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GENETIC VARIABILITY FOR NITROGEN UPTAKE IN WHEAT

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ABSTRACT

Twenty one genotypes and 21 hybrids of wheat were used to define the extent of variability in nitrogen uptake at 45 days and 90 days of plant growth and at harvest (both in grains and straw). Appreciable variability was recorded for nitrogen percentage and total plant nitrogen (PN) at all the stages. The percentage of nitrogen decreased with maturity. The varieties WH 157, UP 368, UP 270, Bulk 1858, CPAN 1281 and K 227 translocated more nitrogen to the grains. Nitrogen harvest index showed positive correlation with grain harvest index. The positive correlation of PN with grain yield and biological yield appeared to be stronger with advancement of growth. Using PN as a parameter, WH 157, WH 147, UP 270, S 311 and hybrids HD 2122 x WH 147, WH 147 x WH 157 and HS 1138-6-4 x K 227 were the promising genotypes.

Key words: Variability, harvest index, nitrogen harvest index.

The high cost of nitrogenous fertilizers in the recent years has drawn attention towards improving the efficiency of nitrogen utilization in cereals. If higher grain and grain protein yields are to be achieved, the future varieties will have to be capable of taking up more nitrogen from the soil and transferring a greater proportion of the element towards development. Nitrogen uptake by the plants and its partitioning between straw and grain are the two major components in nitrogen economy of plants. Keeping this in view, the present study analyses varietal differences for nitrogen uptake and nitrogen harvest index and their possible influence on wheat yield.

MATERIALS AND METHODS

Twenty one varieties of wheat and 21 hybrids involving some of them (Tables 2, 3) were studied to define the extent of variability in nitrogen uptake. The material was sown in the field in randomized block design with three replications. Each progeny was accommodated in 4 m long, single-row plots, spaced at 30 cm with 10 cm distance among plants. Samples were collected 45 and 90 days after sowing and grain and straw samples were collected at harvest. Each sample was first oven dried at 60°C and then ground in a machine. Nitrogen

estimations in all the samples were done by Nesselerization [1]. Total plant nitrogen (PN=Product of dry weight and nitrogen concentration) was calculated for all the stages. The partitioning efficiency of nitrogen between grain and straw was expressed as nitrogen harvest index (NHI) as defined by Canvin [2] and Austin et al. [3].

$$NHI = \frac{\text{Grain yield x grain nitrogen \%}}{\text{Straw yield x straw nitrogen \% + Grain yield x grain nitrogen \%}} \times 100$$

Correlations of plant nitrogen at various stages of crop growth and at harvest, both in straw and grain as well as pooled, were computed with grain yield, biological yield and grain protein per cent. Correlation coefficient between nitrogen harvest index (NHI) and harvest index (HI) was also worked out.

RESULTS AND DISCUSSION

The analysis of variance of the parents and crosses showed significant differences among the genotypes and the F_1s for nitrogen accumulation. Considering the range and mean performance of genotypes and F_1s for nitrogen accumulation, the data revealed the presence of appreciable variability in the material (Table 1).

The nitrogen percentage in the plant, which was maximum at 45 days of growth, decreased at maturity (Table 2). Decrease in nitrogen concentration in the vegetative parts

Table 1. Mean sum of squares, mean performance and range for nitrogen percentage and plant nitrogen (PN) in 21 varieties and 21 hybrids in wheat

Source	d.f.	At different days after sowing				At harvest			
		45		90		grain		straw	
		%N	PN	%N	PN	%N	PN	%N	PN
Replications	2	0.26	2.00	0.04	13329.1	0.003	9794.2	0.009	93.8
Treatments	41	0.43*	30.85**	1.16**	19091.4**	0.54**	27177.0**	1.56**	2132.8
Parents	20	0.60**	44.69**	1.13**	18220.6**	0.91**	26996.3**	2.87**	2952.2
F_1s	20	0.27	18.54**	1.24**	17572.1**	0.19**	18251.0**	0.24**	1357.4
Pvs F_1	1	0.02	0.04	0.10	66895.7**	0.37*	209311.6**	1.84**	1254.6
Error	82	0.19	2.09	0.13	2166.7	0.09	3809.9	0.06	2431.8
Mean:									
Parents		3.98	23.36	1.55	366.1	1.85	314.05	0.52	105.65
F_1s		3.99	23.39	1.51	412.2	1.89	354.81	0.43	99.34
Range:									
Parents		3.03–4.42	16.0–30.5	1.15–2.06	193.3–553.0	1.00–2.11	51.3–516.7	0.34–2.03	76.0–217.5
F_1s		3.57–4.44	19.07–29.7	1.01–2.02	274.8–556.4	1.63–2.07	236.7–557.0	0.33–0.54	65.8–144.4

