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Morphological characterization of Bread wheat (*Triticum aestivum* L.) genotypes grown in the Sudan savanna of Nigeria

Abubakar Alhaji Mustafa[1], Saquib Mohammad[1*] and Dattijo Aminu[2]
[1]Department of Botany, Faculty of Life Sciences, University of Maiduguri, Maiduguri (Borno State), Nigeria
[2]Department of Crop Production, Faculty of Agriculture, University of Maiduguri, (Borno State) Nigeria
[*]Corresponding author: mohammadsaquib941@gmail.com

Abstract

Bread wheat is a self-pollinating, annual, and temperate crop. It is a crop with various uses both for man and his animals. Depending on culture and region, wheat is utilized for bread baking, *chappati, biscuits, pasta, macaroni, noodles* and fermented products. In Nigeria wheat flour is processed into foods such as locally called *alkaki, pinkaso, dubula, chin chin, gurasa*, local spaghetti (*taliya*), meat pie and many more products. Information on genetic diversity is important for crop improvement. A study was conducted during the cold harmattan season (November to March) at Maiduguri under irrigated condition during November, 2018 to March, 2019. The objective was to characterize some important qualitative characters in wheat, using standard wheat hand book descriptors for wheat provided by IBPGRI. Our findings revealed variability grouping of characters such as; spike density (dense, very dense and intermediate); awnedness (short, conspicous); seed size (medium, large); degree of seed shrivelness (plump, intermediate); leaf sheath colour (white, chalky white); leaf size (broad, narrow); grain type (bold, medium); glume colour (white, whitish brown); seed colour (red, white); awn length (long, moderate). The observations suggest that these genotypes can be utilized for crop improvement in future breeding programmes.

Keywords: Breeding, Crop improvement, Qualitative characters, Variability

1. Introduction

Bread wheat (*Triticum aestivum* L.) is a self-pollinating temperate crop (Ashitoshi et al., 2011; Sawsan & Elham, 2012; Shibeshi, 2019). It belongs to the family Poaceae (*Gramineae*) tribe *Triticeae,* and is the most important species of the genus *Triticum*, and most widely grown field crop of the globe (Sokoto & Sing, 2013; Chachaiya et al., 2017). It is adaptable to a wide agroclimatic condition of the world (Negash et al., 2002). Hence it occupies a prominent position among the cereal crops of the world in terms of area of cultivation and production. Bread wheat is a hexaploid crop (2n = 6x = 42) with a genome AABBDD (Shibeshi, 2019). It evolved from the three diploid wild progenitors namely, *T. monococum, Aegilops speltoides*, and *T. tauschii* (syn. *Aegilops squarosa*) (Geleta et al., 2015). Being a cool temperature loving crop, it requires a minimum temperature of 3.5°C to 5.5°C, an optimum of 20°C to 25°C and a maximum of 35°C. Temperatures below the optimum have a negative influence on germinating seeds, while above the maximum leads to forceful maturity, resulting in shrivelled seeds (Olabanji et al., 1990; Turaki et al., 2006). Wheat requires a relatively fertile soil with good humus, and internal drainage, neutral to slightly alkaline pH. In general, sandy to clay loams are good for wheat production (Shewry, 2009; Falaki et al., 1998). It is a staple food grain for urban and rural communities, contributing about 42% of total calories required per capita per day. It is a major source of fodder for animal feeding as well (Bhutto et al., 2016; Chachaiya et al., 2017). Wheat grain also supplies nutrients such as protein, carbohydrate and minerals such as vitamin B, vitamin E, thiamine, niacin, iron, riboflavin, magnesium, selenium, potassium, phosphorus and calcium (Chachaiya et al., 2017). According to culture and region of production, bread wheat is used in making chappati, biscuit, pasta, macaroni, noodles and many fermented food products (Chachaiya et al., 2017). In Nigeria, wheat is used in making foods (snacks) such as *alkaki, pinkaso, dubula, chin chin, gurasa,* meat pie, dough nut, local spaghetti (*taliya*), local couscous, porridge and many palatable and delicious foods (Nkama et al., 1998; Shettima, 1998). However, due to changing food habits as a result of urbanization and ease in preparation of processed wheat products, the demand for wheat crop has increased sharply. This is evidenced by the increase and expansion in bread and pasta industries for the manufacture of crackers and noodles, etc. (Falaki & Mohammed, 2011).

