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Correlation Studies in diverse lines of Wheat (*Triticum aestivum* L.) under Restricted Irrigation

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ABSTRACT

The present field experiment resulted that the correlation analysis reported that grain yield plant[1] shared positive significant association with days to physiological maturity, crop growth rate at 45 days, leaf area duration at 45 and 75 days, leaf area index at 45 and 75 days, the biomass duration at 45 days, chlorophyll content at 70 days, plant height, number of tillers per plant, number of spikelet per spike, number of grain per spike, 1000 grain weight, biological yield per plant, spike length, proline %, protein % and carbohydrate. So it could be possible to bring about gene up gradation in one character by selection of the other pair. However, grain yield plant^{-1} reported significant negative association with days to maturity, content at 90 days, RWC at 75 and 90 days, harvest index, this indicates that simultaneous improvement in both the traits were not possible. It may be concluded that rainfed condition had an additive influence on all phenological developments, physiological, biochemical and morphological structural yield attributing parameters. It is also concluded that these genotypes viz., G_{23}, G_8, G_{11}, G_{12}, and G_{19}, were promising for seed yield of wheat and its attributes under rainfed conditions, these genotypes also may be further utilized for the development of temperature tolerant wheat varieties for rainfed conditions.

Key words: *Wheat, Water logging, Restricted irrigation, Correlations, G_{23}.*

INTRODUCTION

The world's second most important staple food crop, wheat is nutritionally valuable for human and animals containing 15.4 grams of protein, 1.8 grams of total fat, 67 grams of carbohydrate, 12.2 grams of dietary fiber and 3.6 mg of iron per 100 grams. Demand of the wheat is increasing gradually due to growing world population and millions of hectares of agriculture land are being lost every year in India due to abiotic and biotic stresses[2]. The water stress seemed to may have played a significant role in reducing the moisture and fat content of grain while concurrently increasing protein, ash and gluten contents as compared under to normal irrigation conditions[4].

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Wheat is an important winter season cereal shifted to warm regions due to changing climatic conditions such as drought, high-low temperature and salinity stress[11] significantly causes severe yield loss. Drought stress can reduce 17 to 80% of grain yield due to more sensitivity to abiotic stresses involving drought in wheat.

Thus, for effective selection, information on nature and magnitude of variation in population, association of character with yield and among themselves and the extent of environmental influence on the expression of these characters are necessary[11]. Variability in the base population is essential for selection of traits. The task of physiologist is to screen out phenophasic development and morpho-physiological structural component of productivity, quality and grain yield of wheat genotypes under restricted irrigation. The current investigation was carried out to determine the potential and promising wheat genotypes with suitable for yield performance along with quality index under different restricted irrigation conditions.

MATERIAL AND METHODS

The present investigation entitled **"**Correlation study in advanced lines of wheat (*Triticum aestivum* L.) under restricted Irrigation" was carried out during the *Rabi* season of 2013-14 and 2014-15. The experiment was carried out under Wheat Improvement Project at Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, JNKVV, Jabalpur (M.P.) under restricted irrigated conditions. The experiment conducted in Randomized Block design with three replications having 19 genotypes including 4 checks. The observation was recorded on five randomly selected plants from each plot and from each replication for the quality and quantitative characters.

Statistical analysis:

The Phenotypic and genotypic correlation coefficients between characters were computed utilizing respective components of variance and co-variance, by following formula,

Phenotypic correlation (rp) =PCOVxy / √PVx. PVy

Genotypic correlation (rg) = GCOVxy / √GVx . GVy

$$r_{xy} = \frac{\mathrm{Cov}\,(x,\,y)}{\sqrt{V(x) \times V\,(y)}}$$

Where,

r_{xy} = Correlation coefficient between character x and y,

Cov (x,y) = Co-variance of character x and y,

V(x) = Variance of character x, and

V(y) = Variance of character y.

rp = Phenotypic correlation.

rg = Genotypic correlation

To test the significance of correlation coefficients, the estimated values were compared with the tabulated values of Fisher and Yates (1938) at t-2 d.f. at two levels of probability, *viz*., 5% and 1%.

