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Correlation of Early Maturity and Nonsenescence Traits in Sorghum (*Sorghum bicolor L*)

Abdul Shakoor and Afsari Qureshi
National Agricultural Research Centre, Park Road, Islamabad, Pakistan

bstract

orrelation for yield, early maturity and nonsenescence accociated traits was studied to investigate the true part played by ese characters in relation to yield in a set of twelve crosses of sorghum (*Sorghum bicolor L*) involving three pure lines ICSV 07, ICSV 112 and ICSV 219 from ICRISAT and four early local type lines Red Janpur, Bagdar, DS 75 and Pothwar 3-9. rain yield of individual plants was calculated in F2 generation. There was a highly significant positive correlation of maturity ith plant height and %GLA 50DAF and significantly negative correlation with yield per plant and head length. It was oncluded that selection for early maturity and high yield in Pothwar area should be practised among progeny of ICSV 107 Pothwar 3-9, while selection for the stay-green associated characters be practised in progeny of ICSV 219 X Pothwar -9.

ntroduction

arly maturing high yielding cultivars coupled with stay-reen characters, are the need of the farmers in almost all orghum growing areas of the country to fit in to the ropping system and to escape natural weather hazards uch as frost, insects, pests and diseases. Local types aving been adopted to the local prevailing environmental onditions are the major source of early maturity but their ield potential is very low compared to ICRISAT types.

Selection among segregates from crosses of local and CRISAT genotypes could lead to the development of high ielding and early maturing cultivars of sorghum coupled with stay-green characters. Dost *et al.* (1992) while determining the inter relationships among various traits elating to grain and forage yield and forage quality, as well as to establish the relative importance and high stover yield n sorghum reported that high grain yield was associated with high harvest index and greater seed number and size. Late maturity and more plant height, were associated with igh harvest index.

Ramasamy *et al.* (1986) established correlations between grain yield, plant height, leaf number, ear weight and 1000-grain weight of the parents and F2. Grain yield was positively and significantly correlated with 1000-grain weight. The number of leaves was negatively correlated with plant height (r = 0.3), indicating that selection for short plants with many leaves was possible in the cross they tried. Kukadia *et al.* (1983a) reported that correlation between parental measurements and the order of dominance were positive but non-significant for days to 50 percent bloom, plant height, days to maturity and ear circumference. The correlations were negative for the other traits.

On the basis of height and maturity, correlations among the characters showed that early flowering and few leaves were negatively correlated with grain yield while height and days to flowering were positively correlated with fodder yield (Rana, 1984).

Sanchez (1969) got a negative correlation between the silking date and yield, while Eastin (1972) observed that the period from anthesis to maturity in sorghum, which varies among lines from 31 days to 56 days was, consistently longer in the higher yielding hybrids and there was a positive correlation between the lenght of the period and grain yield. Similar results were reported in spring oats by Mckee *et al.* (1979) where they got a correlation value of r = 0.69 for yield and grain filling period.

Chase and Nanda (1967a) obtained a hihgly significant positive correlation between mean number of leaves per plant and mean days from planting to anthesis. Chase and Nanda (1967b) have suggested the number of leaves per plant as a criterion in the selection for maturity. Jagannath *et al.* (1975) have shown that yield in sorghum was more directly correlated with leaf area duration(LAD) and grain-leaf ratio than with leaf area ratio (LAR).

Kirby and Atkins (1968) have reported that seeds per head was the character most highly associated with grain yield, while yield components, 1000-grain weight and seeds per plant were not strongly correlated with grain yield, while Patel *et al.* (1983) reported that selection through panicle length and 1000-grain weight would be most effective for further improvement of yield.

Materials and Methods

This research was a part of a study on inheritance of early maturity and nonsenescence in sorghum to investigate the true part played by these characters in relation to yield in a set of twelve crosses of sorghum (*Sorghum bicolor L*) involving three pure lines namely ICSV 107, ICSV 112 and ICSV 219 from ICRISAT and four early local type lines namely Red Janpur, Bagdar, DS 75 and Pothwar 3-9. The research was carried-out at two locations: National Agril. Research Centre (NARC) Islamabad and Maize & Millet Research Institute (MMRI) Yousafwala during the period 1990 to 1994. A brief deceription of the varieties used in the study is given as below.

