

## Prediction of varietal replacement in wheat (*Triticum aestivum* L. ~~em. Thell.~~)

### Abstract

Nine wheat genotypes, viz., K-508, K-17, K-818, RAJ4037, RAJ3404, K-8903, DBW-14, K-9357 and HD-2967 were evaluated in a randomized block design on nine parameters, viz., tillering ability, plant height, grain yield per plant, peduncle length, spikelets per spike, flag leaf area, thousand grain weight, days to maturity and grains per spike at the experimental farm of BRD PG College, Deoria, Uttar Pradesh, India with ~~an~~ the objective of recommending suitable plant types to farmers of this region. Normalized cumulative ranks (NCR) were used as criteria for selecting suitable plant types. Small flag leaf and early maturity were the criteria of selection (left directional selection) and ~~the~~ rest of the seven characters were selected for higher values (right directional selection). The suitability order of varieties/genotypes, as per NCR values was DBW-14, HD-2967, K-508, RAJ-4037, K-818, RAJ-3404, K-17, K-9357 and K-8903. ~~The~~ Top four varieties, namely DBW-14, HD-2967, K-508 and RAJ-4037 could be recommended for cultivation in this region. When all nine characters were selected for higher values, the suitability order came as HD2967, RAJ4037, DBW-14 and K-9357. High positive correlations were observed between peduncle length and test weight (0.831) and ~~between~~ plant height and days to maturity (0.652). When peduncle length, test weight, plant height and days to maturity were made criteria of selection, the suitability order was DBW-14, K-818, HD-2967 and RAJ-3404. HD-2967 is the standard check variety and ~~is~~ popular in this region. Therefore, a few of these selected/recommended varieties would give ~~a~~ close fight to HD-2967 and might eventually replace ~~it~~.

**Key words:** Ideal plant types, Normalized cumulative ranks, Prediction of varietal replacement, Selection.

### Introduction

Plant breeders' humble duty is to provide correct scientific knowledge of crop varieties to farmers so that enough food ~~could~~ ~~can~~ be produced to feed humans and their pets alike. Novel improved genotypes ~~or~~ varieties must keep replacing established popular varieties that are used as standard check varieties in varietal trials. Therefore, promising new variants ~~or~~ genotypes need to be evaluated along with ~~the~~ current standard check varieties. With this purpose in mind, we evaluated nine wheat genotypes on nine parameters and used three selection approaches/schemes to select suitable plant types for growing in this region. PBW-343 has been gradually replaced by HD-2967. The present varietal trial data ~~predicts~~ the replacement of HD2967 by novel ~~and~~ promising variants/varieties.

### Materials and Methods

Nine wheat genotypes included in this experiment are K-508, K-17, K-818, RAJ4037, RAJ3404, K-8903, DBW-14, K-9357 and HD2967. These varieties/genotypes were evaluated in a randomized block design on nine parameters, namely, tillering

ability (number of tillers), plant height (cm), grain yield per plant (g), peduncle length (cm), spikelets per spike (number), flag leaf area (cm<sup>2</sup> as calculated by length into breadth into correction factor 0.75), thousand grain weight or test weight (in grams), days to maturity (days) and grains per spike (numbers). The experiment was conducted at the experimental farm of BRD PG College, Deoria, Uttar Pradesh, India with a standard package of practices. Normalized cumulative ranks (NCR) were used as criteria for selecting suitable plant types as discussed in a few earlier papers using formula  $NCR = (\sum_{i=1}^n R_i) / (\sum_{i=1}^n R_i)_{min}$  (Singh and Kant 2022; Singh and Tiwari 2020; Yadav et al. 2020; Singh et al. 2018; Singh 2018; Singh, S. N. 2017). Under first selection scheme, small flag leaf and early maturity were the criteria of selection (left directional selection) and the rest of the seven characters were selected for higher values (right directional selection). In the second selection scheme, all nine characters were selected for high values (only right directional selection). Observing the high positive correlations between peduncle length and test weight (0.831) and between plant height and days to maturity (0.652), the third selection scheme was of for feature reduction. In this scheme, ideal plant types were selected on the basis of peduncle length, test weight, plant height and days to maturity. HD\_2967 was used as the standard check variety as it is very popular in this region after replacing PBW343. The common top few varieties and/or the unique list (of varieties under three selection schemes) are predicted to be eventually replacing today's standard check variety HD\_2967.

