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Variability, heritability and genetic advance analysis of some important physiological traits in wheat (*Triticum aestivum* L.)

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Abstract
The present study consists of 20 wheat diverse genotypes that were evaluated for two years Rabi 2007-08 and Rabi 2008-09 at experimental farm of Department of Genetics and Plant Breeding, Sam Higginbottam Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh to study genetic variability, heritability and genetic advance for some important physiological traits *viz*. Nitrogen Use Efficiency, Nitrate Reductase Activity and Nitrogen Harvest Index with yield and yield components. The experiment was laid out in Split Plot Design with three replications. The combined analysis of variance for all the physiological, yield and yield component traits for both years of investigation as well as pooled data over two years were found to be significant due to genotypes, due to nitrogen level and variety X nitrogen interaction, indicating significant genetic variability among elite lines. The magnitudes of genetic and environmental effects involved in the expression of different characters were determined by phenotypic and genotypic coefficient of variation. The magnitude of phenotypic coefficient of variation (PCV) was found higher than the genotypic coefficient of variation (GCV) for all the characters during both years as well as pooled over two years.

Keywords: Genetic advance, genetic variability, heritability wheat, nitrogen use efficiency

Introduction
Wheat (*Triticum aestivum* L.) is the most important grain crop both with regard to its antiquity as well as its use as a source of human food. It is second most important crop after rice in India. Wheat is seen as a staple food for about 3 billion people in as many as in 43 countries of the world. It provides about 20 percent of the total food calories for the human race. Nitrogen in form of urea is perhaps the single most important plant nutrient, which revolutionized the wheat production throughout wheat growing countries in the world. But hardly 30% of total nitrogen applied to the soil in form of urea is taken up by the plants rest 70% is lost through leaching down in the form of nitrate (NO_3^-) and also evaporate in the gaseous form (NO_2^-) to the atmosphere through denitrification. Loss of such a huge amount of nitrogen applied to the soil is the greatest loss to the nation in general and farmers in particular. Second, the prices of fertilizers in general and nitrogen as particular is rising day by day as a result it would be difficult even for rich farmers to apply ever recommended dose of nitrogen to wheat crop which may affect the total wheat production in the country. Under such a situation the farmers may switch to grow other crops like oil seed on place of wheat which will affect adversely food grain production in the country, since our population is rising continuously at the rate of 1.5- 2%, stagnation in the wheat grain production coupled with shifting of farmers interest to replace wheat with oil seeds may Creates food grain crisis in India because wheat alone contributes 33-35% to the total food grain requirement. Keeping in mind, to minimize the loss of most valuable plant nutrient i.e. “Nitrogen” through leaching down in the lower layer of soil and in gaseous form through denitrification on one hand and rising prices of nitrogen fertilizer like urea on the other, it is quite essential to evolve “Nitrogen Use Efficient” wheat varieties which will not only reduce the loss of nitrogen as stated above but also economize the cost of production by enhancing the yield per unit of nitrogen application. Realizing the importance of above aspects in the improvement of this important crop, the present study was under taken with the specific objectives to study the genotypic variability existing for N-Use Efficiency, Nitrate Reuctase Activity, and Nitrogen Harvest Index in wheat varieties and to study the heritability of these physiological traits.

The present study in wheat was undertaken to assess the genotypic variability heritability and genetic advance of some important physiologic traits *viz*. Nitrogen Use Efficiency, Nitrate Reductase Activity and Nitrogen Harvest Index with yield and yield components in 20 wheat diverse varieties. The experiment was conducted for two years (Rabi 2007-08 and Rabi 2008-09) at experimental farm of Department of Genetics and Plant Breeding, Sam Higginbottam Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh (formerly known: Allahabad Agricultural Institute Deemed University, Allahabad). The experimental farm is situated at an elevation of 78 meters above sea levels at 25.87°N latitude and 81.51°E longitude. The experimental field has sandy loam soil, rich in organic carbon, nitrogen, medium in phosphorus and potash. Soil is neutral in pH and contained 60% S and 27% silt and 13% clay. The average rain-fall recorded 1013.4 mm during 2007-08. During Rabi, 2007-08 (November – April) the mean maximum temperature and mean minimum temperature ranged from 5.5 °C, 35.2 °C and during Rabi, 2008-2009 (November – April) it was 7.2 °C, 44.3 °C, while the relative humidity the mean maximum and mean minimum values ranged from 20%, 98% and 16.8% - 90.5% respectively. The experimental field was prepared by giving two deep cross harrowing and one ploughing with cultivator followed by planking. Full dose of phosphorus and potash and half dose nitrogen were given as basal dressing at the time of sowing and remaining quantity of nitrogen was given in two equal splits doses *i.e*. 30 days and 60 days after sowing. Sowing was done at 20 cm row to row distance and 4 cm plant to plant distance was apart. The experiment was laid out in split plot design with three replications. Total three treatments *viz*., a. Nitrogen zero; b. Nitrogen 60 kg per ha and c. Nitrogen 120 kg per ha sown in nine main plots with 180 subplots main plot size of 5 x 13 = 65 m^2 and sub plot size of 1 x 2 m^2 (five row of 2 m length).

