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# Studies on DUS Testing in Durum Wheat (*Triticum durum* Desf.)

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**ABSTRACT**

Present investigation was carried out at CCS Haryana Agricultural University, Hisar to examine the different morphological characters for distinctness, uniformity and stability of durum wheat varieties. Nine genotypes were studied over two years and observations on thirty-seven 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 durum wheat varieties. But some characters like ear density, awn length and 1000 seed weight are not found to be so useful in distinguishing durum wheat varieties in the present investigation. The study also revealed that the characters viz. flag leaf hairs on auricle, brush hairs, peduncle length, straw pith in cross section, ear shape in profile easily distinguished bread wheat variety 'PBW 343' 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 'PBW 343' from all the durum wheat varieties in the study.

***Keywords*****:** DUS, characterization, identification, durum wheat

## Introduction

Globally, wheat is one of the most important cereal crop which is widely adapted to different agro-climatic conditions and unique property of its flour allows us to make a range of products (Kant *et al*. 2014; Guin *et al*. 2019). In India, wheat is the major crop, which is mainly cultivated for grain production (Preeti *et al*. 2016). But, the changing food habits have created additional demand for durum wheat because it has potential to produce value added marketable products. Infact, 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 β-carotene (precursor of vitamin A) too, required to solve the problem of malnutrition among children and rural population (Sethi and Arya, 2012). 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.

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 (Yadav *et al.* 2013).

Hence, studies on DUS testing to acquaint with the procedures involved are needed in various field crops. 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 to examine the different morphological characters for distinctness, uniformity and stability of durum wheat varieties. Eight durum wheat varieties *viz.* PDW 291, HD 4717, PDW 308, WH 896, DDW 11, PDW 233, UAS 415, PDW 307 and one bread wheat variety PBW 343 (used as check) grown in AVT-D-TSI at CCSHAU Hisar in North Western Plain Zone was taken as experimental material. Same set of varieties were grown in the next year at CCSHAU Hisar and similar observations were taken. Observations on morphological characters were recorded on five 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 testing of bread wheat (*Triticum aestivum*) developed by Directorate of Wheat Research, Indian Council of Agricultural Research, Karnal (Kundu *et al*. 2006). Observations were recorded on 37 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), straw pith in cross section, 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 by Fraser and Gieller (1935).

## Results and Discussion

DUS testing of crop varieties is becoming exceedingly important in today's era of Intellectual Property Rights (IPR), as it guarantees 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, DUS testing provides basic information which is used to protect plant varieties under Protection of Plant Varieties and Farmers' Rights Act (2001). It is important that the characters used in DUS testing of crop varieties should be able to 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 eight durum wheat varieties along with a bread wheat variety used as check. Thirty-seven morphological characters were studied to examine their utility for DUS testing of durum wheat varieties (Table 1).

Morphological characteristics of varieties 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 of flag leaf blade, ear waxiness, peduncle waxiness, flag leaf length, flag leaf width, plant length, straw pith in cross section, 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 (Table 1).

These characters have been included in the guidelines for DUS testing of bread wheat (Kundu *et al*. 2006). 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. Schematic diagrams were made for identification of wheat varieties on the basis of plant morphological characters, flag leaf characters (Fig. 1), ear head characters (Fig. 2) and grain characters (Fig. 3).

On the basis of coleoptile colour, wheat varieties were classified into two groups as absent or present. Only two varieties (PDW 233, WH 896) were characterized as present while remaining varieties as absent. This trait is considered as a useful trait in distinguishing wheat varieties. Dhesi *et al*. (1969) and Kochetova (1971) had also reported the usefulness of this trait in differentiating genotypes of wheat. The study of plant growth habit made it possible to divide the wheat varieties into three groups as erect (DDW 11, HD 4717 and UAS 415), semi-erect (PDW 307, PDW 308, PDW 291 and PBW 343) and intermediate (WH 896 and PDW 233). This trait was proved to be a diagnostic characteristic for characterizing and distinguishing wheat varieties. Kumar *et al*. (2002) also reported the utility of this trait for cultivar identification in oat.

