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GENETIC EVALUATION AND MORPHOLOGICAL PROFILING OF NOVEL CYTOPLASMIC LINES IN BREAD WHEAT

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ABSTRACT

The present investigation was conducted during *Rabi* 2024–2025 at JNKVV, Jabalpur under the CRP on Hybrid Wheat programme to characterize CMS-based wheat hybrids. A total of 88 genotypes, including 16 CMS (A) lines, 4 restorers, 64 F₁ hybrids and 4 checks, were evaluated for 17 morphological and one physiological trait following DUS guidelines. Considerable variability was observed across traits such as growth habit, flag leaf structure, waxiness, seed size, and hardness, reflecting a broad genetic base. Coleoptile anthocyanin was detected in only one genotype, while traits like seed colour (amber predominant) and spike attitude (mostly bent) showed wide diversity. Chlorophyll content ranged from 35.8 (2851A) to 55.5 (95A/MP3465), with an overall mean of 46.6. The variability identified among CMS lines, restorers and hybrids highlights the potential for effective selection and utilization in heterosis breeding to enhance wheat yield and adaptability.

Key words : CMS Wheat Hybrids, Genetic Variability, Morphological characterization, Heterosis Breeding, Chlorophyll content.

Introduction

Wheat (*Triticum* spp.) is world's most widely cultivated food crops. It is mainly a rabi season crop in India. It has played a very vital role in stabilizing the food grain production in the country over the past few years. Global wheat production reached an all-time height of 796.85 million metric tons in 2023–2024, marking a modest rise of 0.67% compared to the previous year. With a cultivated area of 31.83 million hectares and an average yield of 3.56 tons per hectare, India, a major contributor to global output, produced a projected 113.3 million metric tons of wheat in 2024. Madhya Pradesh emerged as one of the leading wheat-producing states in India, accounting for nearly 23% of the nation's total production. However, a slight dip in output was noted in 2023, with the state yielding 22.73 million tons, slightly down from 22.98 million tons in 2022. The area under wheat in the state is approximately 3.7 million hectares, with a productivity of 1.6 tonnes per hectare (USDA Foreign Agricultural

Service (USDA-FAS), 2024). These pressing challenges underscore the necessity for innovative research and the development of advanced strategies to booster wheat productivity. In particular, heterosis breeding through CMS-based wheat hybrids presents a promising avenue for enhancing yield potential and ensuring food security amidst the prevailing environmental and economic challenges.

During the late 1990s and later, hybrid wheat made a comeback. This became possible with the marketing authorization of CHAs in the USA and Europe, and also due to renewed interest in CMS in different parts of the world including India, China and Mexico (CIMMYT) (Gupta *et al.*, 2019). In 2009, ICAR in India initiated a network project on hybrid wheat using CMS approach, but no hybrid varieties could be developed (Singh *et al.*, 2010).

Materials and Methods

Plant material for the study comprised of 88 genotypes out of which 16 CMS lines and 4 restorer lines used as a parental material received from IIWBR, Karnal and Division of Genetics, IARI and 64 CMS F₁ hybrids and 4 Checks received from Seed Breeding Farm, JNKVV,

Jabalpur under CRP on hybrid wheat programme. The experiment was planted at Seed Breeding Farm, Department of Genetics and Plant Breeding, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya Jabalpur (M.P.) during *Rabi* 2024-25. Soil of the experiment is medium black with uniform topography and free from water logged conditions. For the assessment

