Seed Res. 50 (2): 100-109, December, 2022

DUS testing in 15 Bread Wheat (*Triticum aestivum* L.) and Durum Wheat (*Triticum durum* Desf.) Varieties of Central India

DK VERMA*, JB SINGH AND RAVINDRA PANWAR

ICAR-Indian Agriculture Research Institute, Regional Station,
Daly College Road, Indore, Madhya Pradesh-452 001, India
* mailmedilipverma@rediffmail.com; Dilip.Verma@icar.gov.mail

(Received September 2022; Revised November 2022; Accepted November 2022)

ABSTRACT Present investigation was carried out at ICAR-Indian Agriculture Research Institute, Regional Station, Indore during Rabi seasons of 2020-21 and 2021-22 to examine the different morphological characters for distinctness, uniformity and stability of durum and bread wheat varieties. Fifteen genotypes were studied over two years and observations on thirty six morphological characters were recorded. The study revealed that morphological characters of wheat plant viz. plant growth habit, coleoptile anthocyanin colouration, flag leaf anthocyanin colouration of auricle, time of ear emergence, ear waxiness, waxiness of peduncle, flag leaf length, peduncle attitude, flag leaf width, plant height, lower glume shoulder width, lower glume shoulder shape, outer glume pubescence, and awns attitude were the most important characters which could easily distinguish the durum wheat varieties. The characters like foliage colour, flag leaf attitude, flag leaf waxiness of sheath, ear length, lower glume beak length, lower glume beak shape, flag leaf waxiness of blade, ear colour, awns colour, are also found useful in distinguishing durum wheat varieties. The seed morphological characteristics such as grain hardness, grain germ width and grain shape are found to be useful in discriminating bread and durum wheat varieties. But some characters like ear density, awn length and 1000 seed weight are not found to be so useful in distinguishing bread and durum wheat varieties in the present investigation. The study also revealed that the characters viz., flag leaf hairs on auricle, brush hairs, peduncle length, ear shape in profile easily distinguished bread wheat variety from rest of the durum wheat varieties. But these characters could not distinguish among durum wheat varieties. The grain colouration with phenol also could not distinguish among durum wheat varieties but it strongly distinguished bread wheat variety from all the durum wheat varieties in the study.

Keywords: DUS, characterization, identification, bread and durum wheat varieties

Globally, wheat is one of the most important cereal crops which is widely adapted to different agro-climatic conditions and unique property of its flour allows us to make a range of products [1 and 2]. In India, wheat is the major crop, which is mainly cultivated for grain production [3]. But the changing food habits have created additional demand for durum wheat because it has potential to produce value added marketable products. In fact, the food basket of Indian consumer is gradually diversifying towards value added commodities. Therefore, the durum wheat is emerging as an important food commodity as it contains 1.5 to 2.0% higher protein than bread wheat. In addition, it contains higher â-carotene (precursor of vitamin A) too, required to solve the problem of malnutrition among children and rural population [4]. Europe, West Asia, Mediterranean countries, North Africa and Russia are in heavy demand of durum wheat. Due to these reasons, India would need more varieties of durum wheat for cultivation. The Science and Technology Studies field focusses our attention on the highly complex interactions between science and technology society. Three key perspectives provide a broad theoretical framework: science and technology shape society (i.e. technological determinism"), society shapes science and technology (i.e. social determinism" and the interactionist (two-way) perspective. Although technological determinism is still highly prevalent in discussion about technology, and often easiest to capture and analyses pronouncements made about emerging technology, overall, there has been a shift away from linear notions of technological progress and the science-push model. Newer, more complex pictures highlight the roles of a wide-range of factors including expectations, social choices, and path-dependency, taking a co-evolutionary perspective [5].

In recent decades, a large number of new candidate varieties are generated for testing every year, thus, underlining the need for establishing their clear-cut diagnostic features. India ratified the agreement on Trade Related aspects of Intellectual Property Rights (TRIPs) under General Agreements on Tariffs and Trade (GATT) and adopted sui generis system of protection of plant varieties. The "Protection of Plant Varieties and Farmers' Rights Act 2001" enacted by our Government prevents unlawful exploitation of plant varieties developed by plant breeders, farmers and communities and also encourages for the development of new varieties. Under this act the varieties will be registered which confirms to the criteria of Distinctness, Uniformity and Stability (DUS). As DUS testing data is essential for grant of protection to new plant varieties to compare the candidate varieties with varieties of common knowledge at the time of filling application [6 and 7].

Hence, studies on DUS testing to acquaint with the procedures involved are needed in various field crops including wheat to reduce the time required for DUS testing after release of variety, it will be appropriate if this information can be generated during final year testing of varieties. Obviously, the standardization of DUS testing procedure in durum wheat will help in registration of varieties under PPV and FR act (2001) and shall be very beneficial in harnessing the market and trade benefits. Accordingly, study was planned with the objective to examine the different morphological characters for distinctness, uniformity and stability of durum wheat varieties.

