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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 172-175

www.thepharmajournal.com
Received: 08-01-2022
Accepted: 19-02-2022

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Morphological characterization of cms based wheat hybrids (*Triticum aestivum* L.)

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Abstract
Wheat is an important cereal crop, which contribute the absolute quantity of dry matter to the world. With the increasing population, there is an urgent need to identify diverse sources of genotypes. To achieve best adaptability, high yield and good nutritive quality parameters, hybrid breeding is the next door to wheat breeding programme. A total of 15 CMS lines, 5 restorer lines and 75 F1 hybrids (total- F1-75, 15 CMS A lines,5 CMS R linens), were used to layout the experiment with the objective to identify diverse cross combinations and classify morphological traits. Genotypes were evaluated in randomized complete block design with two replications at Seed Breeding Farm, J.N.K.V.V, Jabalpur during 2018-19 and 2019-20 Morphological characterizations were done as per the DUS guideline with the objective to select diverse cross combinations. A wide range of variations for morphological traits were observed for thirteen different traits *viz*., growth habit, foliage colour, flag leaf attitude, ear waxiness, flag leaf length, ear shape, ear density, awns length, awn colour, an attitude ear colour, grain colour, grain shape. On the basis of morphological characterization the ideal plant types for hybrid breeding will be having erect to semi-erect plant type, green foliage colour, medium flag leaf length, tapering ear shape, medium ear density, light brown ear colour and oblong seed shape. These results clearly indicated the importance of morphological characterization in crop breeding programme.

Keywords: Wheat, CMS lines and morphological traits

Introduction
Triticum aestivum, commonly known as wheat, is a cereal grass placed in family *poaceae* having chromosome number of 2n=42 hexaploid spp. and belief to originated in South Eastern Asia. It is known as "King of cereals". Wheat is basically a self-pollinated crop with 0.5-1% out crossing. Being a self-pollinated species, hybrids can be produced manually but this is commercially unviable option. Therefore, making wheat as cross pollinated species, there is a need to change in the floral biology *i.e.* to allow cross fertilization between two parental lines. A number of male sterility or pollination control systems are available in wheat. Stable male sterile lines (A line with widely opened glumes/angle), a good agronomic maintenance base (B line with large anther size, long style), and ideal fertility restorer are some of the basic and fundamental components for the successful creation of hybrid wheat (R line with large anthers having high pollen number). In this direction, an effort was being made using development of hybrid wheat using cytoplasmic male sterility. It is one of the innovative and alternatives approach to fulfill the demand of wheat production.
In addition to the agronomic performance, grain quality, and biotic and abiotic stress tolerance, there must be sufficient diversity in the flowering traits of the germplasm to choose the best male and female parents to use in the crossing blocks (Whitford *et al*., 2013) [12]. Screening for the above-mentioned characteristics is the first step toward the creation of a hybrid program. This marker system can reliably be used for identification and confirmation of the male sterile (Ms) and fertile restorer (Rf) genes in common wheat genotypes involved in hybrid seed production. Present study was conducted to decipher the extent of genetic variation and characterization of recently developed CMS lines of wheat based on morphological attributes which could be further utilized in hybrid breeding programs.

Material and Methods
Plant material for the study comprised of newly developed 15 CMS lines and 5 restorer lines, received from IIWBR, Karnal and Division of Genetics, IARI under CRP on hybrid wheat programme. The experiment was planted at Seed Breeding Farm,

Department of Plant Breeding and Genetics, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) during Rabi 2018-19 and 2019-20.Recommended package and practice were followed to raise a healthy wheat crop. A total of 15 CMS lines and 5 restorer lines were mating design to generate 75 F1 hybrids, a total of 95 genotypes (Parents and F1s) were evaluated in Randomized Complete Block Design with two replications. The observations were recorded on thirteen morphological traits *viz*., growth habit, foliage colour, flag leaf attitude, ear waxiness, flag leaf length, ear shape, ear density, awns length, awn colour, awn attitude, ear colour, grain colour, grain shape. Observations were recorded on randomly selected five competitive plants from each line. As per the DUS guideline for the assessment of colour characteristics, the latest Royal Horticultural Society (RHS) colour chart was used. All the genotypes were evaluated for thirteen morphological traits,

Table 1: List of genotypes used as experimental material

S. No.	Name of Entry	S. No.	Name of Entry	S. No.	Name of Entry	S. No.	Name of Entry
A line						R line	
1	CMS 82A	6	CMS 87A	11	CMS 92A	1	Res-7
2	CMS 83A	7	CMS 88A	12	CMS 94A	2	Res-9
3	CMS 84A	8	CMS 89A	13	CMS 95A	3	Res-10
4	CMS 85A	9	CMS 90A	14	CMS 96A	4	Res-37
5	CMS 86A	10	CMS 91A	15	CMS 97A	5	Res-38