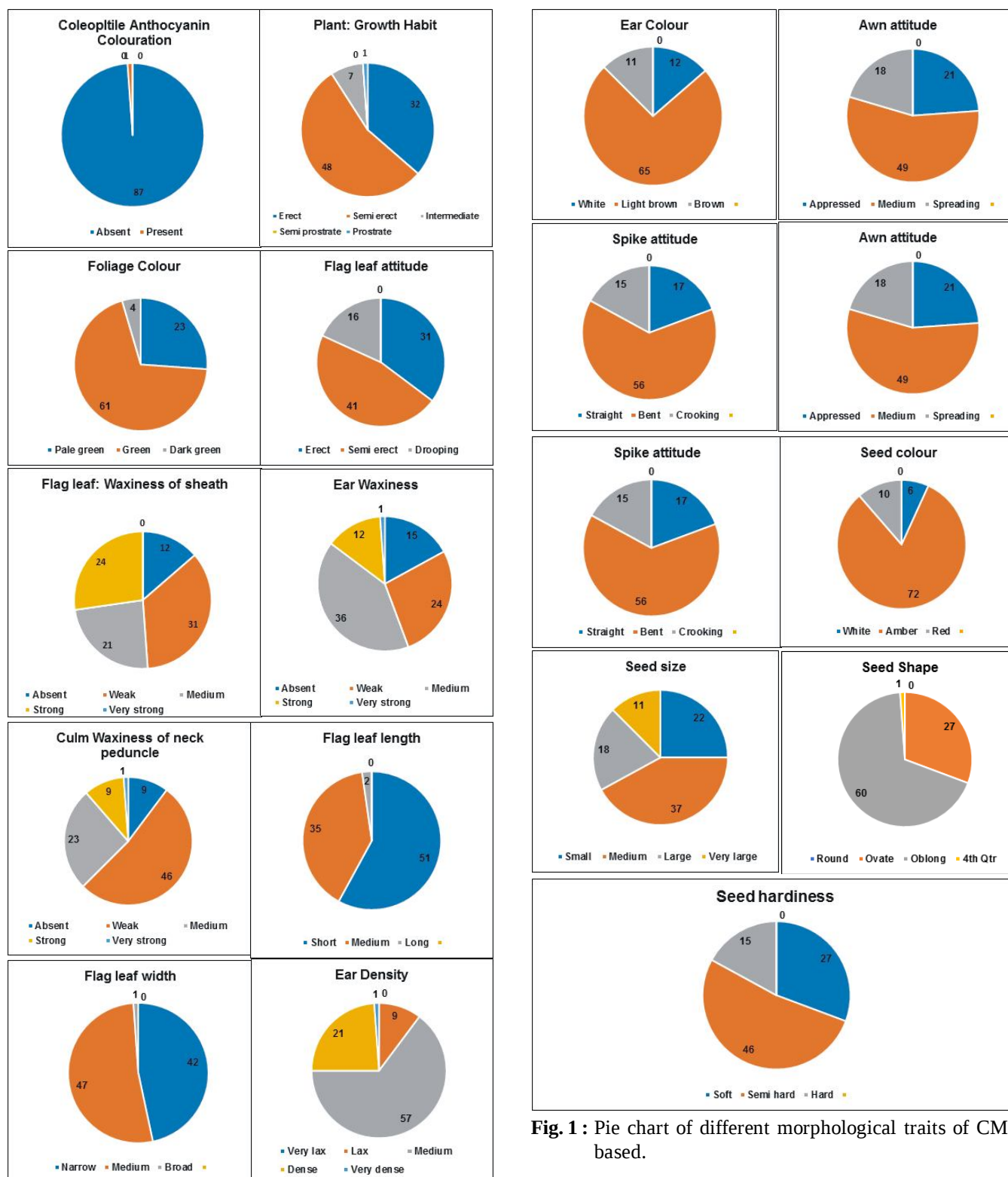


Fig. 1 : Pie chart of different morphological traits of CMS based.

of colour characteristics, the latest Royal Horticultural Society (RHS) colour chart was used. All the genotypes were evaluated for seventeen morphological traits and one physiological trait, viz., coleoptile anthocyanin colouration, plant growth habit, foliage colour, plant: flag leaf attitude, flag leaf: waxiness of sheath, ear waxiness, culm waxiness of neck peduncle, flag leaf length, flag leaf width, ear density, ear colour, awn attitude, spike attitude, seed colour, seed size, seed shape and grain hardness and chlorophyll content (%). Observations were recorded on randomly selected five competitive plants from each line.

Results and Discussion

In the present research, 88 genotypes i.e., “64 CMS hybrids, 4 checks, 4 R lines and 16 A lines” were characterized based on DUS guidelines for 17 morphological traits. All these morphological observations were observed during different stages of plant growth and after harvesting of the plant.

Morphological trait characterization

Morphological analysis of 88 wheat genotypes, including hybrids and parental lines, revealed considerable variation across 17 qualitative traits (Table 1). Coleoptile anthocyanin was present in only one genotype, while absent in the remaining 87. Growth habit showed a predominance of semi-erect (48) and erect types (32), followed by intermediate (7) and prostrate (1). Foliage colour varied from pale green (23) to green (61) and dark green (4). The flag leaf attitude was classified as erect in 31 genotypes, semi-erect in 41, and drooping in 16.

