



STUDIES ON CORRELATION AND PATH ANALYSIS IN INDIAN GENOTYPES OF ITALIAN MILLET [*Setaria italica* (L.) BEAUV]

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Abstract- Correlation and path analysis studied in 18 Indian genotypes for 13 characters during *kharif* and *rabi*. The study indicated that direct selection based on the traits, number of productive tillers per plant and ear weight during *kharif* where as in *rabi* days to maturity and ear weight are effective as the association and direct effects were positive for these traits. The association of protein and calcium content and carotene with grain yield is negative. Simultaneous improvement of grain yield along these traits is not possible so we have to seek a compromise among the attributes to find out an acceptable level of the characters under improvement. The path analysis study indicated that direct selection based on the characters, number of productive tillers per plant and ear weight during *kharif* where as in *rabi* days to maturity and ear weight are effective as the association and direct effects were positive for these traits.

Keywords- Italian millet, correlation, path analysis, foxtail millet, Indian genotypes of Italian millet

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Introduction

The aim of correlation studies is primarily to know the suitability of various characters for indirect selection because selection on any particular trait may bring about undesirable changes in other associated characters [11].

Foxtail millet ranks second in the world's total production of millets and is an important staple food for millions of people in Southern Europe and Asia. Foxtail millet is well adapted to temperate, subtropical and tropical Asia. It is essentially dry land crop on marginal and sub marginal lands although the world. It is grown to meet the domestic needs of rural people. It is usually cooked whole or made into meal or into beer. It can also make useful hay or silage. In addition foxtail millet is consumed as stiff porridge called sargati, or as leavened bread known as roti, after the dehulled grain has been milled into flour. Foxtail millet with a short growing period is grown extensively in diverse agro-climatic regions for grain and fodder. It is known for its drought tolerance and is an indispensable crop of vast rain fed areas in semi-arid regions in India. It is also grown in nutrient deficient soils and possesses tolerance to pests and diseases.

Material and Methods

The present investigation was undertaken at Agricultural College Farm, Bapatla, Guntur (Dt.), Andhra Pradesh with the 18 Indian genotypes of Italian millet [*Setaria italica* (L.) Beauv] obtained from All India Co-ordinated Small Millets Improvement Project (AICSMIP), Bengaluru. The studies were carried out separately during two consecutive seasons of 2008-2009, namely *kharif* 2008

and *rabi* 2009. The genotypes are sown separately in randomized block design with four replications. Each genotype was sown in four rows of 5mts length spaced at 25 X 10 cm apart. Data were collected on 10 randomly tagged competitive plants per genotype per replication for number of productive tillers per plant, plant height, flag leaf area, ear length, ear weight, straw weight, grain yield. However data on days to 50 %flowering, days to maturity, grain protein%, calcium content and grain β -carotene were recorded on plot basis.

Results and Discussion

Genotypic correlations in general were higher than phenotypic correlations. This may be due to the relative stability of genotypes as majority of them were subjected to certain amount of selection [5]. In the present study genotypic correlations are higher than phenotypic correlation for all the characters during both seasons.

The observed correlation between yield and its particular component is the net result of direct and indirect effects of the component characters through other yield attributes. The total correlation between grain yield and its component characters may sometimes be misleading. Since, it may be over or under estimate of its association with other characters. Hence, direct selection on correlated response basis may not be rewarding. The correlation coefficient needs to be split into direct and indirect effects, using path coefficient analysis for critical evaluation as many characters affect a given trait. Thus, the correlation and path analysis in combination, can give a better insight, into cause and effect relationship between different pairs of characters.

The phenotypic and genotypic correlation coefficients between yield and yield components and inter- relationship among them were

estimated and presented in the [Table-1] and [Table-2] during *kharif* 2008 and *rabi* 2009 respectively.