## Results and Discussion

The summarized data as means of five randomly selected plants, the ranks, cumulative ranks, normalized cumulative ranks and the outcome of the first selection scheme are consolidated into a single table (Table 1) as advocated in earlier papers (Singh and Kant 2022; Singh and Tiwari 2020). The descriptive statistics is are given in table 2 for quick reference and overall understanding of the experimental materials. The outcome of the second selection scheme is given in table 3. Correlation data are is given in table 4. The ranks are given in parentheses in tables 1, 3 and 5. Varieties DBW-14 and HD\_2967 are equally good as their CR & and NCR values of both are 40 & and 1, respectively. Similarly, variety varieties K-508 and RAJ\_4037 have equal CR & and NCR values of 42 & and -1.05, respectively. Therefore, these varieties (DBW-14, K-508 and RAJ4037) are likely to appeal to farmers of in this region and eventually replace HD\_2967.

Table 1: Summarized data as means of five randomly selected plants, ranks, cumulative ranks (CR) and normalized cumulative ranks (NCR) values.

S.N	Variety	Tillering	Plant Height (cm)	Grain yield /Plant (g)	Peduncle length (cm)	Spikelets /spike	Flag Leaf Area	1000 Grain Weight	Days to Maturity	Grains /Spike	CR	NCR
.	↓ Sort order→	0	0	0	0	0	1	0	1	0		R

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1	DBW-14	5.71 (7)	95.96 (2)	11.05 (8)	53.18 (2)	17.22 (6)	37.73 (2)	45.11 (1)	123.24 (6)	44.56 (6)	40	1
2	HD_2967	6.14 (5)	90.13 (4)	14.89 (1)	44.75 (6)	18.06 (4)	48.48 (9)	42.22 (4)	119.78 (4)	52.33 (3)	40	1
3	K-508	6.15 (4)	82.03 (8)	12.11 (5)	45.12 (5)	17.6 (5)	42.5 (6)	39.99 (7)	110.21 (1)	56.38 (1)	42	1.05
4	RAJ_4037	7.17 (2)	77.03 (9)	13.26 (3)	45.38 (4)	16.78 (8)	44.25 (8)	42.54 (2)	117.51 (2)	50.52 (4)	42	1.05
5	K-818	6.39 (3)	89.32 (5)	9.98 (9)	54.21 (1)	16.93 (7)	35.89 (1)	42.27 (3)	124.22 (7)	43.51 (7)	43	1.08
6	RAJ_3404	6.14 (5)	88.88 (6)	12.96 (4)	48.77 (3)	15.94 (9)	38.21 (3)	41.02 (5)	119.52 (3)	34.75 (8)	46	1.15
7	K-17	8.12 (1)	90.37 (3)	11.3 (7)	40.37 (8)	18.73 (2)	44.19 (7)	38.87 (8)	120.22 (5)	33.52 (9)	50	1.25
8	K-9357	4.32 (9)	87.81 (7)	14.65 (2)	43.78 (7)	19.34 (1)	38.87 (4)	40.01 (6)	126.81 (9)	49.19 (5)	50	1.25
9	K-8903	5.56 (8)	96.89 (1)	11.34 (6)	37.58 (9)	18.39 (3)	39.03 (5)	37.55 (9)	126.19 (8)	53.28 (2)	51	1.28

Table 2: The descriptive statistics of all nine characters-

Descriptive Statistics	Tillering	Plant Height (cm)	Grain yield/Plant (g)	Peduncle length (cm)	Spikelets/spike	Flag Leaf Area	1000 Grain Weight (g)	Days to Maturity	Number of Grains /Spike
Mean	6.189	88.713	12.393	45.904	17.666	41.017	41.064	120.856	46.449
Standard Error	0.351	2.063	0.558	1.813	0.356	1.354	0.752	1.703	2.688
Median	6.14	89.32	12.11	45.12	17.6	39.03	41.02	120.22	49.19
Standard Deviation	1.052	6.19	1.674	5.44	1.068	4.061	2.257	5.109	8.064
Sample Variance	1.107	38.313	2.801	29.599	1.14	16.493	5.096	26.098	65.024
Kurtosis	1.383	0.514	-0.978	-0.477	-0.605	-0.412	0.12	1.407	-0.758
Skewness	0.175	-0.65	0.305	0.223	0.003	0.659	0.228	-1.004	-0.676
Range	3.8	19.86	4.91	16.63	3.4	12.59	7.56	16.6	22.86
Minimum	4.32	77.03	9.98	37.58	15.94	35.89	37.55	110.21	33.52
Maximum	8.12	96.89	14.89	54.21	19.34	48.48	45.11	126.81	56.38
Sum	55.7	798.42	111.54	413.14	158.99	369.15	369.58	1087.7	418.04
Count	9	9	9	9	9	9	9	9	9
Confidence Level (95.0%)	0.81	4.76	1.29	4.18	0.82	3.12	1.74	3.93	6.2