Observations were recorded on (A) Physiological traits- Nitrogen Use Efficiency (Gw/Ns); Nitrate Reductase Activity (µ mol / min / g fresh weight) – At 50% flowering stage, Nitrogen Harvest Index (%), Harvest index (Donald 1962) (%) and Days to maturity; B) Biochemical traits i.e. Estimation of grain nitrogen (%) and Estimation of straw nitrogen (%) and C) yield and yield attributing traits *i.e*. plant height (cm), tillers per plant, spike length (cm), number of grains per spike, 1000 grains weight (g), total biomass per plot (g), yield per plot (g) and yield per plant (g). The data were collected on five randomly selected competitive plants from each replication. The analysis of variance for yield and yield contributing characters was carried out as suggested by Panse and Sukhatme. The coefficient of variation was calculated as per Burton. The genotypic and phenotypic coefficients of variation were calculated as per the formula suggested by Burton and De Vene. Heritability in broad sense and genetic advance were calculated as per Johnson *i.e.* The present study in wheat was undertaken to assess the genotypic variability heritability, and genetic advance of some important physiologic traits *viz*. Nitrate Reductase Activity, Nitrogen Use Efficiency and Nitrogen Harvest Index with yield and yield components. The data recorded on above seven major physiologic traits and yield and yield components in 20 wheat varieties at three nitrogen levels *viz* N_0, N_{60} and N_{120} were subjected to different statistical analysis.

Results

The accomplishment of any breeding programme objective depends upon the extent of genetic variability in base population and it is essential to subject a population for selection to achieve improvement in a particular trait. In the present study the analysis of variance showed highly significant differences among the genotypes for all the characters studied. The analysis of variance was done separately for all the fifteen characters. It is confirmed from the table 2 and 3 that there is significant differences for mean sum of square values of the genotypes for all the fifteen characters under study at 1% level of significance. This indicates relatively high magnitude of genetic variability among the genotypes for the characters studied in the present investigation.

The analysis of variance for 2007-08 (Table 1) revealed highly significant differences among varieties for all the characters at 1% level of error (a) variance, except tiller per plant, which shows significant differences at 5% level of error variance. The characters like 1000 grains weight, yield per plant, Nitrate Reductase Activity, grain nitrogen, straw nitrogen, nitrogen use efficiency and nitrogen harvest index showed significant differences at 1% level of significance for the nitrogen level. This indicates the genotypes under study are highly diverse and characters are highly sensitive to nitrogen application to the crop.

The analysis of variance for fifteen characters are given in table 2, which shows highly significant differences among the genotypes for all the characters at 1% level of significance except days to maturity and tillers per plant, which showed significant differences at 5%, and 0.05% level of significance respectively. The characters like grain N %, straw N % and nitrogen use efficiency (NUE) showed significant differences for N x varieties interaction at both levels *viz* N_{60} and N_{120} while characters like 1000 grains weight, total biomass per plot, yield per plot, yield per plant, nitrate reductase activity, grain N%, straw N% and nitrate reductase activity have shown significant differences at 1% level of error variance for nitrogen doses.

On the basis of pooled analysis of two years data, same set of five varieties (K9423, HD 2285 HUW 533, K 9162 and HD 2329) have scored highest NUE, which are statistically at par to each other also but significantly superior to remaining varieties included in trial. Here again, NUE at N_{60} in general have been found significantly better than N_{120} but varieties showing higher performance at N_{60} level have also shown relatively higher NUE at N_{120} level too as compared to poor performers *i.e.* level of decline in NUE in better performers at N_{60} level is less than poor performers.

On the basis of analysis of pooled data of two years, it was observed that same set of five varieties *viz* K 8962 (0.171), HUW 468 (0.166), HD 2329 (0.163), K 9423 (0.163) and HUW 510 (0.163) with slight change in position of K 8962 (0.171) which stood first, all have scored highest NRA, among them, they are statistically at par to each other but significantly better to remaining 15 wheat varieties included in the trial. Here again, NRA at N_{120} in general has been found significantly better than N_{60} and N_0 level of nitrogen application.