Variation in waxiness was also evident across plant parts. Sheath waxiness ranged from absent (12), weak (31), and medium (21) to strong (24), with no genotype showing very strong expression. Ear waxiness was absent in 15 genotypes, weak in 24, medium in 36, strong in 12, and very strong in 1. Culm (neck peduncle) waxiness showed a predominance of weak expression (46), while absence (9), medium (23), strong (9), and very strong (1) were also recorded.

Flag leaf length was largely short (51), followed by medium (35) and long (2), whereas flag leaf width was mostly medium (47), followed by narrow (40) and broad (1). Ear density was predominantly medium (57), with dense (22) and lax (9) also observed. Ear colour was mostly light brown (65), while 12 genotypes had white and 11 dark brown ears. Awn attitude varied from appressed (21) to medium (49) and spreading (18). Spike attitude was predominantly bent (56), followed by crooked

Table 1 : Frequency distribution of morphological traits.

S. no.	Trait	Class	No. of entry	Frequency (%)
1	Coleoptile Anthocyanin Colouration	Absent	87	98.9
		Present	1	1.1
2	Plant: Growth habit	Erect	32	36.4
		Semi erect	48	54.5
		Intermediate	7	8.0
		Semi prostrate	0	0.0
		Prostrate	1	1.1
3	Foliage colour	Pale green	23	26.1
		Green	61	69.3
		Dark green	4	4.5
4	Plant: Flag leaf attitude	Erect	31	35.2
		Semi erect	41	46.6
		Drooping	16	18.2
5	Flag leaf: Waxiness of sheath	Absent	12	13.6
		Weak	31	35.2
		Medium	21	23.9
		Strong	24	27.3
		Very strong	0	0.0
6	Ear waxiness	Absent	15	17.0
		Weak	24	27.3
		Medium	36	40.9
		Strong	12	13.6
		Very strong	1	1.1
7	Culm waxiness of neck peduncle	Absent	9	10.2
		Weak	46	52.3
		Medium	23	26.1
		Strong	9	10.2
		Very strong	1	1.1
8	Flag leaf length	Short	51	58.0
		Medium	35	39.8
		Long	2	2.3
9	Flag leaf width	Narrow	40	45.5
		Medium	47	53.4
		Broad	1	1.1
10	Ear density	Very lax	0	0.0
		Lax	9	10.2

Table 1 continued....

Table 1 continued....

		Medium Dense	57 22	64.8 25
		Very dense	0	0.0
11	Ear colour	White	12	13.6
		Light brown	65	73.9
		Brown	11	12.5
12	Awn attitude	Appressed	21	23.9
		Medium	49	55.7
		Spreading	18	20.5
13	Spike attitude	Straight	17	19.3
		Bent	56	63.6
		Crooked	15	17.0
14	Seed colour	White	6	6.8
		Amber	72	81.8
		Red	10	11.4
15	Seed size	Small	22	25.0
		Medium	37	42.0
		Large	18	20.5
		Very large	11	12.5
16	Seed shape	Round	0	0.0
		Medium	37	42.0
		Large	18	20.5
		Very large	11	12.5
17	Seed hardness	Soft	27	30.7
		Semi-hard	46	52.3
		Hard	15	17.0

(15) and straight (17).

Seed traits also showed wide diversity. Seed colour was amber in 72 genotypes, red in 10, and white in 6. Seed size ranged from small (22) to medium (37), large (18), and very large (11). Seed shape was mostly oblong (60), followed by ovate (27) and elliptical (1). Seed hardness was predominantly semi-hard (46), with soft (27) and hard (15) genotypes also recorded.

The considerable variability recorded in traits such as waxiness, flag leaf structure, seed size, and hardness highlight the genetic diversity present in the material under study (Goyal *et al.*, 2019; Shahaji *et al.*, 2020; Gharib *et al.*, 2021; Banjarey *et al.*, 2022; Spanic *et al.*, 2024 and Nawaz *et al.*, 2025).

Physiological trait (Chlorophyll content)

Chlorophyll content exhibited a wide range among the genotypes, with values ranging from 35.8 in genotype



Fig. 2 : Visual observation of Morphological traits.

2851A to 55.5 in hybrid 95A/MP3465. Among the parental lines, 2851A recorded the minimum (35.8), while hybrid 2851A/MP3382 had 36.7. The highest chlorophyll content was noted in hybrid 95A/MP3465 (55.5), followed by the check variety HI1544 (54.2). The overall mean chlorophyll content across genotypes was 46.6 (Wasaya et al., 2021; Khan et al., 2022; Li, Yibo et al., 2023; Gao et al., 2024 and Pervin et al., 2025).

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