Result and Discussion

Newly developed cytoplasmic and restorer lines of wheat were grouped according to different morphological traits as per DUS Guidelines. The frequency distribution of each trait was presented in figure 1 and table 1. A wide range of variation was observed for plant growth habit. Among the total 95 genotypes, 18 were found to have erect type, 74 were semi-erect type and 3 were intermediate type. All studied genotypes were appeared as erect, semi erect or intermediate but none of them were near to prostrate habit. This is an advantageous characteristic for selecting high-yielding plants with reduced grain and straw loss. Ruiz and martin (2000) studied growth habit among Spanish landraces of durum wheat and show that 93% of studied genotypes appeared as erect or intermediate. For foliage colour, 15 genotypes were found to be pale green whereas 64 were green and 16 were dark green. Ear waxiness categorized in five group but in this investigation only 4 types of ear waxiness exhibited in the genotypes, ear waxiness absent in 1 genotype, 56 genotype show weak ear waxiness, 31 shows medium waxiness and 7 genotype show strong waxiness. According to flag leaf length, 63 were having medium (20.1-30 cm) and 32 were having long (>30cm) flag leaf length. Khaliq *et al*., 2008 [4] reported that flag leaf area and its active duration during grain filling had been considered as an essential trait in determining the grain yield. Flag leaf is of utmost importance in cereals like wheat, because it provides the maximum amount of photosynthesis assimilates to be stored in the grains. In case of ear shape, 79 genotypes were found to be typical 'tapering' style and 16 genotype were found to be as parallel sided and none observed as club shaped. Lux type ear density was observed in17 genotype, medium type in 57 genotypes and dense type ear density in 21 genotypes. Traits ear shape and ear density plays a very crucial role in determination of grain yield in wheat. The large variation between the studied genotypes in terms of spike density reflects the genetic variation. Grain character was grouped into two categories, namely grain colour and grain shape. 89 genotypes showed amber, 4 showed white and 2 showed red colour grain. In grain shape, 89 genotypes were oblong type, 5 were elliptical and one was ovate type. Grain shape is one of the most important parameters used in classification, identification and study of variation in wheat varieties (Mebatsion *et al*. 2012) [6]. The production of wheat hybrids, the several CMS lines from the current study will be utilised. Flag leaf attitude, 14genotype were having erect, 62 having semi-erect and 19 having drooping type. Ear density categorized in five groups but in this investigation only three types of ear density exhibited among the genotypes. 17 genotype were having lax, 57 having medium and 21 having dense ear density. Similar characterization pattern was adopted by Goel *et al.,* (2015) and Maity and Das (2015) [5]. All the studied genotypes show the presence of awn. Sourdille, 2002 [11] revealed that the presence of awns can double the photosynthesis rates especially under drier conditions then enhance drought resistance. A very distinct variations among the genotypes were observed for traits awn length and awn colour. The wide variation of awns colour among studied genotypes reflects the variation in genetic structure among these genotypes. Awns length germplasm were categorized in five groups but in this investigation only two types of awn length exhibited in the genotypes, 70 genotype were having medium, 25 having long awns length. On the basis of awns attitude, genotype were categorized in three groups, 17 genotype having appressed, 60 having medium or 18 having spreading type awns attitude. On the basis of awns present or absents, awns having present in all genotypes. Awn colour, genotype had categorized in four groups but in this investigation only two types of awn colour exhibited in the genotypes, 63 having light brown and 32 having dark brown awn colour. Similar characterization pattern was adopted by Motzo and Gunta (2002) [7], Boudour*et al.*, (2004) [1], Goel *et el.*, (2015) [3] and Maity and Das (2015) [5].Ear colour genotype were categorized in three groups. 36 genotype were having dark brown and 59 having light brown ear colour. Grain colour genotype were categorized in three groups, 4 genotype were having white, 89 having amber and 2 having red grain colour. Grain shape, genotype were categorized in four groups but in this investigation only three types of grain shape exhibited in the genotypes, 1 genotype lines were ovate, 89 having oblong and 5 having elliptical grain shape. Similar characterization pattern was adopted by Shouche *et al.*, (2001) [9], Sainis *et al.*, (2009) [10], Boudour *et al.* (2011) [1], Goel *et al.*, (2015) [3], Maity and Das (2015) [5] and Patel *et al.*, (2016) [8]. In this study all observations were recorded as per DUS guide lines and found large variation for different visual trait.