MATERIALS AND METHODS

Present investigation was carried out during Rabi seasons of 2020-21 and 2021-22 to examine the different morphological characters for distinctness, uniformity and stability of durum and bread wheat varieties Fifteen wheat varieties consisting of six notified and nine previously released varieties viz., HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, and HI 8807, HI 8823 HI 8826, HI 8830, HI 8838 grown at ICAR-IARI Regional Station, Indore Central Zone for two years was taken as experimental material. Observations on morphological characters were recorded on ten plants in metric scale for each cultivar, while the qualitative characters were recorded in different classes on population basis. Each character was characterized with the help of descriptors provided in the National Test Guidelines for DUS of bread wheat (*Triticum aestivum* L.) developed by ICAR-Indian Institute of Wheat and Barley Research, Karnal (erstwhile Directorate of Wheat Research, Karnal [8]. Observations were recorded on 36 morphological characters viz. coleoptile anthocyanin colouration, plant growth habit, foliage colour, flag leaf hairs on auricle, flag leaf anthocyanin colouration of auricle, flag leaf attitude, time of ear emergence, flag leaf waxiness of sheath, flag leaf waxiness of blade, ear waxiness, culm waxiness of neck (peduncle), flag leaf length (cm), flag leaf width (cm), plant height (cm), ear shape in profile, ear density, awns presence, ear length (cm), awn length (cm), awn colour, awns attitude, outer glume pubescence, ear colour, lower glume shoulder width, lower glume shoulder shape, lower glume beak length, lower glume beak shape, peduncle length (cm), peduncle attitude, grain colour, grain shape, grain germ width, brush hairs, seed size (1000 seed weight), grain hardness and grain Colouration with phenol as suggested [9].

RESULTS AND DISCUSSION

DUS testing of crop varieties is becoming exceedingly important in today's era of Intellectual Property Rights (IPR), as it provides basic information which is used to protect plant varieties under Protection of Plant Varieties and Farmers' Rights Act (2001). It also assures the farmers and other stakeholders that the new cultivar is distinct from other released cultivars, uniform, stable as well as assures that it is the genotype which has been specified by the breeder. Moreover, It is important that the characters used in DUS testing of crop varieties should be able to clearly distinguish the varieties of that crop. Further, the characters of varieties under study should be stable over repeated propagations of that variety. Generally, no single morphological trait can be used to distinguish a cultivar, so a combination of various characters can be used for DUS testing. In this study an attempt was made to characterize the five durum wheat varieties along with ten bread wheat variety used as check (Table 1). Thirty six morphological characters were studied to examine their utility for DUS testing of durum wheat varieties.

Thirty six morphological characteristics, which are included in the National Guidelines, such as coleoptile colouration, plant growth habit, foliage colour, flag leaf hairs on auricle, auricle colour, flag leaf attitude, time of ear emergence, waxiness of flag leaf sheath, waxiness

Table 1. Wheat cultivars studiedin both years

Sl. No.	Cultivar Name	Vernacular Name	Parentage	Varietal Characteristics
1.	HI 1500	Amrita	HW2002*2//Strempalli/ PNC51	Released for CZ, Rainfed/ Restricted Irrigation, Early Sown, Test weight – 40-45g
2.	HI 1544	Purna	HD2402/HW3007	Released for CZ, Irrigated, Timely Sown, Test weight – 40-45g
3.	HI 1563	Pusa Prachi	MACS 2496*2/MC 10	Released for NEPZ, Irrigated, Late Sown, Test weight – ~40g
4.	HI 1605	Pusa Ujala	BOW/VEE/5/ND/V/G9144/KAL/ BB/3/ YACO/4//CHIL/6/CASKOR/ 3/CROC_1/ AE.SQUARROSA (224)/OPATA/7/ PASTOR// MILAN/KAUZ/3/BAV92	Released for PZ, Timely Sown, Restricted Irrigation, Test Weight - 40-45g
5.	HI 1633	Pusa Vani	GW-322/PBW-498	Released for PZ, Late Sown, Irrigated, Test Weight - 48.9g
6.	HI 1636	Pusa Vakula	DL 788/HW4032	Released for CZ, Timely Sown, Irrigated, Test Weight - 56.9g
7.	HI 1650	-	Giant3/HI 1395	Identified for CZ, Timely Sown Irrigated, 49.4g
8.	HI 1653	-	NADI/COPIO//NADI	Identified for NWPZ, Timely Sown, Restricted Irrigation, Test Weight - 48.9g
9.	HI 1654*	-	SOKOLL/3/PASTOR//HXL7573/ 2*BAU/4/PANDION//FLIN/ 2*PASTOR/3/BERKUT	Identified for NWPZ, Timely Sown, Restricted Irrigation, Test Weight – 45.3g
10.	HI 1655*	-	MACS2496/HI 1531	Identified for CZ, Timely Sown, Restricted Irrigation, Test Weight – 49g
11.	HI 8807	-		Identified for CZ, Timely Sown, Restricted Irrigation, Test Weight – 48g
12.	HI 8823	Pusa Prabhat	HI8709/HD4676	Released for CZ, Timely Sown, Restricted Irrigation, Test weight - 46.4g
13.	HI 8826	-	HI 8713/HI 8663	Identified for PZ, Irrigated, Timely Sown, Test Weight – 52.2g
14.	HI 8830	-	HI 8713/HI 8663	Identified for CZ, Restricted Irrigation, Test Weight - 55.4g
15.	HI 8838	-	HI 8710/Raj1555//HD 8691	Identified for CZ, Restricted Irrigation, Test Weight - 55.3g

of flag leaf blade, ear waxiness, peduncle waxiness, flag leaf length, flag leaf width, plant length, ear shape, ear density, awns presence, ear length, awns length, awn colour, awn attitude, outer glume pubescence, ear colour, lower glume shoulder width, shoulder shape, beak length, beak shape, peduncle length, peduncle attitude, grain colour grain shape, grain germ width, brush hair length, seed size, grain hardness and phenol colouration of grains were recorded over two years. It was observed that the results of both the years were almost same for all the characters and based on these results, varieties were classified for each character into different groups (Table 2). Schematic diagrams were made for identification of wheat varieties on the basis of plant morphological characters, flag leaf characters (Fig. 1), flag leaf hairs on auricle (Fig. 2).