Table 1- Estimates of phenotypic and genotypic correlation coefficients among yield and yield components in Italian millet [*Setaria italica* (L.) Beauv] during *kharif* 2008 for Indian genotypes

S. No	Character	Days to 50 flowering	Plant Height (cm)	Days to Maturity	No. of Productive Tillers	Flag leaf Area (cm ²)	Ear Length (cm)	Ear Weight (g)	Straw Weight (g)	1000 Grain Weight (g)	Carotene (mg/100g)	Crude Protein (%)	Calcium Content (mg/100g)	Grain Yield Per Plant (g)
1	Days to 50 % flowering	-	0.5243**	0.8228**	0.4425**	0.6514**	0.6591**	0.3424**	0.4448**	-0.074	0.0647	0.0325	-0.0501	0.4231**
2	Plant height(cm)	0.5760**	-	0.3462**	0.9285**	0.7626**	0.5121**	0.8281**	0.8268**	0.1058	-0.2417*	0.1625	-0.4167**	0.9124**
3	Days to maturity	0.8927**	0.3635**	-	0.2184	0.5141**	0.5136**	0.0741	0.2578*	-0.0225	0.02	-0.0706	0.0002	0.171
4	No. of productive tillers	0.4956**	0.9387**	0.2262	-	0.7221**	0.5715**	0.8797**	0.8267**	0.0544	-0.2452*	0.2741*	-0.4293**	0.9732**
5	Flag leaf area(cm ²)	0.7162**	0.7678**	0.5365**	0.7325**	-	0.5846**	0.6473**	0.6957**	-0.0045	-0.0853	0.3385**	-0.0936	0.7037**
6	Ear length(cm)	0.7232**	0.5187**	0.5296**	0.5778**	0.5920**	-	0.4354**	0.5505**	-0.0999	-0.2443*	0.3394**	-0.3726**	0.5229**
7	Ear weight(g)	0.3804**	0.8454**	0.0796	0.8985**	0.6656**	0.4383**	-	0.6937**	-0.0392	-0.0674	0.3725**	-0.2524*	0.9167**
8	Straw weight(g)	0.4880**	0.8364**	0.2686*	0.8330**	0.7040**	0.5563**	0.7085**	-	0.2867*	-0.1301	0.2164	-0.3935**	0.7764**
9	1000 grain weight(g)	-0.0951	0.1105	-0.0273	0.0517	-0.0044	-0.1026	-0.0438	0.2933*	-	0.0427	-0.6011**	0.1771	-0.0135
10	Carotene (mg/100g)	0.0809	-0.2694*	0.0049	-0.2682*	-0.1174	-0.2696*	-0.0621	-0.1537	0.0689	-	-0.1238	0.3987**	-0.2204*
11	Crude protein(%)	0.0321	0.165	-0.0708	0.2789*	0.3437**	0.3409**	0.3802**	0.218	-0.6125**	-0.1374	-	-0.3487**	0.2906*
12	calcium content (mg/100g)	-0.0546	-0.4225**	-0.0019	-0.4329**	-0.0951	-0.3771**	-0.2587*	-0.3978**	0.1802	0.4481**	-0.3516**	-	-0.3822**
13	Grain yield per plant (g)	0.4541**	0.9298**	0.1727	0.9965**	0.7221**	0.5319**	0.9356**	0.7908**	-0.0109	-0.2579*	0.2971*	-0.3976**	-

*and ** = significant at 5% and 1% level, respectively;

Values above diagonal indicate phenotypic correlation and values below diagonal indicate genotypic correlation coefficients, respectively

Table 2- Estimates of phenotypic and genotypic correlation coefficients among yield and yield components in Italian millet [*Setaria italica* (L.) Beauv] during *rabi* 2009 for Indian genotypes

