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DETERMINATION OF SELECTION CRITERIA FOR GRAIN YIELD IN CLIMATE RESILIENT SMALL MILLET CROP KODO MILLET (*Paspalum scrobiculatum* L.)

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ABSTRACT

Association and path coefficient analysis has been conducted in twenty seven breeding lines of climate resilient crop Kodo millet to fix the selection criteria for grain yield. Grain weight showed positive and significant phenotypic inter relationship with fodder weight (r_p=0.843), days to maturity (r_g=0.843), panicle length (r_p=0.285) and days to 50% flowering (r_g=0.214) suggesting that these are the major yield contributing traits. While, path coefficient analysis showed plant height (0.192), number of panicles per plant (0.176), number of tillers per plant (0.087) and fodder weight (0.002) had positive direct effect whereas, days to maturity (-0.060) showed direct negative effect on grain yield of kodo millet. Thus, the correlation analysis showed fodder weight, panicle length, number of tillers per plant, plant height, and days to 50% flowering are the important yield components that can be fixed as selection criteria for improvement in grain yield of kodo millet.

INTRODUCTION

Kodo millet (*Paspalum scrobiculatum* L), is a tropical small millet indigenous to India (de Wet *et al.*, 1983) and grown for its grain and fodder. It is a traditional, long duration, hardy and drought resistant crop cultivated in about 9 lakh hectares in India with an annual production of 3.11 lakh tonnes (Bondale 1994; Singh 1994).

Kodo millet is a tetraploid (2n=4x=40) crop species (Burton, 1940). Kodo millet was domesticated roughly 3000 years ago in India, the only country today where it is harvested as a grain in significant quantities, mainly on the Deccan plateau (de Wet et al., 1983). The grain contains a diverse range of high- quality protein (Geervani and Eggum, 1989; Kulkarni and Naik, 2000), and has high anti-oxidant activity (anti-cancer) even when compared to other millets (Hegde and Chandra, 2005; Hegde *et al.*, 2005; Chandrasekara and Shahidi, 2011). Like finger millet, kodo is rich in fiber and hence may be useful for diabetics (Geervani and Eggum, 1989). It is drought tolerant and can be grown in a variety of poor soil types from gravelly to clay (de Wet *et al.*, 1983; M'Ribu and Hilu, 1996). Most genotypes take 4 months to mature (de Wet *et al.*, 1983). In Africa, kodo is referred to as black rice or bird's grass (M'Ribu and Hilu, 1996).

The area under kodo millet cultivation is witnessing a declining trend in the post-green revolution period due to predominance of the major cereals such as rice and wheat. However, an intensified drive to increase the acreage of small millets is important because millets still contribute to the regional food security of the dry and marginal lands, where major cereal crops fail to yield. Nowadays, thrust to grow millets is given due to their nutritional superiority as compared to the major cereals. Kodo millet is predominantly grown as a pure crop and yields high net returns as compared to other dry land crops owing to its high unit area productivity and market price of the produce in addition to its fodder value.

Growing health consciousness among the consumers also creates demand for this type of nutri-cereals which are anti-diabetic and anti-oxidant in nature (Chandrasekara and and Shahidi, 2011). Hence, technological intervention in this crop is essential to boost the production on a profitable scale. Correlation analysis gives an idea about the related traits which can be studied to identify superior lines with respect to specific phenotype. Path analysis helps to partition the correlation coefficients into direct and indirect effects and provide a clear understanding of true relationships between associated traits.

MATERIALS AND METHODS

The present research was conducted at Small millet Research Unit, Research cum Instructional Farm, S.G. College of

Agriculture and Research Station, Jagdalpur, (Chhattisgarh,) India. Jagdalpur is situated in 19° 4′0" N and 82° 2′0" E. The city is nestled on the Bastar Plateau and is positioned at a height of around 552 meters from the mean sea level. The experiment was conducted during *kharif* 2013-14 in randomized complete block design with diverse twenty seven kodo millet advance breeding lines (Table 1). Each entry were represented by 2.25 m X 3 m plot, plant to plant distance was maintained at 10 cm. All the recommended agronomical practices and need based plant protection measures were adopted for raising the crop. Data was recorded on plot basis for each entries replicated for eight quantitative traits *viz.,* days to 50 per cent flowering, days to maturity, plant height (cm), number of productive tillers per plant, panicle length (cm), grain yield and fodder weight for each genotype.