On the basis of foliage colour varieties showed two groups viz. green and dark green. Only two varieties (DDW 11 and UAS 415) green foliage whereas other varieties were observed as dark green. But, this character has been reported to have positive response to high doses of nitrogenous fertilizers (Milan and Hossain, 1973). Therefore, results are likely to vary over different environments. The present investigation revealed that all the durum wheat varieties didn't have hairs on their flag leaf auricle. Only the bread wheat variety 'PBW 343' showed hairs on auricle. Hence this trait failed to distinguish between present set of durum wheat varieties. On the basis of flag leaf anthocyanin colouration of auricle, four varieties are categorized as having medium colouration (PDW 307, PDW 291, PDW 233 and WH 896) and others as absent (PBW 343, PDW 308, HD 4717, DDW11 and UAS 415). The utility of this character for DUS testing of wheat cultivars was reported by Haljak (2005).

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 and their usefulness was also reported by Wel and Lin (1989) in rice varieties. Based on flag leaf attitude varieties were classified into two groups such as erect and semi-erect. Two varieties (PDW 307 and PDW 291) were having semi-erect flag leaf attitude and remaining varieties were having erect flag leaf attitude. Utility of flag leaf attitude was reported by Sharief *et al*. (2005) for identifying rice cultivars and by Kumar *et al*. (2002) for characterization of oat cultivars. This character is also useful 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 by Panwar *et al*. (2013) 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 programmes.

Time of ear emergence was recorded as the number of days required for 50% flowering and the present set of varieties varied from 94 days (PBW 343) to 105 (PDW 291) days. Little variation was observed for this character as varieties could be classified into only two groups viz. medium (91-100 days) and late (101-110 days). Plant height was also found useful in characterization of durum wheat varieties. Wide variation 86.3 cm (PBW 343) to 104.9 cm (WH 896) during first year and 86 cm (PDW 233) to 106.2 cm (WH 896) during second year) was observed in the present investigation. Based on this data varieties were classified into three groups as short (81-90 cm), medium (91-100 cm) and long (101-110 cm). Plant height is highly heritable character and has been used before for identification purpose. Significant differences among durum genotypes for characters days to heading and plant height were reported (Singh and Sharma, 2007).

It was observed that the character straw pith in cross section could not discriminate between durum wheat varieties, as all the durum wheat varieties in the present investigation expressed same size (medium) of straw pith in cross section. Only bread wheat variety PBW 343 expressed different state i.e. thin from those of durum wheat varieties. Similarly character ear shape also could not distinguish the present set of durum wheat varieties as these were having same state of ear shape i.e. parallel sided while bread wheat variety PBW 343 used as check was having tapering ear shape. But as these

characters are stable and highly heritable, they may be useful while testing for large number of varieties.

Varieties could be classified on the basis of ear density. On the basis of this attribute varieties were classified into two groups viz. dense and very dense. Most of the durum varieties in the present study were observed to have dense ears (Fig. 1). Though this 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 *durum* wheat varieties also.

All the varieties in the present investigation were awned like most of the present day varieties and among durums most of the varieties were observed to have long awns. So the durum varieties in the present study could not be distinguished on the basis of awns presence and awns length but Reeves and Boyd (1984) used awn length 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 (Motzo and Giunta, 2002).

Little variation was observed for ear length of wheat varieties. Average ear length varied from 5.8 cm (PDW 291) to 10.4 cm (PBW 343) and almost same range was observed during second year also. Most of the durum varieties had short 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. But these characters are highly stable and may be useful for DUS testing of durum wheat varieties.