RESULT AND DISCUSSION

Correlation studies provide information on the nature and extent of association between any two pairs of metric characters. Correlation between any two traits results due to genotypic and environmental causes. Grain yield is the end product of interactions of many factors known as contributing components hence it is complex trait. Understanding of the interaction of characters among themselves and with the environment has been of great use in the plant breeding. From Correlation studies, it could be possible to bring about genetic up gradation in one character by selection of the other pair. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield. The breeder is always concerned for the selection of superior genotypes on the basis of phenotypic expression. However, for the quantitative characters, genotypes are influenced by environment, thereby affecting the phenotypic expression. Information regarding the nature and extent of association of morphological characters would be helpful in developing suitable plant type, in addition to the improvement of yield a complex character for which direct selection is not effective.

The phenotypic and genotypic correlation coefficients for different pair of character were studied. The correlation coefficients were tested for their significance at (n-2) degree of freedom with a view to draw a comparative idea of nature of association between different character combinations. The results of phenotypic correlation coefficients have been discussed only as the genotypic and environmental correlations were mostly influenced by the environmental conditions, hence phenotypic correlation will give the correct idea about the association between two variables.

Days to physiological maturity showed significant and positive correlation with only one character days to maturity (0.6591). While, no significant and negative association reported with others. Associations of other traits studied were very low in magnitude and non-significant of either sign. Days to maturity had positive and significant association with biological yield per plant (0.3014). While, associations of remaining other traits studied were also very low in magnitude and non-significant of either sign. Crop growth rate at 45 days reported significant and positive association between chlorophyll at 90 days (0.46), biological yield plant^{-1}, grains ear^{-1} (0.3981), leaf area duration (cm^{2}) at 45 days (0.3102). While, negative significant association estimated with spikelet ear^{-1} (-0.4698), 100 grain weight (-0.4266). Associations of remaining other traits studied were also very low in magnitude and non-significant of either sign. Characters having direct bearing on yield, their associations with other characters are to be considered simultaneously as this will indirectly affect yield. The results of correlation coefficients implied that significant positive correlations at both the levels were recorded for plant height with number of grains per spike and biological yield; with days to maturity.

The crop growth rate at 75 days had no positive significant association with other characters. While, negative significant association estimated with economic yield plant^{-1} (-0.0978). Associations of remaining other traits studied were also very low in magnitude and non-significant of either sign. These findings were in agreement with results of Khan[5] and Shukla[8]. However, these results were in disagreement with the findings of [3]. Leaf area duration at 75 days had positive and significant association with specific leaf area at 75 days (0.8098). While, negative and significant association with relative water content at 75 days (-0.2886). Associations of remaining other traits studied were also very low in magnitude and non-significant of either sign. Leaf area index at 45 days had positive significant correlation with leaf area index at 75 days (0.8534), harvest index (0.66616), biological yield plant^{-1}(0.3311), chlorophyll content at 75 days (0.1112). While, negative and significant association with relative water content at 75 days (-0.2989), nitrogen (-0.4485) and 1000 grain weight (-0.4253). Leaf area index at 75 days had positive significant correlation with specific leaf area at 75 days (0.2986), harvest index (0.6423), proline (0.2695). While, negative and significant association with nitrogen (-0.4652), biological y ield plnat^{-1}(-0.4155), 1000 grain weight (-0.3686), relative water content at 75 days (-0.3619), biomass duration (-0.3288) and chlorophyll content at 90 days (-0.2942). Associations of remaining other traits studied were also very low in magnitude and non-significant of either sign.

Biomass duration at 45 days had positive significant correlation with chlorophyll content at 90 days (0.3931), relative water content at 75 days (0.2798). While, significant and negative association reported with proline (-0.287). Associations of other traits studied were very low in magnitude and non-significant of either sign. Specific leaf area at 75 days had positive significant correlation with carbohydrate (0.3162). While, significant and negative association reported with 1000 grain weight (-0.4211), grains ear^{-1}(-0.2729). Associations of other traits studied were very low in magnitude and non-significant of either sign.

Chlorophyll content at 70 days had positive significant correlation with relative water content at 75 days (0.1759), plant height (0.2107) While, negative significant association reported with economic yield^{-1} (-0.2833). Chlorophyll content at 90 days had no positive significant correlation with other traits. While, negative significant association reported with harvest index (-0.3027), grains ear^{-1}(-0.2853). Associations of other traits studied were very low in magnitude and non-significant of either sign. RWC at 75 days had no positive significant association with other traits. While, negative significant correlation with harvest index (-0.4091). Associations of other traits studied with RWC at 75 days were very low in magnitude and negligible of either sign. RWC at 90 days had no positive and negative significant association with other traits.

