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INTERRELATIONSHIPS BETWEEN YIELD AND YIELD COMPONENTS IN FOXTAIL MILLET [*Setaria italica* (L.) Beauv.] GENOTYPES

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ABSTRACT

Thirty four genotypes of foxtail millet evaluated for correlation and path coefficient analysis at research farm of Tirhut College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar. Data were recorded for twelve quantitative characters, viz., plant height, days to flowering, number of basal tillers per plant, flag leaf blade length, flag leaf blade width, flag leaf sheath length, peduncle length, panicle exertion, inflorescence length, inflorescence width, weight of five panicles, yield per plot, yield per hectare. Correlation studies indicated that positive correlation was observed for weight of five panicles, inflorescence length, inflorescence width, flag leaf sheath length, flag leaf blade length, flag leaf blade width, number of basal tillers, plant height and days to fifty per cent flowering with yield per hectare and out of these inflorescence length (0.2199*), inflorescence width (0.5270**) and weight of five panicles (0.7172**) showed significant values. However, the association of peduncle length (-0.3691**) and panicle exertion (-0.3665**) with yield per hectare was negative, simultaneous improvement of yield along with these traits is not possible. The path analysis study indicated that direct selection based on the characters, weight of five panicles and number of basal tiller are effective as their association and direct effects were positive.

INTRODUCTION

Foxtail {*Setaria italica* (L.) Beauv.} millet is one of the oldest crop cultivated for food grain and fodder for livestock. Foxtail millet grains are highly nutritious with good quality protein, rich in minerals, dietary fibre, phyto-chemicals and vitamins (Thiamin, Riboflavin, Niacin). Foxtail millet is an important food and feed crop in the semi-arid regions of the world. It is grown under rainfed and irrigated conditions (Siles *et al.*, 2001). The grains are fed to cage birds. It is usually cooked whole or made into meal or into bear. 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. It is known for its drought tolerance. It is also grown in nutrient deficit soils and possesses tolerance to pests and diseases. Foxtail millet grain possesses 12.3 per cent protein, 4.7 per cent fat, 60.6 per cent carbohydrates and 3.2 per cent ash. It is also a good source of beta-carotene. The potentiality of foxtail millet is not yet exploited properly in India. The yield level in China is 11ton per hectare, whereas in India it is just ranging from 0.4 to 0.8 tonn per hectare suggested a greater scope for exploitation of this millet under Indian conditions (Jaiyju, 1996). For improvement of complex traits like yield in any crop, indirect selection based on associated traits is the best breeding strategy. The study of relationships among the quantitative traits is important for assessing the feasibility of joint selection of two or more traits. Positive correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. On the other hand, a negative correlation between two desirable traits impedes or makes it possible to achieve a significant improvement in both traits. The path coefficient analysis initially suggested by Wright (1921) and described by Dewey and Lu (1959) allows partitioning of correlation coefficient into direct and indirect contributions (effects) of various traits towards dependent variable and thus helps in assessing the cause- effect relationship as well as effective selection (Arunkumar, 2013). Hence, to identify the traits having positive influence on yield, this study was undertaken in foxtail millet with 34 genotypes.

MATERIALS AND METHODS

The experimental material consists of 34 foxtail millet genotypes was grown in a randomized block design with three replications were kharif, 2014 at the research farm of Tirhut College of Agriculture, Muzaffarpur, Bihar. All the recommended agronomic and cultural practices were followed for raising a good crop. Data were recorded on five randomly selected plants per replication of each genotype for twelve quantitative characters, viz., plant height (cm), days to 50 per cent flowering, number of basal tillers per plant, flag leaf blade length (mm), flag leaf blade width (mm), flag leaf sheath length (mm), peduncle length (mm), panicle exertion (mm), inflorescence length (mm), inflorescence width (mm), weight of five panicles (g), yield per plot (g), yield per hectare (q/ha.). Each genotype was sown in five rows of three meter length each with a spacing of 22.5 cm between rows and 7.5 cm between plants (within rows). The data were subjected to statistical analysis, phenotypic and genotypic correlations were worked out as per the procedures suggested by Falconer (1964). Path analysis was used to calculate the direct and indirect contribution of various traits to yield as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). All the observations were calculated as per the descriptors of foxtail millet. Basal tiller number was calculated by counting the number of basal tillers. Flag leaf blade length was measured from ligule to leaf tip at the time of flowering while flag leaf blade width was measured across the centre. Flag leaf sheath length was measured from node to ligule of flag leaf from the top at the time of flowering. Panicle exertion was measured as exertion of panicle at dough stage. Inflorescence length was measured from base to tip of longest spike on main tiller stage and inflorescence width was measured across the centre of longest finger at dough.

