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Inheritance and association of traits in wheat *(Triticum aestivum* L.) related to yield and chapatti making quality

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ABSTRACT

Early maturing high yielding varieties are most promising in West Bengal as they are able to complete their life cycle successfully within short period of prevailing cool temperature. The present investigation attempted to identify high yielding early maturing genotypes with high gluten content because wheat is generally used as chapattis and gluten content in flour is an important component for chapatti making. The genotypes were evaluated on the basis of traits related to yield like plant height (cm), number of tillers/ plant, panicle length (cm), number of spikelets/spike, awn length (cm), number of grains/panicle, 1000 grain weight (g), biological yield (g), grain yield/plant (g), harvest index, days to 50% flowering and 100% maturity as well as gluten content of the genotypes, on the basis of the estimated values of GCV, PCV, heritability, genetic advance as percent of mean and with association between these traits. Thirteen genotypes of wheat were sown in randomized block design with three replications at the Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia on last week of November and second week of December 2010. Analysis of variance depicted significant differences among the genotypes for all the traits with high influence of environment influencing these traits. High heritability coupled with high genetic advance as percent of mean were revealed by 1000 grain weight, harvest index, days to 50 % flowering and days to 100 % maturity and these can be predicted to be controlled by additive gene action whereas grain yield/plant was found to be controlled by both additive as well as non- additive gene action and gluten content can be influenced by non-additive or higher order of gene interactions. The variety NW 3069 was found to be highest yielder with high gluten content showing promise for improvement of wheat respect to yield and gluten content.

Key words: Additive gene action, dominance gene action, genetic advance, gluten content, heritability

Advance technology had remarkably boosted up wheat production in most of the states of India except some parts like West Bengal where favorable period for wheat cultivation conditioned by prolonged winter season is very short and thereby giving comparatively low yield. It emphasized development of early maturing high yielding varieties to maintain productivity at comparative level. Moreover, wheat is mainly consumed as chapatti and as gluten content in wheat flour is an important component for making good chapattis, the gluten rich high yielding varieties have been recognized to be most desirable ones. The present investigation attempted to identify high yielding early maturing genotypes with high gluten content. The evaluation of the genotypes was made on the basis of traits related to yield as well as for gluten content in light of estimated values of genetic parameters of the related traits as well as the correlation coefficient.

MATERIALS AND METHODS

Thirteen wheat genotypes namely, K0 123, HW 775, UP 2932, HW 2054, NH(S) 2-4, PBW 579, PBW 524, NGSN 2, RAJ 4084, HD 2932, NW 3069, CBW 37, PBW 513 were sown in randomized block design with three replications at the farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia on last week of November and second week of December 2010. Data were recorded for the characters like plant height (cm), number of tillersplant^{-1}, panicle length (cm), number of spikelets spike^{-1}, awn length (cm), number of grains panicle^{-1}, gluten content, 1000 grain weight (g), biological yield (g), grain yield plant^{-1} (g), harvest index, days to 50% flowering and maturity of the genotypes were also recorded. Gluten content of flour was estimated by following the method suggested by Ram and Srivastva (1975). Coefficient of variation, GCV and PCV were estimated as per Burton (1952); heritability (broad sense) and genetic advance were estimated using the formula by Johnson *et al.* (1955) and Hanson *et al.* (1956) respectively.

RESULTS AND DISCUSSION

Analysis of variance (Table 1) revealed significant differences among genotypes for all the traits which provided evidence for presence of ample genetic variation which can be utilized in the breeding improvement of these traits. Pawar *et al.* (2003) also reported wider genetic variation for traits in wheat like plant height, length of spike, number of spikelets spike^{-1}, grains panicle^{-1}, 1000 grain weight and grain yield. High difference between PCV and GCV were found in most of traits except 1000 grain weight, days to 50 % flowering, maturity period, harvest index, biological yield and grain yield and these traits were consistently and substantially influenced by environment. Heritability along with genetic advance was found to be comparatively higher at early sown crop with respect to plant height, number of tillers plant^{-1}, panicle length and awn length and gluten content at late sown crop while other traits showed consistent results irrespective of date of sowing.

