

GRAIN AND PROTEIN YIELD CORRELATION IN WHEAT AS INFLUENCED BY CROP CULTIVAR AND NITROGEN FERTILIZER

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Two parameters namely the yield of protein and the yield of grain were correlated in ten high yielding cultivars of wheat. This relationship was, however, found non-significant. Hence, the protein content of the existing wheat cultivars need further improvement to enhance the per ha yield of protein. The effect of nitrogen fertilizer on such correlations in two wheat cultivars, Khushal-69 and Mexi Pak-69 was also studied. It was observed that the increase in grain yield due to nitrogen fertilizer resulted in a significant increase in the protein yield of both the cultivars, which suggests that in intensive cultivation, nitrogen fertilizer can play an important role in increasing the protein yield along with the yield of grain.

INTRODUCTION

The introduction of high yielding cultivars of wheat in Pakistan has increased the yield per unit area [1], and has thus very much narrowed the food gap in the country [2]. Since wheat is the staple diet of the people of Pakistan, improvement in the quality and quantity of wheat grain protein could have enormous impact on raising the nutritional standard of the people of low income group. The increase in the yield of grain should be accompanied with the simultaneous increase in the yield of protein.

The yield and protein content of wheat grain have been reported to be much affected by the crop cultivar and nitrogen fertilizer [3 - 6]. In Pakistan the yield potential of the new high yielding cultivars of wheat have been evaluated recently [7, 8]. Likewise, the effect of nitrogen on the crude protein content of these cultivars have been studied in the Punjab and the North West Frontier Province (N.W.F.P.) [9, 10], but no efforts have been made to correlate the grain yield with the protein yield on per unit area basis in the new cultivars of wheat, which are grown in the N.W.F.P. The present work was therefore, undertaken to compute the grain protein yields correlation in ten cultivars of wheat and to study the effect of nitrogen fertilizer on such correlation in two cultivars-'Khushal-69 and Mexi Pak-69' which are very popular among the farmers of N.W.F.P. These correlations will be helpful to work out the possibility of increasing the protein yield on the basis of grain and can be further

exploited in selective improvement of wheat for higher yield of protein.

MATERIALS AND METHODS

Varietal and fertilizer trials were conducted at Peshawar (N.W.F.P.) during the year 1977-78 on alluvial, clay loam soils of pH 7.8. In varietal trial 10 cultivars were grown with a randomized block design. Each cultivar was replicated four times. The plot size in each replication was 6 x 3 meter, out of which a net plot size of 5.4 x 2.4 was harvested for yield evaluation. The cultivars used in the present study were Tarnab-73, Tarnab-70, Pak-70, Barani-70, Maxi Pak-70, Max-69, Khushal-69, Blue silver and Damani (IRN-149) x (271). Each cultivar received a basal dose of 120 kg N, 80 kg P₂O₅ and 50 kg of K₂O ha as urea, superphosphate and potassium sulphate, respectively.

For fertilizer trials two cultivars of wheat, Khushal-69 and Mexi Pak-69 were selected and ten doses of nitrogen (30 to 300 kg/ha) were applied to each cultivar in the form of urea. Each dose was applied along with 80 kg P₂O₅ and 50 kg K₂O/ ha before sowing. The randomized block design was used for both the trials. Each treatment was replicated thrice. The plot size was the same as for varietal trial.

The grain yield data were recorded after the harvest and sun-drying of the crop. Oven dried grain samples were analysed for their nitrogen content by the Micro-Kjeldhal method of A.O.A.C. [11].

The crude protein content was calculated by multiplying the nitrogen content with the factor 5.7.

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The yield of crude protein on per unit area basis was calculated from the per ha yield of grain and the percentage of crude protein in the grain.

The analysis of variance of the experimental data in both the varietal and fertilizer trial was computed by the method of Snedecor and Cochran [12]. The least significance difference (L.S.D) for each parameter was computed for the comparison of the treatment means. The inter-relationship between the grain and protein yields in 10 cultivars of wheat and the effect of nitrogen fertilizer on this relationship in wheat cultivars, Khushal-69 and Mexi Pak-69 were studied by computing the correlation co-efficient (r), co-efficient of determination (r^2) and the regression co-efficient (b) according to Snedecor and Cochran [12].

RESULTS AND DISCUSSION

The correlation between the grain and protein yields in ten important cultivars of wheat grown in N.W.F.P. was computed and presented in Table 1. The results revealed that the grain yield varied from 2880 to 3764 kg ha with a mean of 3397 kg ha. The grain yield of Chenab-70, Pak-70, Tarnab-70 and Tarnab-73 was significantly ($P = 0.05$) higher than all other cultivars except, Khushal-69. The nitrogen content in Blue Silver, Damani and Khushal-69 was significantly ($P = 0.01$) higher than other cultivars. The same was true for the crude protein content of the grain. Like these observations, higher grain yield of Chenab-70 as compared to Mexi Pak cultivars have been reported by Ali and Farzand [7]. The grain yield data are also in agreement to those of Saleem and Rehman [13] who reported that the grain yield of 47 cultivars of wheat ranged from 2838 to 4441 kg/ha. The crude protein content of the grain fairly agrees to the recent work of Khan and Eggum [14] who reported 12.3 to 16.7 % crude protein in the new improved cultivars of wheat grown in Pakistan. Iqtidar *et al.* [15, 16] reported similar results. However, Saleem and Rehman [13] obtained lower protein content (7.4 – 12.4 %) in wheat cultivars.