To meet with the high demands for wheat and other wheat products, breeding efforts in Nigeria must be doubled in order to evolve, deploy and release high-yielding, heat-tolerant and adaptable wheat varieties. Therefore, characterization of wheat genotypes is essential in order to know the extent of genetic variability within the germplasm and to identify key traits based on distinctness, uniformity and stability (DUS) for breeding purposes (Prajapati et al., 2018). Variability within genotypes is important towards selecting parental types for improvement. Characterization is also a management tool in regenerations to allow validating the identity of genotypes (Aghaee et al., 2010). Studies on morpho-physiological characterization have been carried out in several field crops such as wheat (Chandna et al., 2010; Hakeem et al., 2011; Chandna et al., 2012a; Chandna et al., 2012b), chickpea (Siddiqui et al., 2013), maize (Noor et al., 2019), pearl millet (Singh et al., 2016), sorghum (Prajapati et al., 2018), and soybean (Malek et al., 2014). In bread wheat, morphological characters were used to characterize key characters for identification, maintenance, conservation and to determine the extent of variability for future breeding programme. Several of these characters showed degree of variable groups as reported by Sawsan and Elham, (2012); Sonia et al. (2015); Chachaiya et al. (2017); Lutfullah et al. (2017) and Kinnary et al. (2010). Variability studies within genotypes will enable identify parental types to breed for high yielding, heat tolerant and adaptable genotypes or varieties for wheat-growing zones in Nigeria. The present study was undertaken with the objective to characterize bread wheat genotypes and identify their key characters to be included for improvement in wheat breeding programme.

2. Materials and Methods

2.1 Experimental Site

The experiment was carried out at the University of Maiduguri, Faculty of Science Complex, Biological Sciences Department Experimental Garden, Maiduguri. Borno State, Nigeria (Lat:11^{o}50'N and Long:13^{o}09'E). Maiduguri is the capital of Borno State, elevated at 359 meters above sea level (Anon, 2021). Soil of the experimental site was sandy loam with low fertility status [sand (752g/kg); silt (178g/kg); clay (100g/kg); total N (0.085g/kg); organic carbon (0.163g/kg); phosphorus (4.55mg/kg); potassium (1.76c molkg^{-1}); sodium (0.07c molkg^{-1}); and pH (6.38)].

Source of Seed

Thirty (30) bread wheat genotypes (*T. aestivum* L.) were obtained from Lake Chad Research Institute (LCRI), Maiduguri and used as the seed materials. Included in the seed materials are two checks (Reyna 28 and Norman) (Table 1).

Experimental Design and Setting

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Plots measured 3m x 2m and plot to plot distance was 0.50m. Distance between replicates was 1m. Seeds were drilled at 30cm between rows.

Cultural Operations

Standard fertilize dose at 100kg N, 40kg P_2O_5 and 40kg K_2O Perhectare was applied using NPK 15: 15: 15 (Kumar et al., 1990). All plots received 50kgN, 40kg per hectare each of P_2O_5 and K_2O as basal application during land preparation. The balance of 50kg per hectare N was applied 4 weeks after sending (WAS). A seedrate of 100kg per hectare was used at planting for genotype. Sowing was done onthe 26th November, 2018. Prior to sowing, seeds were dressed with seed dressingchemical [Apron Star (20% w/w thiamethoxam, 20% w/w Metalaxyl and 21% w/w difenoconazole)] at the rate of 10g per 4kg seeds to guard against soil borne pests anddiseases. Immediately after sowing, irrigation was carried out at a frequency of 4-dayinterval. At full maturity, irrigation was stopped 10 to 14 days before harvest to allow proper drying and mellowing of the crops. This gave ease in harvesting and threshing of the matured crops. Weeding was carried out at when due to keep the field weed–free and clean. All other recommended cultural practices for wheat production were followed.