Table 2. Nitrogen percentage (% N), plant nitrogen (PN) (mg/kg dry weight of plant) and nitrogen harvest index (NHI) at different stages of plant growth in 21 wheat varieties

Variety	At different days after sowing				At harvest				NHI
	45 days		90 days		grain		straw		
	% N	PN	% N	PN	% N	PN	% N	PN	
CPAN 1281	3.84	20.5	1.98	316.6	2.03	252.2	0.45	98.9	71.8
CPAN 1518	4.42	26.4	1.57	323.6	1.77	275.9	0.48	88.9	75.6
WL 711	4.01	26.6	1.82	379.1	1.86	322.0	0.45	98.1	76.6
HI 676	4.27	22.8	1.52	334.1	1.65	287.9	0.49	81.9	77.9
WH 108	3.97	22.8	1.89	427.9	1.96	370.0	0.48	110.6	77.0
WH 129	3.87	27.5	1.61	355.0	1.69	282.2	0.36	76.0	78.8
WH 147	4.07	26.7	1.51	449.6	1.96	381.7	0.48	122.2	75.7
WH 156	3.03	16.0	1.64	344.3	1.90	286.1	0.39	79.5	78.3
WH 157	4.31	28.1	1.72	553.0	2.11	516.7	0.43	105.8	83.0
UP 270	4.02	26.7	1.64	404.4	2.07	404.2	0.53	116.3	77.7
UP 368	3.72	23.1	1.71	395.8	2.10	361.3	0.41	84.3	81.1
Bulk 1858	4.18	22.6	1.19	397.0	2.04	354.0	0.34	97.2	78.5
HD 2122	3.98	30.5	1.61	419.7	1.87	363.6	0.57	142.7	71.8
J 40	4.31	16.2	1.41	336.9	1.88	311.5	0.41	79.4	79.7
Cno'S' Chris	4.08	22.1	1.22	298.3	1.78	251.0	0.46	94.2	72.2
WG 377	3.99	25.2	1.49	375.9	1.78	308.0	0.48	108.5	73.9
K 227	3.67	20.4	1.49	400.0	2.02	330.3	0.50	136.7	70.7
K 227AL	4.16	17.3	2.06	193.3	1.00	51.3	2.03	217.5	19.1
C 591	4.19	22.7	1.15	209.3	1.73	154.6	0.40	85.7	64.3
HS 1138-6-4	3.77	23.3	1.25	360.0	1.72	315.3	0.42	99.6	76.0
S 311	3.78	23.0	1.15	415.0	1.90	415.1	0.34	94.7	81.4
C.D., 5%	0.69	2.3	0.58	74.8	0.47	98.8	0.41	78.9	

Note. CD based on transformed values.

of the plants during growth has also been reported by Lasztity [4]. In our studies, nitrogen concentration in K 227 AL (an awnless mutant of K 227) at harvest was significantly more than that in other varieties for vegetative parts but significantly less for grains resulting in accumulation of more nitrogen in the vegetative parts, and less in the grains. This mutant may be less efficient in translocating the absorbed nitrogen from the vegetative parts to the grain. As compared to others, the varieties WH 157, UP 368, UP 270, Bulk 1858, CPAN 1281 and K 227 accumulated higher proportion of their nitrogen in the grain. Similar trend of nitrogen percentage was observed in F_1 hybrids. Some hybrids had more nitrogen concentration while others had less as compared to the parent varieties (Table 3). However, more nitrogen in F_1 hybrids than the parents has been reported also by Becker [5].

Table 3. Nitrogen percentage (% N), plant nitrogen (PN) (mg/kg dry wt of the plant) and nitrogen harvest index (NHI) at different stages of plant growth in 21 wheat hybrids

