Analysis of Agro-Morphological Characters in Wheat (Triticum aestivum L.) Genotypes for Yield and Yield Components

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A B S T R A C T

The present experiment was conducted to evaluate the yield and yield components of 30 wheat varieties for identification desirable genotypes. Two consecutive rabi cropping seasons of 2014-15 and 2015-16 trial was carried out at Crop Research Farm (CRF) of department of Agronomy. Morphological data for agronomic characters were recorded for plant height (cm), number of spikelets spike⁻¹, number of grains spike⁻¹, 1000-grain weight, grain yield and harvest index. The analysis of variance for agronomic traits (plant height, number of spikelets spike⁻¹ number of grains spike⁻¹, 1000-grain weight, grain yield and harvest index) revealed significant variation in first cropping season, number of grains per spike was non-significant in second cropping season and number of spikelets spike⁻¹ was non-significant in second cropping season as well as in pooled data. Majority of the wheat genotypes possessed yield higher levels. Higher yielding varieties had recorded higher values of harvest index. The present study demonstrated high grain yield genotypes possessed the combination of other agronomic desirable characters.

Keywords: Agro-morphological characters, Wheat, Yield.

Article Info

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Introduction

Wheat (Triticum aestivum L.) is one of the major staple food crops grown worldwide on more than 17% of the cultivated land and produced in a wide range of climatic environments systems, where and geographic regions (Gupta et al., 2008). It is the leading cereal grain produced, consumed and traded in the world. India harvested a record 86.53 million tonnes of wheat during the crop year 2014-15 (DWR, Annual Report, 2016). India witnessed the dramatic successes of the green revolution and has been able to rise from a deficit state to a self-sufficient one going on to have surplus production at times. This is indeed an important and reassuring milestone.

During the past four decades, wheat has made a significant contribution to the increase in global food production as total production rose steadily through the use of higher yielding, water- and fertilizer-responsive, and disease-resistant varieties supported by a strengthened input system, tailored management practices and improved marketing (Dixon et al., 2009).

Morphological and agronomic characters of wheat have a special role in determining the importance of each trait in increasing yield, so these traits were used in breeding programs which at least led to improving yield and
Introducing commercial varieties (Mollasadeghi et al., 2011).

Improvement of wheat yield based on breeding concept and use of large number of germplasm and best cultivars as a parent. The success in breeding process is not simple because of complex relationships between grain yield and yield components. Some of yield components are in positive correlation and other in a negative correlation which presents difficulties in efficiency of selection genotypes for yield. The wheat yield is affected by many factors: genetic, environment and theirs interaction. The value of yield varied in dependence of yield components such as stem height, leaf area, spike length, number of spikelets per spike and number of kernels per spike were also found associated with the vegetative growth period (Knezevic et al., 2012). Agronomically important traits are valuable for a species in cultivation and form the basis for the breeder's selection of promising plant material. Number of kernels per spike associated by the number of spikelets per spike which have direct connection with productivity in wheat (Knezevic et al., 2007). Days to heading, spike number per square meter, flag-leaf area and grain yield are mainly controlled by environmental variance, like temperatures and water stresses in post-anthesis period which have influence on reduction of kernels developing and filling in wheat as a result both grain weight and grain number are found to decline (Mohammadi et al., 2011). The two most frequently cited factors contributing to the increase in grain yield are improved cultivars and fertilizer application. Yield contributors i.e. effective tillers per plant, grain yield and biological yield increase with the progressive increase in fertilizer dosage (Abraham and Lal, 2004).

The present study was performed to evaluate the yield and yield components of 30 wheat varieties for identification desirable genotypes for further utilization in plant breeding programs.