Data Collection

Visual as well as standard wheat descriptor hand book of IBPGR/CIMMYT (1985) were used to characterize the 30 bread wheat genotypes. Morphological characters such as; spike density, awnedness, glume colour, glume hairiness, seed colour, seed size, growth habit, tillering capacity, degree of seed shrivelling, stem base colour, leaf sheath colour, leaf size, grain type and awns length were recorded.

Data Analysis

The characterized data were subjected to descriptive statistical analysis where frequencies and percentages were used to describe the different characters (Schaum's outlines, statistics 2008). Flow chart diagram was prepared depicting the frequencies and percentage occurrence of each character following Singh et al. (2016) and Kinnary et al. (2020).

3. Results

The data recorded on the 30 bread wheat genotypes for 15 qualitative characters are presented in Tables 1 and 2. Figure 1 presents the summary of occurrence and percentages for each of the characterized traits. From the figure, it comes out that 20 out of the 30 wheat genotypes possessed dense spikes (66.67%), 7 genotypes had very dense spikes (23.33%) and 3 genotypes recorded intermediate spike density (10%). As regards the awn length character, 26 genotypes (86.67%) had short awns, while 4 genotypes (13.33%) had conspicuous awn length. The seed size results show that 27 genotypes (90%) possessed large seeds, while 3 genotypes (10%) recorded medium seed size. Similarly, degree of seed shrivellness indicates that 26 genotypes (86.67%) had plump seeds and 4 genotypes (13.33%) had intermediate seed shrivellness. Also, of the 30 bread wheat genotypes, 24 genotypes (80%) recorded chalky white leaf sheath, while 6 genotypes (20%) had leaf sheath of whitish colour. Similarly, 19 genotypes (63.33%) had narrow leaves while 11 genotypes (36.67%) recorded broad leaves. Observations on the grain type show that 27genotypes (90%) had bold grain type and 3 genotypes (10%) had medium grain type. The results for glume colour indicate that 16 genotypes (53.33%)

had white glume colour, while 14 genotypes ((46.67%) had whitish brown glume colour. Results on seed colour reveal that 20 genotypes (66.67%) had white seeds and 10 genotypes (33.33%) possessedred seeds. However, results for the awn length indicate that 26 genotypes (86.67%) recorded moderately long awns, while 4 genotypes (13.33%) recorded long awns. All of the 30 genotypes recorded low glume hairiness (100%). Upright growth habit (100%), low tillering capacity (100%) and white stem base colour (100%) were the common characters.