Even if we select for large flag leaf area and late maturity (the second selection scheme), the top four selected varieties are HD\_2967, RAJ\_4037, DBW-14 and K-9357. In this selection scheme, the standard check variety HD\_2967 itself proved to be the topper. Out of these two lists (the outcomes of the first and second selection schemes), three varieties, namely HD2967, RAJ4037, and DBW-14 are common to both the lists and the total number of selected varieties under the first two selection schemes is five (HD2967, RAJ4037, DBW-14 (common to both selection schemes), K-508 (exclusive to selection scheme one) and K-9357(exclusive to selection scheme two)). These five varieties could be tried further in multi-location trials at farmers' fields at on a large scale (demonstration trials).

Table 3: The outcome of second selection scheme:

S.N.	Variety↓  Sort order→	Tillering	Plant Height (cm)	Grain yield /Plant (g)	Peduncle length (cm)	Spikelets /spike	Flag Leaf Area	1000 Grain Weight (g)	Days to Maturity	Number of Grains /Spike	CR	NCR
		0	0	0	0	0	0	0	0	0		
1	HD_2967	6.14 (5)	90.13 (4)	14.89 (1)	44.75 (6)	18.06 (4)	48.48 (1)	42.22 (4)	119.78 (6)	52.33 (3)	34	1
2	RAJ_4037	7.17 (2)	77.03 (9)	13.26 (3)	45.38 (4)	16.78 (8)	44.25 (2)	42.54 (2)	117.51 (8)	50.52 (4)	42	1.24
3	DBW-14	5.71 (7)	95.96 (2)	11.05 (8)	53.18 (2)	17.22 (6)	37.73 (8)	45.11 (1)	123.24 (4)	44.56 (6)	44	1.29
4	K-9357	4.32 (9)	87.81 (7)	14.65 (2)	43.78 (7)	19.34 (1)	38.87 (6)	40.01 (6)	126.81 (1)	49.19 (5)	44	1.29
5	K-8903	5.56 (8)	96.89 (1)	11.34 (6)	37.58 (9)	18.39 (3)	39.03 (5)	37.55 (9)	126.19 (2)	53.28 (2)	45	1.32
6	K-17	8.12 (1)	90.37 (3)	11.3 (7)	40.37 (8)	18.73 (2)	44.19 (3)	38.87 (8)	120.22 (5)	33.52 (9)	46	1.35
7	K-818	6.39 (3)	89.32 (5)	9.98 (9)	54.21 (1)	16.93 (7)	35.89 (9)	42.27 (3)	124.22 (3)	43.51 (7)	47	1.38
8	K-508	6.15 (4)	82.03 (8)	12.11 (5)	45.12 (5)	17.6 (5)	42.5 (4)	39.99 (7)	110.21 (9)	56.38 (1)	48	1.41
9	RAJ_3404	6.14 (5)	88.88 (6)	12.96 (4)	48.77 (3)	15.94 (9)	38.21 (7)	41.02 (5)	119.52 (7)	34.75 (8)	54	1.59

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Table 4: Correlation data-

	Tillering	Plant Height (cm)	Grain yield /Plant (g)	Peduncle length (cm)	Spikelets/ spike	Flag Leaf Area	1000 Grain Weight	Days to Maturity	Number of Grains /Spike
Tillering	1								