The two years pooled data presented in table 3 reveals that same set of four varieties *viz* K 9162 (81.50%) followed by Raj 3077 (80.76%), K 9423 (80.66%) and Raj 3777 (77.38%), have scored highest NHI value which are significantly higher than remain varieties included in this trial. Here again, NHI value at N_{120} level in general has been found significantly better than N_{60} and N_0.

The analysis of pooled data of two year shows, same set of five varieties, *viz* HD 2329 (114.00 days) followed by HD

2285 (115.78 days), PBW 373 (115.89 days) and K 9423 (115.89 days) scored shortest maturity duration as compared to other varieties included in trial. The perusal of two year pooled data indicates that same set of three varieties (Raj 3077, HUW 318 and HUW 468) have scored highest grain nitrogen %, and are significantly superior to the remaining varieties included in trial. Performance of individual variety for grain nitrogen % at different nitrogen level reveals that; there is significant increase in the grain nitrogen content (%) with increase in the nitrogen levels ($N_{0,}$ N_{60} and N_{120}). This indicates that grain nitrogen increases with increase in nitrogen level.

Pooled data of both the year trails (2007-08 and 2008-09) presented in table 3 reveals that same set of three varieties (kanlyansona, HUW 318 and Raj 1972) has scored highest straw nitrogen (%) which are significantly better to other varieties included in experiment. Again straw nitrogen at N_{120} in general has been found significantly higher than at N_{60} and N_0 in all the varieties.

Grain yield: The analysis of variance of grain yield per plot (g) is presented in table 1 and 2 which indicate that varietal as well nitrogen level differences are significant but no significant differences have been found for variety X nitrogen level interaction. Thus, it makes clear that genetic variability for grain yield per plot exist among the genotypes taken under this study. The mean performance for grain yield per plant of the 20 wheat varieties tested during 2007-08 in a spit replicated trail is given in table 3. The result presented in table indicates that K 8962 (23.13 g) gave highest grain yield per plant followed by Raj 4037 (20.61 g), K 9423 (20.39 g), K 9162 (20.29 g) and PBW 373 (19.95 g) which are statistically at par with is each other but differences in yield has been found highly significant over checks PBW 343 (15.12g) and Kalyansona (13.34g). The mean yield performance of 20 wheat varieties (including two checks) tested in the first year (2007-08) crop season is presented in table 3. The result indicates that K 9423 (1055.56 g) recorded higher grain yield per plot followed by HUW 533 (1000 g), HD 2285 (988.89 g) and K 9162 (988.89 g). All the four varieties yielded significantly higher than the checks (Kalyansona and PBW 343) as well as other 14 wheat varieties.

The pooled analysis of two years data for grain yield per plot gives the average performance of varieties. On the pooled basis too same set of four varieties (K 9423, HD 2285, K 9162 and HUW 533) with slight change in their position scored highest grain yield per plot, and were statistically at par with each other but all are significantly superior to the remaining 16 varieties included in trial. Here again, the grain yield per plot is increasing with increases in nitrogen level.

Coefficient of variation (GCV and PCV)

The genotypic and phenotypic coefficients of variation of the 15 characters are presented in table 3. The data indicated that in general phenotypic coefficients of variability were higher in magnitude than the genotypic coefficient of variability for all the characters under study.

The perusal of two years (2007-08 and 2008-09) pooled data has been reflected in table 3 and in figure 2 which indicate that genotypic coefficient of variation (GCV) ranged from 1.13 for days to maturity to 20.72 for straw nitrogen (%). Higher magnitude of GCV were recorded for straw nitrogen (20.72%) followed by nitrogen use efficiency (15.43%), grain yield per plot (14.83%), harvest index (14.05%), plant height (13.19%), and nitrate reductase activity (11.55%). Moderate to low GCV were observed for total biomass per plot (10.88%), yield per plant (10.33%), and number of grains per spike (10.42%), 1000 grains weight (7.22%), spike length (6.18%), tillers per plant (5.08%), grain nitrogen (4.85%), and days to maturity (1.30%).