S. No	Character	Days to 50 flowering	Plant height (cm)	Days to maturity	No. of productive tillers	Flag leaf area (cm ²)	Ear length (cm)	Ear weight (g)	Straw weight (g)	1000 grain weight (g)	Carotene (mg/100g)	Crude protein (%)	Calcium content (mg/100g)	Grain yield per plant (g)
1	Days to 50 % flowering	-	0.5166**	0.9420**	0.7279**	0.2818*	0.4288**	0.4040**	0.7143**	0.1211	0.4878**	-0.1768	-0.1188	0.6514**
2	Plant height(cm)	0.5487**	-	0.4904**	0.3613**	0.1153	0.4062**	0.0639	0.5092**	-0.1628	0.3151**	0.0558	-0.0635	0.2495*
3	Days to maturity	0.9838**	0.5125**	-	0.7312**	0.2637*	0.4070**	0.4996**	0.7528**	0.0944	0.4715**	-0.2179	-0.0851	0.7464**
4	No. of productive tillers	0.7729**	0.3630**	0.7582**	-	0.1331	0.3182**	0.3627**	0.6614**	0.0911	0.3251**	-0.2724*	-0.0634	0.6530**
5	Flag leaf area(cm ²)	0.2915*	0.1163	0.2771*	0.1337	-	0.6179**	0.4615**	0.1897	0.3956**	0.0658	0.1644	0.2661*	0.0671
6	Ear length	0.4627**	0.4119**	0.4288**	0.3198**	0.6254**	-	0.3913**	0.3167**	-0.0569	0.2528*	-0.0432	0.3623**	0.1716
7	Ear weight(g)	0.4280**	0.0656	0.5269**	0.3671**	0.4700**	0.3987**	-	0.4874**	0.5292**	0.0267	-0.2886*	0.2152	0.7233**
8	Straw weight(g)	0.7526**	0.5172**	0.7759**	0.6722**	0.1937	0.3215**	0.5014**	-	-0.0339	0.136	0.0454	-0.0854	0.7776**
9	1000 grain weight(g)	0.1306	-0.1651	0.0961	0.0931	0.4052**	-0.0537	0.5356**	-0.0305	-	-0.0736	-0.0728	-0.2339*	0.2354*
10	Carotene (mg/100g)	0.5818**	0.3454**	0.5494**	0.3592**	0.0704	0.2757*	0.0328	0.1398	-0.0696	-	-0.0999	0.3127**	0.1682
11	crude protein (%)	-0.1948	0.055	-0.2362*	-0.2750*	0.1687	-0.039	-0.2899*	0.0512	-0.072	-0.1021	-	-0.0597	-0.1834
12	calcium content (mg/100g)	-0.1232	-0.0636	-0.0821	-0.0649	0.2680*	0.3642**	0.2138	-0.0852	-0.2376*	0.3449**	-0.0576	-	-0.0466
13	Grain yield per plant (g)	0.6934**	0.2599*	0.7788**	0.6733**	0.0695	0.1769	0.7506**	0.8050**	0.2321*	0.1731	-0.1865	-0.0465	-

*and ** = significant at 5% and 1% level, respectively;

Values above diagonal indicate phenotypic correlation and values below diagonal indicate genotypic correlation coefficients, respectively

Table 3- Estimates of direct and indirect effects (phenotypic) of yield components on yield per plant in Italian millet [*Setaria italica* (L.) Beauv] during *kharif* 2008 for Indian genotypes.