Table 1. Names of the Genotypes/Lines used

S/No	Genotypes/Lines	Treatment Number
1	Reyna 28 (check 1)	Geno 1
2	Norman (check 2)	Geno 2
3	Qafzah-19//Vee 7/Kauz	Geno 3
4	Kauz//Altar 84/Aos 3/Kauz/3/Katila-1/4/Chen/Aegilopes Squarrosa (Taus)//BCN/3/Kauz	Geno 4
5	Seri/B*2/3/Kauz*2/Bow//Kauz/4/Kauz/Florkwa-1/5/ Pl.861/Rdwg//Naama-6	Geno 5
6	YMI#6/Gen//Tia.1/3/Vee #5//Dove/Bud 4/Milan/Pastor /S/Attila *2/3/Kauz*2/Trap//Kauz	Geno 6
7	Vee/Pjn//2*Kauz/3/Milan/Pastor/4/Kauz//Trap#1/Bow	Geno 7
8	Goumria – 8//Milan/Pastor/3/Tnmu/Milan	Geno 8
9	Kauz//Altar 84/ Aos 3/Kauz/3/Catbird – 10/4/Milan Ducula	Geno 9
10	Giza – 168/4/Attila *2/3/Kauz*2/Trap//Kauz	Geno 10
11	Seri.1B//Kauz/Hevo/3/Amad/4/Kauz/GYS//Kauz	Geno 11
12	Seri.1B//Kauz/Hevo/3/Amad/4/Pfau/Milan	Geno 12
13	Vee/Pjn//2*Kauz/3/Shuha -4/Fow2	Geno 13
14	Hubara – 7/4/Chen/Aegilops Squarrosa (Taus)//Ben/3/Kauz	Geno 14
15	Seri.1B//Kauz/Hevo/3/Amad/4/Milan/Pastor/5/Icarda – srrl – 6	Geno 15
16	Hubara – 7//Milan/Pastor	Geno 16
17	Seri.1B *2/3/Kauz*2/Bow///Kauz/4/Milan/Pastor	Geno 17
18	Attila *2/P6w65//Pfau/Millan	Geno 18
19	Kauz ‘S’/Seri//Pfau/Milan	Geno 19
20	Shuha –7/Shuha -1//Nemura/Cettia	Geno 20
21	Jawahir -10/Sekhrah -1	Geno 21
22	Pfau/Milan//Jawahir – 9	Geno 22
23	Faris – 17//Pfau/Milan	Geno 23
24	Munia/Altar 84//Milan/3/Milan/Pastor	Geno 24
25	Bacanora T88/Ruth -2	Geno 25
26	Cham – 8/Ruth – 3	Geno 26
27	Hubara -5/3/Nesma*2/261 – 9/Firtail	Geno 27
28	Galvez/Weaver/3/Vorona/Cno79//Kauz/4/Milan//Psn/Bow	Geno 28
29	Seri.1B//Kauz/Hevo/3/Amad/4/Milan/Pastor	Geno 29
30	Mex 94.27. 1. 20/3/50Koll//Attila/3 *Bcn/4/Zafir – 3	Geno 30