The correlation between yield and yield component traits were estimated as per the method suggested by Goulden (1952) and Johnson *et al*. (1955). Phenotypic (r_{pxy}), genotypic (r_{gxy}) and environmental (r_{exy}) correlation coefficients were estimated by employing the formulae of Al-Jibouri *et al.* (1958):

$$r_{pxy} = CoV_{pxy} / (s^2_{px} s^2_{py})^{1/2}$$

$$r_{gxy} = CoV_{gxy} / (s^2_{gx} s^2_{gy})^{1/2}$$

$$r_{exy} = CoV_{exy} / (s^2_{ex} s^2_{ey})^{1/2}$$

where, CoV_{pxy} = phenotypic covariance of characters of x and y;

CoV_{gxy} = genotypic covariance of characters of x and y

CoV_{exy} = environmental covariance of characters of x and y.

Further partitioning of correlations in to direct and indirect effects by path coefficient analysis was estimated by using the procedure suggested by Dewey and Lu (1959). The statistical analysis was done by statistical software package (Ahuja *et al*. 2008) (IASRI, New Delhi, India).

RESULTS AND DISCUSSION

From the result it was clear that the genotypic correlation was greater than the phenotypic correlation indicating environmental influence on the association of characters correlation coefficients. Choudhary *et al*. (1984) and Shrivastava *et al.* (1981) also observed the environmental influence on the magnitude of correlation coefficient (Table 2). The high genotypic correlation coefficient values (Table 2) indicating strong inherent association between different traits and phenotypic selection would be effective as the association was mainly governed by genetic factors, while the phenotypic values were reduced by the significant interaction of the environment. fodder weight (r_p=0.843), days to maturity (r_p=0.843), panicle length (r_p=0.285) and days to 50% flowering (r_p=0.214) showed high positive and significant correlation with seed yield per plant both at genotypic and phenotypic levels. Similar observations were also demonstrated by Abraham *et al*. (1989), Bedis *et al*. (2006) Gowda *et al*. (2008), Kadam *et al*. (2009), Subramanian *et al*. (2010) Priyadharshini *et al*. (2011) and Suryanarayana *et al*. (2014).

Path-coefficient analysis is simply a standardized partial regression coefficient, which splits the correlation coefficient into the measures of direct and indirect effects (Singh and Choudhary, 1997). In this investigation, the genotypic correlation coefficient was further divided into direct and

Table 1: List of kodo millet breeding lines and their detailed information

S. No.	Entries	Pedigree	Place of origin
1	BK 14	Mutant of CO-3	Jagdalpur
2	TNAU 103	Selection from IPS 187	Coimbatore
3	DPS 41-2	Pure line selection from local germplasm	Dindori
4	BK 8	Mutant line of CO-3	Jagdalpur
5	TNPSC 122	Gamma ray mutant of TNAU 51	Coimbatore
6	RK 390-25	Mutant of RK -390	Rewa
7	NDLK 1	Landraces from Nandyal	Nandyal
8	BK 15	Mutanat line of CO-3	Jagdalpur
9	TNAU 111	Gamma ray mutant of TNAU 51	Coimbatore
10	DHKM 3-3	Selection from DhPPLM-1024	Hanumanamatti
11	BK-10	Mutant line of CO-3	Jagdalpur
12	TNAU 86	Selection from IPS 85	Coimbatore
13	DHKM 3	Selection from DhPPLM-1024	Hanumanamatti
14	RK 24/RPS 739	Selection from local germplasm	Rewa
15	TNPSC 142	Gamma ray mutant of CO-3	Coimbatore
16	BK 22	TNAU-51 600 Gy(8)	Jagdalpur
17	DPS 90	Selection from local germplasm	Dindori
18	GPUK 3	Selection from germplasm GPLM 826	Bangalore
19	RK 739	Selection from local germplasm,Sidhi	Rewa
20	TNPSC 144	Gamma ray mutant of CO-3	Coimbatore
21	DPS 110	Pure line selection from local germplasm	Dindori
22	BK 20	TNAU-51 600 Gy(2)	Jagdalpur
23	RK 753	Selection from local germplasm,Sidhi	Rewa
24	TNAU 128	Mutant of TNAU 51	Coimbatore
25	RPS 384	Selection from local germplasm	Rewa
26	DPS 12	Pure line selection from local germplasm	Dindori
27	Indira Kodo-1	Gamma ray mutant of CO-3	Jagdalpur

