VARIATION FOR MAJOR PLANT NUTRIENT UPTAKE IN A SET OF WHEAT LINES AND THEIR CROSSES

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Abstract : An experiment was conducted in RBD design with three replications for study the variation for major plant nutrient uptake in a set of wheat lines and their crosses. The significant mean squares found for most of the nutrient content traits. The crosses were found superior in comparison to parents in relation to nutrient contents and the ranges of various nutrients were wider in crosses as comparison to parents. The association of N content (grain content) in testers as well as lines showed significant negative association with grain yield. In testers, the associations of N content in straw showed positive association with grain yield. Similarly N content in straw also exhibited strong association with P and K contents in both straw as well as grain in lines as well as in testers. In the lines however, the association of N content in grain with P in grain and K in straw were only found significant. The interrelationships among the nutrient traits in the crosses for these traits were however found non significant. In testers, the N content showed positive associations with p and K content in both straw as well as grain. In the lines however, the association of N content in grain with P in grain and K in straw were only found significant. The genotypes viz., UP-2338 followed by HD-2687 and Job 673 observed as nutrient efficient genotypes and they were also high yielder's. Thus this study indicates that it is possible to select genotypes which are high yielding as well as requires less applied fertilizers.

Keywords: Crosses, Correlation, Genotype, Nutrient index, Variability

INTRODUCTION

Wheat is cultivated through out the world on an area of about 229.0 million hectares. It is grown in temperate, sub-tropical and tropical regions. Even in India there is great variation among the temperature and environmental conditions through out where it is cultivated. Its growth, development and yield are influenced by a range of environmental factors. Besides the environmental factors, the escalating cost of fertilizers is also acting as a deterrent to the applications of fertilizers is recommended doses. It would therefore be ideas to breed varieties, which has optimized capacity for nutrient uptake. The present investigation is an attempt to estimate the variation in terms of nutrient uptake and to propose suitable strategy for breeding the nutrient uptake.

MATERIAL AND METHODS

10 parents were selected at random from the available wheat germplasm at NARP, SKN College of Agriculture, Jobner (Rajasthan). Of these 6 were used as females and the rest were used as males and crosses were made. The resulting 24 F_1 along with 10 parents were sown in RBD design with three replications on field which had uniform fertility. Each parent, F_1 was sown in a plot of 2 rows, 2 m long. The inter plant distance was maintained at 10 cm while inter row distance was 30 cm. All the required agronomic practices were followed to raise a good crop. At the time of maturity, 5 plants were randomly selected from each plot and were used to determine seed yield (g)/ plant, biological yield (g) per plant. The contents of Nitrogen, phosphorus, potassium and calcium contents were determined is the grain and straw as per the methods of Jackson 1950 and 1958, Richards 1954 and Snell and Snell 1939. The data was subjected to appropriate statistical analyses.

RESULTS AND DISCUSSION

Partitioning of the parents mean sum of squares into mean sum of squares into mean sum of square due to lines, testers and lines x testers indicated that significant difference among lines as well as testers existed for 5 out of 8 traits. They were found non significant for nitrogen content in straw, phosphorus content in straw and calcium content in grain. Thus apparently lines and tester are diverse. The divergence among lines as a group and testers as a group is evident from the significant mean squares found for nitrogen content in grain, phosphorus content in grain potassium content in straw, potassium content in grain and calcium content in straw. Partitioning of the crosses sum of squares indicated that MSS due to lines were significant for all the traits except nitrogen content in straw and calcium content in grain. While MSS due to tester significant for all the traits except nitrogen content in straw, phosphorus content in straw and calcium content in grain. The line x tester SS were significant for all the traits except nitrogen content in straw and calcium content in grain. The lines vs testers were significant for N content in grain, P content in straw and grain, K content in straw and grain, Ca content in straw indicating significant differences testers and lines as a group while the same was found non significant for N content in straw and Ca content in grain.