On the basis of awns attitude, varieties were classified into three distinct groups viz. appressed (DDW 11, PDW 233 and PDW 308), medium (PDW 307, HD 4717, UAS 415 and WH 896) and spreading (PBW 343 and PDW 291). This character can be easily observed on the field and has importance in distinguishing durum wheat varieties. On the basis of outer glume pubescence varieties were categorized into those having medium pubescence (PDW 307, PDW 308 and DDW 11) and no pubescence i.e. absent (UAS 415, PDW 291, WH 896, PDW 233, HD 4717 and PBW 343). Glume pubescence was also used by Galussi *et al*. (1999) 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. Mor *et al*. (2006) reported the importance of beak characteristics in identification of rice cultivars. Little variation was observed for peduncle length of varieties and this character failed to discriminate the present set of durum wheat varieties. On the basis of peduncle attitude two distinct groups were observed as straight and bent. Most of the varieties were having straight peduncle attitude.

All the varieties in the present investigation were found to be amber coloured like most of the present day cultivars. But due to its high heritability and stability it has been used in varietal identification (Nethra *et al*. 2007) 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 durum wheat varieties. But in case of grain size all the varieties (except UAS 415) were found to be bold. The grain size and shape are the major identifying traits in wheat. Mor *et al*. (2006) also reported the usefulness of seed characters viz. seed length, seed shape, seed colour and beak characteristics for varietal identification of rice cultivars. The character brush hairs was also failed to distinguish the present set of durum wheat varieties as brush hairs were absent in all of them. Only bread wheat variety PBW 343 was having brush hairs. Wheat varieties also differed in their grain hardness and two categories were made on the basis of this character viz. semi-hard and hard. Wrigley (1976) 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 by Gupta *et al.* (2007) 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 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 study also revealed that seed morphological characteristics such as grain hardness, grain germ width and grain shape are found to be useful in discriminating *durum* wheat varieties. But some characters like ear density, awn length and 1000 seed weight are not found to be so useful in distinguishing durum wheat varieties in the present investigation The characters *viz.* flag leaf hairs on auricle, brush hairs, peduncle length, straw pith in cross section, ear shape in profile easily distinguished bread wheat variety 'PBW 343' 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.

Table 1. Classification of wheat varieties on the basis of plant morphological characters

| Plant Descriptors | Range | No. of Variety | Classification of Varieties |
|---|---|---|---|
| Coleoptile Anthocyanin Colouration | Absent | 7 | PBW 343, PDW 291, DDW 11, HD 4717, PDW 308, UAS 415, PDW 307 |
| | Present | 2 | PDW233, WH 896 |
| Plant Growth Habit | Erect | 3 | DDW 11, HD 4717, UAS 415, |
| | Semi-erect | 4 | PDW 307, PDW 308, PDW 291, PBW 343 |
| | Intermediate | 2 | WH 896, PDW 233 |
| | Semi Prostrate | 0 | Nil |
| | Prostrate | 0 | Nil |
| Foliage Colour | Pale green | 0 | Nil |
| | Green | 2 | DDW 11, UAS 415 |
| | Dark green | 7 | PBW 343, PDW 307, PDW 233, PDW 308, PDW 291, HD 4717, WH 896 |
| Straw Pith in Cross Section | Thin | 1 | PBW 343 |
| | Medium | 8 | PDW 233, HD4717, PDW 291, DDW 11, UAS 415, PDW 307, PDW 291, WH 896 |
| | Thick | 0 | Nil |
| Plant Height | Short | 2 | PBW 343, PDW 291 |
| | Medium | 4 | HD4717, PDW 233, PDW 307, DDW 11 |
| | Long | 3 | UAS 415, PDW 308, WH 896 |
| Flag Leaf Length | Short | 4 | PBW 343, PDW 291, DDW 11, UAS 415 |
| | Medium | 5 | PDW 307, PDW 291, PDW 233, HD 4717, WH 896 |
| | Long | 0 | Nil |