**Materials and Methods**

The experiment was conducted during two consecutive *rabi* cropping seasons of 2014-15 and 2015-16 at Crop Research Farm, Department of Agronomy, Allahabad School of Agriculture, SHIATS, Allahabad (UP), which is located at 250 24' 42" N latitude, 810 50' 56" E longitude and 98 m altitude above the mean sea level. The soil pH was 7.5 and 7.4 with an electrical conductivity (EC) of 0.10 dSm⁻¹ and 0.10 dSm⁻¹ in 2015 and 2016, respectively. The organic carbon content was 0.40 % during both the years. The soil available phosphorus was analyzed to be (18.90 and 17.80 kg ha⁻¹) and available potassium was analyzed (292.10 and 327.3 kg ha⁻¹) in 2015 and 2016 respectively. The experiment was laid out in Randomized Block Design replicated thrice. Thirty wheat genotypes were included in the study, given in table 1. Genotypes were grown in a plot size of 1.2m × 2.5m (6 rows of 2.5m length with 20 cm space between rows) with seed rate of 12g/m².

Optimum dose of Nitrogen, Phosphorus, and Potassium i.e. @ 120, 60, 40 kg/ha was used respectively at the time of seed bed preparation and crop growth periods. Sowing was done by hand drilling and covered lightly with soil. Five irrigations were applied at critical stages; 1st, 2nd, 3rd and 4th irrigation was given at 24, 50, 75 and 105 DAS, respectively. All other agronomic practices are done as recommended for wheat production in the area. Morphological data on plant height (cm), number of spikelets spike⁻¹, number of grains spike⁻¹, 1000-grain weight (g), grain yield (t ha⁻¹) and harvest index (%) were recorded manually in each genotype per replication.
Results and Discussions

The two years data associated with their pooled data is presented in table 2a and 2b. It is observed that among the agronomic traits, almost all traits were significant during both of the experimental years. Traits such as, plant height, 1000- grains weight, grain yield (t ha\(^{-1}\)) and harvest index (%), were significant across the years as well as their pooled. Only, two traits number of spikelets spike\(^{-1}\) and number of grains spike\(^{-1}\) showed non-significant variation in 2016 and the pooled data of number of grains spike\(^{-1}\) was found to be non-significant.

During first and second experimental years as well as pooled data minimum plant height (78.4 cm, 79.3 cm and 78.9 cm) was recorded under K 8020. All most all genotypes was found to have normal plant height, however, the HUW 251 and HUW 213 genotypes have recorded higher plant height. Wheat plant height is considered as an important trait, since taller cultivars are more vulnerable to lodging than medium or short stature cultivars. There was significant variation among the genotypes for this trait, so selection within the genotype can be done for the promise varieties. Similar findings have been reported by Munsif et al., (2015).

Number of spikelets spike\(^{-1}\) showed wide range of variation. Genotype HUW251 recorded to have higher (18.7) number of spikelets spike\(^{-1}\) in first cropping seasons, while genotype Raj1972 recorded maximum number of spikelets spike\(^{-1}\) in second cropping season as well as in pooled data of two cropping seasons (18.9) and (18.7) respectively. Number of spikelets spike\(^{-1}\) plays a very important role in the possible increase of grain yield of wheat because it significantly affects the grain number and grain mass per spike in wheat. Therefore, best performing genotypes of this study can be selected and incorporated for further breeding program. Similar findings have also been reported by Zecevic et al., (2009) and Amagai, et al., (2014).

Number of grains spike\(^{-1}\) showed significant differences in the first cropping season only, while it was non-significant in second cropping season as well as in pooled data, which could be due to environmental factor. Highest number of grains spike\(^{-1}\) (48.9) was recorded under HD2385 genotype in the first cropping season. Number grain spike\(^{-1}\) is the main yield component in the cereal crops as well as in wheat. Improvement in number grain spike\(^{-1}\) is important to achieve genetic gains in wheat yield. Number of grain spike\(^{-1}\) is dependent on floret production and survival from flag leaf initiation period to anthesis when the grain number spike\(^{-1}\) is determined. Similar findings have been reported by (Knezevic, et al., 2012) and (Farooq, et al., 2011).