The differences between the general means of nutrient contents were almost negligible between the parents and the crosses. The means were lower in crosses than lines in case of N content in straw and grain, K content in grain and higher in case of P content in straw and grain, K content in straw and Ca content in straw and grain (Fig 1). The nutrient content was lower in crosses than in testers in case of N content in straw and grain, P content in straw and grain, K content in grain and Ca content in straw while higher in case of K content in straw and Ca content in grain. The crosses are thus superior in comparison to parents. The higher content of N in grain than in straw indicates its mobility. The opposite was observed in case of K i.e. content were more in straw than in grain. Dubey (1997) and Meena (1999) also noted similar trend in mean values of various traits as in the present study. When mean values of partitioning percentage of nutrients (in grain to total content) were compared, the crosses had lower partitioning percentage for all the nutrients. This may indicate negative heterosis, for all the characters. Positive heterosis is desirable for nutrient traits. The ranges of various nutrients were wider in comparison to parents. This can be ascribed to the role of minor genes in the inheritance of these traits. It is expected that such characters may exhibit wide variation even in later generations facilitating selection. No specific trend was observed for nutrient contents. RS-392 among lines and Kharchia-65 among testers had highest N in grain. PBW-343 and Kharchia-65 had highest N in straw. HD-2687 among lines and Kharchia-65 among testers had high P in straw and PBW-343 among lines and Kharchia-65 among testers had highest K content in straw and WH-542 among lines and Job-673 among testers had high K in grain. WH-542 among lines had Kharchia-65 among testers had high Ca in straw and PBW-343 among lines and Job-673 among testers had highest Ca in grain.

PBW-343 x Job-666 had highest N in straw, RS-392 x Kharchis-65 contained highest N in grain, HD-2687 x Job-666 had highest P in straw, WH-542 x Job-666 had highest P in grain. RS-392 x Raj-3077 had highest K content in straw, RS-392 x Job-666 had highest K in grain. UP-2338 x Job-673 had highest Ca in straw and HD-2687 x Raj-3077 had highest Ca in grain (Table 1).

Character associations between different traits were worked out separately in lines testers and crosses (Table 2).Very few associations were found significant among nutrient contents and their associations with grain yield. Unlike morphological traits, differences in the direction of the association also differed among lines and testers. The association of N content (grain content) in testers as well as lines showed significant negative association with grain yield. In testers, the associations of N content in straw showed positive association with grain yield. Similarly N content in straw also exhibited strong association with P and K contents in both straw as well as grain in lines as well as in testers. In the lines however, the association of N content in grain with P in grain and K in straw were only found significant. The interrelationships among the nutrient traits in the crosses for these traits were however found non significant.

An ideal wheat plant type is one which utilizes the applied fertilizer well and at the same time gives higher yield. A higher content of N in grain is essential as it is and indirect measure of protein content and are needed in relatively high quantities for the plant as well as for human beings who feed on the grain. All these being major nutrients have to be applied in high quantities to the soil. However, even today, farmer applies less than the required quantity of fertilizer, thus depleting the soil of these essential nutrients. In such cases it is highly recommended to grow varieties which can efficiently utilize available nutrients. That is they give high yields even at low fertility. This can be measured by the following formula-

$$\text{Nutrient index} = \frac{\text{Nutrient content in the grain + straw}}{\text{Biological yield}} \times 100$$

It is assumed here that the soil is uniformly fertilized; hence a genotype which has lowest index will be the one which is nutrient efficient. In the present investigation, comparing the values (Table 3) for the parents indicated that UP-2338 followed by HD-2687 among lines were the genotypes which meet the above criterion. Incidentally these are the genotypes which were highest yielder's/biological yielder's. Similarly Job-673 among testers was the best genotype in terms of nutrient efficiency. This genotype was also high yeilders among the testers. Thus this study indicates that it is possible to select genotypes which are high yielding as well as highly nutrient efficient in other words requires less applied fertilizer.