Plant height had positive significant correlation with economic yield plant^{-1}(0.5500), spikelet per spike (0.3978), harvest index (0.3786). Some authors also reported that plant height has significant and positive association with grain yield[9]. Grain yield per plant showed highly significant and positive correlation with biological yield per plant, grains per spike, spike weight, tillers per plant and ear length whereas, negative significant correlation associated with proline (-0.3161). Correlations of other traits studied with plant height were very low in magnitude and non-significant of either sign. Number of tillers plant^{-1} had positive significant correlation with grain ear^{-1} (0.7721), economic yield plant^{-1}(0.7367), biological yield plant^{-1} (0.5553), spikelets per ear (0.4021), 1000 grain weight (0.3822). Correlations of other traits studied with plant height were very low in magnitude and non-significant of either sign. Number of spiklets plant^{-1} had positive significant correlation with biological yield plant^{-1}(0.6141), 1000 grain weight (0.5759), grains ear^{-1} (0.4789), and economic yield plant^{-1} (0.4130). Association of other traits studied with plant height was very low in magnitude and non-significant of either sign. The strong positive association of grain yield with one or more than one of the above studied traits has also been observed by previous workers [7]. Some studies indicated that 1000 kernel weight, grains per spike, tiller per meter and days to maturity have direct effect on yield. The indirect effects of tillers per plant, grain per spike, spike weight, ear length, harvest index, plant height and days to heading were of high order positive contribution on grain yield per plant via biological yield per plant[7]. Several researchers reported that grain yield was positively correlated with 1000-grain weight.

Economics yield plant^{-1} (0.6868), biological yield per plant (0.4240), 1000 grain weight (0.3786), and nitrogen (0.3371) had positive significant association. Correlations of other traits studied with number of grains per spike were very low in magnitude and non-significant of either sign. 1000-grain weight had positive significant association with economic yield plant^{-1}(0.7545), biological yield per plant (0.7227) and nitrogen (0.4928). Correlations of other traits studied with 1000 grain weight were very low in magnitude and non-significant of either sign. Biological yield per plant had positive significant association with nitrogen (0.4254) and economics yield plant^{-1}(0.3376). Associations of other traits studied were very low in magnitude and non-significant of either sign. The results obtained were supported by the reports of Singh *et al.*[9].

As regard harvest Index, no value had positive significant association with other traits. While, negative significant association estimated with proline (-0.4906), economic yield plant^{-1} (-0.3653). Associations of other traits studied with harvest Index were very low in magnitude and non-significant of either sign. Proline had positive significant association with economic yield plant^{-1} (-0.2713). Associations of other traits studied with proline were very low in magnitude and non-significant of either sign.

Carbohydrate had positive significant association with nitrogen (0.3476). Associations of other traits studied with carbohydrate were very low in magnitude and non-significant of either sign. Nitrogen had no positive and negative values significantly association with other traits. Protein had positive significant association with nitrogen (0.9345). Associations of other traits studied with protein were very low in magnitude and non-significant of either sign. In other research finding protein content was not significantly correlated with plant height, effective tillers plant^{-1}, grains spike^{-1}, 100-seed weight and grain yield plant^{-1} at both levels, except the negative correlation with effective tillers plant^{-1} at the genotypic level. Plant height showed no significant correlation with effective tillers plant^{-1}, grains spike^{-1}, 100-seed weight and grain yield plant^{-1} both at the phenotypic and genotypic levels. Similarly, grains spike^{-1}and 100-seed weight were not significantly correlated with each other or with grain yield plant^{-1} at the phenotypic and genotypic levels, except the positive correlation between 100-seed weight and grain yield plant^{-1} at the genotypic level[6].