Pooled data given in table 3 and fig 2 revealed that phenotypic coefficient of variation (PCV) ranged from 1.50% for days to maturity to 21.10% for straw nitrogen (%). The characters exhibited higher PCV were straw nitrogen (21.10%) followed by nitrogen use efficiency (20.54%), grain yield per plot (19.45%), harvest index (17.61%), yield per plant (16.33%), number of grains per spike (14.63%), plant height (14.10%), nitrate reductase activity (13.59%) and total biomass per plot (13.01%), Moderate to low PCV were observed for, 1000 grains weight (11.34%), nitrogen harvest index (9.62%), spike length (9.57%), tillers per plant (6.23%), grain nitrogen (5.65%) and days to maturity (1.50%). In general, characters like straw nitrogen (%), NUE, grain yield per plot and harvest index recorded higher magnitude of GCV and PCV.

Heritability (broad Sence)

The pooled data of both the year (2007-08 and 2008-09) has been presented in table 3 and fig. 2 which reveals that estimates of heritability in broad sensce for 15 characters. From above table it may be seen that heritability range from 44% for yield per plant to 96% for straw nitrogen %. It was found that except few, such as most of the characters exhibited high to moderate heritability. Highest heritability was recorded for straw nitrogen (96%) followed by plant height (87%), grain nitrogen (74%), days to maturity (74%), nitrate reductase activity (72%), spike length (70%) and total biomass per plot (70%). Moderate heritability were recorded for harvest index (69%), nitrogen harvest index (68%), tillers per plant (67%), yield per plot (58%), nitrogen use efficiency (56%) and number of grains per spike (51%).

Genetic Advance as % of mean

Pooled data of two years (2007-08 and 2008-09) are given in table 3 and also presents through fig 2 which indicate that the genetic advance for all the characters ranged from 2.30% for days to maturity to 53.71% for straw nitrogen. The highest value of genetic advance as percent of mean was recorded for straw nitrogen (53.71%) followed by plant height (32.55%), nitrogen use efficiency (30.60%), yield per plot (29.87%), harvest index (24.11%) and total biomass per plot (24.04%). Moderate genetic advance as percent of mean were recorded in nitrate reductase activity (20.22), number of grains per spike (19.60%), yield per plant (18.87%), nitrogen harvest index (17.33%), 1000 grains weight (13.34%) and grain nitrogen (11.00%) while lowest genetic advance as percent of mean were observed for days to maturity (2.30%) tillers per plant (8.44%) and spike length (10.69%).

Discussion

Nitrogen in form of urea is perhaps the single most important plant nutrient, which revolutionized the wheat production throughout wheat growing countries in the world. But hardly 30% of total nitrogen applied to the soil in form of urea is taken up by the plants rest 70% is lost through leaching down in the form of nitrate (NO_3^-) and also evaporate in the gaseous form (NO_2^-) to the atmosphere through denitrification. 70% loss of such a huge amount of nitrogen applied to the soil is the greatest loss to the nation in general and farmers in particular.

Second, the prices of fertilizers in general and nitrogen is particular is rising day by day as a result it would be difficult even for rich farmers to afford recommended dose of nitrogen (100-120 kg/ha) to wheat crop which may affect the total wheat production in the country. Under such a situation, the farmers may switch to grow other crops like oil seed on place of wheat, which will affect adversely food grain production in the country. Since our population is rising continuously at the rate of 1.5- 2%, stagnation in the wheat grain production coupled with shifting of farmers interest to replace wheat with oil seeds may creates food grain crisis in India because wheat alone contributes 33-35% to the total food grain requirement.

Keeping in mind, to minimize the loss of most valuable plant nutrient i.e. "Nitrogen" through leaching down in the lower layer of soil and in gaseous form through denitrification on one hand and rising prices of nitrogen fertilizer like urea on the other, it is quite essential to evolve "Nitrogen Use Efficient" wheat varieties which will not only reduce the loss of nitrogen as stated above but also economize the cost of production by enhancing the yield per unit of nitrogen application.

Genetic variability, Heritability and Genetic advance

In any crop improvement programme evaluation of germplasm for identification of genetic variability in various traits is very important, mostly when considering the adoption of new traits (like some physiological traits in present study) to create further variability through hybridization is of vital importance. Therefore, for successful and efficient crop improvement programme it would be desirable to have systemic and detailed information on yield component characters. Improvement in any desirable trait is largely dependent upon the magnitude of genetic variability available in for the target trait. Phenotypic variability arises due to the genotypic and environmental interaction. High phenotypic variability does not necessarily mean high available genetic variation. Selection on the basis of phenotypic variation is not effective and is sometimes misleading. However additive genetic variability ensures high scope for efficient selection. Therefore evaluation and utilization of genetic variability in a desired direction is extremely important in any crop improvement programme. Being a complex phenomenon, variability is measured by estimation of genetic parameters including coefficient of variation, heritability and genetic advance as percent mean.