Cross	At different days after sowing				At harvest				NHI
	45 days		90 days		grain		straw		
	% N	PN	% N	PN	% N	PN	% N	PN	
CPAN 1518 x WL 711	4.00	22.2	2.02	404.0	2.07	370.3	0.49	93.7	79.8
HI 676 xWL 711	3.80	22.9	1.74	440.6	1.92	387.2	0.49	107.3	78.3
HI 676 x UP 368	3.78	21.9	1.01	274.8	1.63	319.3	0.35	71.9	81.6
HI 676 x WH 157	4.08	22.5	1.90	497.6	1.98	436.2	0.54	131.7	76.9
WH 129 x WH 157	3.98	29.7	1.54	491.8	1.91	456.6	0.51	119.0	79.3
Bulk 1858 x WH 157	3.99	25.1	1.31	454.0	1.91	421.6	0.43	115.1	78.6
H 147 x WH 157	4.05	22.1	1.48	475.5	1.88	487.4	0.33	92.9	84.0
WH 147 x K 227AL	4.06	24.8	1.96	437.8	2.02	415.5	0.44	95.1	81.4
HD 2122 x WH 147	4.44	22.5	1.59	556.4	1.98	557.0	0.41	86.5	86.6
J 40 x WH 147	3.67	24.4	1.41	412.4	1.93	443.0	0.41	85.7	82.2
UP 368 x WH 147	4.06	23.7	1.38	324.6	1.94	358.0	0.37	65.8	84.5
WG 377 x WH 147	4.00	19.4	1.54	399.2	2.03	409.3	0.36	80.2	83.6
Cno'S' Chris x WH 157	3.57	20.0	1.13	388.0	1.83	406.5	0.43	105.8	79.3
Cno'S' Chris x UP 368	4.11	24.0	1.41	307.1	1.70	268.9	0.42	84.6	76.1
WH 156 x K 227 AL	3.90	26.4	1.87	435.9	2.02	394.2	0.37	86.3	82.0
W 337 x C 591	4.16	23.5	1.78	310.8	1.93	236.7	0.46	101.5	70.0
K 227 x UP 270	4.28	27.2	1.13	437.3	1.73	419.2	0.45	142.8	74.6
HS 1138-6-4 x K 227	4.23	22.6	1.34	484.8	1.89	474.1	0.43	100.1	82.6
UP 368 x HS 1138-6-4	3.83	19.1	1.52	327.1	1.82	275.9	0.40	88.2	75.8
S 311 x WH 108	3.83	23.4	1.38	477.9	1.73	446.8	0.52	144.4	75.6
CPAN 1281 x WH 156	4.10	23.9	1.56	319.4	1.84	322.9	0.38	87.6	78.6
C.D., 5%	0.69	2.3	0.58	74.5	0.47	98.8	0.41	78.9	

Note. CD based on transformed values.

Biological yield, plant nitrogen, harvest index and NHI among others represent the efficiencies of C and N assimilation and translocation processes, ultimately contributing to grain yield and grain protein yield. The lowest NHI was recorded in K 227 AL (19.08), while in the other parent varieties it varied from 64.3 (C 591) to 83% (WH 157) and in hybrids from 70.0 to 86.6%. The NHI showed significant positive correlation with HI (Table 4). High correlations between these parameters have also been reported earlier [6]. Obviously, HI can reliably be considered as an index to NHI, thus the labour and cost involved in determination of NHI can be saved. Correlation coefficients of plant nitrogen with grain yield and biological yield were almost positively significant (Table 4), as also reported earlier [7, 8]. This relationship appeared to be stronger with advancement of growth till maturity. Thus, PN can be a useful parameter in the choice of genotypes for various studies. On this

Table 4. Correlation coefficients of plant nitrogen (PN) at various stages of crop growth with grain yield and grain protein in wheat varieties and hybrids

PN estimate	Grain yield			Biological yield			Grain protein percent		
	parents	F_1s	pooled	parents	F_1s	pooled	parents	F_1s	pooled
PN (Straw)	–0.36	0.38	–0.11	–0.35	0.64*	–0.03	–0.54*	–0.17	–0.45**
PN (Grain)	0.97**	0.95**	0.97**	0.92**	0.79**	0.89**	0.80**	0.30	0.62**
PN (Total)	0.90**	0.95**	0.94**	0.86**	0.87**	0.88**	0.65**	0.23	0.49**
PN (at 45 day)	0.54*	0.18	0.35*	0.51*	0.26	0.38*	0.27	0.002	0.20
PN (at 90 day)	0.93**	0.83**	0.88**	0.89**	0.74**	0.84**	0.71**	0.39	0.58**

Correlation coefficient of nitrogen harvest index (NHI) with harvest index (HI)

Nitrogen harvest index	Harvest index		
	parents	F_1s	pooled
	0.66**	0.84**	0.68

*,**Significant at 5% and 1% levels, respectively.

basis, the genotypes WH 157, WH 147, UP 270, and S 311 and the hybrids WH 147 x WH 157 and HS 1138-6-4 x K 227 were the best genotypes/hybrids.

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