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 (Johnson *et al.,* 1955 and Kumari and Singh, 2016). Comparatively low phenotypic values might be attributed due to differential interaction of the genotypes with environment. 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 components characters may sometimes be misleading. Since, it may be over or under estimate of its associate 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 (Prasanna *et al*., 2013b). 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, respectively. Positive correlation was observed for weight of five panicles, inflorescence length, inflorescence width, flag leaf sheath length, flag leaf blade length, flag leaf blade width, number of basal tillers, plant height and days to 50 per cent flowering with yield per hectare and out of these all weight of five panicles and inflorescence width showed significant values. Improvement of yield per hectare may be possible if the above traits are considered in the selection programme. These findings are in conformity of reports given by Gill and Randhawa (1975); Muhammed and Hussain, 2004; Tyagi *et al.,* (2011) and Prasanna *et al*. (2013a). The association of panicle exertion and peduncle length with yield per hectare was negative. Simultaneous improvement of yield along with these traits is not possible so we have to seek a comprise among the attributes to find out an acceptable level of characters under improvement. Weight of five panicles recorded significant positive association with inflorescence width and non-significant positive association with inflorescence length, flag leaf blade length, flag leaf blade width and days to flowering. This result was similar to the finding of Singh and Nagaraja, 1989; Tyagi *et al*.,2011 and Prasanna *et al*., 2013b. This indicated that increase in weight of five panicles resulted in more above mentioned traits. Whereas association of panicle exertion and peduncle length with weight of five panicles is significantly negative and this indicated that simultaneous improvement of these traits is not possible. Inflorescence width exhibited significant positive association with flag leaf blade width. Simultaneous improvement of these two traits is possible, whereas, it showed negative and significant association with peduncle length. Inflorescence length showed significant positive association with flag leaf sheath length, flag leaf blade length, plant height and days to flowering. These results were in accordance with the findings of Gill and Randhawa, 1975; Singh and Nagaraja, 1989; Santhakumar, 1999; Tyagi *et al*., 2011 and Prasanna *et al*., 2013a. Improvement of inflorescence length may be possible if the above traits are considered in selection programme. Panicle exertion and peduncle length showed significantly negative association with most of the traits including yield. It indicated that panicle exertion and peduncle length are undesirable traits for yield and most of the yield attributing traits. Flag leaf sheath length exhibited positive and significant association with flag leaf blade length and plant height.

Table 1: Inter-relationship of different yield attributing characters in foxtail millet at phenotypic levels

Sl. No.	DF	PH	BTN	FLBL	FLBW	FLSL	PL	PE	IL	IW	WP	Y/ha
DF	1.0000	0.2763*	0.2109	0.1805	0.0251	0.2037	-0.0868	-0.2442	0.2732*	0.0550	0.0644	0.0439
PH		1.0000	0.0898	0.5326**	0.2350	0.5095*	0.0711	-0.3775**	0.6447**	0.0738	-0.0219	0.0593
BTN			1.0000	0.0457	-0.2309	0.0962	-0.2133	-0.3580**	0.1732	-0.2394	-0.1650	0.0718
FLBL				1.0000	0.2242	0.4611**	-0.0359	-0.3591**	0.6386**	0.0038	0.0627	0.1147
FLBW					1.0000	0.1862	0.0496	-0.0916	0.1485	0.3225**	0.2634	0.1710
FLSL						1.0000	0.3698**	-0.3384**	0.6186**	-0.0911	-0.0328	0.0209
PL							1.0000	0.6846**	-0.0239	-0.2930*	-0.3655**	-0.3691**
PE								1.0000	-0.5388**	-0.2149	-0.3242**	-0.3665**
IL									1.0000	-0.0028	0.2205	0.2199*
IW										1.0000	0.5994**	0.5270**
WP											1.0000	0.7172**
Y/ha												1.0000