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Table 1: Variability and genetic parameters for the different traits in wheat

Traits	Range	Variances			GCV	PCV	h^2	GA % mean
		PV	GV	EV				
Plant height (cm)	**95.74-78.80**	**30.31**	**28.17**	**2.14**	**6.02**	**6.25**	**0.92**	**11.96**
	99.93-84.13	45.42	5.95	39.46	2.68	7.40	0.13	2.00
No of tillers plant^{-1}	**11.73-6.36**	**3.92**	**2.55**	**1.36**	**17.54**	**21.72**	**0.65**	**29.17**
	11.73-9.66	4.45	1.47	5.92	11.63	20.26	0.32	13.76
Panicle length (cm)	**13.27-8.29**	**2.70**	**1.26**	**1.44**	**11.01**	**16.10**	**0.46**	**15.52**
	13.06-8.65	1.91	0.47	1.44	6.66	13.44	0.24	6.80
No of spikelets spike^{-1}	**20.99-17.50**	**1.95**	**0.61**	**1.33**	**4.14**	**7.39**	**0.31**	**4.78**
	22.00-17.92	1.86	0.64	1.21	4.15	7.04	0.34	5.05
Awn length (cm)	**14.21-5.8**	**5.87**	**4.29**	**1.58**	**29.12**	**34.07**	**0.73**	**51.28**
	12.52-5.91	5.98	2.25	3.73	21.09	34.39	0.37	26.74
No of grains panicle^{-1}	**66.00-45.93**	**38.68**	**37.08**	**1.60**	**10.60**	**10.83**	**0.95**	**21.39**
	64.60-49.06	38.88	6.57	32.31	4.57	11.13	0.16	3.87
Gluten content	**6.54-4.38**	**1.42**	**-0.16**	**1.58**	**6.97**	**20.65**	**0.11**	**4.85**
	6.04-4.48	1.11	-0.25	1.36	9.02	19.08	0.22	8.79
1000 grain weight (g)	**50.33-31.03**	**35.71**	**33.49**	**2.21**	**15.52**	**16.03**	**0.93**	**30.97**
	49.16-27.96	33.04	31.89	1.15	15.33	15.61	0.96	31.03
Days to 50% flowering	**71.66-55.66**	**26.12**	**23.58**	**2.53**	**7.82**	**8.23**	**0.90**	**15.30**
	69.00-53.00	26.96	24.63	2.33	8.35	8.74	0.91	16.44
Days to 100% maturity	**120.33-71.33**	**52.95**	**46.08**	**6.87**	**6.27**	**6.72**	**0.87**	**12.04**
	108.00-93.00	26.32	24.41	1.51	4.99	5.18	0.92	9.91
Harvest Index	**60.12-38.15**	**68.26**	**53.85**	**14.40**	**14.96**	**16.84**	**0.78**	**27.38**
	61.13-37.17	64.29	39.00	15.28	14.39	16.39	0.77	25.89
Biological yield (g)	**31.27-16.90**	**14.12**	**12.14**	**1.97**	**16.09**	**17.35**	**0.85**	**30.74**
	32.18-17.59	14.23	13.08	1.15	16.15	16.85	0.91	31.90
Grain yield plant^{-1} (g)	**13.09-7.41**	**3.55**	**2.36**	**1.19**	**15.39**	**18.86**	**0.66**	**25.87**
	13.57-7.58	5.63	3.04	2.58	16.89	22.98	0.54	25.59

Note: Underlined figures are for late sowing

Table 2: Phenotypic and genotypic correlation with respect to yield

Traits	Early sown		Late sown	
	Phenotypic	Genotypic	Phenotypic	Genotypic
Plant height (cm)	-0.008	0.008	-0.035	-0.020
No of tillers plant^{-1}	-0.258	-0.564**	-0.045	-0.195
Panicle length (cm)	0.217	0.389*	-0.068	-0.441
No of spikelets spike^{-1}	0.043	0.021	-0.115	-0.625
Awn length (cm)	-0.408**	-0.522**	0.036	-0.086
No of grains panicle^{-1}	0.066	0.056	-0.264	-0.587
Gluten content	0.107	0.417**	0.203	0.523**
1000 grain weight (g)	0.134	0.214	0.101	0.151
Days to 50% flowering	0.267	-0.374*	-0.287	0.413
Days to 100% maturity	-0.129	0.224	-0.303	-0.379
Harvest Index	0.222	0.354*	0.539**	0.664**
Biological yield (g)	0.592**	0.800**	0.538**	0.620**

