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Correlation and Path analysis studies in mutant 296B genotype of sorghum (*Sorghum bicolor* L.)

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ABSTRACT
An investigation was carried out at experimental research farm of Sorghum Research Station, Parbhani during Kharif 2016.*Entitled "Studies on genetic variability induced through mutation in M_2 generation of Kharif sorghum (Sorghum bicolor L.)".Different doses of gamma rays (10kR, 20kR, 30kR, 40kR and 50kR) were used to irradiate seeds of 296B genotype. Genetic variability was significant for yield and yield contributing characters among the M_2 generation. Results indicated relatively higher mean performance in treatment 50kR dose for most of the characters.The positive significant correlation was noticed for grain yield per plant with flag leaf area, number of primaries per panicle, number of grain per primary, panicle length, 100 seed weight and harvest index. Path analysis revealed that the 100 seed weight exerted the highest positive direct effect on seed yield followed by followed by harvest index, panicle length, plant height, and number of grains per primary, flag leaf area, number of primaries per panicle and fodder yield per plant.The maximum indirect positive effect on seed yield was exhibited by days to 100 seed weight through number of grains per primary (0.7647), number of primaries per panicle (0.7157) and panicle length (0.6458). The remaining character viz., plant height, flag leaf area, fodder yield per plant, had exerted either weak positive or negative indirect effect on seed yield.*
Keywords *: Sorghum, Correlation, Path analysis.*

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INTRODUCTION

Sorghum [*Sorghum bicolor* (L.)Moench] is an important staple food for more than 300 million people and feed for cattle in Asia and Africa. It is the fourth most important cereal crop followed by rice, wheat and maize. India is a major sorghum growing country in the world, ranks first in acreage and second in production next to United States of America. In India sorghum is grown in areas receiving 500 to 1000 mm annual rainfall with temperature ranging between 26 to 32^{0}C. Plain and plateau below 1000 m elevation offer an excellent scope for successful cultivation of the crop in two seasons viz., *'Kharif'* as rainfed crop and '*Rabi*' with protective irrigation constituting 60 and 40 per cent cultivation respectively. (Anand*et al*., 2014). In India it is grown as a dual purpose crop serving both grain and fodder requirements of the farming community and its regional importance as a major food crop is as much as that of wheat and rice.Correlation coefficients nearly describe the existence of association between characters. It is rather difficult to explain a system of correlation as the indirect association of the character increase. The method of path coefficient developed by Wright (1921) is helpful in assessing whether association of characters with yield is having direct or indirect effect on yield or is a consequence in indirect effect through some other traits.

MATERIAL AND METHODS

The present investigation on "Studies on genetic variability induced through mutation in M_2 generation of *Kharif* sorghum (*Sorghum bicolor* L.)"was undertaken in sorghum (*Sorghum bicolor* L.) at research farm of Sorghum Research Station, Parbhani.Uniform 200pure dry seeds with about 10 ± 1 per cent moisture of one *kharif* sorghum variety 296B were exposed to 10, 20, 30, 40 and 50kR dose of gamma rays (Co^{60})with a dose rate of 2.39kR per minute at Nuclear and Agriculture Division, BARC, Trombay, Mumbai and the same number of untreated seedsof each variety served as control. For M_2 generation seeds selected from M_1 generation that treated with physical mutagen. The observations were recoeded on following nine characters. Plant height (cm), Flag leaf area(cm^2),Panicle length(cm), Number of primaries/panicle, Number of grains/Primary,100 seed weight (g),Fodder yield/Plant (g), Harvest index (%) and Grain yield / Plant (g)

RESULTS

Correlation

The correlation coefficient study was undertaken in order to find out the interrelationship of different yield components.The estimated association among yield contributing important characters with seed yield per plant is given in Table 1and Fig 1. Grain yield per plant had recorded significant and positively association with flag leaf area (G = 0.90, P = 0.85), panicle length (G = 0.96, P = 0.90), number of primaries per panicle (G = 0.99, P = 0.83), number of grains per primary (G = 0.90, P = 0.85), 100 seed weight (G = 0.93, P = 0.88) and harvest index (G = 0.80, P =0.78) at both the genotypic and phenotypic levels except plant height and fodder yield per plant with grain yields per plant.The character plant height exhibited significant positive correlation with fodder yield per plant (G = 0.98, P = 0.88) at both levels. The character plant height showed significant negative correlation with number of grains per primary (G = -0.77, P = -0.69), 100 seed weight (G = -0.72, P =0.65) and harvest index (G = -0.88, P = -0. 83) at both levels.