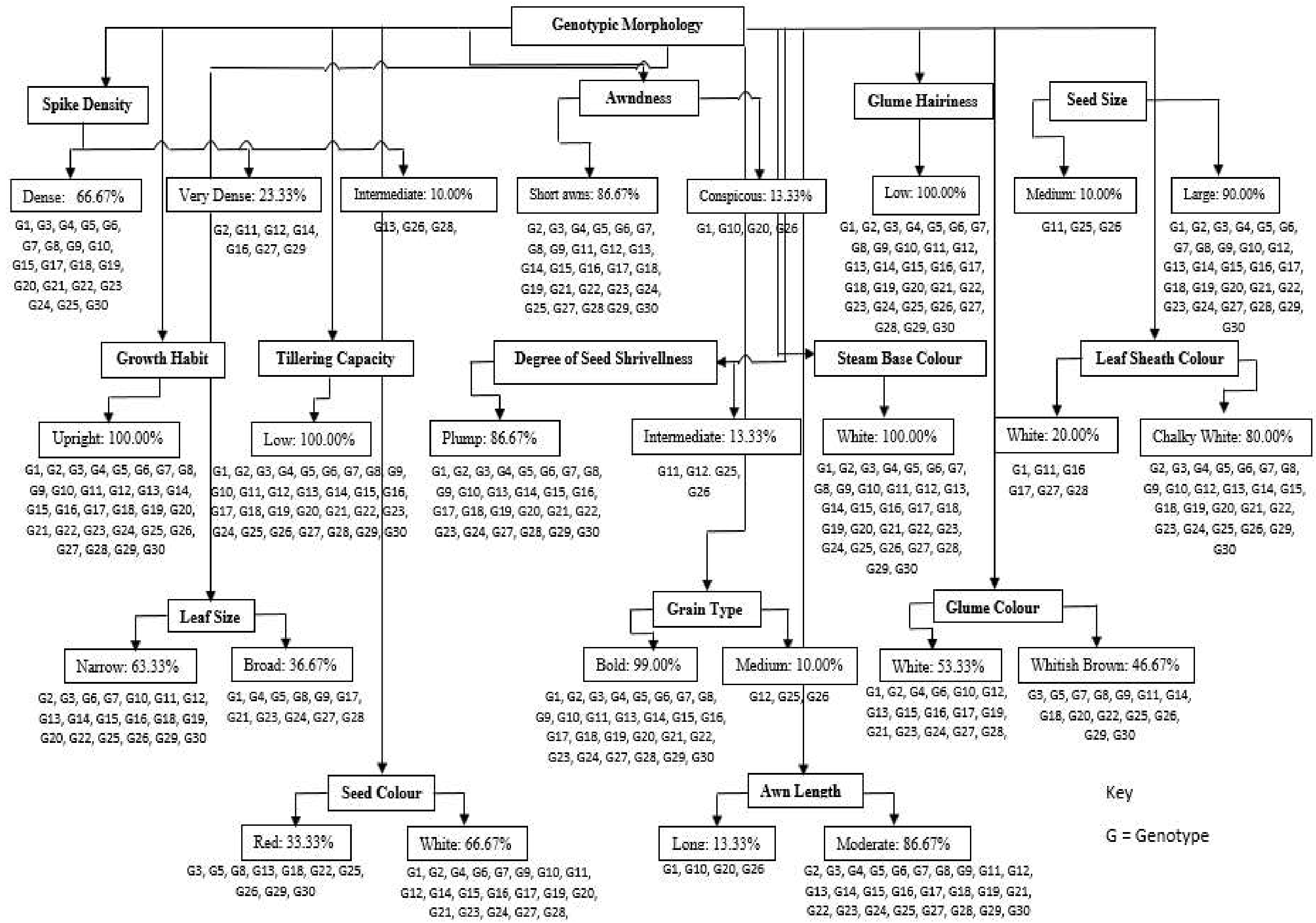

Fig 1. Flow chart diagram depicting the qualitative characters of the 30 bread wheat genotypes identifying key characters of the wheat at Maiduguri in 2018/2019 season

Table 2. Characterized Morphology of 30 Bread Wheat Genotypes Studied at Maiduguri in 2018/2019 Cool Season

