongated parents, all the F_1's were elongated internodes. This revealed that elongated internodes were dominant over condensed internodes. It was also observed that all dwarf plants *i.e.* condensed internodes had deep cup leaves and elongated internodes had flat leave shape indicating pleiotropic effect or tight linkage of genes governing these two traits. The cup shaped leaf was determined by a single recessive gene. Crosses of deep cup × deep cup and flat × flat cup, all F_1's were deep cup and flat cup leaf, respectively. However, deep cup × flat cup parent produced flat cup except, cross SKP-84 × SKI-2015 (GCH-7). The results were not sufficient to interpret; this could be because of quasi quantitative character.

The conical × conical and cylindrical × cylindrical crosses produced conical and cylindrical spike shape, respectively. The results were not sufficient to interpret; this could be because of quasi quantitative character. An expression of spike type showed more than one class of F_1's from all the genotypes, which indicated involvement of more than one gene, and epistatic type of gene interaction for the inheritance of the character and expression of the character was also influenced by different genetic background of parents. When convergent × divergent parent was crossed, all the F_1's produced divergent branching habit. This revealed that divergent branching pattern was dominant over convergent branching pattern. Regarding inflorescence spike types, in most of the genotypes inflorescence spike types nature was observed, which indicated its dominant nature. The interspersed inflorescence spike type's nature was dominant over monoecious and pistillate whereas, monoecious nature was dominant over pistillate.

Table.1 Characterization of different qualitative characters of castor

Sr. No.	Genotypes	Stem color	Bloom	Capsule type	Types of internodes	Leaf shape	Spike shape
		1	2	3	4	5	6
1	GAUCH-1	Green	Triple	Spiny	Elongated	Flat	Conical
2	GCH-2	Green	Triple	Spiny	Elongated	Flat	Conical
3	GCH-4	Mahogany	Triple	Semi-spiny	Elongated	Flat	Conical
4	GCH-5	Mahogany	Double	Semi-spiny	Elongated	Flat	Conical
5	GCH-6	Green	Double	Spiny	Elongated	Flat	Conical
6	GCH-7	Mahogany	Triple	Semi-spiny	Elongated	Semi cup	Conical
7	SHB-1005	Mahogany	Triple	Spiny	Condensed	Flat	Conical
8	SHB-1018	Mahogany	Triple	Semi-spiny	Elongated	Flat	Conical
9	SHB-1019	Mahogany	Triple	Spiny	Elongated	Flat	Conical
10	SHB-1029	Mahogany	Triple	Spiny	Elongated	Flat	Conical
11	GNCH-1	Mahogany	Triple	Spiny	Elongated	Flat	Conical
12	VP-1	Green	Triple	Spiny	Condensed	Deep cup	Conical
13	GEETA	Red	Double	Non spiny	Elongated	Flat	Conical
14	JP-65	Red	Zero	Spiny	Elongated	Flat	Conical
15	SKP-84	Mahogany	Triple	Spiny	Condensed	Deep cup	Conical
16	VI-9	Green	Double	Spiny	Elongated	Flat	Conical
17	JI-35	Green	Double	Spiny	Elongated	Flat	Conical
18	48-1	Red	Double	Non-spiny	Elongated	Flat	Conical
19	SH-72	Green	Double	Spiny	Elongated	Flat	Conical
20	JI-96	Mahogany	Triple	Spiny	Elongated	Flat	Conical
21	SKI-215	Mahogany	Double	Non-spiny	Elongated	Flat	Conical
22	SKI-352	Mahogany	Triple	Spiny	Elongated	Flat	Conical
23	SKI-370	Mahogany	Triple	Spiny	Elongated	Flat	Conical
24	SKI-372	Mahogany	Triple	Spiny	Elongated	Flat	Conical
25	SKI-373	Mahogany	Double	Spiny	Elongated	Flat	Conical
26	DCS-94	Green	Triple	Spiny	Elongated	Flat	Conical

Table 1 (Contd.)