Significant differences were observed among genotypes for 1000-grain weight. Maximum value of 1000-grain weight was recorded for genotype HD2687 and HD2278 (44.5 g) and (48.6 g) in first and second cropping seasons respectively, while genotype K8020 had recorded higher value (45.1 g) of 1000-grain weight in pooled of two years data. 1000-grain weight is one of the most 1000-grain weight is wheat major yield traits and grading parameter that measure the agronomic yield of a wheat cultivars. Enhancing grain size in wheat breeding programs can improve grain weight to increase crop yield important yield components and could be used as potential selection criteria for grain yield. Similar findings have also been reported by Ghuttai et al., (2015) and Ramya et al., (2010).

Genotype HD1941 showed maximum grain yield (4.9 t ha\(^{-1}\)) in the first cropping season and genotype K9162 showed maximum grain
yield (4.4 t ha\(^{-1}\)) in second cropping season, while for pooled of two years, genotype HUW37 showed higher value (4.5 t ha\(^{-1}\)). Grain yield is a complex quantitative trait and it is directly or indirectly influence by other plant traits. Ultimate goal of any wheat breeding is to get maximum yield. The most important task of wheat breeding is to develop cultivars possessing high genetic yield potential. Grain yield is a complex inherited trait associated with combination of several plant characteristics. Similar findings have also been reported by Longove et al., (2014) and Ali et al., (2007).

**Table.1 List of wheat genotypes and their pedigree**

| No. | Genotypes | Pedigree/Parentage |
|-----|------------|---------------------|
| 1   | HD 1982    | YT54/N10B//HD845    |
| 2   | HD2643     | VEE"S"/ HD2407 //HD 2329 |
| 3   | HD2428     | HD1949 /HD2160      |
| 4   | HD2402     | HD2177//CNO67/BB/3/HD2160/4/HD2236 |
| 5   | HD2204     | HD 2092 //HD 1962/E 4870/K 65 |
| 6   | HD 2891    | WL711 // HD 2624    |
| 7   | HD 2177    | HD1962-E 4870-K65/HD1593 |
| 8   | HD 2385    | HI686/ HD 2263      |
| 9   | HD 2270    | HD 1962/E4870/ K65/HD 2119 /247 |
| 10  | HD 2236    | HD 2119 / HD 1981   |
| 11  | HD 2278    | HD 2119 //HD 1912 /HD 1592/3/HD 1962/E 4870/4/ K65 |
| 12  | HD 2954    | DL 975-1/BAVIOCRA   |
| 13  | HD 2824    | PTO-1 / CNO 79 / PRL /GAA /3/HD 1951 |
| 14  | HD 1941    | E 5477 * S64        |
| 15  | HD 2687    | CPAN 2009 / HD 2329 |
| 16  | HUW 37     | KALYANSONA / S 331 // HD 1982 |
| 17  | HUW 318    | HUW 206 / HUW 202   |
| 18  | HUW 251    | WH-147/HD-2160//2*WH-147 |
| 19  | HUW 213    | NORTENO / MOTI // HD 2160 |
| 20  | HUW 55     | E 4870 / HD 1982 // INIA 66 /HD 2189 |
| 21  | K 88       | VEERY "S" / WL 711  |
| 22  | K 9162     | K 7827/HD 2204      |
| 23  | K 9006     | CPAN 1687 /HD 2204  |
| 24  | K 9533     | HI 1077/HUW 234     |
| 25  | K 8020     | KALYANSONA/HD 1982  |
| 26  | Raj 3765   | HD 2402/VL639       |
| 27  | Raj 6560   | TOPDY 6             |
| 28  | Raj 3077   | HD 2267/RAJ 1482/5/BB/INIA66'S'/NAPO |
| 29  | Raj 1555   | COCORIT'S' / RAJ 911 |
| 30  | Raj 1972   | HD 2195 / HD 2160   |
### Table 2a Mean performance of thirty wheat genotypes for different agronomic traits