The observation revealed that character flag leaf area had significant positive correlation with panicle length (G = 0.83, P = 0.77), number of primaries per panicle (G = 0.84, P = 0.59), number of grain per primary (G = 0.71, P = 0.58), 100 seed weight (G = 0.74, P = 0.66) and harvest index(G = 0.55, P = 0.49) with flag leaf area at both genotypic and phenotypic levels. The character fodder yield per plant (G = 0.14, P = 0.05) had non-significant positive correlation with flag leaf area.The character panicle length had significant positive correlation with number of primaries per panicle (G = 0.98, P = 0.88), number of grain per primary (G = 0.88, P = 0.76), 100 seed weight (G = 0.83, P = 0.81) and harvest index (G = 0.74, P = 0.67) at both genotypic and phenotypic levels. The character fodder yield per plant (G = 0.03, P = 0.04) had reported non-significant with positive association.The characternumber of primaries per panicle had significant positive correlation with number of grains per primary (G = 0.97, P = 0.83), 100 seed weight (G = 0.92, P = 0.86) and harvest index (G = 0.86, P = 0.74) at bothgenotypic and phenotypic levels.The character fodder yield per plant showed non-significant negative association (G = -0.19, P = -0.07) at bothgenotypic and phenotypic level.

The character number of grain per primary had significant positive correlation with 100 seed weight (G = 0.99, P = 0.91) and harvest index (G = 0.98, P = 0.95) with this character at genotypic and phenotypic level.The character fodder yield per plant showed the significant negative association (G = -0.51, P = -0.46) at bothgenotypic and phenotypic levels.The character 100 seed weight had significant positive correlation with harvest index (G = 0 .95, P = 0.88) at genotypic and phenotypic levels.The character fodder yield per plant showed non-significant negative association (G = -0.50, P = -0.38 atbothgenotypic and phenotypic levels.The character fodder yield per plant had significant negative correlation with harvest index (G = -0.66, P = -0.64) at genotypic and phenotypic level.

The character harvest index had significant positive correlation with flag leaf area (G = 0.55, P = 0.49),panicle length (G = 0.74, P = 0.67),number of primaries per panicle (G = 0.86, P = 0.74),number of grains per primary (G = 0.98, P = 0.95) and 100 seed weight (G = 0.95, P = 0.88) at genotypic and phenotypic levels.The characters plant height (G = -0.88, P = -0.83) and fodder yield per plant (G = -0.66, P = -0.64) showed the significant negative association at both genotypic and phenotypic level.The various associations between grain yields per plant with principle component characters have been discussed. Among the three M_2 progenies of 296B genotype, grain yield per plant exhibited positive significant correlation with independent traits like flag leaf area, number of primaries per panicle, number of grain per primary, panicle length, and 100 seed weight in M_2 generation of *Kharif* sorghum indicating that selection for flag leaf area, number of primaries per panicle, number of grain per primary, panicle length, and 100 seed weight has a important role in enhancing the grain yield. While, plant height and fodder yield per plant exhibited negative significant association with grain yield. These results are in accordance with the findings of Potoduke*et al.* (1994), Iyanar *et al.* (2001), Bheemashankar (2007) for panicle length. Nimbalkar *et al.* (1988) and Veerabadhiran *et al.* (2001) for panicle length and 100 seed weight. Mahajan *et al.* (2011) reported that grain yield per plant had showed positive significant association at both levels with all characters like panicle length, and test weight with controversy of plant height showed negative correlation with grain yield per plant. Anupam raj and tripathi (2000), singh (2009) and Prakash *et al*. (2011) observed that grain yield was positively related with flag leaf area.

Path analysis

Path coefficient analysis is an effective tool to analyse the direct and indirect influence of different characters on yield. This helps in giving due weightage to a particular character during selection.Path analysis between yield and yield contributing character was carried out by using simple correlation coefficient. The results obtained are presented in Table 2and Fig 2. The results of path coefficient analysis revealed that plant height has positive direct effect (0.40) on grain yield. It had positive indirect effect through number of primaries per panicle (0.47) and fodder yield per plant (0.18).While, it had negative indirect effect via flag leaf area (-0.03), panicle length (-0.13), number of grains per primary (-0.1902), 100 seed weight (-0.55) and harvest index (-0.5816).

The flag leaf area revealed positive direct effect(0.24) on grain yield. It revealed positive indirect effect via panicle length (0.3878), number of grains per primary (0.17), 100 seed weight (0.57), fodder yield per plant (0.02) and harvest index (0.36).

Negative indirect effect was observed on yield through number of primaries per panicle (-0.80) and plant height (-0.05). Panicle length has positive direct effect (0.46) on yield. It observed positive indirect effect on yield through flag leaf area (0.20), number of grains per primary (0.21), 100 seed weight (0.64), fodder yield per plant (0.01) and harvest index (0.49) while, it had indirect negative effect via plant height (-0.11) and number of primaries per panicle(-0.94).