*Continuing table 1*

| Plant Descriptors | Range | No. of Variety | Classification of Varieties |
|---|---|---|---|
| Flag Leaf Waxiness of Blade | Absent | 7 | HD 4717, PDW 233, PDW307, DDW11, PBW 343, UAS 415 |
| | Weak | 2 | PDW 291, PDW 308 |
| | Medium | 0 | Nil |
| | Strong | 0 | Nil |
| Flag Leaf Hairs on Auricle | Absent | 8 | PDW 307, PDW 233, PDW 308, PDW 291, HD 4717, WH 896, DDW 11, UAS 415 |
| | Medium | 1 | PBW 343 |
| | Strong | 0 | Nil |
| Flag Leaf Anthocyanin Colouration of Auricle | Absent | 0 | Nil |
| | Medium | 5 | PBW 343, PDW 308, HD 4717, DDW 11, UAS 415 |
| | Very strong | 4 | PDW 307, PDW 291, PDW 233, WH 896 |
| Flag Leaf Width | Narrow | 6 | PDW 291, DDW 11, UAS 415, PDW 307, PDW 291, WH 896 |
| | Medium | 3 | PDW 233, HD 4717, PBW 343 |
| | Broad | 0 | Nil |
| Ear Shape in Profile | Tapering | 1 | PBW 343 |
| | Parallel sided | 9 | PDW 233, HD 4717, PDW 291, DDW 11, UAS 415, PDW 307, PDW 291, WH 896 |
| | Clavate | 0 | Nil |
| | Fusiform | 0 | Nil |
| Ear Density | Very lax | 0 | Nil |
| | Lax | 0 | Nil |
| | Medium | 0 | Nil |
| | Dense | 2 | PBW 343, PDW 291 |
| | Very Dense | 7 | HD4717, PDW 308, PDW233, WH 896, PDW 307, UAS 415, DDW 11 |
| Awn Length | Long | 7 | HD 4717, PDW 291, DDW 11, UAS 415, PDW 307, PDW 291, WH 896 |
| | Medium | 2 | PDW 233, PBW 343 |
| | Short | 0 | Nil |

*Continuing table 1*

| Plant Descriptors | Range | No. of Variety | Classification of Varieties |
|---|---|---|---|
| Lower Glume Beak Length | Short | 0 | Nil |
| | Medium | 8 | PDW 308, PDW233, WH 896, PDW 307, UAS 415, DDW 11, PBW 343, PDW 291 |
| | Long | 1 | HD 4717 |
| Lower Glume Shoulder Shape | Sloping | 0 | Nil |
| | Round | 5 | DDW 11, WH 896, PDW 307, PDW 308, PDW233 |
| | Straight | 3 | PBW 343, HD4717, PDW 291 |
| | Elevated | 1 | UAS 415 |
| Outer Glume Pubescence | Absent | 6 | UAS 415, PDW 291, WH 896, PDW 233, HD 4717, PBW 343 |
| | Medium | 3 | DDW 11, PDW 307, PDW 308 |
| | Strong | 0 | Nil |
| Awns Attitude | Appressed | 3 | DDW 11, PDW 233, PDW 308 |
| | Medium | 4 | PDW 307, HD 4717, UAS 415, WH 896 |
| | Spreading | 2 | PBW 343, PDW 291 |
| Ear Colour | White | 7 | UAS 415, PDW 291, WH 896, DDW 11, PDW 233, HD 4717, PBW 343 |
| | Light brown | 2 | PDW 307, PDW 308 |
| | Dark brown | 0 | - |
| Brush Hairs | Medium | 1 | PBW 343 |
| | Absent | 8 | PDW 308, WH 896, DDW 11, PDW 233, HD 4717, PDW 291, PDW 307, UAS 415 |
| Seed Size | Small | 0 | - |
| | Medium | 1 | UAS 415 |
| | Bold | 8 | PDW 308, WH 896, DDW 11, PDW 233, HD 4717, PDW 291, PDW 307, PBW 343 |
| Grain Hardness | Soft | 0 | - |
| | Semi hard | 3 | PDW 307, PBW 343, HD 4717 |
| | Hard | 6 | PDW 308, WH 896, DDW 11, PDW 233, PDW 291, UAS 415 |