S. No	Character	Days to 50 flowering	Plant Height (cm)	Days to Maturity	No. of Productive Tillers	Flag Leaf Area (cm ²)	Ear length (cm)	Ear Weight (g)	Straw Weight (g)	1000 Grain Weight (g)	Carotene (mg/100g)	Crude Protein (%)	Calcium Content (mg/100g)
1	Days to 50 % flowering	0.0411	0.0215	0.0338	0.0182	0.0267	0.0271	0.0141	0.0183	-0.003	0.0027	0.0013	-0.0021
2	Plant height (cm)	0.0161	0.0308	0.0107	0.0286	0.0235	0.0158	0.0255	0.0254	0.0033	-0.0074	0.005	-0.0128
3	Days to maturity	-0.0521	-0.0219	-0.0633	-0.0138	-0.0325	-0.0325	-0.0047	-0.0163	0.0014	-0.0013	0.0045	0
4	No. of productive tillers	0.3157	0.6624	0.1558	0.7135	0.5152	0.4077	0.6276	0.5898	0.0388	-0.1749	0.1955	-0.3063
5	Flag leaf area(cm ²)	0.0194	0.0227	0.0153	0.0215	0.0298	0.0174	0.0193	0.0207	-0.0001	-0.0025	0.0101	-0.0028
6	Ear length(cm)	-0.0138	-0.0107	-0.0108	-0.012	-0.0123	-0.021	-0.0091	-0.0116	0.0021	0.0051	-0.0071	0.0078
7	Ear weight(g)	0.089	0.2153	0.0193	0.2288	0.1683	0.1132	0.26	0.1804	-0.0102	-0.0175	0.0969	-0.0656
8	Straw weight(g)	0.0055	0.0103	0.0032	0.0103	0.0087	0.0069	0.0086	0.0124	0.0036	-0.0016	0.0027	-0.0049
9	1000 grain weight(g)	0.0071	-0.0101	0.0021	-0.0052	0.0004	0.0095	0.0037	-0.0274	-0.0955	-0.0041	0.0574	-0.0169
10	Carotene (mg/100g)	-0.002	0.0075	-0.0006	0.0076	0.0026	0.0076	0.0021	0.004	-0.0013	-0.031	0.0038	-0.0124
11	Crude protein(%)	-0.0025	-0.0125	0.0054	-0.0211	-0.0261	-0.0262	-0.0287	-0.0167	0.0463	0.0095	-0.0771	0.0269
12	Calcium content (mg/100g)	-0.0003	-0.0029	0	-0.003	-0.0006	-0.0026	-0.0017	-0.0027	0.0012	0.0028	-0.0024	0.0069
13	Grain yield per plant(g)	0.4231**	0.9124**	0.171	0.9732**	0.7037**	0.5229**	0.9167**	0.7764**	-0.0135	-0.2204*	0.2906*	-0.3822**

*and ** = significant at 5% and 1% level, respectively;

R SQUARE = 0.9701 RESIDUAL EFFECT = 0.1730;

Bold and diagonal values indicate direct effects

The study of Indian genotypes during *kharif* revealed positive significant correlation of days to 50% flowering, plant height, number of productive tillers per plant, flag leaf area, ear length, ear weight, straw weight and protein content with grain yield per plant and improvement of seed yield may be possible if the above traits are considered in the selection programme. During *rabi* the study revealed positive significant correlation of days to 50% flowering, plant height, days to maturity, number of productive tillers per plant, ear weight, straw weight and 1000 grain weight with grain yield per plant and improvement of seed yield may be possible if the above traits are considered in the selection programme.

The association of protein and calcium content and carotene with grain yield is negative. Simultaneous improvement of grain yield along these traits is not possible so we have to seek a compromise

among the attributes to find out an acceptable level of the characters under improvement. Similar results were earlier recorded by [1-4,6-8,10].

Path Coefficient Analysis

The direct and indirect effects of different yield components on grain yield worked out through path analysis at phenotypic and genotypic levels are presented during *kharif* 2008 and *rabi* 2009 in [Table-3], [Table-4], [Table-5] and [Table-6]. The path analysis study in Indian genotypes indicated that direct selection based on the characters, number of productive tillers per plant and ear weight during *kharif* where as in *rabi* days to maturity and ear weight are effective as their association and direct effects were positive. High phenotypical residual effect during *rabi* might be due to non significant association of several characters. Similar results were also noted by [2,6-8].

Table 4- Estimates of direct and indirect effects (genotypic) of yield components on yield per plant in Italian millet [*Setaria italica* (L.) Beauv] during *kharif* 2008 for Indian genotypes.