* significant at 5%,** significant at 1%; DF = Days to Flowering, PH = Plant Height, BTN = basal tillers number, FLBL = Flag Leaf Blade Length, FLBW = Flag Leaf Blade Width, FLSL = Flag Leaf Sheath Length, PL = Peduncle Length, PE = Panicle Exertion, IL = Inflorescence Length; IW = Inflorescence Width, WP = Weight of 5 Panicles, Y/ha = Yield in Q/ha

Table 2: Inter-relationship of different yield attributing characters in foxtail millet at genotypic levels

Sl. No.	DF	PH	BTN	FLBL	FLBW	FLSL	PL	PE	IL	IW	WP	Y/ha
DF	1.0000	0.3035	0.2349	0.1930	0.0190	0.2164	-0.0933	-0.2579	0.2849	0.0586	0.0553	0.0394
PH		1.0000	0.0865	0.5810	0.3053	0.5508	0.0618	-0.3853	0.7049	0.0900	-0.0134	0.0896
BTN			1.0000	0.0392	-0.3505	0.1065	-0.2308	-0.3704	0.1855	-0.2462	-0.1353	0.0743
FLBL				1.0000	0.3278	0.4874	-0.0429	-0.3753	0.6549	0.0028	0.0791	0.1305
FLBW					1.0000	0.3108	0.1272	-0.1074	0.2613	0.4432	0.3536	0.2518
FLSL						1.0000	0.3890	-0.3545	0.6720	-0.0899	-0.0631	0.0093
PL							1.0000	0.7260	-0.0229	-0.3382	-0.4234	-0.4040
PE								1.0000	-0.5605	-0.2452	-0.3624	-0.4170
IL									1.0000	-0.0035	0.2520	0.2533
IW										1.0000	0.6802	0.6298
WP											1.0000	0.8495
Y/ha												1.0000

DF = Days to 50 per cent Flowering, PH = Plant Height, BTN = basal tillers number, FLBL = Flag Leaf Blade Length, FLBW = Flag Leaf Blade Width, FLSL = Flag Leaf Sheath Length, PL = Peduncle Length, PE = Panicle Exertion, IL = Inflorescence Length; IW = Inflorescence Width, WP = Weight of 5 Panicles, Y/ha = Yield in Q/ha.

Table 3: Phenotypic Path coefficient analysis of various characters on grain yield of foxtail millet

Characters	DF	PH	BTN	FLBL	FLBW	FLSL	PL	PE	IL	IW	WP
DF	-0.0843	-0.0233	-0.0178	-0.0152	-0.0021	-0.0172	0.0073	0.0206	-0.0230	-0.0046	-0.0054
PH	0.0108	0.0390	0.0035	0.0207	0.0092	0.0198	0.0028	-0.0147	0.0251	0.0029	-0.0009
BTN	0.0484	0.0206	0.2296	0.0105	-0.0530	0.0221	-0.0490	-0.0822	0.0398	-0.0550	-0.0379
FLBL	0.0074	0.0218	0.0019	0.0409	0.0092	0.0188	-0.0015	-0.0147	0.0261	0.0002	0.0026
FLBW	-0.0007	-0.0063	0.0062	-0.0060	-0.0267	-0.0050	-0.0013	0.0024	-0.0040	-0.0086	-0.0070
FLSL	0.0300	0.0750	0.0142	0.0678	0.0274	0.1471	0.0544	-0.0498	0.0910	-0.0134	-0.0048
PL	0.0182	-0.0149	0.0446	0.0075	-0.0104	-0.0774	-0.2092	-0.1432	0.0050	0.0613	0.0765
PE	-0.0413	-0.0638	-0.0605	-0.0607	-0.0155	-0.0572	0.1157	0.1690	-0.0910	-0.0363	-0.0548
IL	0.0040	0.0095	0.0025	0.0094	0.0022	0.0091	-0.0004	-0.0079	0.0147	0.0000	0.0032
IW	0.0115	0.0154	-0.0499	0.0008	0.0673	-0.0190	-0.0611	-0.0448	-0.0006	0.2085	0.1250
WP	0.0400	-0.0136	-0.1025	0.0389	0.1635	-0.0204	-0.2269	-0.2013	0.1369	0.3721	0.6208
Y/ha	0.0439	0.0593	0.0718	0.1147	0.1710	0.0209	-0.3691	-0.3665	0.2199	0.5270	0.7172