Genotype	Spike Density	Awnedness	Glume Hairiness	Seed Size	Growth Habit	Tillering Capacity	Degree of Seed Shrivellness	Stem Base Colour	Leaf Sheath Colour	Leaf Size	Grain Type	Glume Colour	Awn Length	Seed Colour
Geno 1	Dense	Conspicous	Low	Large	Upright	Low	Plump	White	White	Broad	Bold	White	Long	White
Geno 2	Very Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	White	Moderate	White
Geno 3	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Moderate	Red
Geno 4	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Broad	Bold	White	Moderate	White
Geno 5	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Broad	Bold	Whitish Brown	Moderate	Red
Geno 6	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	White	Moderate	White
Geno 7	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Moderate	White
Geno 8	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Broad	Bold	Whitish Brown	Moderate	Red
Geno 9	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Broad	Bold	Whitish Brown	Moderate	White
Geno 10	Dense	Conspicous	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	White	Long	White
Geno 11	Very Dense	Short	Low	Medium	Upright	Low	Intermediate	White	White	Narrow	Bold	Whitish Brown	Moderate	White
Geno 12	Very Dense	Short	Low	Large	Upright	Low	Intermediate	White	Chalky White	Narrow	Medium	White	Moderate	White
Geno 13	Intermediate	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	White	Moderate	Red
Geno 14	Very Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Moderate	White
Geno 15	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	White	Moderate	White
Geno 16	Very Dense	Short	Low	Large	Upright	Low	Plump	White	White	Narrow	Bold	White	Moderate	White
Geno 17	Dense	Short	Low	Large	Upright	Low	Plump	White	White	Broad	Bold	White	Moderate	White
Geno 18	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Moderate	Red
Geno 19	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	White	Moderate	White
Geno 20	Dense	Conspicous	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Long	White
Geno 21	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Broad	Bold	White	Moderate	White
Geno 22	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Moderate	Red
Geno 23	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Broad	Bold	White	Moderate	White
Geno 24	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Broad	Bold	White	Moderate	White
Geno 25	Dense	Short	Low	Medium	Upright	Low	Intermediate	White	Chalky White	Narrow	Medium	Whitish Brown	Moderate	Red
Geno 26	Intermediate	Conspicous	Low	Medium	Upright	Low	Intermediate	White	Chalky White	Narrow	Medium	Whitish Brown	Long	Red
Geno 27	Very Dense	Short	Low	Large	Upright	Low	Plump	White	White	Broad	Bold	White	Moderate	White
Geno 28	Intermediate	Short	Low	Large	Upright	Low	Plump	White	White	Broad	Bold	White	Moderate	White
Geno 29	Very Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Moderate	Red
Geno 30	Dense	Short	Low	Large	Upright	Low	Plump	White	Chalky White	Narrow	Bold	Whitish Brown	Moderate	Red

Table 3. Summary of the Morphological Characters of 30 Bread Wheat (*Triticum aestivum* L.) genotypes Studied at Maiduguri in 2018/2019

Character	Genotype	Frequency	Percentage (%)
Spike Density			
Dense	Geno 1, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 15, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25 and Geno 30	20	66.67
Very Dense	Geno 2, Geno 11, Geno 12, Geno 14, Geno 16, Geno 27 and Geno 29	7	23.33
Intermediate	Geno 13, Geno 26, and Geno 23	3	10.00
Awnedness			
Short awns	Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 11, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25, Geno 27, Geno 28 Geno 29, Geno 30	26	86.67
Conspicous	Geno 1, Geno 10, Geno 20, and Geno 26,	4	13.33
Glume Hairiness			
Absent	0	-	-
Low	Geno 1, Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 11, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25, Geno 26, Geno 27, Geno 28 Geno 29 and Geno 30	30	100
Seed Size			
Small	0	0	0
Medium	Geno 11, Geno 25, and Geno 26	3	10.00
Large	Geno 1, Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 27, Geno 28 Geno 29 and Geno 30	27	90.00
Growth Habit			
Upright	Geno 1, Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno	30	100

	11, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25, Geno 26, Geno 27, Geno 28, Geno 29, and Geno 30		
Prostrate	0	0	0
Tillering Capacity			
Low	Geno 1, Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 11, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25, Geno 26, Geno 27, Geno 28, Geno 29, and Geno 30	30	100
High	0	0	0
Degree of Seed Shrivellness			
Plump	Geno 1, Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 27, Geno 28 Geno 29 and Geno 30	26	86.67
Intermediate	Geno 11, Geno 12, Geno 25, Geno 26	4	13.33
Stem Base Colour			
White	Geno 1, Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 11, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25, Geno 26, Geno 27, Geno 28, Geno 29 and Geno 30	30	100
Green	0	0	-
Dark Green	0	0	-
Leaf Sheath Colour			
White	Geno 1, Geno 11, Geno 16, Geno 17, Geno 27, Geno 28	6	20.00
Chalky White	Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 12, Geno 13, Geno 14, Geno 15, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25, Geno 26, Geno 29 and Geno 30	24	80.00