Table-1, 2 and 3 shows analysis of variance for all the physiological, yield and yield component traits for both years of investigation as well as pooled data over two years were found to be significant due to genotypes, due to nitrogen level and variety X nitrogen interaction, indicating significant genetic variability among elite lines. The magnitude of genetic and environmental effects involved in the expression of different characters were determined by phenotypic and genotypic coefficient of variation. The magnitude of phenotypic coefficient of variation (PCV) was found higher than the genotypic coefficient of variation (GCV) for all the characters during both years as well as pooled over two years. High coefficient of variability (PCV and GCV) among physiologic traits, yield and yield component traits were observed for straw nitrogen racorded 21.10% followed by nitrogen use efficiency (20.54%), grain yield per plot (19.45%), harvest index (17.61%), yield per plant (16.33%), number of grains per spike (14.63%), plant height (14.10%) and total biomass per plot (13.01%). GCV and PCV for yield attributing traits in wheat were also reported by Kumar and Luthra (1994) [9], Jagshoaran (1995) [7], Walia and Garg (1996) [10] and Gupta and Verma (2000) [5]. PCV and GCV coefficient of variation NUE reported by Tripathi *i.e.* (2004) [8] and Anbessa *i.e.* (2009) [1] in their experiment.

The estimate of genotypic coefficient of variation reflects the total amount of genotypic variability present in the material. However, the proportion of this genotypic variability which is transmitted from parents to the progeny is reflected by heritability. Only the genetic coefficient of variation is not sufficient for the estimation of the amount of heritable variation. The heritable variation can be determined with greater degree of accuracy if genetic advance is also studied along with heritability. A greater advance under selection is achieved when the characters under selection are highly heritable and stable. Therefore, the characters with high heritability values are of much importance to plant breeder than those, which are less heritable and more susceptible to environmental fluctuations. Low heritability indicates that the character is highly influenced by the environmental fluctuation and one has to raise a large population for selecting the desirable genotypes.

Heritability specifies the proportion of the total variability that is due to genetic cause. It is a good index of the transmission of character from parent to the offspring and helps in determining whether phenotypic differences observed among individuals are due to genetic or environmental factors. Genetic advance is directly related with the heritability as it gives an idea about the expected genetic change on account of selection applied to a particular trait. Heritability estimates along with advance are normally more helpful in predicting the gain under selection. In the present investigation, from above table 3 it may be seen that heritability range from 44% for yield per plant to 96% for straw nitrogen. It was found that except few, most of the characters exhibited high to moderate heritability. Highest heritability was recorded for straw nitrogen (96%) followed by plant height (87%), grain nitrogen and days to maturity (74% each), nitrate reductase activity (72%), total biomass per plot and spike length (70% each). Moderate heritability were recorded for harvest index (69%), nitrogen harvest index (68%), tillers per plant (67%), yield per plot (58%), nitrogen use efficiency (56%) and number of grains per spike (51%).

The results of our present study (table 3) indicates that all the seven physiologic traits studies *viz.* nitrogen use efficiency (56%), nitrate reductase activity (72%), nitrogen harvest index (68%), harvest index (69%), days to maturity (74%), grain nitrogen (74%) and straw nitrogen (96%) are highly heritable hence these could be exploited in wheat breeding programmes to evolve nitrogen efficient high yielder wheat verities which will economize the cost of production to a great to extent that will benefit not only to the farmers but to the national economy as a whole. The heritable portion of variation could be determined with the help of estimates of heritability along with genetic advance as percent mean. According to Johnson *i.e..* (1955) [6] a heritable estimates along with genetic advance as percent mean is more meaningful than the heritability alone in predicting the ultimate effect of solution. Our findings on nitrogen use efficiency, nitrate reductase activity, harvest index, nitrogen harvest index, straw nitrogen, plant height, total biomass per plot and number of grains per spike quite encouraging since these characters exhibited high heritability estimates along with high genetic advance and these traits were least influenced by the environment and might show least genotype x environment interaction. Similar findings were observed by

Raha and Ramgiri (1998), Singh *i.e.*. (2001) and Dwivedi *i.e.*. (2002).

The perusal of two years (2007-08 and 2008-09) data indicates that higher magnitude of GCV and PCV among physiological traits was observed for straw nitrogen followed by nitrogen use efficiency, harvest index, 1000 grains weight, grain nitrogen, nitrate reductase activity and days to maturity. High heritability estimates among yield and yield components were recorded for grain yield per plot, plant height, total biomass per plot, yield per plant, and number of grains per spike, spike length and tillers per plant. High heritability was observed for straw nitrogen followed by plant height, grain nitrogen and total biomass per plot, nitrogen harvest index, yield per plot, nitrogen use efficiency, number of grains per spike and nitrate reductase activity. High heritability along with genetic advance as percent of mean were observed for straw nitrogen, plant height, nitrogen use efficiency, total biomass per plot, number of grains per spike and nitrogen harvest index.