S.No	Character	Days to 50 flowering	Plant height (cm)	Days to maturity	No. of productive tillers	Flag leaf area (cm ²)	Ear length (cm)	Ear weight (g)	Straw weight (g)	1000 grain weight (g)	Carotene (mg/100g)	crude protein (%)	calcium content (mg/100g)
1	Days to 50 % flowering	1.8486	1.0647	1.6503	0.9161	1.3239	1.337	0.7031	0.9022	-0.1758	0.1496	0.0594	-0.101
2	Plant height (cm)	-0.2972	-0.516	-0.1875	-0.4844	-0.3962	-0.2677	-0.4362	-0.4315	-0.057	0.139	-0.0851	0.218
3	Days to maturity	-0.7814	-0.3181	-0.8753	-0.198	-0.4696	-0.4636	-0.0697	-0.2351	0.0239	-0.0043	0.062	0.0017
4	No. of productive tillers	0.4612	0.8736	0.2105	0.9306	0.6817	0.5377	0.8362	0.7752	0.0482	-0.2496	0.2596	-0.4029
5	Flag leaf area(cm ²)	-0.175	-0.1876	-0.1311	-0.179	-0.2444	-0.1447	-0.1627	-0.172	0.0011	0.0287	-0.084	0.0232
6	Ear length(cm)	-0.5556	-0.3985	-0.4069	-0.4439	-0.4548	-0.7682	-0.3367	-0.4274	0.0788	0.2071	-0.2619	0.2897
7	Ear weight(g)	0.1382	0.3072	0.0289	0.3265	0.2419	0.1593	0.3633	0.2574	-0.0159	-0.0226	0.1382	-0.094
8	Straw weight(g)	-0.1253	-0.2147	-0.0689	-0.2138	-0.1807	-0.1428	-0.1818	-0.2567	-0.0753	0.0394	-0.056	0.1021
9	1000 grain weight(g)	-0.0473	0.0549	-0.0136	0.0257	-0.0022	-0.051	-0.0218	0.1459	0.4973	0.0343	-0.3046	0.0896
10	Carotene(mg/100g)	-0.0358	0.1193	-0.0022	0.1187	0.052	0.1194	0.0275	0.068	-0.0305	-0.4427	0.0608	-0.1984
11	Crude protein(%)	0.0144	0.0742	-0.0319	0.1255	0.1546	0.1534	0.171	0.0981	-0.2755	-0.0618	0.4498	-0.1582
12	Calcium content (mg/100g)	0.0092	0.0708	0.0003	0.0725	0.0159	0.0632	0.0433	0.0666	-0.0302	-0.0750	0.0589	-0.1675
13	Grain yield per plant(g)	0.4541**	0.9298**	0.1727	0.9965**	0.7221**	0.5319**	0.9356**	0.7908**	-0.0109	-0.2579*	0.2971*	-0.3976**

*and **= significant at 5% and 1% level, respectively;
 R SQUARE = 0.9701 RESIDUAL EFFECT = 0.1730;
 Bold and diagonal values indicate direct effects

Table 5- Estimates of direct and indirect effects (phenotypic) of yield components on yield per plant in Italian millet [*Setaria italica* (L.) Beauv] during *rabi* 2009 for Indian genotypes.