On the basis of coleoptile colour, wheat varieties were classified into two groups as absent or present. All varieties were characterized as absent. This trait is considered as a useful trait in distinguishing wheat varieties [9 and 10]. The usefulness of this trait in differentiating genotypes of wheat were also reported. [9] The study of plant growth habit made it possible to divide the wheat varieties into three groups as erect (HI 1544, HI 1633, HI 1650, HI 8823, HI 8826, HI 8838,) semi-erect (HI 1563, HI 1605, HI 1650, HI 1636, HI 1653, HI 1654, HI 1655 and HI 8807, HI 8830). This trait was proved to be a diagnostic characteristic for characterizing and distinguishing wheat varieties.

On the basis of foliage colour varieties showed two groups viz. green and dark green. Ten varieties (HI 1500 HI 1544, HI 1563, HI 1633, HI 1650, HI 1654, HI 1655, HI 8830, HI 8826,) green foliage whereas other five varieties were observed as dark green. But, this character has been reported to have positive response to high doses of nitrogenous fertilizers [11]. Therefore, results are likely to vary over different environments. The present investigation revealed that all the five durum wheat varieties and two bread wheat varieties didn't have hairs on their flag leaf auricle. Eight bread wheat variety (HI 1500, HI 1544, HI 1563, HI 1633, HI 1653, HI 1655, HI 1654) showed Medium hairs on auricle. Hence this trait failed to distinguish between present set of durum wheat varieties. On the basis of flag leaf anthocyanin colouration

Table 2. Classification 15 wheat varieties on the basis of plant morphological characters

Plant Descriptors	Range	No. of Variety	Classification of Varieties
Coleoptile Anthocyanin	Absent	15	HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8807, HI 8823, HI 8826, HI 8830 and HI 8838
Colouration	Present	0	Nil
Plant Growth Habit	Erect	6	HI 1544, HI 1633, HI 1650, HI 8823, HI 8826 and HI 8838
	Semi-erect	9	HI 1500, HI 1605, HI 1563, HI 1636, HI 1653, HI 1654, HI 1655, HI 8807 and HI 8830
	Intermediate	0	Nil
	Semi Prostrate	0	Nil
	Prostrate	0	Nil
Foliage colour	Pale green	0	Nil
	Green	10	HI 1500 HI 1544, HI 1563, HI 1633, HI 1605, HI 1654, HI 1655, HI 8823, HI 8826 and HI 8830
	Dark green	5	HI 1636, HI 1650, HI 1653, HI 8807 and HI 8838
Plant Height	Short	2	HI 8807 and HI 8823.
	Medium	8	HI 1544, HI 1563, HI 1605, HI 1650, HI 1653, HI 8826, HI 8830 and HI 8838
	Long	4	HI 1633, HI 1636, HI 1654 and HI 1655.
	Very Long	1	HI 1500.
Flag Leaf Length	Short	0	Nil
	Medium	14	HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8826, HI 8830, HI 8807, HI 8823 and HI 8838
	Long	1	HI 1500
Flag Leaf:	Absent	5	HI 1544, HI 1633, HI 1654, HI 8826 and HI 8830
Waxiness on	Weak	7	HI 1500, HI 1563, HI 1636, HI 1653, HI 1655, HI 8807 and HI 8838
leaf blade	Medium	2	HI 1650 and HI 8823
	Strong	1	HI 1605
	Very strong		Nil
Flag Leaf Hairs	Absent	7	HI 1650, HI 1605, HI 8807, HI 8823, HI 8838, HI 8826 and HI 8830
on Auricle	Medium	8	HI 1500, HI 1544, HI 1563, HI 1633, HI 1636, HI 1653, HI 1654 and HI 1655
	Strong	0	Nil
Flag Leaf	Absent	9	HI 1500, HI 1544, HI1633, HI 1650, HI 1653, HI1654, HI 1655, HI 8807 and HI 8838
Anthocyanin	Medium	3	HI 1636, HI 8823 and HI 8830
Colouration of Auricles	Very strong	3	HI 1563, HI 1605 and HI 8826
Flag Leaf Width	Narrow		Nil
	Medium	9	HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 1653, HI 1654 and HI 8838
	Broad	6	HI 1650, HI 1655, HI 8807, HI 8823, HI 8826 and HI 8830
Ear Shape in Profile	Tapering	9	HI 1544, HI 1563, HI 1605, HI 1633, HI 1653, HI 1654, HI 1655, HI 8807 and HI 8838
	Parallel sided	5	HI 1500, HI 1636, HI 1650, HI 8826 and HI 8823
	Club shaped	1	HI 8830
	Fusiform	0	Nil
Ear Density	Very lax	1	HI 1654
	Lax	1	HI 1633.
	Medium	9	HI 1500, HI 1544, HI 1563, HI 1605, HI 1636**,** HI 1650, HI 1653, HI 1655 and HI 8830
	Dense	4	HI 8807, HI 8823, HI 8826 and HI 8838
	Very Dense		Nil
Awn Length	Very Short	0	Nil
	Short	4	HI 1544, HI 1633, HI 1653 and HI 1650
	Medium	5	HI 1563, HI 1500, HI 1605, HI 1636 and HI 1654
	Long	3	HI 1655, HI 8826 and HI 8830
	Very Long	3	HI 8807, HI 8823 and HI 8838
Lower Glume	Very Short	0	Nil
Beak Length	Short	5	HI 1653, HI 8807, HI 8823, HI 8826 and HI 8830.
	Medium	7	HI 1500, HI 1544, HI 1605, HI1633, HI 1636, HI 1655 and HI 8838
	Long	2	HI 1650 and HI 1654
	Very Long	1	HI 1563

Contd...