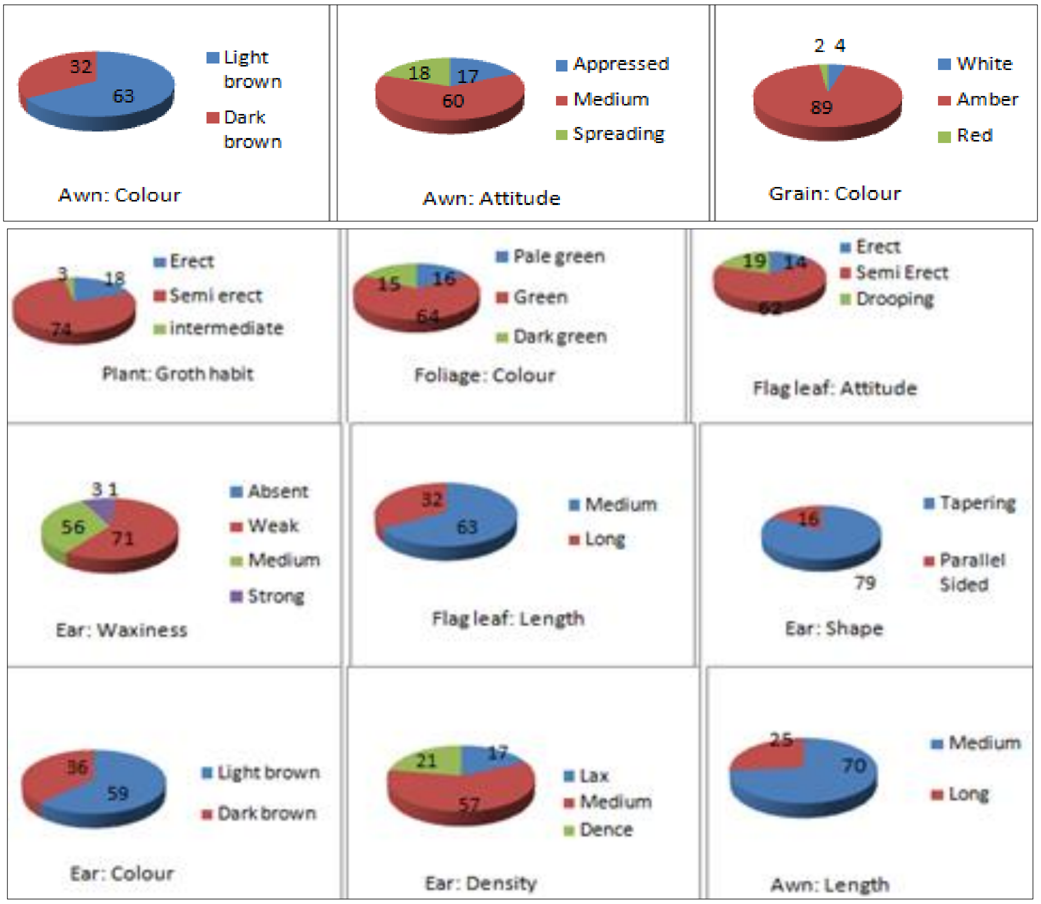

Fig 1: Variations for morphological trait

Table 2: Frequency distribution of morphological traits in CMS based wheat genotypes

Traits	Classes	Number of entry	Percentage of entry (%)
Plant growth habit	Erect	18	17.1
	Semi-erect	74	70.3
	Intermediate/spreading	3	2.85
Foliage Colour	Pale green	15	14.25
	Green	64	60.8
	Dark green	16	15.2
Ear Waxiness	Absent	1	0.95
	Weak	56	53.02
	Medium	31	29.45
	Strong	7	6.65
Plant: Flag Leaf Attitude	erect	14	13.3
	Semi-erect	62	58.9
	drooping	19	18.05
	Medium(20.1-30.0cm)	63	59.85
	Long(>30cm)	32	30.4
Ear Shape in profile	Tapering	79	75.05
	Parallel	16	15.2
	Lax	17	16.15
	Medium	57	54.15
	Dense	21	19.95
Awn: Attitude	Apprised	17	16.15
	Medium	60	57
	Spreading	18	17.1
	short (6.0-7.5cm)	17	15.88
	medium (7.51-9.0cm)	70	66.5
	Long (9.0-10.5)	25	23.75
Awn Colour	Light brown	63	59.85
	Dark brown	32	30.4
Ear Colour	White	59	56.05
	Light brown	36	34.2
Grain Colour	White	4	3.8

	Amber	89	84.55
	Red	2	1.9
Grain Shape	Ovate	1	0.95
	Oblong	89	84.55
	Elliptical	5	4.75

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