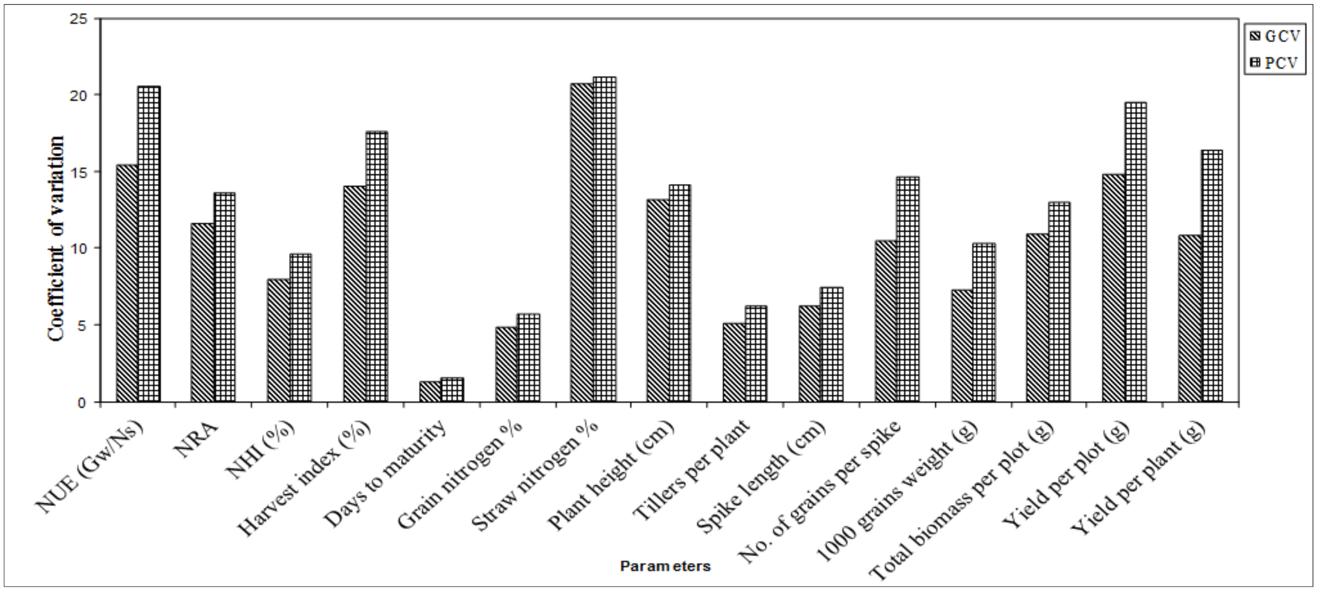

Fig 1: Histogram depecting estimates of GCV & PCV for 15 important physiological and morphological traits in wheat