Plant Descriptors	Range	No. of Variety	Classification of Varieties
Lower Glume	Sloping	6	HI 1500, HI 1544, HI 1636, HI 1653, HI 1654 and HI 8807
Shoulder Shape	Round	2	HI 1605 and HI 8826
	Straight	2	HI 1633 and HI 8838
	Elevated	5	HI 1563, HI 1650, HI 1655, HI 8823 and HI 8830
	Strongly Elevated		Nil
Outer Glume Pubescence	Absent	13	HI 1544, HI 1563, HI 1636, HI 1605, HI 1633, HI 1650, HI 1653, HI 1654, HI 1655, HI 8826, HI 8830, HI 8823 and HI 8807
	Medium	1	HI 8838
	Very Strong	1	HI 1500
Awns Attitude	Appressed	6	HI 1500, HI 1650, HI 1654, HI 8807, HI 8823 and HI 8838
	Medium	5	HI 1563, HI 1605, HI 1653, HI 8826, HI 8830
	Spreading	4	HI 1544, HI 1633, HI 1636 and HI 1655
Ear colour	White	15	HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8807, HI 8823, HI 8826, HI 8830 and HI 8838
	Light brown	0	Nil
	Dark brown	0	Nil
Grain: Brush	Absent	3	HI 8826, HI 8830 and HI 1636
Hairs Length	Medium	9	HI 1500, HI 1544, HI 1563, HI 1605, HI 1650, HI 1654, HI 1655, HI 8807 and HI 8838
	Long	3	HI 1653, HI 1633 and HI 8823
Seed Size	Small		Nil
	Medium	6	HI 1500, HI 1563, HI 1650, HI 8807, HI 8823 and HI 8838
	Large	1	HI 8823
	Very Large	9	HI 1544, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8826 and HI 8830
Grain Hardness	Soft	1	HI 1654
	Semi hard	11	HI 1563, HI 1544, HI 1605, HI 1633, HI 1653, HI 1655, HI 8807, HI 8823, HI 8826, HI 8830 and HI 8838
	Hard	3	HI 1500, HI 1636 and HI 1650
Grain Germ Width	Narrow	4	HI 1563, HI 1605, HI 1633 and HI 8830
	Medium	7	HI 1500, HI 1544, HI 1650, HI 1655, HI 8807, HI 8823 and HI 8838
	Wide	4	HI 1653, HI 1654, HI 8826 and HI 1636
Grain Shape	Round		Nil
	Ovate	3	HI 1544, HI 1650 and HI 1653
	Oblong	9	HI 1500, HI 1563, HI 1605, HI 1633, HI 1654, HI 1655, HI 8807, HI 8823 and HI 8838
	Elliptical	3	HI 1636, HI 8826 and HI 8830
Flag Leaf Waxiness	Absent	0	Nil
of Sheath	Weak	0	Nil
	Medium	1	HI 1544
	Strong	10	HI 1500, HI 1563, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8830, HI 8807 and HI 8838
	Very Strong	4	HI 1605, HI 1633, HI 8823 and HI 8826
Ear Waxiness	Absent	2	HI 1633 and HI 1655
	Weak	7	HI 1500, HI 1563, HI 1636, HI 1653, HI 1654, HI 8826 and HI 8830
	Medium	2	HI 1544 and HI 1650
	Strong	4	HI1605, HI 8823, HI 8807 and HI 8838
	Very Strong	0	Nil
Culm Waxiness	Absent	0	Nil
of Neck (Peduncle)	Weak	1	HI 1544.
	Medium	5	HI 1500, HI 1563, HI 8807, HI 8830 and HI 8838
	Strong	7	HI 1605, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655 and HI 8826
	Very Strong	2	HI 1633, HI 8823
Time of Ear Emergence	Early	11	HI 1544, HI 1563, HI 1633,HI 1636, HI 1650, HI 1653,HI 1654, HI 1655, HI 8807, HI 8826 and HI 8838
	Medium	4	HI 1500, HI 1605, HI 8823 and HI 8830
	Late	0	Nil

Contd...

Plant Descriptors	Range	No. of Variety	Classification of Varieties
Awns Presence	Absent	0	Nil
	Present	15	HI 1500, HI 1544, HI 1563, HI 1605, HI 1650, HI 1653, HI 1654, HI 8826, HI 8830, HI 8807, HI 8823, HI 8838
Awn colour	White	15	HI 1650, HI 1653, HI 1654, HI 1650, HI 8826, HI 8830, HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 8807, HI 8823 and HI 8838
	Light brown	0	Nil
	Dark brown	0	Nil
Flag Leaf Attitude	Erect	6	HI 1605, HI 1654, HI 8807, HI 8830, HI 8838 and HI 8826
	Semi Erect	6	HI 1500, HI 1544, HI 1563, HI 1605, HI 1650 and HI 1653
	Drooping	3	HI 1633, HI 1636 and HI 8823
Lower Glume:	Absent	1	HI 1653
Shoulder Width	Narrow	5	HI 1500, HI 1563, HI 1605, HI 1654 and HI 8807
	Medium	7	HI 1544, HI 1636, HI 1650 HI 1655, HI 8823, HI 8830 and HI 8838
	Broad	2	HI 8826 and HI 1633
	Very Broad	0	Nil
Lower Glume	Straight	5	HI 1563, HI 1605, HI 1654, HI 1633 and HI 8807
Beak Shape	Moderately Curved	8	HI 1500, HI 1544, HI 1636, HI 1650, HI 1653, HI 1655, HI 8830 and HI 8838
	Strongly Curved	2	HI 8823 and HI 8826
	Geniculate	0	Nil
Peduncle Length	Short	0	Nil
	Medium		HI 1500, HI 1544, HI 1563, HI 1605, 1633, HI 1636, HI 1653, HI 8826, HI 8823, HI 8830 and HI 8838
	Long		HI 1650, HI 1655, HI 1654 and HI 8807
Peduncle Attitude	Straight	2	HI 1500 and HI 1654
	Bent	13	HI 1544, HI 1563, HI 1605, HI 1650, HI 1653, HI 1655, HI 1633, HI 1636, HI 8807, HI 8823, HI 8826, HI 8830 and HI 8838
	Crooked	0	Nil
Grain Colour	White	0	Nil
	Amber	15	HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8807, HI 8823, HI 8826, HI 8830 and HI 8838
	Red	0	Nil
Ear Length	Very short	0	Nil
	Short	0	Nil
	Medium	9	HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 8807, HI 8823 and HI 8838
	Long	3	HI 1653, HI 8826 and HI 8830
	Very Long	3	HI 1650, HI 1654 and HI 1655
Season Type	Winter type	0	Nil
	Alternative type	0	Nil
	Spring type	15	HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8807, HI 8823, HI 8826, HI 8830 and HI 8838