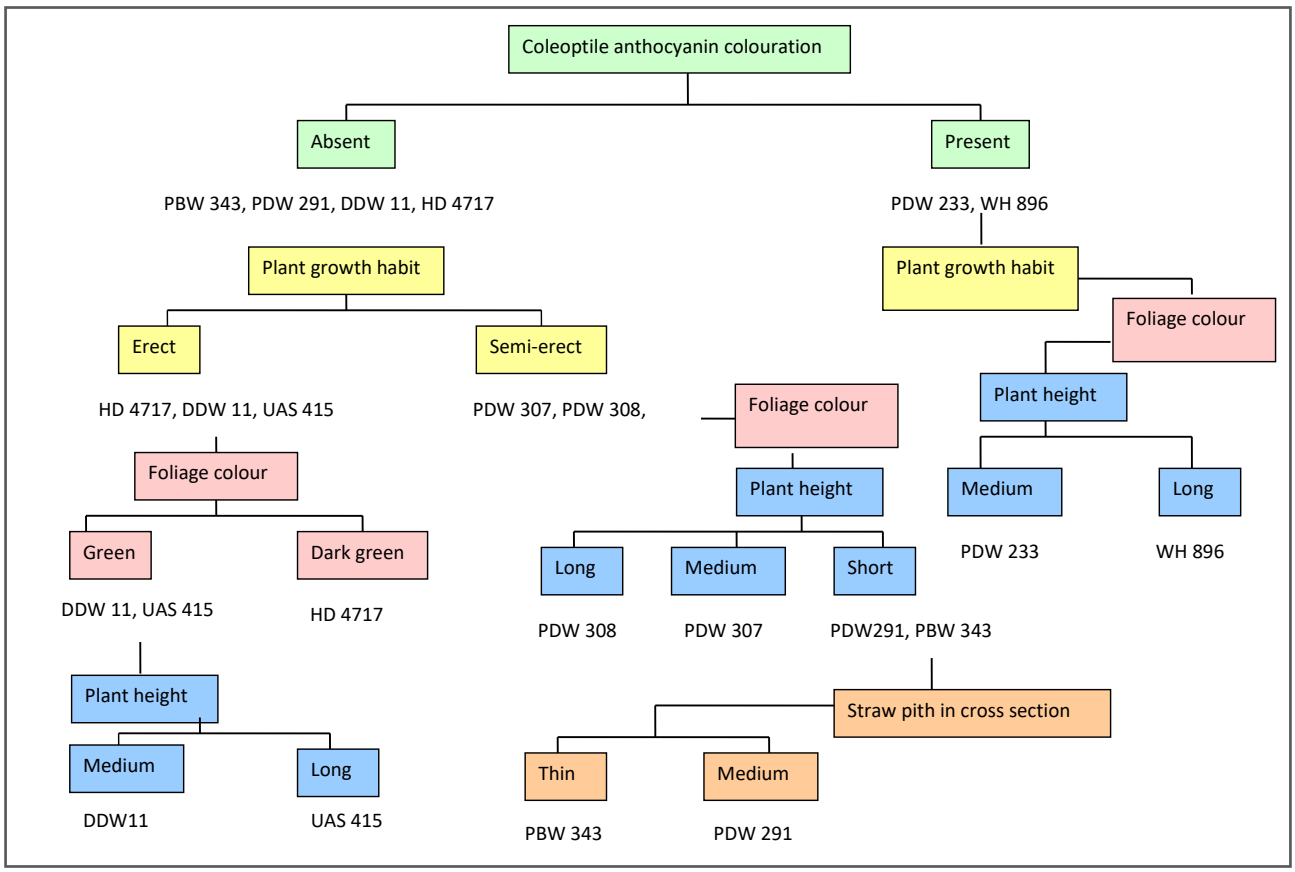
*Continuing table 1*

| Plant Descriptors | Range | No. of Variety | Classification of Varieties |
|---|---|---|---|
| Grain Germ Width | Narrow | 0 | - |
| | Medium | 4 | PDW 233, HD 4717, PBW 343, UAS 415 |
| | Wide | 5 | PDW 308, WH 896, DDW 11, PDW 291, PDW 307 |
| Grain Shape | Round | 0 | - |
| | Ovate | 1 | PDW 308 |
| | Oblong | 5 | WH 896, UAS 415, PDW 233, PBW 343, PDW 307 |
| | Elliptical | 3 | DDW 11, PDW 291, HD 4717 |
| Flag Leaf Waxiness of Sheath | Weak | 0 | - |
| | Medium | 3 | DDW11, PBW 343, UAS 415 |
| | Strong | 6 | HD 4717, WH 896, PDW 233, PDW307, PDW 291, PDW 308 |
| Ear Waxiness | Weak | 3 | PBW 343, UAS 415, DDW11 |
| | Medium | 4 | HD4717, PDW 233, WH 896, PDW 307 |
| | Strong | 2 | PDW 291, PDW 308 |
| Culm Waxiness of Neck (Peduncle) | Weak | 2 | PBW 343, DDW11 |
| | Medium | 4 | PDW233, WH 896, PDW 307, UAS 415 |
| | Strong | 2 | HD4717, PDW 291 |
| Time of Ear Emergence | Early | 0 | - |
| | Medium | 5 | PBW 343, HD 4717, PDW 308, PDW 307, UAS 415 |
| | Late | 4 | WH 896, PDW 233, PDW 291, DDW11 |
| Awns Presence | Absent | 0 | - |
| | Present | 9 | All varieties |
| Awn Colour | White | 7 | HD 4717, DDW 11, UAS 415, PDW 291, WH 896, PDW 233, PBW 343 |
| | Light brown | 2 | PDW 307, PDW 308 |