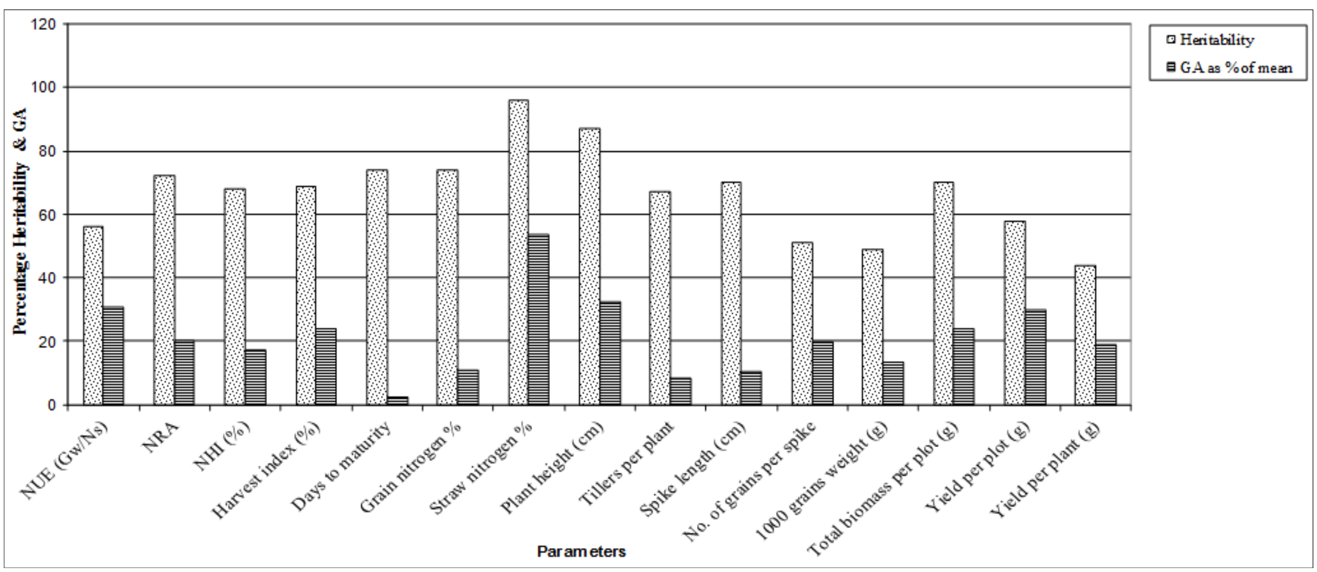

Fig 2: Histogram depicting estimates of heritability & genetic advance for 15 important physiological and morphological traits in wheat

Table 1: Analysis of variance for 15 characters studies in 20 varieties of wheat (*Rabi* 2007 – 08)

Source of variation	d.f.	Mean Sum of Square														
		NUE (Gw/Ns)	NRA	NHI (%)	Harvest Index	Days to maturity	Grain Nitrogen	Straw Nitrogen	Plant Height	Tillers per plant	Spike Length	No. of Grains per spike	1000 grains weight	Total Biomass per plot	Yield per Plot	Yield per Plant
Replicates	2.00	1032.08	0.008*	190.38***	400.13*	11.87	0.01	0.004	60.90*	0.88	0.15	6.69	33.11***	781263.88**	445680.56*	40.49**
N Levels	2.00	72406.80***	0.009***	216.05***	155.77	6.27	1.28***	0.40***	53.93*	11.47*	0.63	87.77	82.47***	1834263.88**	626680.56**	166.50**
Error (A)	4.00	298.99	0.0001	0.24	28.90	5.59	0.01	0.001	6.48	0.77	0.26	31.89	0.08	30513.89	32722.22	1.46
Varities	19.00	282.28***	0.001***	334.38***	147.93***	34.74***	0.08***	0.06***	1505.18***	1.31**	3.15***	217.98***	90.40***	480803.38***	116470.03***	46.18**
N Levels X Varities	38.00	104.87*	0.0001	2.70	11.69	2.52	0.01	0.01***	8.49	0.60	0.38	28.90*	2.23	56720.03	15189.33	1.11
Error (B)	114.00	61.11	0.0001	14.86	23.28	2.58	0.01	0.001	14.46	0.58	0.39	18.27	4.79	46085.53	16208.33	5.04
Total	179.00	918.37	0.0002	50.08	39.87	6.20	0.03	0.01	172.20	0.79	0.67	42.67	14.42	122332.32	38622.83	10.69

*,**,*** significant at 0.05%, 5% and 1% respectively

Table 2: Analysis of variance for 15 characters studies in 20 varieties of wheat (*Rabi* 2008 – 09)

Source of variation	d.f.	Mean sum of square														
		NUE (Gw/Ns)	NRA	NHI	Harvest Index	Days to maturity	Grain Nitrogen	Straw Nitrogen	Plant Height	Tillers per plant	Spike Length	No. of Grains per spike	1000 grains weight	Total Biomass per plot	Yield per Plot	Yield per Plant
Replication	2.00	2907.42	0.0001	701.91***	940.20***	108.16	0.0001	0.0002	38.59	8.25	3.89**	77.07	152.98 **	1863597.25**	1304310.50**	125.34***
N Levels	2.00	73375.34***	0.02***	4.76	522.30**	9.74	0.94***	0.42***	6.52	11.78	1.14	13.34	458.88***	4930889.00***	1777860.50***	582.78***
Error (A)	4.00	878.30	0.0001	6.13	9.08	37.29	0.001	0.001	16.51	2.50	0.19	93.45	3.66	36513.89	27935.55	0.54
Varities	19.00	308.03***	0.001***	391.01***	169.91***	9.03**	0.06***	0.07***	1538.05***	3.02*	3.64***	356.95***	119.25***	497000.00***	155119.77***	44.29***
NLevelsXVarieties	38.00	99.19***	0.0001	30.49*	11.34	3.33	0.01***	0.01***	10.72	1.59	0.44	85.13*	4.29	23929.82	10500.91	2.32
Error (B)	114.00	36.92	0.0001	17.54	22.61	3.69	0.001	0.0002	12.62	1.77	0.34	51.87	11.37	35863.30	12969.91	6.39
Total	179.00	949.21	0.0004	67.18	51.39	6.17	0.02	0.01	174.44	2.07	0.76	92.10	27.73	157406.58	62016.56	17.19