**, ** Significant at 5% and 1% level of significance, respectively*

Table 3: *Per se* performance of wheat genotypes

Genotypes	Plant height (cm)	No. of tillers plant^{-1}	Panicle length (cm)	No. of spiklets spike^{-1}	Awn Length (cm)	No. of grains panicle^{-1}	Gluten content	1000 Grain wt.(g)	Days to 50% flowering	Days to 100% maturity	Harvest index	Biological yield (g)	Grain yield plant^{-1}(g)
K0123	**92.11**	**11.73**	**8.82**	**18.75**	**6.43**	**66.00**	**5.71**	**35.83**	**69.00**	**117.00**	**52.59**	**22.35**	**10.40**
	89.06	10.46	8.65	18.92	9.62	57.80	5.54	34.04	60.00	104.00	51.92	22.96	11.59
HW 775	**86.27**	**7.50**	**9.58**	**18.89**	**6.29**	**62.63**	**5.29**	**40.63**	**71.66**	**120.33**	**41.11**	**24.77**	**11.29**
	87.16	9.93	9.61	19.36	12.52	64.60	5.74	40.16	69.00	108.00	41.32	23.80	9.20
UP 2932	**86.47**	**9.23**	**9.63**	**20.49**	**5.89**	**47.86**	**4.38**	**42.76**	**58.33**	**71.33**	**44.40**	**22.08**	**9.43**
	96.13	9.60	13.06	19.30	6.69	40.06	6.04	41.86	53.00	93.00	42.87	24.86	9.60
HW 2045	**95.74**	**6.36**	**10.02**	**18.40**	**5.98**	**50.73**	**6.22**	**36.90**	**55.66**	**98.00**	**56.13**	**21.97**	**11.43**
	86.90	10.93	9.99	18.44	6.36	50.86	6.03	37.40	56.00	95.00	55.64	22.58	11.90
NH(8)2-4	**92.50**	**10.26**	**10.57**	**20.99**	**6.15**	**45.93**	**5.79**	**50.33**	**60.00**	**103.00**	**56.28**	**22.89**	**10.60**
	99.93	11.73	10.53	19.42	6.63	53.93	5.24	49.16	58.00	96.66	54.14	23.77	11.54
PBW 579	**91.31**	**7.30**	**13.27**	**18.42**	**7.21**	**61.81**	**6.54**	**36.80**	**60.00**	**105.00**	**59.65**	**20.70**	**11.47**
	90.13	9.66	10.15	17.92	6.27	53.86	5.96	35.96	58.00	96.33	61.13	21.69	13.20
PBW 524	**93.45**	**7.46**	**11.20**	**18.58**	**6.19**	**54.33**	**5.39**	**37.96**	**60.00**	**105.66**	**53.42**	**18.92**	**10.29**
	89.10	10.53	10.52	18.72	6.45	57.73	5.85	37.23	58.00	97.00	52.34	19.37	10.13
NGSN 2	**78.80**	**11.10**	**9.51**	**18.17**	**6.19**	**56.46**	**6.12**	**28.13**	**60.33**	**108.00**	**60.12**	**16.90**	**8.92**
	84.13	10.86	10.50	22.00	6.02	55.73	5.45	27.96	60.00	98.66	57.84	17.59	9.43
RAJ 4084	**84.32**	**10.83**	**9.52**	**17.60**	**7.56**	**61.81**	**5.50**	**41.86**	**57.66**	**102.00**	**48.04**	**20.57**	**9.69**
	92.96	9.80	10.32	20.22	6.54	59.00	5.86	42.00	53.00	93.00	47.39	22.01	10.77
HD 2932	**80.30**	**9.20**	**9.68**	**20.20**	**6.48**	**57.93**	**6.44**	**37.83**	**64.33**	**112.33**	**41.74**	**19.45**	**8.38**
	93.56	10.20	10.43	19.38	6.27	57.60	5.311	37.96	56.00	95.00	42.02	19.45	7.85
NW 3069	**79.66**	**8.33**	**10.81**	**18.66**	**6.60**	**62.13**	**6.44**	**31.03**	**57.66**	**101.66**	**42.11**	**31.27**	**13.09**
	90.33	9.66	9.84	19.20	6.58	53.13	5.49	31.23	60.00	98.66	44.26	32.18	13.57
CBW 37	**90.81**	**10.96**	**8.29**	**18.16**	**14.21**	**61.20**	**5.37**	**31.56**	**65.33**	**112.66**	**43.65**	**18.67**	**7.53**
	95.06	11.60	10.35	18.50	6.57	60.53	4.45	30.90	62.33	104.00	43.87	21.39	7.86
PBW 513	**90.45**	**8.20**	**11.78**	**18.24**	**7.30**	**57.80**	**5.95**	**32.86**	**67.33**	**117.00**	**38.15**	**22.17**	**7.41**
	88.00	10.46	9.94	20.14	5.91	53.93	4.99	32.76	69.00	106.00	27.17	40.03	7.51
Mean	**88.09**	**9.11**	**10.21**	**18.88**	**7.11**	**57.41**	**5.78**	**73.27**	**62.10**	**105.69**	**49.03**	**21.65**	**9.99**
	90.96	10.42	10.30	19.35	7.12	55.98	5.53	36.82	59.41	98.87	48.61	22.38	10.32
SEm(±)	**1.19**	**0.95**	**0.98**	**0.94**	**1.02**	**1.03**	**1.02**	**1.21**	**1.30**	**2.14**	**3.09**	**1.14**	**0.89**
	5.12	1.98	0.98	0.89	1.57	4.64	0.95	0.87	1.24	1.12	3.19	0.87	1.31
LSD(0.05)	**2.46****	**1.96****	**2.01***	**1.95***	**2.12***	**2.13***	**2.12***	**2.51****	**2.68****	**4.41****	**6.39****	**2.37****	**1.83***
	10.58**	4.10**	2.02*	1.85*	3.25**	9.57**	1.97*	1.81*	2.57**	2.32**	6.68**	1.80*	2.71**