Pot. 3-9: Pothwar 3-9 is a local adapted pure line developed from a local landrace of Pothwar tract by head-to-a-row selection. This pure line was evaluated in 1987 in the Preliminary Sorghum Yield Trials at NARC and was observed to be a stable high yielder. Pot. 3-9 ranked first for earliness among the varieties tested in the Coordinated Multilocational Advanced Variety Trials. Overall Pot. 3-9 mean grain yield performance has been recorded 1000 kg ha $^{-1}$. By virtue of its tall height Pot.3-9 also yielded significant quantity of fodder (8380 kg ha $^{-1}$). Pot.3-9 is an early maturing variety. It takes about 40 days from planting to 50 percent flowering and matures in 80-85 days. The plants are 230 cm tall, having tan pigmentation, non juicy stalks and leaves of medium size with white midribs. The panicle is semi compact and well exerted. The glumes are red coloured and cover more than half the grain and are free threshing. The line is moderately susceptible to foliar diseases and insect pests. Pot.3-9 can be sown to a population of 1,11,000 plants per hectare at a spacing of 75 X 15 cm. Pot. 3-9 has pear-shaped medium size (3.02 gm per 100 grains) light creamy coloured grains. This variety is suitable for cultivation as a rainfed crop in the rainy (monsoon) season in the Pothwar area of Pakistan.

Red Janpur: Red Janpur is a dual purpose (grain-cum-fodder) variety of Sindh province which is characterized by the presence of red pigment in the dry leaves, stems and seeds. It is a relatively early maturing variety which takes about 100 days to mature. It is a drought tolerant variety and is grown in rainfed and high temperature areas of Sindh, particularly in districts of Jacobabad, Khairpur and Nawabshah. It has got tall, non juicy stems, red grain colour and is moderately resistant to foliar diseases. Its grain yield potential ranges from 1680 to 2000 kg ha $^{-1}$.

Bagdar: Bagdar is a dual purpose (grain-cum-fodder) variety of Balochistan province which is characterized by bold white grains. It is widely grown in Balochistan and also in Dadu and Larkana districts of Sindh. It is a tall variety (250 to 270cm), with non juicy stalks. It matures in 110 to 115 days and is moderately resistant to foliar diseases. Its grain yield potential ranges from 1800 to 2200 kg ha $^{-1}$.

DS - 75: It was developed at Agricultural Research Institute, D.I. Khan (NWFP) by pure line selection from a sorghum entry No.954125 which was introduced from Purdue University USA in 1973 and was named in 1975. It is characterized by high grain yield (1800 to 2500 kg ha $^{-1}$), having medium maturity (90-100 days) and dwarf-to-intermediate height (130 to 150cm). It is moderately resistant to foliar diseases. Its grains are chalky white with a brown sub-coat which gives brownish "Chappati" (bread), whereas the local consumer preference is for pearly white grains.

ICSV 107: ICSV 107 was introduced from ICRISAT as one of the entries of ISVHAT and tested at NARC and ot locations in the country. ICSV 107 emerged as a promi variety not only at NARC but also across locat combining high yield and stability of performance. Its g yield potential is 3000-3500 kg ha^{-1}. ICSV 107 developed at ICRISAT by pedigree selection from cross 108-3 X CS 3541 made in 1975. The line was tested un different designation viz SPV 351, ICSV 107, ICSV 1 CSV 11. In 1984, the line was released in India as CSV for cultivation in all areas of India where kharif sorghum grown.

ICSV 112: ICSV 112 (bred at ICRISAT; also released Zimbabwe as SV 1) was developed by pedigree selection the F2-F5 from a multiple cross involving 5 lines bulking in the F6. It is photoperiod insensitive; and matu in 110-120 days. Its plant height is 1.5-1.8 meter, hav an exerted, elliptic, semicompact panicle and medium-si light-cream grains (100-grain weight = 2.5 gm), with a t pericarp, which contain 9.6 percent protein (2.6 perc lysine per 100 gm of protein). Its average grain y potential is 3432 kg ha^{-1} and 11.4t fodder/ha^{-1}.

ICSV 219: ICSV 219 is a pure line variety developed pedigree selection made at ICRISAT. It was introduced f ICRISAT as one of the entries of ISVHAT. On the basi its performance at NARC as well as at other location 1987 and the following season, ICSV 219 recommended for testing in the National Uniform Sorgh Yield Trials. ICSV 219 when grown under irriga condition at NARC in an off-season nursery (during sp season), its performance
was outstanding and had good seed set despite extremely high temperature prevailing at flowering in J which causes sterility in some varieties. In 1987, it grown on farmers fields near Islamabad; they liked it only because of its high grain yield (3400 kg ha^{-1}), but because the stover remained green after grain matu providing good fodder which is important in the area. T lines were grown in the field during the year 1990 and crossed in a 3x4 factorial mating design using the e lines as female parents and the local ones as the parents.
F1 seed of the following 12 hybrids was produced d kharif
1990-91.

ICSV 107 X Pothwar 3-9	ICSV 112 X Bagda
ICSV 107 X Red Janpur	ICSV 112 X DS 7
ICSV 107 X Bagdar	ICSV 219 X Pothw
ICSV 107 X DS 75	ICSV 219 X Red J
ICSV 112 X Pothwar 3-9	ICSV 219 X Bagd
ICSV 112 X Red Janpur	ICSV 219 X DS 7

Field trial (F1 generation): The twelve F1 hybrids alo their parents were planted at NARC Islamabad on

and at the MMRI, Yousafwala Sahiwal on July 10, 1993. A randomized complete block design with three replications was used at each location. At both the locations normal cultural practices were followed throughout the season. Fertilizer was applied at the rate of 60-30-0 kg^{-1}/NPK in the form of nitrophos and urea.