| S. No. | Genotypes   | Plant height  | Number of spikelets spike\(^{-1}\) | Number of grains spike\(^{-1}\) |
|--------|-------------|---------------|-----------------------------------|---------------------------------|
|        |             | 2015          | 2016 | Pooled | 2015 | 2016 | Pooled | 2015 | 2016 | Pooled |
| 1      | HD 1982     | 104.8         | 104.3 | 104.5  | 18.1 | 17.5 | 17.8  | 48.1 | 40.9 | 44.5  |
| 2      | HD 2643     | 86.6          | 85.3  | 85.9   | 17.3 | 17.5 | 17.4  | 42.3 | 45.9 | 44.1  |
| 3      | HD 2428     | 87.1          | 93.3  | 90.2   | 18.3 | 18.7 | 18.5  | 39.5 | 41.5 | 40.5  |
| 4      | HD 2402     | 84.9          | 86.3  | 85.6   | 17.3 | 17.1 | 17.2  | 37.9 | 42.2 | 40.0  |
| 5      | HD 2204     | 85.6          | 87.8  | 86.7   | 18.2 | 17.9 | 18.1  | 41.4 | 39.5 | 40.4  |
| 6      | HD 2891     | 87.3          | 89.9  | 88.6   | 17.5 | 18.1 | 17.8  | 44.7 | 42.1 | 43.4  |
| 7      | HD 2177     | 83.1          | 83.3  | 83.2   | 16.7 | 16.2 | 16.5  | 42.9 | 43.1 | 43.0  |
| 8      | HD 2385     | 87.2          | 85.8  | 86.5   | 18.2 | 18.2 | 18.2  | 48.9 | 39.9 | 44.4  |
| 9      | HD 2270     | 83.1          | 80.9  | 82.0   | 18.1 | 17.9 | 18.0  | 40.5 | 43.5 | 42.0  |
| 10     | HD 2236     | 92.7          | 92.9  | 92.8   | 18.6 | 18.5 | 18.5  | 43.1 | 45.5 | 44.3  |
| 11     | HD 2278     | 92.5          | 93.1  | 92.8   | 17.7 | 17.8 | 17.7  | 44.1 | 45.5 | 44.8  |
| 12     | HD 2954     | 88.2          | 88.9  | 88.6   | 16.6 | 17.3 | 16.9  | 42.0 | 38.9 | 40.5  |
| 13     | HD 2824     | 91.5          | 90.3  | 90.9   | 18.2 | 18.2 | 18.2  | 46.2 | 39.8 | 43.0  |
| 14     | HD 1941     | 90.2          | 84.6  | 87.4   | 17.7 | 16.9 | 17.3  | 43.4 | 40.2 | 41.8  |
| 15     | HUW 37      | 81.3          | 83.1  | 82.2   | 17.5 | 17.4 | 17.5  | 41.1 | 43.7 | 42.4  |
| 16     | HUW 318     | 83.5          | 80.7  | 82.1   | 18.1 | 17.1 | 17.6  | 40.5 | 40.4 | 40.4  |
| 17     | HUW 251     | 113.0         | 114.1 | 113.6  | 18.7 | 17.5 | 18.1  | 43.1 | 38.3 | 40.7  |
| 18     | HUW 213     | 112.9         | 113.2 | 113.0  | 16.9 | 18.8 | 17.8  | 46.3 | 46.7 | 46.5  |
| 19     | HUW 55      | 85.9          | 87.7  | 86.8   | 17.0 | 17.9 | 17.5  | 48.7 | 42.1 | 45.4  |
| 20     | K 88        | 81.2          | 83.4  | 82.3   | 17.5 | 17.1 | 17.3  | 38.4 | 40.1 | 39.2  |
| 21     | K 9006      | 95.7          | 94.7  | 95.2   | 17.7 | 17.9 | 17.8  | 38.5 | 40.9 | 39.7  |
| 22     | K 9533      | 94.0          | 93.9  | 94.0   | 16.6 | 18.5 | 17.5  | 41.4 | 40.6 | 41.0  |
| 23     | K 8020      | 78.4          | 79.3  | 78.9   | 17.5 | 17.9 | 17.7  | 40.7 | 44.0 | 42.4  |
| 24     | Raj 3765    | 104.1         | 105.9 | 105.0  | 18.2 | 17   | 17.6  | 44.9 | 42.5 | 43.7  |
| 25     | Raj 6560    | 97.9          | 99.0  | 98.5   | 15.9 | 17.9 | 16.9  | 44.3 | 41.3 | 42.8  |
| 26     | Raj 3077    | 87.6          | 93.7  | 90.7   | 17.4 | 19.3 | 18.3  | 45.9 | 46.5 | 46.2  |
| 27     | Raj 1555    | 94.3          | 93.6  | 93.3   | 18.2 | 17.8 | 18.0  | 42.7 | 45.9 | 44.3  |
| 28     | Raj 1972    | 92.5          | 91.0  | 91.8   | 18.6 | 18.9 | 18.7  | 43.1 | 43.7 | 43.4  |
| 29     | HD 2687 (C1)| 91.2          | 85.0  | 88.1   | 16.5 | 17.8 | 17.1  | 43.3 | 39.6 | 41.4  |
| 30     | K 9162 (C2) | 94.4          | 92.9  | 93.7   | 17.5 | 18.6 | 18.1  | 40.7 | 42.3 | 41.5  |
|        | SEd (±)     | 1.55          | 1.16  | 0.98   | 0.76 | 0.86 | 0.57  | 2.97 | 3.84 | 2.95  |
|        | CD (P = 0.05)| 3.1           | 1.32  | 1.96   | 1.53 | NS   | 1.14  | 5.95 | NS   | NS    |
### Table 2b Mean performance of thirty wheat genotypes for different agronomic traits