*Note: Underlined figures are for late sowing, *, ** Significant at 5% and 1% level of significance, respectively*

High heritability accompanied by high genetic advance were revealed by1000 grain weight, days to 50% flowering, days to 100% maturity, harvest index, biological yield and these traits may be considered to be highly controlled by additive gene effect and responsive to selection. Conventional breeding method had been suggested for improvement on these traits. Grain yield plant^{-1} was found to show good genetic advance with moderate level of heritability and it may be controlled by the influence of both additive and non-additive gene effect. Heritability and genetic advance for gluten content were found to be very low at early sowing which was moderately improved at late sowing and these traits considered to be influenced by non-additive or higher order of gene interaction and complex breeding method like recurrent selection via population improvement method may be approached to enrich wheat flour for chapatti making and better result may be expected if breeding and selection for these traits could be done on late sown crop. However, Ram and Srivastava (1975) reported additive gene action accompanied by high heritability for gluten content. Genotypic and phenotypic correlations (Table 2) between yield and harvest index as well as biological yield were positively significant irrespective of date of sowing. Donmez *et al.* (2001) reported significant association between yield and harvest index Gluten content in wheat flour also showed significant positive correlation with grain yield at genotypic level. Smiaowski *et al.* (2006) also found positive correlation between gluten content and grain yield. Yield was found to be highest in the variety NW 3069 accompanied by high gluten content (Table 3) irrespective of date of sowing and it may be considered as an important parent for wheat development with respect to yield and gluten content, so that desirable high yielding good chapatti making varieties can be developed.

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