of auricle, three varieties are categorized as having medium colouration (HI 1636, HI 8823 and HI 8830) and others as absent (HI 1500, HI 1544, HI 8807, HI 8838, HI1633, HI 1650, HI 1653, HI1654, and HI 1655) and others very strong (HI 1563, HI 1605 HI 8826) The utility of this character for DUS testing of wheat cultivars was reported [12]. Some more characters of plant were studied such as flag leaf attitude, flag leaf length and flag leaf width. Variation was observed for flag leaf length and flag leaf width. Varieties were classified into different groups such as long, medium, short and narrow, medium, broad for flag leaf length and flag leaf width respectively. Almost same results were obtained during second year also. These characters are proved to be useful characters in distinguishing and identification of wheat varieties. Based on flag leaf attitude varieties were classified into three groups such as erect and semi-erect and drooping. Two varieties (HI 1500, HI 1563, HI 1605, HI 1653, HI 1654, HI 1655, HI 1636, HI 8807, HI 8830) were having semi-erect flag leaf attitude and six varieties (HI 1544, HI 1633, HI 8823, HI 8838, HI 1650, HI 8826) were having erect and remaining three varieties drooping type flag leaf attitude. Utility of flag leaf attitude was reported [13] for identifying rice cultivars. This character is also useful

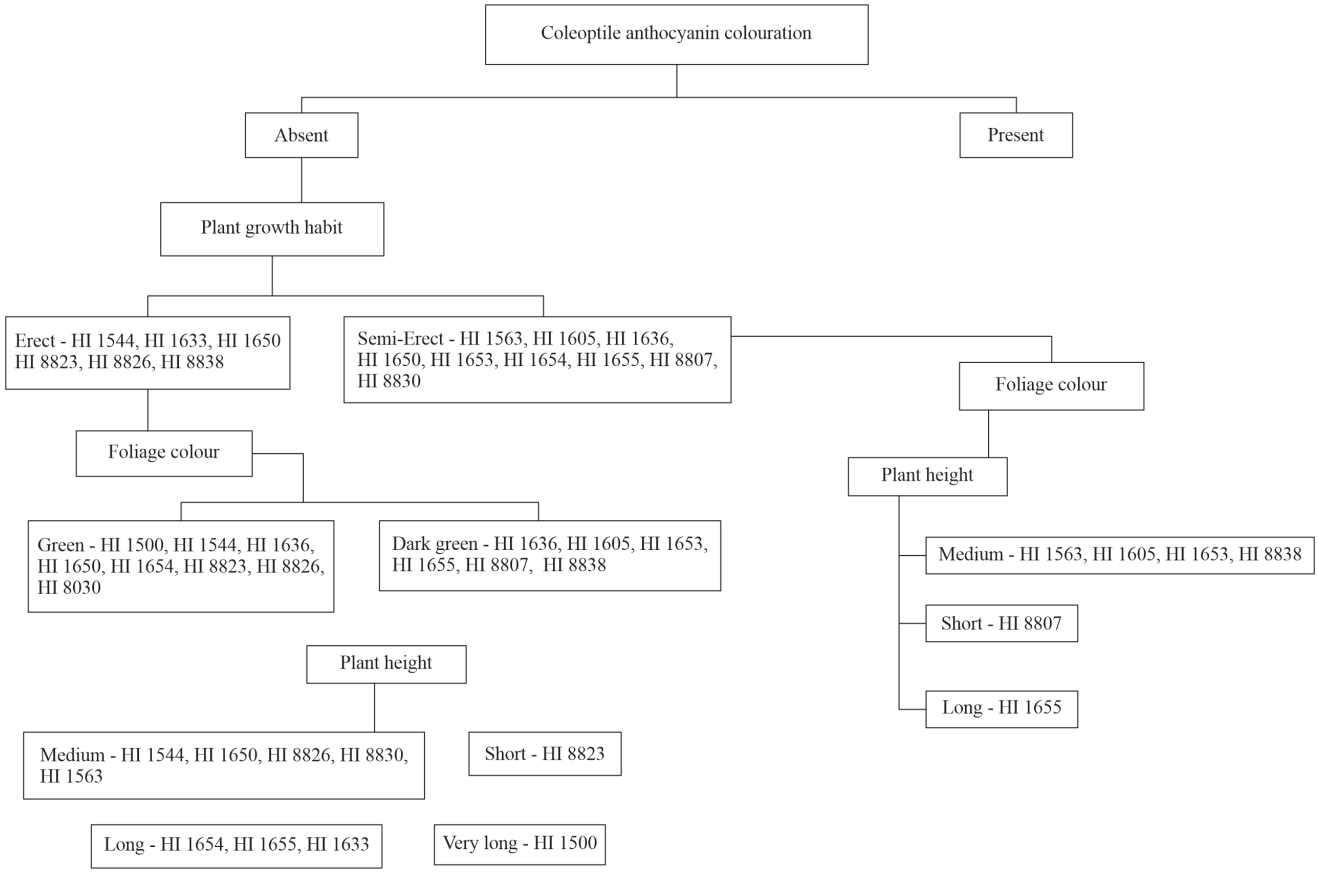

Figure 1. Schematic diagram for cultivar identification of wheat varieties on the basis of plant morphological characters

for characterization and identification of wheat varieties.

The present study revealed that varieties differed with respect to waxiness of different plant parts such as waxiness of flag leaf sheath, flag leaf blade, ear waxiness and peduncle waxiness. These characters are not measurable but visually observed and so their accuracy depends upon the skill of observer to correctly assess the intensity of waxiness of different plant parts. Therefore, it was also used [14] to characterize WH 1105. Further, weather should be clear for observing these characters. These difficulties make these characters less important in DUS testing and variety identification programme.

Time of ear emergence was recorded as the number of days required for 50% flowering and the present set of varieties varied from 60 days (HI 1544, HI 1563, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8807, HI 8826, HI 8838) to 80 (HI 1500, HI 1605, HI 8823, HI 8830,) days. Little variation was observed for this character as varieties could be classified into only two groups viz. medium (70-80 days) and late (80-90 days). Plant height was also found useful in characterization of wheat varieties. Wide variation in plant height viz. 75 cm (HI 8823) to 110 cm (HI 1544) during first year and 85 cm (HI 8807) to 105.8 cm (HI 1544) during second year) was observed in the present investigation. Based on this data variety were classified into four groups as short (70-90 cm), medium (90-100 cm) and long (100-120 cm) and very long (above 120 days duration) Plant height is highly heritable character and has been used before for identification purpose. Significant differences among bread and durum genotypes for characters' days to heading and plant height were reported [15].

Varieties could be classified on the basis of ear density. On the basis of this attribute varieties were classified into four groups viz., very lax, lax, medium, dense and very dense. Most of the bread varieties in the present study were observed to have medium ears (Fig. 1) Though this