Table 2: Phenotypic (P), Genotypic (G) and Environmental (E) coefficient of correlation for yield and its contributing traits in Kodo millet

Characters		Plant Height	No. of Tillers	Panicle length	No of Finger	Days to 50% Flowering	Days to Maturity	Fodder weight	Grain Weight
Plant Height	P	1.000	0.133	0.216	0.37	-0.062	-0.176	0.08	0.069
	G	1.000	0.102	-1.000	0.920**	-0.135	-0.313	0.014	-0.061
	E	1.000	0.072	0.447*	0.447*	0.276	0.009	0.155	0.275
No. of Tillers	P		1.000	0.006	0.031	-0.078	-0.015	-0.118	-0.01
	G		1.000	0.921**	0.342*	0.142	0.654**	0.987**	0.654**
	E		1.000	0.103	-0.009	-0.246	0.271	-0.142	-0.009
Panicle Length	P			1.000	-0.083	0.08	0.117	0.29	0.285
	G			1.000	-0.102	0.145	0.382*	0.973**	0.823**
	E			1.000	0.027	0.163	0.001	0.003	0.131
No of panicles	P				1.000	-0.107	-0.116	-0.114	-0.114
	G				1.000	-0.232	-0.278	-0.617	-0.419
	E				1.000	-0.163	-0.174	0.241	0.017
Days to 50% Flowering	P					1.000	0.879**	0.380*	0.214
	G					1.000	0.938**	0.395*	0.232
	E					1.000	-0.365	0.198	0.073
Days to Maturity	P						1.000	0.479	0.319
	G						1.000	0.529*	0.372
	E						1.000	0.274	-0.231
Fodder weight	P							1.000	0.843**
	G							1.000	0.897**
	E							1.000	0.476*
Grain Weight	P								1.000
	G								1.000
	E								1.000

*, ** Significant at 1 and 5 % respectively

Table 3: Direct and indirect genetic effects via various paths of seven characters on grain yield per plant

Indirect effect Characters	Plant Height	No. of Tillers	Panicle Length	No of panicles	Days to50% Flowering	Days to Maturity	Fodder weight	Total correlation with grain weight (q/ha)
Plant Height	0.192	0.107	0.218	-0.385	0.161	-0.365	0.0111	-0.061
No. of Tillers	0.087	0.235	0.223	-0.180	0.070	-0.268	-0.1928	0.654
Panicle Length	-0.192	-0.242	-0.217	0.462	-0.173	0.446	0.7406	0.823
No of panicles	0.176	0.101	0.24	-0.419	0.276	-0.325	-0.4697	-0.419
Days to 50% Flowering	-0.026	-0.014	-0.031	0.097	-1.189	1.095	0.3013	0.232
Days to Maturity	-0.060	-0.054	-0.083	0.116	-1.116	1.16	0.4028	0.372
Fodder weight	0.002	-0.059	-0.211	0.258	-0.470	0.617	0.7612	0.897

Residual effect (h) = 0.4244

indirect effects using path-coefficient analysis (Table 3). In computing the path-analysis, grain yield per plant was considered as resultant (dependable) variable while, the rest of the variables which are significantly correlated with grain yield per plant were used as causal (independent) variables. The information obtained by this technique helps in indirect selection for genetic improvement of yield. Among the seven causal (independent) variables, four of them plant height (0.192), number of panicles (0.176), number of tillers per plant (0.087) and fodder weight (0.002) had positive direct effect and days to maturity (-0.060) showed negative direct effect. Similar findings were also reported by Muppidathi *et al*. (1996), Bedis *et al*. (2006), Kadam *et al*. (2009), Andualem and Tadesse (2011), Priyadharshini *et al*. (2011), Arunkumar (2013) and Nagaraja *et al*. (2015).

Path coefficient analysis is useful in determining the direct and indirect interrelations of various yield attributes. In this study path analysis revealed that plant height had the highest positive direct effect on seed yield which was followed by number of tillers, number of panicles and fodder weight. The genotypic association of these characters suggesting the true perfect association of these characters and also indicating its role in simultaneous selection, while selecting genotypes with high seed yield. Hence, direct selection for these traits would be rewarding for yield improvement and which will also reduce the undesirable effect of the component traits studied.

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