Table 4: Genotypic Path coefficient analysis of various characters on grain yield of foxtail millet

Characters	DF	PH	BTN	FLBL	FLBW	FLSL	PL	PE	IL	IW	WP
DF	-0.1110	-0.0337	-0.0261	-0.0214	-0.0021	-0.0240	0.0104	0.0286	-0.0316	-0.0065	-0.0061
PH	0.0589	0.1941	0.0168	0.1127	0.0592	0.1069	0.0120	-0.0748	0.1368	0.0175	-0.0026
BTN	0.0639	0.0235	0.2723	0.0107	-0.0954	0.0290	-0.0628	-0.1008	0.0505	-0.0670	-0.0368
FLBL	0.0025	0.0077	0.0005	0.0132	0.0043	0.0064	-0.0006	-0.0049	0.0086	0.0000	0.0010
FLBW	-0.0010	-0.0162	0.0186	-0.0174	-0.0531	-0.0165	-0.0068	0.0057	-0.0139	-0.0235	-0.0188
FLSL	0.1208	0.3075	0.0594	0.2721	0.1735	0.5583	0.2172	-0.1979	0.3751	-0.0502	-0.0352
PL	0.0626	-0.0415	0.1549	0.0288	-0.0854	-0.2611	-0.6711	-0.4872	0.0154	0.2269	0.2842
PE	-0.1777	-0.2654	-0.2552	-0.2586	-0.0740	-0.2443	0.5001	0.6889	-0.3862	-0.1689	-0.2497
IL	-0.0342	-0.0847	-0.0223	-0.0787	-0.0314	-0.0807	0.0028	0.0673	-0.1201	0.0004	-0.0303
IW	0.0065	0.0099	-0.0271	0.0003	0.0488	-0.0099	-0.0373	-0.0270	-0.0004	0.1102	0.0749
WP	0.0481	-0.0116	-0.1176	0.0687	0.3072	-0.0548	-0.3679	-0.3149	0.2190	0.5910	0.8689
Y/ha	0.0394	0.0896	0.0743	0.1305	0.2518	0.0093	-0.4040	-0.4170	0.2533	0.6298	0.8495

Simultaneous improvement of these traits is possible. Flag leaf blade length showed positively significant association with plant height and plant height exhibited positively significant association with days to fifty per cent flowering.

The direct and indirect effects of different yield components on grain yield worked out through path analysis at phenotypic and genotypic levels are presented in Table 3 and 4. The phenotypic and genotypic path coefficients analysis revealed that weight of five panicles had the highest positive effect on grain yield, followed by number of basal tillers at phenotypic level and by panicle exertion at genotypic level. Inflorescence width via weight of five panicles showed highest indirect effect followed by flag leaf blade width via weight of five panicles at phenotypic level. Highest indirect effect exhibited by inflorescence width via weight of five panicles followed by peduncle length via panicle exertion and flag leaf blade width via weight of five panicles at genotypic level. The path analysis study indicated that direct selection based on the characters, weight of five panicles and number of basal tiller are effective as their association and direct effects were positive. Similar results were also reported by Sandhu *et al.*, 1974; Singh and Nagaraja, 1989; Chidambaram, and Palanisamy, 1995; Santhakumar, 1999; Maloo and Pililip, 2001: Tyagi *et al.*, 2011 Prasanna *et al.*, 2013a and Prasanna *et al.*, 2013b.

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