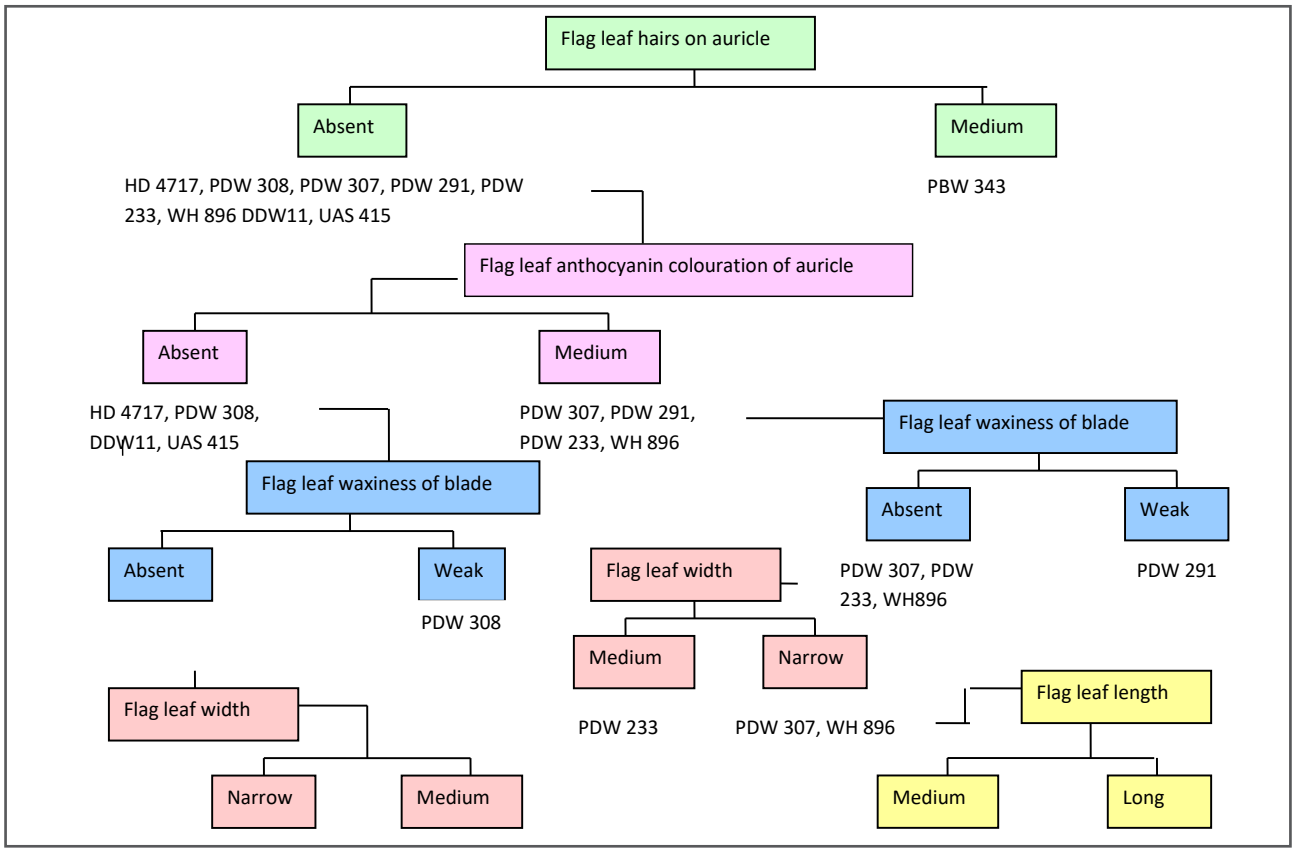
*Continuing table 1*

| Plant Descriptors | Range | No. of Variety | Classification of Varieties |
|---|---|---|---|
| Flag Leaf Attitude | Erect | 7 | PBW 343, PDW 308, HD 4717, DDW 11, UAS 415,PDW 233, WH 896 |
| | Semi Erect | 2 | PDW 307, PDW 291 |
| | Drooping | 0 | - |
| Lower Glume Shoulder Width | Narrow | 7 | DDW 11, WH 896, PDW 307, UAS 415, PDW 308, HD4717, PDW 291 |
| | Medium | 0 | Nil |
| | Broad | 2 | PDW233, PBW 343 |
| Lower Glume Beak Shape | Straight | 2 | PBW 343, HD4717 |
| | Moderately Curved | 7 | DDW 11, WH 896, PDW 307, UAS 415, PDW 308, PDW 291, PDW233 |
| | Strongly Curved | 0 | - |
| | Geniculate | 0 | - |
| Peduncle Length | Short | 1 | PBW 343 |
| | Medium | 8 | PDW 308, WH 896, DDW 11, UAS 415, PDW 291, PDW 233, HD 4717, PDW 307 |
| | Long | 0 | - |
| Peduncle Attitude | Straight | 6 | UAS 415, PDW 291, PDW 233, HD 4717, PBW 343, PDW 307 |
| | Bent | 3 | PDW 308, WH 896, DDW 11 |
| | Crooked | 0 | - |
| Grain Colour | White | 0 | - |
| | Amber | 9 | PDW 308, WH 896, DDW 11, UAS 415, PDW 291, PDW 233, HD 4717, PBW 343, PDW 307 |
| | Red | 0 | - |
| Grain Colouration With Phenol | None | 8 | PDW 308, WH 896, DDW 11, PDW 307, HD 4717, PDW 233, PDW 291, UAS 415 |
| | Very dark | 1 | PBW 343 |
| Ear Length | Very short | 1 | PDW 291 |
| | Short | 6 | HD 4717, PDW 233, PDW 307, DDW 11, PDW 308, WH 896 |
| | Medium | 2 | PBW 343, UAS 415 |
| | Long | 0 | - |