Plant Height (cm)	-0.286	1							
Grain yield /Plant (g)	-0.34	-0.341	1						
Peduncle length (cm)	-0.084	-0.027	-0.292	1					
Spikelets/spike	-0.252	0.256	0.244	-0.639	1				
Flag Leaf Area	0.434	-0.366	0.552	-0.467	0.242	1			
1000 Grain Weight (g)	-0.016	-0.088	-0.006	0.831	-0.521	-0.072	1		
Days to Maturity	-0.44	0.652	-0.089	-0.003	0.347	-0.49	-0.049	1	
Number of Grains /Spike	-0.445	-0.228	0.292	-0.227	0.247	0.249	-0.048	-0.193	1

On the basis of correlation analysis, highly positive correlations were observed between 1. peduncle length and test weight (0.831), 2. plant height and days to maturity (0.652) and 3. grain yield per plant and flag leaf area (0.552). Seeing the first two high correlations, characters like peduncle length, test weight, plant height and days to maturity could be considered as criteria of selection (the third selection scheme) and the rest of the characters could be left for further research thoughts like feature reduction, linkage etc.

Table 5: The outcome of third selection scheme.

S.N.	Variety↓	Plant Height (cm)	Peduncle length (cm)	1000 Grain Weight (g)	Days to Maturity	CR	NCR
	Sort order→	0	0	0	0		
1	DBW-14	95.96 (2)	53.18 (2)	45.11 (1)	123.24 (4)	9	1
2	K-818	89.32 (5)	54.21 (1)	42.27 (3)	124.22 (3)	12	1.33

3	HD_2967	90.13 (4)	44.75 (6)	42.22 (4)	119.78 (6)	20	2.22
4	RAJ_3404	88.88 (6)	48.77 (3)	41.02 (5)	119.52 (7)	21	2.33
5	K-8903	96.89 (1)	37.58 (9)	37.55 (9)	126.19 (2)	21	2.33
6	K-9357	87.81 (7)	43.78 (7)	40.01 (6)	126.81 (1)	21	2.33
7	RAJ_4037	77.03 (9)	45.38 (4)	42.54 (2)	117.51 (8)	23	2.56
8	K-17	90.37 (3)	40.37 (8)	38.87 (8)	120.22 (5)	24	2.67
9	K-508	82.03 (8)	45.12 (5)	39.99 (7)	110.21 (9)	29	3.22

Long peduncles of tall and late varieties might be the result of high mobility of solvent (water), solutes (nutrients) and photosynthates, metabolites, etc., so as to facilitate grain filling and increasing test weight. That is why, early or timely sowing of late varieties is important so that the crop gets enough time for biomass accumulation and resource allocation towards grains. The third selection scheme is based on this logic. Therefore, future breeding efforts should be towards tall type, non-lodging with high harvest index ideotypes, towards tall, non-lodging ideotypes with high harvest indexes. The third selection scheme is given in table 5. The top four varieties here are DBW-14, K-818, HD\_2967 and RAJ\_3404. Thus, DBW-14 is likely to give a close fight to the standard check variety HD2967. As a result, DBW-14 is likely to compete with the standard check variety HD2967. The farmers are suggested to try this on their farms.

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## References

- Singh, S. N. 2017. Normalized Cumulative Ranks for Plant Breeding: An Example. *Frontiers in Crop Improvement Journal* 5 (Spl.): 304-306.
- Singh, S. N. 2018. Normalized Cumulative Ranks for Rice Breeding: An Example. In *Practices For Sustainable Development*. ANU BOOKS, Meerut. Pages. 34-42.
- Singh, S. N., Sahu, R.K. and Tarkeshwar 2018. Selection from Quinoa (*Chenopodium quinoa* Willd.) accessions through normalized cumulative ranks. *Progressive Research* 13 (Special Issue): 537-538.
- Singh, S.N. and U. Tiwari 2020. On Wheat (*Triticum aestivum* L. em Thell.) Breeding. *J. of Pl. Dev. Sci.* 12(7): 439-441.
- Yadav, M., S.N. Singh, Tarkeshwar, R.K. Sahu, Kumar, K. and P.K. Yadav 2020. Selecting Suitable Wheat (*Triticum aestivum* L.) Variety for Gorakhpur and Deoria Region through Normalized Cumulative Ranks. *Int. J. Curr. Microbiol. & App. Sci* Special Issue-11: 556-560.

Singh, S. N. and Kant S. 2022. Varietal selection, recommendation and comparison with crop ideotype. *IJCRT* 10(1): 531-536.

<https://www.ijert.org/papers/IJCRT2201510.pdf> ISSN: 2320-2882; IF: 7.97

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