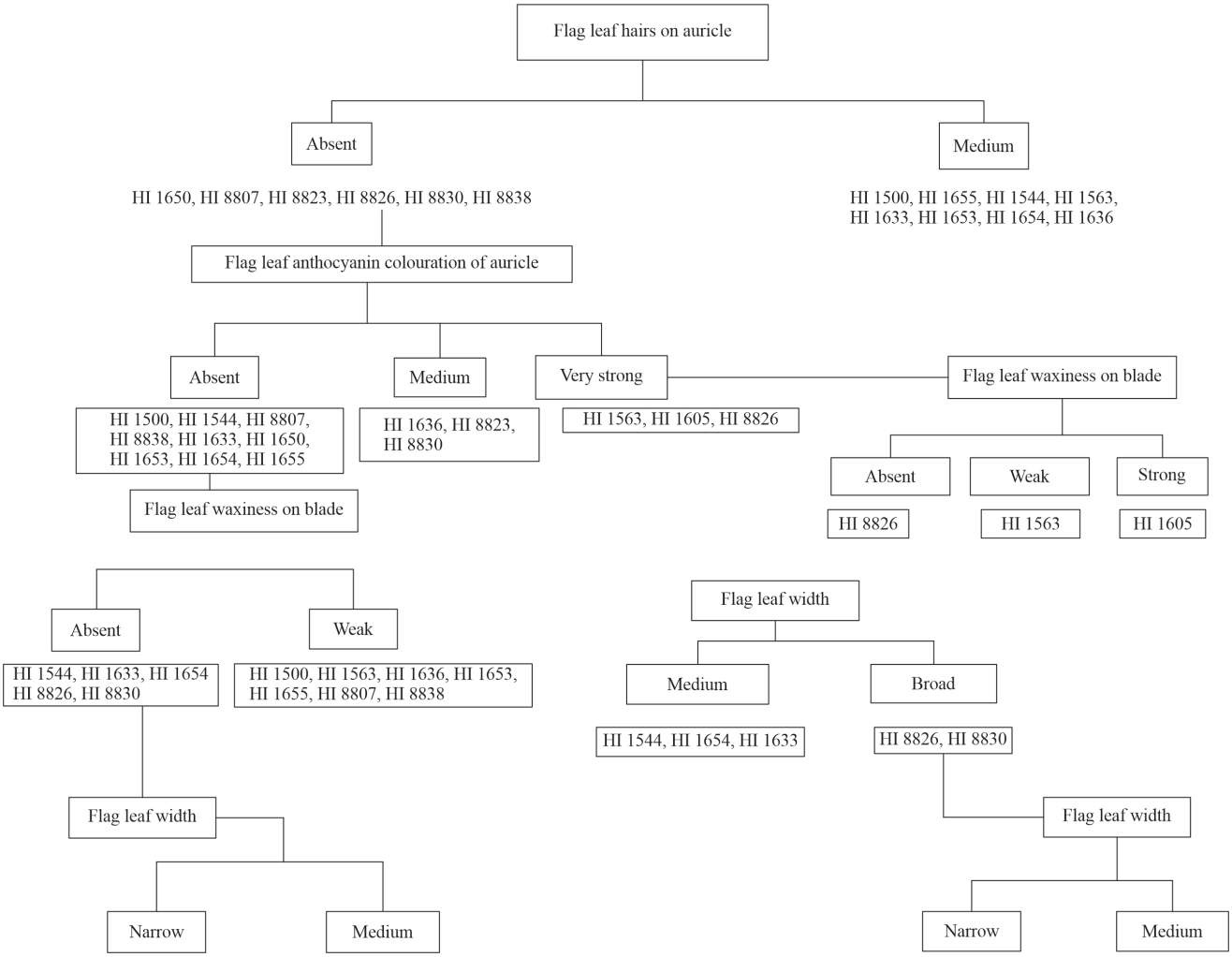

Figure 2. Schematic diagram for cultivar identification of wheat varieties on the basis of flag leaf characters

attribute could not distinguish among the present set of durum varieties, this character has been used by many workers for characterization and identification of wheat varieties and may be used for DUS testing of bread and durum wheat varieties also.

All the varieties in the present investigation were awn Length. the varieties were observed to have five groups viz., very short, short, medium, long and very long. So the durum varieties in the present study could not be distinguished on the basis of awns presence and awns length but awn length [16] along with other spike characters to establish the distinctness of rye cultivars and on the basis of this they suggested their inclusion in the standard character set for use in DUS testing. Awn length has been also reported to have positive effect on grain yield [17].

Little variation was observed for ear length of wheat varieties. Average ear length varied from 8-9 cm (HI 1500, HI 1544, HI 1563, HI 1605, HI 1633, HI 1636, HI 8807, HI 8823 and HI 8838) to above 10 cm (HI 1650, HI 1654 and HI 1655) and almost same range was observed during second year also. Most of the bread and durum varieties had medium to long ears and so ear length could not distinguish among these varieties. The characters like ear colour and awn colour were studied and it was observed that most of the varieties were having white coloured ears and awns. However, as these characters are highly stable thesemay be useful for DUS testing of durum wheat varieties.

On the basis of awns attitude, varieties were classified into three distinct groups viz., appressed (HI 1500, HI 1650, HI 1654, HI 8807, HI 8823 and HI 8838), medium

(HI 1563, HI 1605, HI 1653, HI 8826 and HI 8830) and spreading (HI 1544, HI 1633, HI 1636 and HI 1655). This character can be easily observed on the field and has importance in distinguishing bread and durum wheat varieties. On the basis of outer glume pubescence varieties were categorized into those having medium pubescence (HI 8838) and very Strong (HI 1500) and no pubescence i.e. absent (HI 1563, HI 1544, HI 1605, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8807, HI 8823, HI 8826 and HI 8830). Glume pubescence was also used [18] for characterizing the varieties of oat, wheat and rice. The study of lower glume in respect to its shoulder width and shoulder shape made it possible to divide the varieties into distinct groups. Glume beak length and glume beak shape were also observed to be helpful for categorization of wheat varieties into different groups. Little variation was observed for peduncle length of varieties and this character failed to discriminate the present set of bread and durum wheat varieties. On the basis of peduncle attitude two distinct groups were observed as straight and bent. Most of the varieties were having bent peduncle attitude.