The results of path coefficient analysis noticed that the number of primaries per panicle has positive direct effect (0.95) on yield. It observed that positive indirect effect via flag leaf area (0.20), panicle length (0.45), number of grains per primary (24), 100 seed weight (0.71) and harvest index (56).

Negative indirect effect was recorded on yield through plant height (-0.20) and fodder yield per plant (-0.03). Number of grains per primary had recorded positive direct effect (0.24) on grain yield. It revealed that positive indirect effect viaflag leaf area (0.17), panicle length (0.40), 100 seed weight (0.76) and harvest index (0.64).It had negative indirect effect through plant height (-0.31),number of primary per panicle (-0.93) and fodder yield per plant (-0.09).

The results of path coefficient analysis indicated that the 100 seed weight has positive direct effect (0.77) on yield. It showed positive indirect effect on seed yield per plant through flag leaf area (0.18), panicle length (0.38), number of grains per primary (0.24) and harvest index (0.62).Negative indirect effect recorded through plant height (-0.29), number of primaries per panicle (-0.88) and fodder yield per plant (-0.09).

Fodder yield per panicle had direct positive effect (0.18) on grain yield. It indicated positive indirect effect on seed yield per plant through plant height (0.40), flag leaf area (0.03), panicle length (0.01) andnumber of grain per primary (0.18).

It noticed indirect negative effect via number of grains per primary (-0.12), 100 seed weight (-0.39) and harvest index (-0.43).

The results of path coefficient analysis revealed that harvest index has positive direct effect (0.65) on yield.It observed positive indirect effect on seed yield per plant via flag leaf area (013), panicle length (0.34), number of grains per primary (0.24) and 100 seed weight (0.73). Negative indirect effect was recorded on yield through plant height (-0.36), number of primaries per panicle (-0.82) and fodder yield per plant (-0.12)

The maximum positive indirect effect on seed yield was observed by number of grains per primary (0.76), numberof primaries per panicle (0.71) and panicle length (0.64) through 100 seed weight. The remaining character *viz.,* plant height, flag leaf area, fodder yield per plant, had exerted either weak positive or negative indirect effect on seed yield.Potdukhe *et al.* (1994) indicated that plant height; panicle length and 100-grain weight had high positive direct effects on grain yield in study involving 42 genotypes.

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Table 1: Genotypic and phenotypic correlation coefficient for nine characters studied in sorghum

characters		Plant height (cm)	Flag leaf area (cm^2)	Panicle length (cm)	No. of primaries /panicle	No. of grains/ primary	100 seed weight (g)	Fodder yield/Plant (g)	Harvest index (%)	Grain yield / Plant (g)
Plant height (cm)	G	1	-0.13	-0.29	-0.49	-0.77**	-0.72**	0.98**	-0.88**	-0.43**
	P	1	-0.18	-0.27	-0.36	-0.69 **	-0.65 **	0.88**	-0.83**	-0.41**
Flag leaf area (cm^2)	G		1	0.83**	0.84**	0.71**	0.74**	0.14	0.55*	0.90**
	P		1	0.77**	0.59**	0.58**	0.66**	0.05	0.49*	0.85**
Panicle length (cm)	G			1	0.98**	0.88**	0.83**	0.03	0.74**	0.96**
	P			1	0.88**	0.76**	0.81**	0.04	0.67**	0.90**
No. of primaries /panicle	G				1	0.97**	0.92**	-0.19	0.86**	0.99**
	P				1	0.83**	0.86 **	-0.07	0.74**	0.83**
No. of grains/primary	G					1	0.99**	-0.51*	0.98**	0.90**
	P					1	0.91**	-0.46*	0.95**	0.85**
100 seed weight (g)	G						1	-0.50	0.95**	0.93**
	P						1	-0.38	0.88**	0.88**
Fodder yield/plant (g)	G							1	-0.66**	-0.12
	P							1	-0.64**	-0.13
Harvest index (%)	G								1	0.80**
	P								1	0.78**
Grain yield /plant (g)	G									1
	P									1

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

Table 2:Direct (diagonal) and indirect effects of different characters on seed yield in sorghum