| S. No. | Genotypes   | 1000-grains weight (g) | Grain yield (t ha⁻¹) | Harvest index (%) |
|--------|-------------|-------------------------|-----------------------|-------------------|
|        |             | 2015  | 2016  | Pooled | 2015  | 2016  | Pooled | 2015  | 2016  | Pooled |
| 1      | HD 1982     | 38.7  | 41.9  | 40.3   | 3.2   | 3.5   | 3.3    | 26.4  | 28.8  | 27.6  |
| 2      | HD 2643     | 44.3  | 46.5  | 44.9   | 3.9   | 3.6   | 3.8    | 33.0  | 30.9  | 31.9  |
| 3      | HD 2428     | 43.7  | 44.5  | 44.1   | 4.5   | 3.7   | 4.1    | 35.8  | 29.8  | 32.8  |
| 4      | HD 2402     | 38.5  | 47.1  | 42.8   | 4.1   | 4.0   | 4.0    | 35.3  | 33.7  | 34.5  |
| 5      | HD 2204     | 37.6  | 44.3  | 41.0   | 3.1   | 2.8   | 2.9    | 30.3  | 24.4  | 27.4  |
| 6      | HD 2891     | 43.8  | 46.2  | 45.0   | 3.2   | 3.4   | 3.3    | 28.1  | 28.6  | 28.4  |
| 7      | HD 2177     | 41.3  | 39.4  | 40.3   | 3.7   | 3.3   | 3.5    | 30.0  | 28.6  | 29.3  |
| 8      | HD 2385     | 41.8  | 36.9  | 39.4   | 3.6   | 4.3   | 3.9    | 33.2  | 36.4  | 34.8  |
| 9      | HD 2270     | 37.6  | 44.1  | 40.8   | 4.0   | 3.7   | 3.8    | 34.5  | 31.7  | 33.1  |
| 10     | HD 2236     | 43.8  | 44.2  | 44.0   | 2.8   | 3.1   | 3.0    | 23.2  | 25.4  | 24.3  |
| 11     | HD 2278     | 41.0  | 48.6  | 44.8   | 3.8   | 3.5   | 3.7    | 33.3  | 29.4  | 31.4  |
| 12     | HD 2954     | 35.4  | 42.0  | 38.7   | 3.8   | 3.6   | 3.7    | 30.3  | 28.4  | 29.3  |
| 13     | HD 2824     | 43.6  | 44.4  | 44.0   | 3.0   | 4.3   | 3.7    | 30.0  | 38.5  | 34.2  |
| 14     | HD 1941     | 40.5  | 39.5  | 40.0   | 4.9   | 3.7   | 4.3    | 39.7  | 30.4  | 35.1  |
| 15     | HUW 37      | 42.6  | 39.7  | 41.2   | 4.1   | 4.8   | 4.5    | 34.6  | 40.1  | 37.4  |
| 16     | HUW 318     | 38.6  | 40.1  | 39.3   | 2.8   | 2.6   | 2.7    | 37.5  | 27.3  | 32.4  |
| 17     | HUW 251     | 42.8  | 45.2  | 44.0   | 3.9   | 3.9   | 3.9    | 31.7  | 33.8  | 32.7  |
| 18     | HUW 213     | 40.1  | 43.2  | 41.7   | 3.5   | 3.6   | 3.6    | 27.9  | 30.1  | 29.0  |
| 19     | HUW 55      | 38.8  | 43.7  | 41.2   | 4.1   | 3.9   | 4.0    | 36.5  | 35.5  | 36.0  |
| 20     | K 88        | 32.0  | 42.0  | 37.0   | 3.1   | 4.1   | 3.6    | 31.5  | 38.8  | 35.1  |