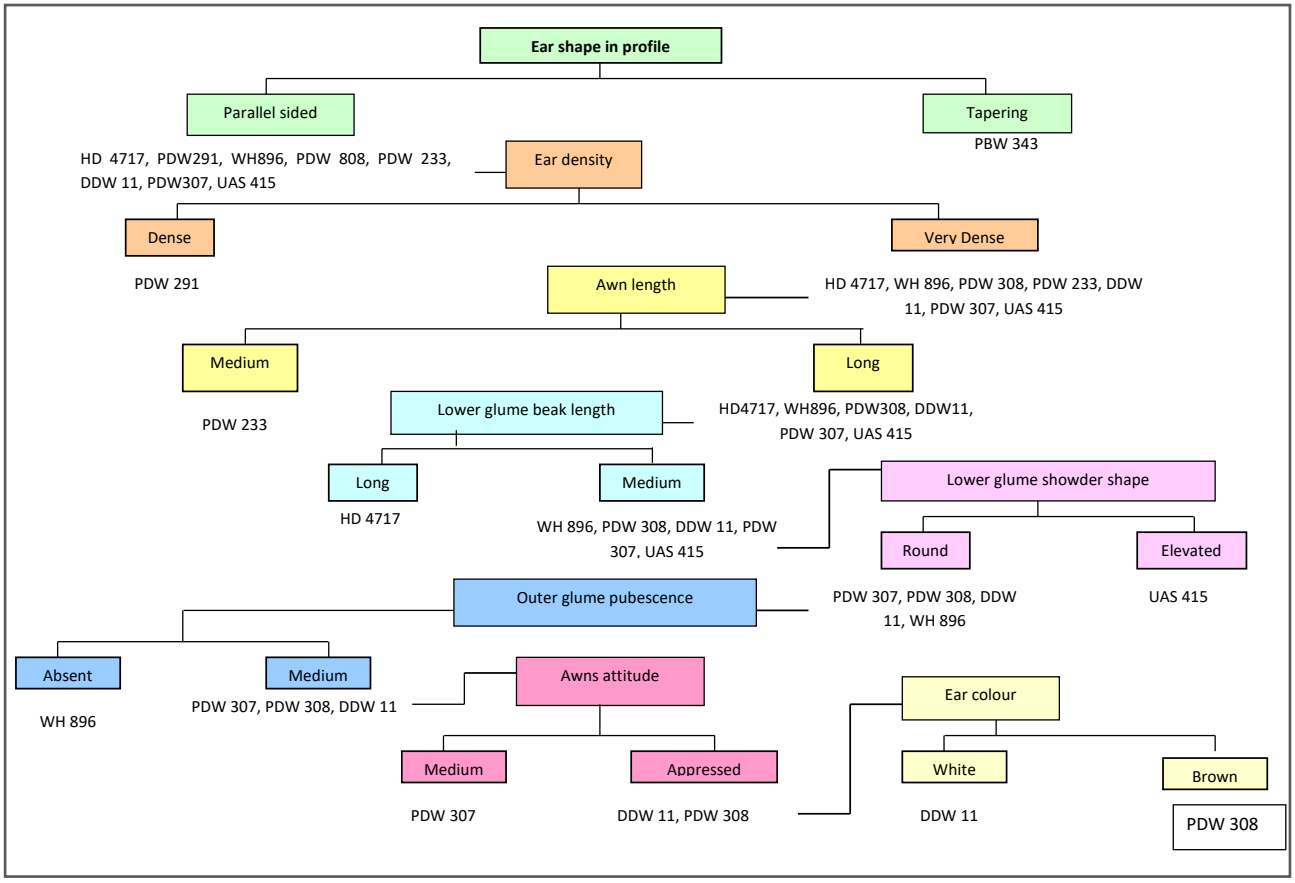
Figures 1. Schematic diagram for cultivar identification of wheat varieties on the basis of plant morphological characters




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



Figures 3. Schematic diagram for cultivar identification of wheat varieties on the basis of ear shape characters



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