Characters	Plant height (Cm)	Flag leaf area (cm^2)	Panicle length (cm)	No. of primaries/ panicle	No. of grains/ Primary	100 seed weight (g)	Fodder yield/ Plant (g)	Harvest index (%)
Plant height (cm)	0.40	-0.05	-0.11	-0.20	-0.31	-0.29	0.40	-0.36
Flag leaf area (cm^2)	-0.03	0.24	0.20	0.20	0.17	0.18	0.03	0.13
Panicle length (cm)	-0.13	0.38	0.46	0.45	0.40	0.38	0.01	0.34
No. of primaries /panicle	0.47	-0.80	-0.94	0.95	-0.93	-0.88	0.18	-0.82
No. of grains/primary	-0.19	0.17	0.21	0.24	0.24	0.24	-0.12	0.24
100 Seed weight (g)	-0.55	0.57	0.64	0.71	0.76	0.77	-0.39	0.73
Fodder yield/plant (g)	0.18	0.02	0.01	-0.03	-0.09	-0.09	0.18	-0.12
Harvest index (%)	-0.58	0.36	0.49	0.56	0.64	0.62	-0.43	0.65

Grain yield /plant (g)	-0.43	0.90	0.96	0.99	0.90	0.93	-0.12	0.80

Residual effect = 0.09

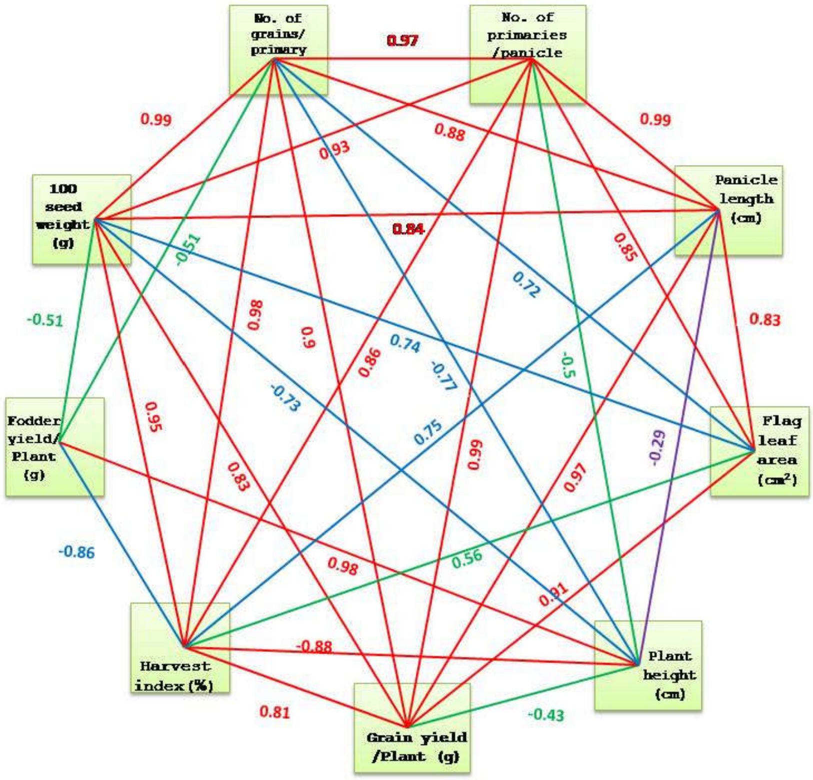

Fig. 1: Genotypic correlation for grain yield per plant (g)

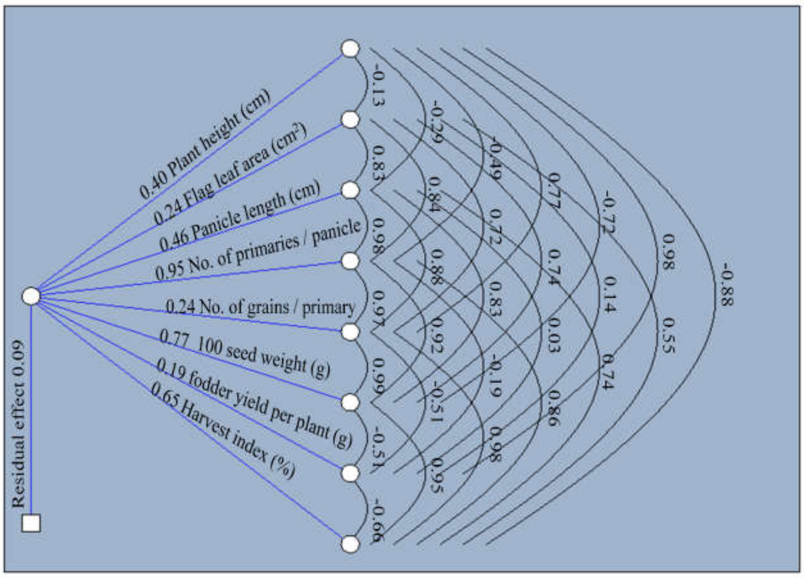

Fig. 2: Genotypic path diagram for grain yield per plant (g)

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