From the foregoing discussions, it can be seen that characters such as biological yield, harvest index, number of grains per spike and grain weight per spike show effective correlations with grain yield and its components traits under restricted irrigation conditions. High positive association of biological yield with grain yield indicates that this character should be given keen importance while breeding for higher yield. The published report supports the results obtained in this investigation. Thus, it can be concluded that the characters biological yield, harvest index, grain filling duration, grains per spike and grain weight per spike should be given utmost consideration during breeding for moisture stress condition in order to minimize the losses in grain yields. Selection for shorter height and earlier maturity could also be effective for the above purpose. The correlation coefficient does not always give precise information on the contribution of each trait towards dependent variable. To understand the characters which really contribute towards grain yield, the path analysis is obvious.

Table 1: Genotypic correlation between yield and other traits

Characters	DPM	DTM	CGR 45	CGR 75	LAD 45	LAD 75	LAI 45	LAI 75	BMD 45	SLA 75	Chlo 70	Chlo 90	RWC 75	RWC 90
DPM	**1.000**	1.2876	0.2952	0.2347	0.3207	0.4116	-0.3127	-0.1843	0.1341	0.2441	-0.3094	-0.0065	-0.0802	0.1612
DTM		**1.000**	-0.0086	0.1384	0.0908	0.3343	-0.368	-0.2037	-0.0072	0.1318	-0.2852	-0.2746	-0.6505	-0.0496
CGR 45			**1.000**	-0.2179	0.3517	0.137	0.1808	0.2246	0.0542	0.0697	0.3073	0.5262	0.3522	0.2025
CGR 75				**1.000**	-0.2223	-0.1983	-0.1787	-0.2694	0.2527	0.0358	-0.2608	-0.1622	0.3861	-0.1864
LAD 45					**1.000**	0.8919	-0.0007	-0.0884	0.1234	0.7322	-0.0116	0.0590	-0.1105	0.1558
LAD 75						**1.000**	0.2515	0.1478	-0.0106	0.9049	-0.0975	-0.1581	-0.3383	0.1460
LAI 45							**1.000**	0.9446	-0.1887	0.3826	-0.1023	-0.2710	-0.3667	0.1225
LAI 75								**1.000**	-0.3509	0.2171	0.0093	-0.3179	-0.4529	0.2471
BMD									**1.0000**	0.1149	0.1870	0.4456	0.3970	-0.0200
SLA										**1.0000**	-0.2454	-0.2500	-0.2805	0.0010
Chlo 70											**1.0000**	0.3402	0.1424	0.5618
Chlo 90												**1.0000**	0.4063	-0.1251
RWC 75													**1.0000**	0.0061
RWC 90														**1.0000**
PH (cm)														
T/P														
S/ear														
G/ear														
1000 GW(g)														
BY/P														
HI														
Proline														
Protein														
Carbo														
N														
E/Y														