Leaf Size			
Narrow	Geno 2, Geno 3, Geno 6, Geno 7, Geno 10, Geno 11, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 18, Geno 19, Geno 20, Geno 22, Geno 25, Geno 26, Geno 29 and Geno 30	19	63.33
Broad	Geno 1, Geno 4, Geno 5, Geno 8, Geno 9, Geno 17, Geno 21, Geno 23, Geno 24, Geno 27, Geno 28,	11	36.67
Grain Type			
Bold	Geno 1, Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 10, Geno 11, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 20, Geno 21, Geno 22, Geno 23, Geno 24, Geno 27, Geno 28, Geno 29 and Geno 30	27	90.00
Medium	Geno 12, Geno 25, Geno 26,	3	10.00
Glume Colour			
White	Geno 1, Geno 2, Geno 4, Geno 6, Geno 10, Geno 12, Geno 13, Geno 15, Geno 16, Geno 17, Geno 19, Geno 21, Geno 23, Geno 24, Geno 27, Geno 28,	16	53.33
Whitish Brown	Geno 3, Geno 5, Geno 7, Geno 8, Geno 9, Geno 11, Geno 14, Geno 18, Geno 20, Geno 22, Geno 25, Geno 26, Geno 29 and Geno 30	14	46.67
Seed Colour			
Red	Geno 3, Geno 5, Geno 8, Geno 13, Geno 18, Geno 22, Geno 25, Geno 26, Geno 29 and Geno 30	10	33.33
White	Geno 1, Geno 2, Geno 4, Geno 6, Geno 7, Geno 9, Geno 10, Geno 11, Geno 12, Geno 14, Geno 15, Geno 16, Geno 17, Geno 19, Geno 20, Geno 21, Geno 23, Geno 24, Geno 27, Geno 28	20	66.67
Awn Length			
Long	Geno 1, Geno 10, Geno 20, Geno 26	4	13.33
Moderate	Geno 2, Geno 3, Geno 4, Geno 5, Geno 6, Geno 7, Geno 8, Geno 9, Geno 11, Geno 12, Geno 13, Geno 14, Geno 15, Geno 16, Geno 17, Geno 18, Geno 19, Geno 21, Geno 22, Geno 23, Geno 24, Geno 25, Geno 27, Geno 28, Geno 29, and Geno 30	26	86.67

4. Discussion

Characterization is a breeding procedure wherein genotypes are sorted out, grouped and distinguished. Each genotype is given a passport of identity based on its peculiar characteristics (de Vicente et al., 2016). Distinctness, uniformity and stability of genotypes are important to conserve and utilize for future breeding purposes to maintain genetic purity (Singh et al., 2016). Therefore, the first step in generating information on the diversity of crops is to characterize the genotypes (Chachaiya et al., 2017). This is because plant breeding programme depends solely on the extent and magnitude of the genetic variability present. Thus, in the present investigation the 30 bread genotypes showed genetic variability within and between the qualitative characters studied. These characters can be used for varietal identification and genetic purity test Prajapati et al. (2018), in their study found out varying groups for glume colour and panicle diversity. Also, Singh et al. (2016) found wide genetic diversity among genotypes studied for spikelet glume colour, tillering, spike density, leaf length and leaf width. Several studies focused on morphological characterization of bread wheat genotypes for several qualitative characters showing variability (Sonia et al., 2015; Lutfullah et al., 2017; Kinnary et al., 2020), corroborate the present findings. However, glume hairiness, tillering capacity, stem-base colour and growth habit showed genotypic uniformity. Therefore, maintenance and preservation of genetic purity of these varieties is of prime importance in preventing the varietal deterioration during successive regeneration cycles (Mansing, 2010).

5. Conclusion

The present study has identified groups of genotypes based on the different morphological characters. The grouping further indicated diversity for the characters under study. In plant breeding, variability is important for crop improvement. On the other hand, the uniformity as regards the other morphological characters, namely glume hairiness, tillering capacity, stem base colour and growth habit, can be maintained and preserved for identification and conservation for future breeding purposes.

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