| 21     | K 9006      | 41.0  | 38.7  | 39.8   | 4.2   | 3.0   | 3.6    | 27.0  | 19.1  | 23.1  |
| 22     | K 9533      | 42.0  | 42.1  | 42.1   | 4.7   | 4.1   | 4.4    | 38.6  | 34.4  | 36.5  |
| 23     | K 8020      | 42.2  | 48.1  | 45.1   | 3.9   | 4.5   | 4.2    | 33.8  | 38.8  | 36.3  |
| 24     | Raj 3765    | 42.9  | 37.9  | 40.4   | 4.1   | 3.2   | 3.7    | 32.8  | 25.9  | 29.4  |
| 25     | Raj 6560    | 37.8  | 40.5  | 39.1   | 3.7   | 3.6   | 3.6    | 30.0  | 29.0  | 29.5  |
| 26     | Raj 3077    | 39.0  | 41.0  | 40.0   | 4.0   | 3.9   | 4.0    | 35.3  | 33.1  | 34.2  |
| 27     | Raj 1555    | 43.7  | 42.2  | 42.9   | 4.0   | 4.3   | 4.2    | 32.2  | 34.6  | 33.4  |
| 28     | Raj 1972    | 39.0  | 39.3  | 39.2   | 3.5   | 3.6   | 3.6    | 28.6  | 29.1  | 28.9  |
| 29     | HD 2687     | 44.5  | 42.9  | 43.7   | 4.3   | 4.0   | 4.1    | 37.0  | 33.7  | 35.3  |
| 30     | K 9162      | 45.4  | 34.6  | 40.0   | 4.2   | 4.4   | 4.3    | 33.1  | 36.6  | 34.9  |
|        | SE (±)      | 1.5   | 2.03  | 1.17   | 0.28  | 0.19  | 0.17   | 2.66  | 2.1   | 1.65  |
|        | CD (P = 0.05)| 3.01  | 4.06  | 2.34  | 0.56  | 0.38  | 0.34   | 5.32  | 4.21  | 3.3   |
Maximum value for harvest index was recorded for genotype HD1941 (39.7%) in the first cropping season, while in the second cropping season and pooled of the two years, the higher values of harvest index were recorded for genotype HUW37 as (40.1% and 37.4%) respectively. Harvest index has direct effect on grain yield. Enhancing in harvest index will boost grain yield. Similar findings have also been reported by (Dai, et al., 2016) and (Ahmad, et al., 2010).

Finally, from the present finding it is concluded that the wheat varieties used in the present study showed that there was significant different among the genotype. High yield wheat genotypes possessed better agronomic performance in all yield related attributes across the yeas such as, number of spikelets per spike, number of grains per spike, 1000-grain weight and higher harvest index value. As a whole the study was efficient and the promising genotypes can be used in future wheat breeding programme.

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