*,**,*** significant at 0.05%, 5% and 1% respectively

Table 3: GCV, PCV, heritability, genetic advance and Genetic advance as % of mean (Genetic gain) studied for 15 characters in wheat

S.No	Characters	GCV (%)			PCV (%)			Heritability, broad sense (%)			Genetic Advance (1%)			Genetic advance as % of mean (Genetic gain)		
		2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled
1	NUE (Gw/Ns)	15.83	14.85	15.43	20.10	20.93	20.54	62	50	56	13.26	11.66	12.58	32.91	27.81	30.60
2	NRA	8.35	9.16	11.55	10.23	10.84	13.59	66	71	72	0.02	0.02	0.03	14.05	15.94	20.22
3	NHI (%)	7.17	8.70	7.95	8.75	10.46	9.62	67	69	68	11.54	13.81	12.71	15.51	19.11	17.33
4	Harvest index (%)	12.39	14.75	14.05	15.12	16.88	17.61	67	70	69	7.85	9.83	9.19	20.87	25.47	24.11
5	Days to maturity	1.18	1.13	1.30	1.41	1.40	1.50	70	65	74	2.43	2.21	2.71	2.05	1.89	2.30
6	Grain nitrogen %	4.55	5.04	4.85	5.82	5.45	5.65	61	85	74	0.21	0.27	0.24	9.38	12.30	11.00
7	Straw nitrogen %	20.26	21.26	20.72	20.74	21.47	21.10	95	98	96	0.28	0.28	0.28	52.23	55.59	53.71
8	Plant height (cm)	12.81	13.99	13.19	13.38	14.88	14.10	92	88	87	32.50	32.34	31.52	32.36	34.71	32.55
9	Tillers per plant	6.97	13.01	5.08	9.27	16.88	6.23	50	57	67	0.78	1.58	0.66	10.15	21.06	8.44
10	Spike length (cm)	7.39	7.83	6.18	9.14	9.17	7.42	65	73	70	1.20	1.38	1.06	12.24	13.75	10.69
11	No. of grains per spike	8.55	11.44	10.42	11.75	16.99	14.63	53	45	51	8.92	11.12	10.68	16.44	20.33	19.60
12	1000 grains weight (g)	7.03	7.46	7.22	9.09	11.34	10.31	60	43	49	6.08	5.62	5.72	14.35	12.93	13.34
13	Total biomass per plot (g)	10.86	10.41	10.88	13.30	12.72	13.01	67	67	70	600.68	588.48	622.59	23.43	22.49	24.04
14	Yield per plot (g)	15.42	14.33	14.83	19.48	19.41	19.45	63	54	58	312.89	283.38	296.69	32.20	27.92	29.87
15	Yield per plant (g)	10.42	9.22	10.80	16.11	16.48	16.33	42	31	44	3.55	2.97	3.94	17.78	13.61	18.87

Conclusion
On the basis of present investigation, it is concluded that significant genetic variability was found among the all physiological (Nitrogen Use Efficiency, Nitrate Reductase Activity, Nitrogen Harvest Index, Harvest index**,** Days to maturity, grain nitrogen and straw nitrogen) yield and yield component, along with high heritability. Therefore these physiological traits have good scope to be utilized s selection parameter to bread Nitrogen Use Efficient (NUE) wheat verities. All the physiological traits have shown significant correlation with yield and yield component traits such as spike length, grains per spike, 1000 grains weight and harvest index. It is clear from the present investigation that these traits are fully under genetic control and are linked with genes governing yield and yield component characters. Therefore selection based on these physiological traits along with traits like spike length, grains per spike, 1000 grains weight and harvest index may bring about considerable improvement in yield. Based on the finding of present study, two genotypes HD 2285 and K 9162 have been identified superiors in NUE, NRA and yield. Hence both these varieties could be utilized as germplasm in wheat breeding programme to evolve new wheat varieties biologically efficient in nitrogen uptake and conversion in to grain. Therefore integration of these physiological traits (NUE, NRA and NHI) as selection criteria with conventional breeding methods is very much logical and excepted to advance yield per unit area and time without raising input level to economize the cost of production as well as better utilization of nitrogen applied to the crop.

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