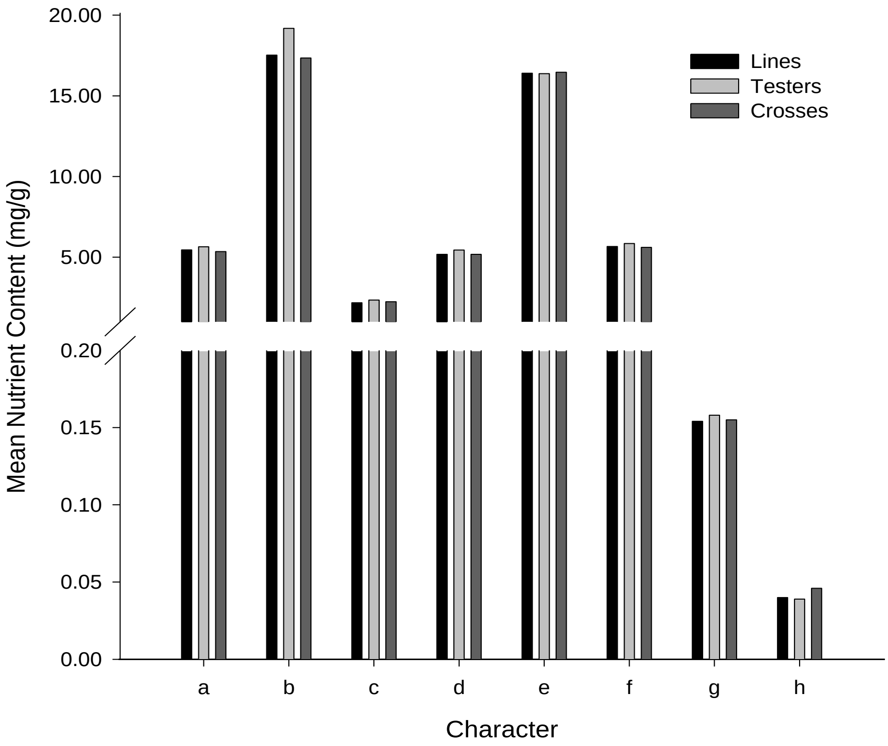

Fig. 1: Means of parents and crosses for various nutrient content. (a and b= Nitrogen content in straw and grain, c and d= Phosphorus content in straw and grain, e and f= Potassium content in straw and grain and g and h= calcium content in straw and grain respectively).

Table 1. Mean of Nutrient content traits in wheat genotypes and their best crosses

Parents	Characters							
	Nitrogen content in straw (mg/gm)	Nitrogen content in grain (mg/gm)	Phosphorus content in straw (mg/gm)	Phosphorus content in grain (mg/gm)	Potassium content in straw (mg/gm)	Potassium content in grain (mg/gm)	Calcium content in straw (mg/gm)	Calcium content in grain (mg/gm)
HD 2687	5.350	17.870	2.310	5.110	16.330	6.010	0.155	0.044
Raj 1114	5.246	17.910	2.130	5.140	16.100	5.4100	0.152	0.040
PBW 343	5.983	17.040	2.020	5.410	16.540	5.500	0.156	0.042
RS-392	5.983	17.040	2.020	5.410	16.540	5.500	0.156	0.042
UP 2338	5.280	18.600	2.210	5.300	16.430	5.610	0.152	0.040
WH 542	5.520	16.890	2.260	5.240	16.800	5.236	0.151	0.037
Job 666	5.340	16.810	2.170	4.900	16.210	6.230	0.160	0.039
Job 673	5.623	18.680	2.450	5.500	16.140	5.770	0.153	0.038
K-65	5.850	20.770	2.450	5.600	16.830	6.050	0.161	0.039
Raj 3077	5.520	18.486	2.200	5.270	16.250	5.710	0.159	0.039
Best crosses								
PBW 343 X Job 666	6.21	16.31	2.25	4.95	16.51	5.35	0.151	0.047
RS-392 X K-65	5.26	19.47	2.19	5.32	16.78	5.82	0.153	0.040
HD 2687 X Job 666	4.99	17.89	3.14	4.65	15.43	5.41	0.156	0.046
WH 542 X Job 666	5.13	17.29	1.98	5.63	16.41	5.63	0.164	0.042
RS-392 X Raj 3077	5.38	16.41	2.04	5.42	16.94	5.70	0.163	0.041