The crude protein production depends upon both the grain yield and crude protein content of the grain. Hence the cultivar which gave good yield and higher protein content was better with respect to crude protein production. The cultivar Khushal-69 produced significantly ($P = 0.01$) higher crude protein per ha as compared to Chenab-70, Pak-70, Tarnab-70 and Tarnab-73. Since the difference in the grain yield of Khushal-69 with respect to these four cultivars was non-significant, Khushal-69 could be screened as a better cultivar with respect to both the grain yield and crude protein production.

The results (Table 1) indicate that the grain yield was positively correlated with the yield of crude protein.

Though this relationship was non-significant, however, it revealed that both the grain and crude protein yields can be increased concurrently. The co-efficient of determination (r^2) was 0.13 which shows that 13 % of the total variability in the protein yield was due to its association with the grain yield. The regression co-efficient of protein yield on grain yield was 0.06, which means that an increase of one kg in grain yield was accompanied by an increase of 0.06 kg in crude protein yield. The regression equations are given in Table 1.

These observations are in agreement to those of Middleton *et al.* [17] and Saleem and Rehman [13] who reported positive correlation between the grain yield and protein content of grain in wheat varieties. However, in contrast to these findings, Ahmad *et al.* [18] observed a significant negative correlation between the grain yield of plant and protein content of the kernels in F2 generations of some wheat crosses. Likewise, Misikova and Riman [19] found negative relationship between percent protein and the yield of grain in wheat varietal crosses. Halloran [20] also recorded similar negative relationship in the F4 and F5 populations of a high protein X low protein wheat cross. However, he concluded that there were no strong genetic limitations to improvement in the protein content of wheat. The differences in observations may be due to varietal variation, soil and climatic conditions and the technique used [3]. In order to improve the positive correlation between the grain and protein yields in wheat, it is suggested that the protein content of the existing wheat cultivars should be increased by breeding and selection methods.

The grain and crude protein production of two cultivars of wheat, Khushal-69 and Mexi Pak-69 as influenced by various doses of nitrogen fertilizer is given in Table 2. The results indicate that nitrogen application significantly ($P = 0.01$) increased the grain yield of both the cultivars. The highest yield was recorded with 120 kg N/ha. Since the difference in the grain yield obtained by 90 and 120 kg N/ha was non-significant in case of both the cultivars, 90 kg N/ha was the optimum dose for economic returns.

The grain nitrogen and crude protein content increased with increasing levels of nitrogen fertilizer. The crude protein yield was positively correlated with the yield of grain in both the cultivars. The co-efficient of determination (r^2) being 0.69 and 0.45 indicate that 69 and 45 % of the total variability in the protein yield of Khushal-69 and Mexi Pak-69, respectively was associated with the grain yield. The regression lines are plotted in Figs. 1 and 2 for Khushal-69 and Mexi Pak-69, respectively.

These results are in agreement to the earlier reports [4,9,10,21] which state that the yield and crude protein content of wheat increased by nitrogen application. Higher crude protein production in wheat due to nitrogen fertilizers have also been recorded by a number of workers.

Table 1. Correlation between grain and crude protein yields in important cultivars of wheat grown in the north west frontier province (Pakistan).

Cultivars	Grain yield (kg/ha)	Grain ^a nitrogen (%)	Grain crude protein ^b	
			Yield (kg/ha)	(%)
1. Barani-70	2880	2.33	382	13.25
2. Blue Silver	3086	2.73	480	15.54
3. Chenab-70	3641	2.20	456	12.51
4. Damani (IRN-149 x C ₂₇₁)	3240	2.81	520	16.04
5. Khushal-69	3487	2.64	525	15.06
6. MexiPak-69	3230	2.17	400	12.38
7. MexiPak-70	3343	2.08	396	11.86
8. Pak-70	3620	2.32	479	13.23
9. Tarnab-70	3682	2.21	465	12.62
10. Tarnab-73	3764	2.12 ₆	454	12.07
Mean:	3397	2.36	455	13.45
L.S.D. 5 %	281	0.16	31	0.91
1 %	374	0.22	43	1.25

Relationship between the grain and protein yields (kg/ha):

a) Co-efficient of correlation, $r = +0.36n$;

b) Co-efficient of determination, $r^2 = 0.13$;

c) Regression equations:

(i) Protein yield, $Y = 0.06x + 245$;

(ii) Grain yield, $X = 2.12y + 2431$.

a: Each value was calculated up to four decimal and the figures were rounded., b = Crude protein = $N \times 5.70$, n = non-significant.