S. No	Character	Days to 50 flowering	Plant height (cm)	Days to maturity	No. of productive tillers	Flag leaf area (cm ²)	Ear length (cm)	Ear weight (g)	Straw weight (g)	1000 grain weight (g)	Carotene (mg/100g)	crude protein (%)	calcium content (mg/100g)
1	Days to 50 % flowering	-0.0231	-0.0119	-0.0218	-0.0168	-0.0065	-0.0099	-0.0093	-0.0165	-0.0028	-0.0113	0.0041	0.0027
2	Plant height (cm)	-0.0281	-0.0544	-0.0267	-0.0197	-0.0063	-0.0221	-0.0035	-0.0277	0.0089	-0.0172	-0.003	0.0035
3	Days to maturity	0.3437	0.1789	0.3648	0.2668	0.0962	0.1485	0.1823	0.2746	0.0344	0.172	-0.0795	-0.031
4	No. of productive tillers	0.1366	0.0678	0.1372	0.1877	0.025	0.0597	0.0681	0.1241	0.0171	0.061	-0.0511	-0.0119
5	Flag leaf area(cm ²)	-0.0941	-0.0385	-0.088	-0.0444	-0.3338	-0.2063	-0.154	-0.0633	-0.132	-0.022	-0.0549	-0.0888
6	Ear length(cm)	-0.0441	-0.0418	-0.0419	-0.0328	-0.0636	-0.1029	-0.0403	-0.0326	0.0059	-0.026	0.0044	-0.0373
7	Ear weight(g)	0.253	0.0401	0.3129	0.2272	0.2891	0.2451	0.6264	0.3053	0.3315	0.0167	-0.1808	0.1348
8	Straw weight(g)	0.1502	0.1071	0.1583	0.139	0.0399	0.0666	0.1025	0.2102	-0.0071	0.0286	0.0095	-0.018
9	1000 grain weight(g)	-0.0008	0.001	-0.0006	-0.0006	-0.0025	0.0004	-0.0034	0.0002	-0.0064	0.0005	0.0005	0.0015
10	Carotene(mg/100g)	-0.0108	-0.007	-0.0105	-0.0072	-0.0015	-0.0056	-0.0006	-0.003	0.0016	-0.0222	0.0022	-0.0069
11	Crude protein(%)	-0.0294	0.0093	-0.0362	-0.0452	0.0273	-0.0072	-0.0479	0.0075	-0.0121	-0.0166	0.166	-0.0099
12	Calcium content (mg/100g)	-0.0018	-0.0009	-0.0013	-0.0009	0.0039	0.0054	0.0032	-0.0013	-0.0035	0.0046	-0.0009	0.0148
13	Grain yield per plant(g)	0.6514**	0.2495*	0.7464**	0.6530**	0.0671	0.1716	0.7233**	0.7776**	0.2354*	0.1682	-0.1834	-0.0466

*and **= significant at 5% and 1% level, respectively.
 R SQUARE = 0.9064 RESIDUAL EFFECT = 0.306

Table 6- Estimates of direct and indirect effects (genotypic) of yield components on yield per plant in Italian millet [*Setaria italica* (L.) Beauv] during rabi 2009 for Indian genotypes.

S.No	Character	Days to 50 flowering	Plant height (cm)	Days to maturity	No. of productive tillers	Flag leaf area (cm ²)	Ear length (cm)	Ear weight (g)	Straw weight (g)	1000 grain weight (g)	Carotene (mg/100g)	crude protein (%)	calcium content (mg/100g)
1	Days to 50 % flowering	0.4794	0.2631	0.4716	0.3705	0.1397	0.2218	0.2052	0.3608	0.0626	0.2789	-0.0934	-0.0591
2	Plant height (cm)	0.0026	0.0048	0.0024	0.0017	0.0006	0.002	0.0003	0.0025	-0.0008	0.0016	0.0003	-0.0003
3	Days to maturity	0.5235	0.2727	0.5321	0.4034	0.1475	0.2282	0.2803	0.4129	0.0511	0.2923	-0.1257	-0.0437
4	No. of productive tillers	0.1453	0.0683	0.1426	0.1881	0.0251	0.0601	0.069	0.1264	0.0175	0.0676	-0.0517	-0.0122
5	Flag leaf area(cm ²)	-0.1406	-0.0561	-0.1337	-0.0645	-0.4823	-0.3016	-0.2267	-0.0934	-0.1954	-0.034	-0.0814	-0.1293
6	Ear length(cm)	-0.0938	-0.0835	-0.0869	-0.0648	-0.1268	-0.2027	-0.0808	-0.0652	0.0109	-0.0559	0.0079	-0.0738
7	Ear weight(g)	0.288	0.0441	0.3545	0.247	0.3162	0.2682	0.6728	0.3373	0.3604	0.0221	-0.195	0.1438
8	Straw weight(g)	-0.1584	-0.1088	-0.1633	-0.1415	-0.0408	-0.0677	-0.1055	-0.2105	0.0064	-0.0294	-0.0108	0.0179
9	1000 grain weight(g)	-0.0028	0.0036	-0.0021	-0.002	-0.0088	0.0012	-0.0117	0.0007	-0.0218	0.0015	0.0016	0.0052
10	Carotene (mg/100g)	-0.2513	-0.1492	-0.2373	-0.1552	-0.0304	-0.1191	-0.0142	-0.0604	0.03	-0.4319	0.0441	-0.149
11	Crude protein(%)	-0.0649	0.0183	-0.0787	-0.0917	0.0562	-0.013	-0.0966	0.0171	-0.024	-0.034	0.3334	-0.0192
12	Calcium content (mg/100g)	-0.0337	-0.0174	-0.0224	-0.0177	0.0732	0.0994	0.0584	-0.0233	-0.0649	0.0942	-0.0157	0.2731
13	Grain yield per plant (g)	0.6934**	0.2599*	0.7788**	0.6733**	0.0695	0.1769	0.7506**	0.8050**	0.2321*	0.1731	-0.1865	-0.0465