Table 2: Genotypic correlation between yield and other traits

Characters	PH (cm)	T/P	S/ear	G/ear	1000 GW (g)	BY/P	HI	Proline	Protein	Carbo	N	E/Y
DPM	-0.0913	0.1080	-0.1756	-0.1674	0.0678	0.4169	-0.3121	-0.0758	0.2608	-0.8918	0.2867	0.2256
DTM	0.0970	0.2101	0.0213	-0.0124	0.3463	0.6015	-0.1698	-0.0339	0.3342	-0.6635	0.3115	0.4539
CGR 45	-0.0868	-0.1931	-0.4842	-0.4093	-0.4361	-0.4043	-0.0647	0.1043	-0.2333	-0.2439	-0.2317	-0.4092
CGR 75	-0.2830	0.0991	-0.0340	-0.0833	-0.0543	-0.0764	0.0093	0.0862	-0.0005	-0.144	0.0053	-0.0792
LAD 45	-0.2866	-0.2570	-0.2862	-0.3424	-0.2796	-0.0276	-0.3403	0.1427	0.1434	-0.2564	0.1383	-0.247
LAD 75	-0.2060	-0.0957	0.0156	-0.1628	-0.2271	0.0730	-0.0213	-0.0102	0.0857	-0.1469	0.0865	0.0641
LAI 45	0.0227	0.0097	-0.0400	-0.1074	-0.4546	-0.3545	0.7167	-0.3423	-0.4756	0.2242	-0.4813	0.1374
LAI 75	0.0566	-0.1361	-0.1392	-0.1491	-0.4170	-0.4327	0.7301	-0.2820	-0.6246	0.4227	-0.6626	0.0586
BMD	0.3441	0.2830	0.1752	0.0473	-0.0234	0.0696	0.0085	-0.2977	0.2931	-0.2693	0.29	0.0844
SLA	-0.2208	-0.2320	0.0430	-0.2866	-0.4574	-0.1642	0.2054	-0.0955	-0.1694	0.1118	-0.2057	-0.0442
Chlo 70	0.2399	0.0195	-0.2290	-0.1063	-0.0880	-0.2742	-0.0439	-0.1945	-0.2399	-0.0923	0.2319	-0.2993
Chlo 90	0.1794	-0.1410	-0.2113	-0.4085	-0.0731	-0.0613	-0.3096	0.1721	0.1299	-0.0937	0.1233	-0.2498
RWC 75	-0.3717	0.0387	-0.1155	-0.2800	0.0510	0.1070	-0.4786	0.0997	0.0536	-0.1316	0.0407	-0.2002
RWC 90	0.1173	0.0083	-0.0495	-0.0726	-0.0349	-0.1118	-0.0340	0.0810	-0.1257	0.0253	-0.1328	-0.1173
PH (cm)	**1.0000**	0.0624	0.3238	-0.0259	0.3961	0.1036	0.4991	-0.3665	0.1374	-0.2423	0.1429	0.4322
T/P		**1.0000**	0.5190	0.7590	0.4335	0.6216	0.0217	-0.1712	0.2951	0.0364	0.2968	0.6063
S/ear			**1.0000**	0.5329	0.6199	0.6659	0.2264	-0.1360	0.2855	0.0913	0.2897	0.7813
G/ear				**1.0000**	0.4998	0.5630	0.0235	-0.2010	0.4884	0.0082	0.4928	0.5309
1000 GW (g)					**1.0000**	0.7557	-0.1178	0.1276	0.5638	0.0585	0.5604	0.6697
BY/P						**1.0000**	-0.3662	-0.0199	0.4942	-0.0159	0.495	0.7772
HI							**1.0000**	-0.5202	-0.2623	0.0016	-0.2582	0.3426
Proline								**1.0000**	0.0783	0.2018	0.0829	-0.3784
Protein									**1.0000**	-0.0825	1.0376	0.3163
Carbo										**1.000**	0.1491	0.0304
N											**1.000**	0.311
E/Y												**1.000**

Table 3: Phenotypic correlation between yield and other traits

Characters	DPM	DTM	CGR 45	CGR 75	LAD 45	LAD 75	LAI 45	LAI 75	BMD 45	SLA 75	Chlo 70	Chlo 90	RWC 75	RWC 90
DPM	**1.000**	0.6591***	0.1411	0.0943	0.2523	0.171	-0.2143	-0.1742	0.0162	0.0612	0.1637	0.0779	0.1091	0.007
DTM		**1.0000**	-0.0664	0.0051	0.254	0.1396	-0.2258	-0.1379	-0.0514	0.0371	-0.0427	0.1049	0.1846	-0.0819
CGR 45			**1.000**	-0.1197	0.3102*	0.1087	0.1644	0.2223	0.0383	0.0809	0.2554	0.46***	0.2236	0.1508
CGR 75				**1.000**	-0.2249	-0.2006	-0.1663	-0.225	0.2185	0.0501	-0.2452	-0.1712	0.2376	-0.1581
LAD 45					**1.000**	0.8164***	0.0078	-0.00876	0.1019	0.6601***	0.0231	0.1321	0.0617	0.1078
LAD 75						**1.000**	0.02541	0.1248	0.0546	0.8098***	0.11167	-0.1611	-0.2886*	0.1682
LAI 45							**1.000**	0.8534***	0.1631	0.3368	*0.1112	-0.2597	-0.2989*	0.2303
LAI 75								**1.000**	-0.3288*	0.2986*	-0.0280	-0.2942*	-0.3619**	0.1683
BMD									**1.000**	0.0984	0.1357	0.3931**	0.2798*	0.0201
SLA										**1.000**	-0.2499	-0.25553	-0.2364	-0.028
Chlo 70											**1.000**	0.3345	*0.1759	0.3883
Chlo 90												**1.000**	0.3883*	0.2107
RWC 75													**1.000**	-0.0342
RWC 90														**1.000**
PH (cm)														
T/P														
S/ear														
G/ear														
1000 GW(g)														
BY/P														
HI														
Proline														
Protein														
Carbo														
N														
E/Y														