Sr. No.	Genotypes	Spike type	Branching habit	Inflorescence spike types	Plant type	Seed shape	Seed coat color
		7	8	9	10	11	12
1	GAUCH-1	Compact	Divergent	Monoecious	Medium	Oval	Dark brown
2	GCH-2	Compact	Divergent	Interspersed	Medium	Oval	Dark brown
3	GCH-4	Semi- compact	Divergent	Interspersed	Medium	Oval	Dark brown
4	GCH-5	Semi-compact	Divergent	Interspersed	Tall	Oval	Dark brown
5	GCH-6	Compact	Divergent	Interspersed	Medium	Oval	Light brown
6	GCH-7	Semi-compact	Divergent	Interspersed	Medium	Oval	Light brown
7	SHB-1005	Semi-loose	Divergent	Interspersed	Medium	Oval	Dark brown
8	SHB-1018	Semi-loose	Divergent	Interspersed	Medium	Oval	Dark brown
9	SHB-1019	Semi-loose	Divergent	Interspersed	Medium	Oval	Dark brown
10	SHB-1029	Semi-loose	Divergent	Interspersed	Medium	Oval	Dark brown
11	GNCH-1	Loose	Divergent	Interspersed	Medium	Oval	Dark brown
12	VP-1	Compact	Convergent	Pistillate	Dwarf	Oval	Dark brown
13	GEETA	Loose	Divergent	Pistillate	Tall	Round	Dark brown
14	JP-65	Compact	Divergent	Pistillate	Medium	Oval	Dark brown
15	SKP-84	Semi-compact	Convergent	Pistillate	Dwarf	Oval	Dark brown
16	VI-9	Compact	Divergent	Monoecious	Medium	Oval	Dark brown
17	JI-35	Compact	Divergent	Interspersed	Tall	Round	Dark brown
18	48-1	Loose	Divergent	Interspersed	Tall	Oval	Light brown
19	SH-72	Compact	Divergent	Interspersed	Tall	Oval	Dark brown
20	JI-96	Loose	Divergent	Monoecious	Tall	Oval	Dark brown
21	SKI-215	Semi-compact	Divergent	Interspersed	Tall	Oval	Dark brown
22	SKI-352	Compact	Divergent	Interspersed	Medium	Oval	Light brown
23	SKI-370	Compact	Divergent	Interspersed	Medium	Oval	Dark brown
24	SKI-372	Semi-loose	Divergent	Interspersed	Medium	Oval	Light brown
25	SKI-373	Semi-loose	Divergent	Interspersed	Medium	Oval	Dark brown
26	DCS-94	Semi-loose	Divergent	Interspersed	Medium	Oval	Dark brown