Grains of all varieties in the present investigation were found to be amber colored like most of the present day cultivars. But due to its high heritability and stability it has been used in varietal identification [19] and DUS testing of wheat varieties. A number of other grain characters viz. grain shape, grain germ width and grain size were studied. Grain shape and grain germ width were able to differentiate the varieties into few distinct classes and hence are important for DUS testing of bread and durum wheat varieties. But in case of grain size all the varieties were found to be medium (HI 1500, HI 1563, HI 1650, HI 8823, HI 8807 and HI 8838), large (HI 8823) and very large (HI 1544, HI 1633, HI 1636, HI 1650, HI 1653, HI 1654, HI 1655, HI 8826 and HI 8830,). The grain size and shape are the major identifying traits in wheat [20]. The character brush hairs length was observed in three categories viz., absent, medium and long. Most of the bread and durum wheat variety having medium brush hairs. Wheat varieties also differed in their grain hardness and three categories were made on the basis of this character viz. soft, semi-hard and hard. Wrigley [21] also observed that grain hardness and texture of the grains in wheat as important parameters for identification of varieties. In case of grain colouration with phenol, it was observed that all the durum wheat varieties in the present study remained unstained and so the durum varieties could not be distinguished on the basis of grain colouration with phenol. These results were in accordance with those reported [22] for durum wheat cultivars.

With the help of results obtained in the present study it is concluded that the characters viz. plant growth habit, coleoptile anthocyanin colouration, flag leaf anthocyanin colouration of auricle, time of ear emergence, ear waxiness, waxiness of peduncle, flag leaf length, peduncle attitude, flag leaf width, plant height, lower glume shoulder width, lower glume shoulder shape, outer glume pubescence, and awns attitude were the most important characters which could easily distinguish the bread and durum wheat varieties. The characters like foliage colour, flag leaf attitude, flag leaf waxiness of sheath, ear length, lower glume beak length, lower glume beak shape, flag leaf waxiness of blade, ear colour, awns colour, are also found useful in distinguishing bread and durum wheat varieties. The study also revealed that seed morphological characteristics such as grain hardness, grain germ width and grain shape are found to be useful in discriminating bread and durum wheat varieties. Characters like ear density, awn length and 1000 seed weight are not found to be so useful in distinguishing wheat varieties in the present investigation. The characters viz. flag leaf hairs on auricle, brush hairs, peduncle length, ear shape in profile easily distinguished bread wheat variety from rest of the durum wheat varieties. But these characters could not distinguish among durum wheat varieties. Similar result was obtained for the character grain colouration with phenol.