*and **= significant at 5% and 1% level, respectively

RESIDUAL EFFECT = 0.1175

Bold and diagonal values indicate direct effect

Conclusion

The study of Indian genotypes during *kharif* 2008 revealed positive significant correlation of days to 50% flowering, plant height, number of productive tillers per plant, flag leaf area, ear length, ear weight, straw weight and protein content with grain yield per plant and improvement of grain yield may be possible if these traits are considered in the selection programme.

The study of Indian genotypes during *rabi* 2009 revealed positive significant correlation of days to 50% flowering, plant height, days to maturity, number of productive tillers per plant, ear weight, straw weight and 1000 grain weight with grain yield per plant and improvement of grain yield may be possible if the above traits are considered in the selection programme.

The association of protein content and calcium content with grain yield is negative, while with carotene is negative *kharif* only. Simultaneous improvement of these two traits is not possible so we have to strike a balance among the attributes to find out an acceptable level of the characters under improvement.

The study of Indian genotypes indicated that direct selection based on the traits, number of productive tillers per plant and ear weight during *kharif* where as in *rabi* days to maturity and ear weight are effective as the association and direct effects were positive for these traits.

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References

- [1] Chidambaram S. and Palanisamy (1995) *Madras Agricultural Journal*, 82(1), 1-3.
- [2] Dhagath N.K., Patidar G.L., Shrivastava P.S and Joshi R.C (1973) *JNKVV Research Journal*, 7, 2312-215.
- [3] Singh G. (1974) *Indian Journal of Genetics and Plant Breeding*, 34(2), 411-416.
- [4] Godawat S.L and Gupta S.C. (1981) *Madras Agricultural Journal*, 68(3), 153-156.

- [5] Johnson H.W., Robinson H.F and Comstock R.E. (1955) *Agronomy Journal*, 47, 314-318.
- [6] Murugan R. and Nirmalakumari A. (2006) *Indian Journal of Genetics*, 66(4), 339-340.
- [7] Nagarajan K. and Prasad M.N. (1980) *Madras Agricultural Journal*, 67(1), 28-38.
- [8] Reddy C.D.R and Jhansi Lakshmi K. (1991) *Indian journal of Genetics*, 51(2), 272-275.
- [9] Sandhu T.S., Arora B.S. and Singh Y. (1974) *Indian Journal of Agricultural Sciences*, 44(9), 563-566.
- [10] Singh K.D and Nagaraja Rao M. (1989) *Journal of Research APAU*, XVII, 68-69.
- [11] Singh P. (1998) *Cotton Breeding*, Kalyani Publishers, New Delhi, 191-211.