Fig.1 Different qualitative characters of castor

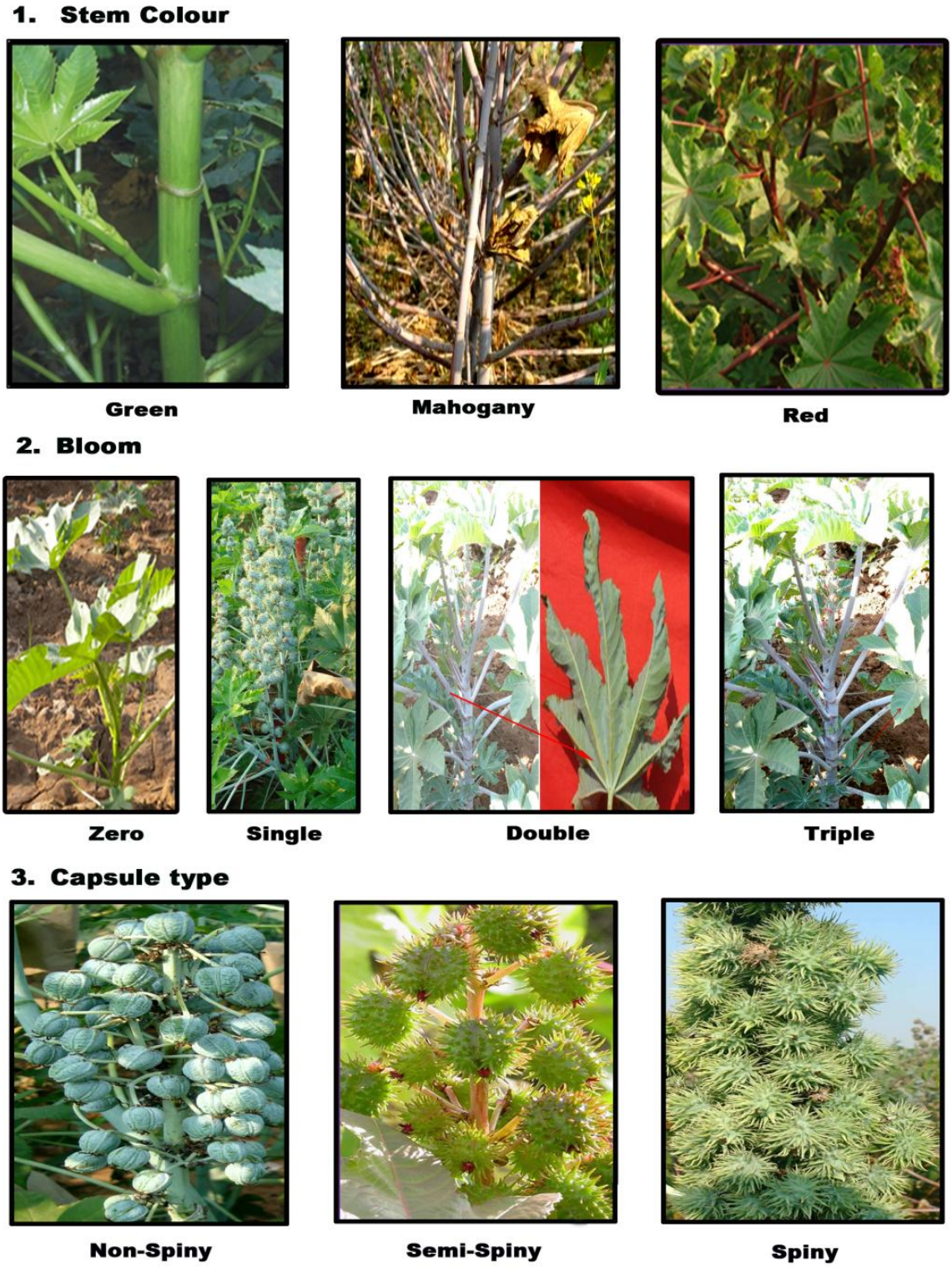

Fig.2 Different qualitative characters of castor

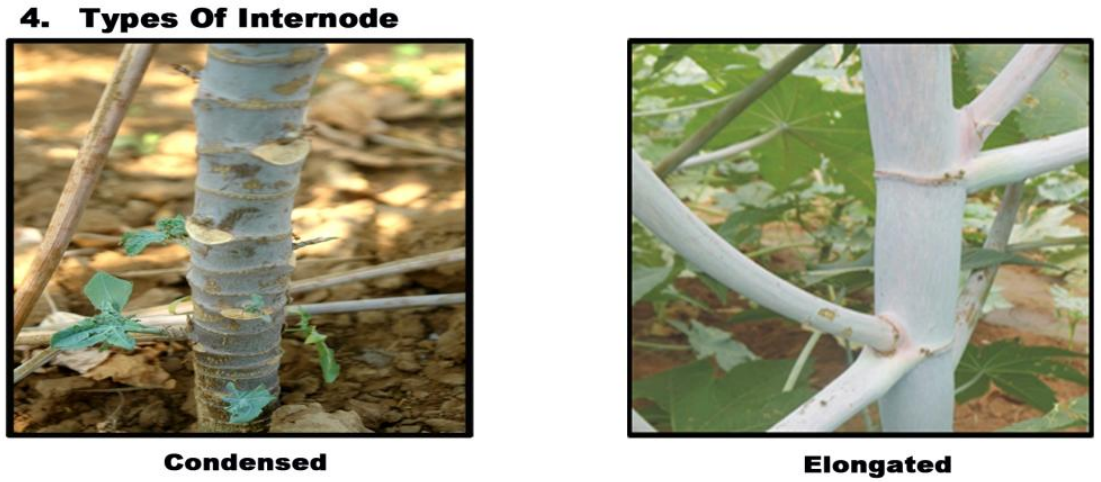

Fig.3 Different qualitative characters of castor

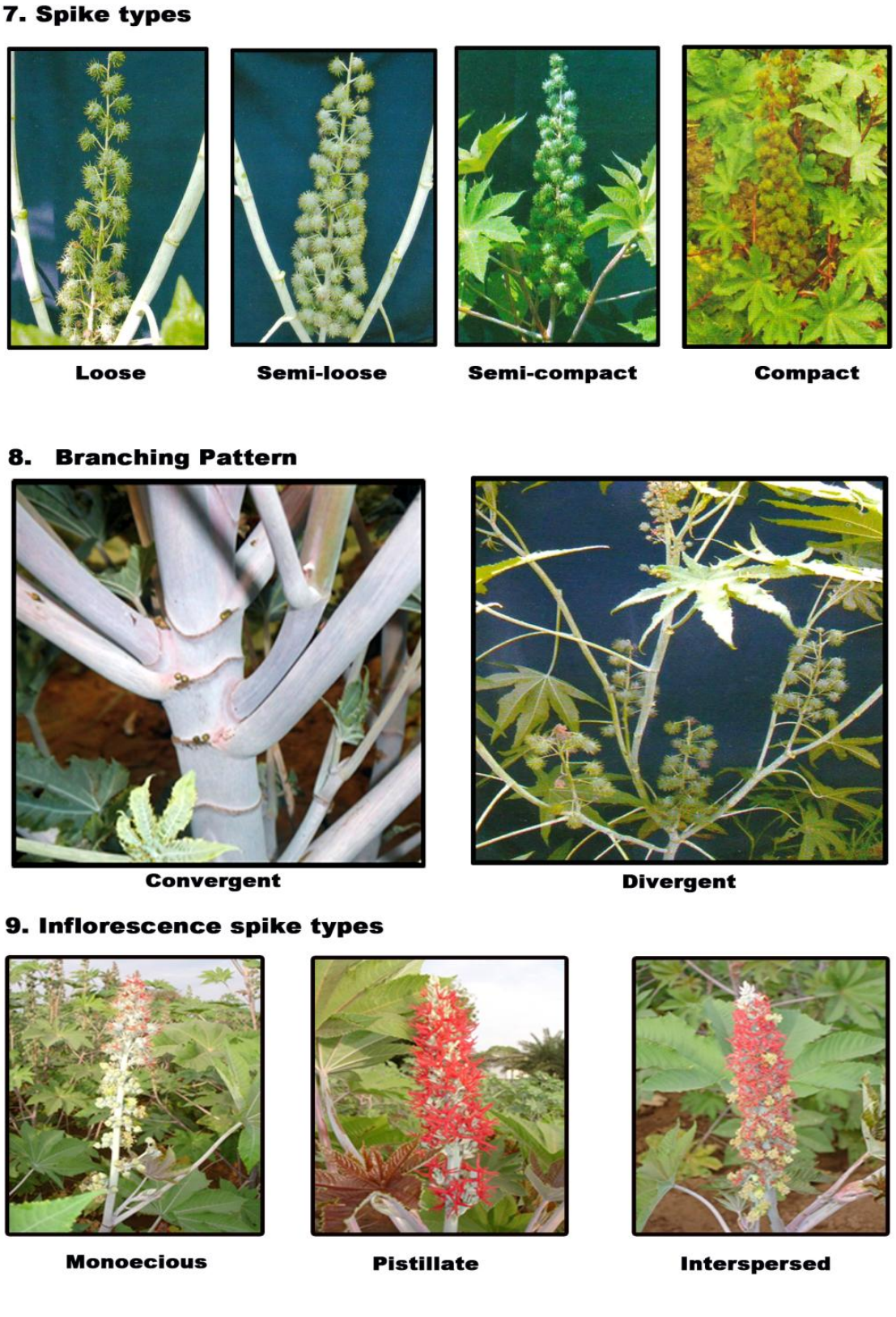

Fig.4 Different qualitative characters of castor

Dwarf plant stature is desirable for pistillate patent. Crosses between dwarf × medium plants produced medium plant which indicated that medium plant type was dominant over dwarf plant type. In most of the genotypes and hydrides oval seed shape was observed. The results revealed that oval seed shape was dominant over round seed shape. Dark brown × dark brown seed color produced all F_1's with dark brown seed color except, dark brown [JI-65 × JI-96 (GCH-6)] × dark brown [SKP-84 × SKI-215 (GCH-7)] seed color produced F_1's with light brown. While in some crosses dark brown × light brown produced dark brown *viz.*, VP-1 × 48-1 (GCH-4), SKP-84 × SKI-352 (SHB-1005) and SKP-84 × SKP-372 (SHB-1019). The results were not sufficient to interpret; this could be because of quasi quantitative character.

In conclusion, morphological characters *viz.*, stem color, bloom, seed shape, plant type, leaf shape, types of internodes, spike shape, inflorescence spike shape, seed coat color, branching habits, spike types and capsule type are important markers to varietal identification and genuineness of variety in castor. They are very important during the development, maintenance and multiplication of new varieties, parental lines and hybrids. Hence, from of breeder point of view, study of qualitative characters is very useful to differentiate to various hybrids and their parental lines.

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