REFERENCES

1. KANT, S., R.A.S. LAMBA., R.K. ARYA & I.S. PANWAR (2014). Effect of terminal heat stress on stability of yield and quality parameters in bread wheat in southwest Haryana. *Journal of Wheat Research* **6**(1): 64-73.
2. GUIN, K., S.K. SETHI & R.K. ARYA (2019). Genetic Studies on *Triticum timopheevi* Based Cytoplasmic Genetic Male Sterility (CGMS) System in Relation to Hybrid Seed Production in Wheat (*T. aestivum* L.). *Ekin Journal of* Crop *Breeding and Genetics*. **5**(2): 103-110
3. PREETI PANWAR, I.S. & R.K. ARYA (2016). Effects of changing environment on wheat dry matter yield *Forage Research*, **42** (1): 56-61.
4. SETHI, S.K. & R.K. ARYA (2012). Importance of durum wheat in changing social life. *Wheat and Barley Sawarnima*.**4**: 76-79.
5. VERMA, D.K., A.K. SINGH & D.N. SINGH (2021) Wheat Breeding for Multifunctional Agriculture, *Biotech Books*, New Delhi, pp978.
6. YADAV, A.K., M.S. NARWAL & R.K. ARYA (2013). Morphological characterization of Indian mustard *(Brassica juncea*) genotypes and their application for DUS testing. *Indian Journal of Agricultural Sciences.* **83**(12):1305-1316.

7. PPV&FRA (2007) Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on Bread Wheat (*Triticum aestivum* L), Bulletin SG/02/2007 dt 20 February, 2007, PPVFRA Authority, GOI, New Delhi, pp 17.

8. KUNDU, S., J. SHORAN & B. MISHRA (2006). National Guidelines for the conduct of tests for Distinctness, Uniformity and Stability- Bread wheat (*Triticum aestivum* L.). Research Bulletin No. 22. *Directorate of Wheat Research,* Karnal, 132001 (India), pp32.

9. DHESI, N.S., R.W. DESORMEAUX & J. PAUKENS (1969). Identification of wheat and barley varieties at the seedling stage. *Proceedings of Association of Official Seed Analysts*. **59**: 134-140.

9. FRASER, J.G.C. & F. GIELIER (1935). Two new methods of distinguishing certain Canadian wheat. *Sci. Agric.* **15**: 564-572.

10. KOCHETOVA, E.A. (1971). Determination of authenticity of wheat seeds by laboratory methods. *Trudypo Prikladnoi Botanike, Genetike Selektsii*. **44**(3): 5-49.

11. MILAN, A.L. & S.M.A. HOSSAIN (1973). Evaluation of plant characters of some local and exotic varieties of rice. *Science and Industry*. **8**(3-4): 269-276.

12. HALJAK, M. (2005). The distinctness of spring wheat perspective breeds by morphological characteristics. *Transactions of the Estonian Agricultural University, Agronomy*. **220**: 51-53.

13. SHARIEF, A.E., S.A. EL-MOURSY, A.M. SALAMA, M.I. EL-EMERY & F.E. YOUSSEF (2005). Morphological and molecular biochemical identification of some rice (*Oryza sativa* L.) cultivars. *Pakistan Journal of Biological Sciences*. **5**(9): 1275-1279.

14. PANWAR, I.S., A.S. REDHU, S.R. VERMA, S.K. KARWASRA, O.P. BISHNOI & R.K. ARYA (2013). WH 1105: A new wheat variety for timely sown irrigated conditions in north western plains zone of India. *Journal of Wheat Research*. **5**(2):74-75.

15. SINGH, T. & R.K. SHARMA (2007). Genetic variability, character association and path analysis of yield and its component characters in durum wheat. *Progressive Agriculture*. **7**(1/2): 15-18.

16. REEVES, J.C. & M.M. BOYD (1984). The use of some spike and spikelet characters in establishing the distinctness of ryegrass cultivars. *Journal of the National Institute of Agricultural Botany, UK*. **16** (3): 513-525.

17. MOTZO, R. & F. GIUNTA (2002). Awnedness affects grain yield and kernel weight in near isogenic lines of durum wheat. *Australian Journal of Agricultural Research*. **53**(2): 1285-1293.

18. GALUSSI, A.A., L.R. ZIMMERMANN, F.G. MARCHESE, M.E. MOYA, D.P. REINOSO, A. CEVEDO & C. ROMERO (1999). Using seedling hairiness to identify varieties of oats, rice and wheat. *Seed Science and Technology*. **27**(3): 1047-1050.

19. NETHRA, N., S. RAJENDRAPRASAD, K. VISHWANATH, K.N. DHANRAJ & R. GOWDA (2007). Identification of rice hybrids and their parental lines based on seed, seedling characters, chemical tests and gel electrophoresis of total soluble seed proteins. *Seed Science and Technology*. **35**: 176-186.

20. Mor, R.S., K.R. Buttan & B.S. Mehla (2006). Identification of rice varieties by laboratory techniques. *National Journal of Plant Improvemen*t. **8**(1): 28-31

21. Wrigley C.W. (1976). Single seed identification of wheat varieties: use of grain hardness testing, electrophoretic analysis and a rapid test paper for phenol reaction. *Journal of Science, Food and Agriculture*. **27**: 429-432.

22. GUPTA, N., M.A. JOSHI, N.K. SARAO & R.C. SHRAMA (2007). Utility of phenol test in varietal characterization. *Crop Improvement*. **34**(1): 77-81.