[5,22]. Likewise, Hutcheon and Paul [23] reported positive effect of nitrogen on the yield-protein relationship

in wheat. In contrast, other workers [6,10] observed negative correlation between the grain yield and protein

Table 2. Effect of nitrogen fertilizer on the production of grain and crude protein in two cultivars of wheat, khushal-69 and maxiPak-69.

Treatment nitrogen (kg/ha)	Cultivar: Khushal-69				Cultivar: MexiPak-69			
	Grain yield (kh/ha)	Grain nitrogen (%)	Grain C.P. ^b		Grain yield (kg/ha)	Grain nitrogen (%)	Grain C.P. ^b	
			Yield (kg/ha)	(%)			Yield (kg/ha)	(%)
NO	2756	2.37	372	13.50	2520	1.90	272	10.80
N30	2880	2.40	395	13.70	2654	1.94	293	11.05
N60	3137	2.45	438	13.98	2839	1.97	319	11.25
N90	3374	2.51	482	14.30	3106	2.02	357	11.50
N120	3548	2.58	522	14.70	3250	2.12	359	12.05
N150	3497	2.68	533	15.25	3188	2.19	399	12.50
N180	3325	2.72	531	15.50	3127	2.25	402	12.85
N210	3188	2.76	501	15.72	3044	2.30	400	13.13
N240	3034	2.79	482	15.88	2900	2.34	287	13.35
N270	2952	2.81	472	16.00	2818	2.37	380	13.50
N300	2798	2.82	450	16.08	2633	2.39	358	13.62
Mean:	3135	2.63	471	14.06	2916	2.16	348	12.33
L.S.D 5%:	261	0.23	40	1.31	163	0.13	22	0.74
1%:	347	0.31	56	1.77	216	0.17	28	0.97

Relationship between the grain and crude protein yields (kg/ha):	Khushal-69	MexiPak-69
a) Co-efficient of correlation:	+0.83**	+0.67*
b) Co-efficient of determination:	0.69	0.45
c) Regression equation:	See Fig.1	See Fig.2

a = Each value was calculated up to four decimal and the figures were rounded., b = Crude protein = N x 5.70., *Significant at 5% level of probability., ** Significant at 1% level of probability.

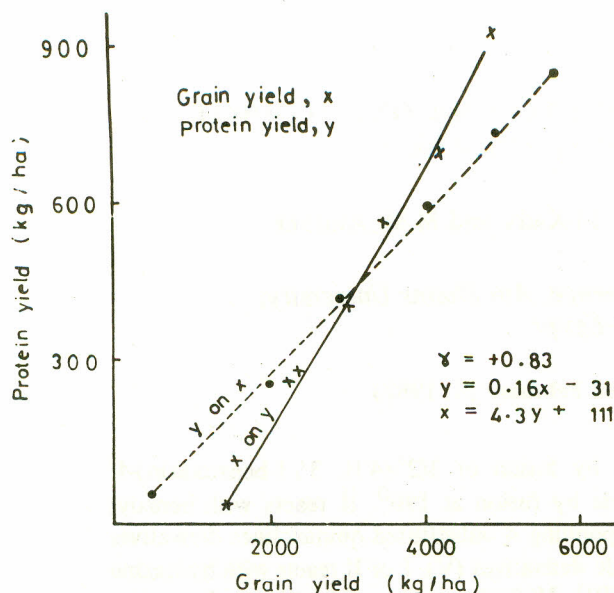


Fig. 1. Regression lines, showing grain-protein yields relationship in wheat cultivar, Khushal-69 as influenced by nitrogen.

content of wheat, which may be due to an increase in moisture supply during the crop growth [3,24].

From the preceding discussion it can be concluded that the protein content of the existing wheat cultivars need further improvement, so that maximum yield of protein can be obtained along with higher grain yield. In intensive cultivation nitrogen fertilizer can play a vital role in increasing both the grain and protein yields on per unit area basis.

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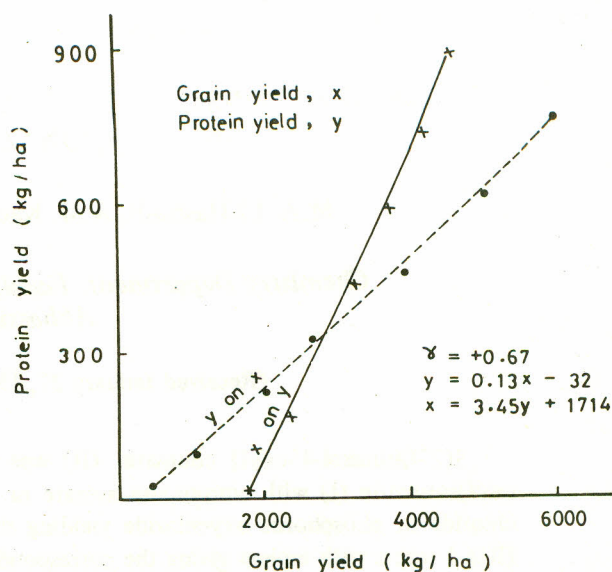


Fig. 2. Regression lines, showing grain-protein yields correlation in wheat cultivar, Mexi Pak-69 as affected by nitrogen.

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