Table 4: Phenotypic correlation between yield and other traits

Characters	PH (cm)	T/P	S/ear	G/ear	1000 GW (g)	BY/P	HI	Proline	Protein	Carbo	N	E/Y
DPM	-0.0055	0.0821	-0.0825	-0.413	-0.0053	0.2307	-0.2016	-0.0622	0.1078	0.0373	0.0829	0.0982
DTM	0.1459	0.1673	0.059	0.0881	0.1563	0.3014*	-0.1510	-0.0426	0.105	0.0912	0.1328	0.2294
CGR 45	-0.115	-0.1921	-0.4698***	0.3623**	-0.4266***	0.3981**	-0.0837	0.096	-0.1864	0.1825	-0.1883	-0.4041
CGR 75	-0.2741	0.0729	-0.05	-0.1015	-0.0771	-0.091	-0.0179	0.0792	0.0242	0.1328	0.0241	**-0.0978
LAD 45	-0.2063	-0.2185	-0.2533	-0.2448	-0.274*	-0.0388	-0.3337*	0.1298	0.1097	0.1021	0.1162	-0.2429
LAD 75	-0.2022	-0.1022	-0.0028	-0.1573	0.2007	0.0828	-0.0024	-0.0015	0.0616	0.0292	0.0637	0.0679
LAI 45	0.0037	-0.0132	0.046	-0.1248	-0.4253***	0.3311*	0.6616***	0.3056	-0.4555	'0.1580	-0.4485 **	0.1256
LAI 75	0.0037	-0.1455	-0.1505	-0.165	-0.3868**	-0.4155**	0.6423***	0.2695*	-0.5315	'0.1489	-0.4652 **	0.0497
BMD	0.2553	0.2534	0.1497	0.0236	-0.0126	0.0738	0.0161	-0.287*	0.2583	0.1067	0.2529	0.0873
SLA	-0.22219	-0.233	0.15	-0.2729*	-0.4211**	-0.1665	0.1678	0.0936	-0.1234	0.3162*	-0.0576	-0.0445
Chlo 70	**0.2107	0.03037	-0.1906	-0.0546	0.1006	-0.2494	-0.0516	-0.1862	-0.2224	-0.0788	-0.2345	-0.2833*
Chlo 90	0.028	-0.1051	-0.1778	-0.2853*	-0.0819	-0.078	-0.3027*	0.1522	0.088	0.0110	0.0972	-0.2425
RWC 75	-0.1832	0.0658	-0.0553	-0.1232	0.0179	0.0568	-0.4091**	0.0367	-0.0102	-0.0190	0.0071	-0.1721
RWC 90	0.0413	-0.042	-0.0645	-0.1356	-0.0237	-0.0813	-0.0231	0.1216	-0.1552	-0.1143	-0.1407	-0.1014
PH (cm)	**1.000**	0.0992	0.3978**	0.0768	0.3197	0.0619	0.3786**	-0.3161*	0.0841	-0.0401	0.0657	0.550***
T/P		**1.000**	0.4021***	0.7721***	0.3822**	0.5553***	0.0050	-0.1728	0.2468	-0.0918	0.2374	**0.7367*** **
S/ear			**1.000**	0.4789***	0.5759***	0.6141***	0.1936	-0.134	0.2467	-0.1262	0.2336	**0.4130** **
G/ear				**1.000**	0.3786**	0.4240**	-0.0236	-0.1856	0.3507	-0.1437	0.3371 *	**0.6868*** **
1000 GW (g)					**1.000**	0.727***	0.0890	0.1269	0.485	0.0498	0.4928 **	**0.7545*** **
BY/P						**1.000**	-0.2745	-0.0164	0.4351	0.0556	0.4254 **	0.3376*
HI							**1.000**	-0.4906***	0.2503	0.0735	-0.2534	-0.3653**
Proline								**1.000**	0.0628	0.1189	0.0707	0.2713*
Protein									**1.000**	0.1284	0.9345 **	-0.0321
Carbo										**1.000**	0.3476 **	0.2750
N											1.000	0.3476
E/Y												1.000

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