RS-392 X Job 666	4.88	17.28	2.30	5.51	16.36	6.32	o.157	0.041
UP 2338 X Job 673	5.30	17.09	2.40	5.56	16.69	5.59	0.156	0.057
HD 2687 X Job 673	5.23	16.44	1.95	5.30	16.19	5.80	0.157	0.157

Table 2. Correlation coefficients in different wheat lines, testers and their crosses

Characters	a	b	c	d	e	f	g	h	Y
a	1.00	0.827**	0.648*	0.751*	0.767*	0.820**	0.186	-0.002	-0.457
		0.001	-0.072	-0.115	0.119	-0.159	0.116	-0.003	-0.023
b	-0.421*	1.00	0.590	0.789*	0.972**	0.925**	0.254	-0.013	0.647*
			0.053	0.097	-0.145	-0.172	-0.021	-0.112	0.439
c	0.483*	0.249	1.00	0.941**	0.391	0.568	-0.458	-0.016	-0.473
				-0.278	-0.383	-0.030	-0.182	-0.079	-0.182
d	0.496*	0.221	-0.360	1.00	0.634	0.794*	-0.233	-0.009	-0.590
					0.062	0.009	0.264	0.032	0.264
e	0.435*	-0.328	0.142	0.588**	1.00	-0.906*	0.418	-0.009	-0.590
						-0.047	0.122	-0.068	0.122
f	-0.262	-0.067	0.220	-0.719**	-0.524**	1.00	0.310	0.008	-0.550
							0.015	0.042	0.015
g	0.378	-0.493*	-0.349	-0.223	-0.144	0.605**	1.00	0.001	0.312
								0.096	-0.189
h	-0.006	0.193	0.052*	-0.164	-0.126	0.353	0.062	1.00	0.315
Y	-0.456*	0.156	0.061	-0.278	-0.348	0.260	0.012	0.342	1.00

* Significant at p=0.05 and ** significant at p=0.01 (Upper diagonal represent testers and crosses while lower diagonal represents lines respectively)
(a and b= Nitrogen content in straw and grain, c and d= Phosphorus content in straw and grain, e and f= Potassium content in straw and grain and g and h= calcium content in straw and grain, Y grain yield per plant respectively).

Table 3. Nutrient index (%) of the wheat genotypes

S. No.	**Entries**	**Nitrogen**	**Phosphorous**	**Potassium**	**Calcium**
1	HD-2687	47.12	15.05	45.34	3.93
2	RJ-1114	53.95	16.94	0.12	3.85
3	PBW-343	48.24	15.57	46.19	3.98
4	RS-392	53.03	16.67	48.92	4.21
5	UP-2338	46.66	15.61	45.87	3.74
6	WH-542	48.76	15.56	49.40	4.17
7	Job-666	56.32	18.42	50.78	4.17
8	Job 673	52.52	16.62	47.82	4.31
9	Kharchia-65	61.26	18.55	52.67	4.37
10	Raj. 3077	55.26	17.20	50.56	4.14

REFERENCES

Dubey, L. D. (1997). Combining ability analysis for yield and yield components in bred wheat (*Triticum aestivum* L.) in normal and saline soil. Ph. D. Thesis, RAU Bikaner.

Jackson, M. L. (1950). Soil chemical analysis prentice Hall of Indian Pvt. Ltd. New Delhi, pp 1-498.

Jackson, M. L. (1958). Soil chemical analysis prentice Hall of Indian Pvt. Ltd. New Delhi, pp 1-498.

Meena, B. S. (1999). Diallel analysis for yield and nutrient components in wheat *(Triticum aestivum* L.. M. Sc. Ag. Thesis., RAU, Bikaner.

Richards, R. (1954). Diagnosisnand improvement of saline and alkali soils. U. S. D. A. hand book No. 60.

Snell, F. D. and Snell, C. T. (1939). Colorimetric method of analysis, 3rd Ed. VII. Van. Nostrand Co. Inc. New York.