Each plot consisted of two rows 5m long 75 cm apart with 25 cm spacing between the hills. Planting was made at the rate of two seeds per hill and when the seedlings reached six leaf stage, these were thinned to a stand of one plant per hill. At both the locations, the crop had a mild attack of shootfly. Furadan 3 G granules were applied at the rate of 16 kg ha^{-1} for control of the shootfly. A random sample of twenty plants, regarded statistically adequate, was harvested from each plot and data were recorded for the following characters.

Days to 50 percent flowering.	Plant Height(cm).
Head Length(cm).	Number of seeds per head
1000-grain weight.	Yield per plant(gm).
Threshing percentage.	Maturity Index.
Number of Leaves per plant.	LAUSL per plant.
Percent GLA 50 DAF.	Sugar percent in stem.

Analysis of variance for parents and crosses was performed by location and across locations. Genotypic and phenotypic correlations were calculated according to the farmula of Singh and Chaudhry (1979)

$$\text{Genotypic Correlation} = \frac{\text{G.Cov.(XY)}}{\text{GV(X)GV(Y)}}$$

Where: G.Cov.(XY) = Genotypic Covarince of X and Y
GV(Y) = Genotypic Variance of Y

$$\text{Phenotypic Correclation} = \frac{\text{P.Conv.(XY)}}{\sqrt{\text{PV(X)PV(Y)}}}$$

Phenotypic Correlation = P.Cov.(XY) PV(X)PV(Y)
Where: P.Cov.(XY) = Phenotypic Covarince of X and Y
PV(X) = Phenotypic Variance of X
PV(Y) = Phenotypic Variance of Y

Field trial (F2 Generation): Seed from all replications of the F1 trial was bulked for each entry. A random sample from bulked seed of all the entries was taken to plant F2 trial. The F2 entries with the parents were planted in July 1994 at the same sites as for the F1 tests. The trial was conducted in randomized complete block design with three replications. The trial was conducted at NARC Islamabad and MMRI Yousafwala. At both the locations normal cultural practices were followed throughout the season. Fertilizer was applied at the rate of 60-30-0 kg^{-1}/NPK in the form of nitrophos and urea.

Each plot consisted of four rows 5m long 75 cm apart with 25 cm spacing between the hills. Planting was made at the rate of two seeds per hill and when the seedlings reached six leaf stage, these were thinned to a stand of one plant per hill. At NARC the crop had been attacked by shootfly. Furadan 3 G granules were applied at the rate of 16 kg ha^{-1} for control of the shootfly. Each trial was harvested 120 days after planting. A sample of 5-10 heads was collected from each plot in each replication. The data was recorded on the parameters as described for F1 generation.

Results and Discussion

Early maturity was significantly negatively correlated with yield, head length, 1000-grain weight and threshing percentage. The correlation of maturity was also negatively significant with plant hight, number of leaves per plant, LAUSL, %GLA 50 DAF and sugar percentage, while the correlation of yield was significantly positive with number of leaves per plant, LAUSL, %GLA 50 DAF and sugar percentage in F1 generation (Table 1).

In F2 generation the correlation of yield per plant was positively significant with head length, number of seeds per head, number of leaves per plant, LAUSL, %GLA 50DAF and sugar percentage. Maturity was significantly negatively correlated with head length, seeds per head, leaves per plant, LAUSL, %GLA 50 DAF and sugar percentage (Table 2).

The correlations among yield and yield components and with that of maturity and the stay-green associated characters reveal that the correlation coefficients were small in magnitude, indicating that improvement for early maturity and high yield coupled with stay-green character is possible. These results are in agreement with Rana *et al.* (1984) who has reported that early maturity was negatively correlated with grain yield whereas Dalton (1967) has reported a positive regression between yield and maturity. Saeed and Francis (1983) have found that differences in yield stability among genotype were largely a function of relative maturity. As the yield per plant and head length were highly correlated with 1000-grain weight and the correlation between yield and head length was low, these results indicate that improvement for yield could be possible by selection from the progenies having more 1000-grain weight, while Liang (1967), who has obtained a low correlation of 100-grain weight with grain yield both phenoty-pically and genotypically, was of the opinion that seed weight (100-grain weight) had little predictive value in relation to grain yield.

In light of the results so obtained from this study it was concluded that selection for early maturity and high yield in agro-climatic conditions of Pothwar area should be

Table 1: Correlation coefficients for different characters in F1 generation-1993.

Character	Yield per plant (G)	Length of head (cm)	Seeds per head	1000-grain Weight (g)	Threshing %	Maturity Index	Plant Height (cm)	Leaves Plant	PerLAUSL (cm^3)	% GLA 50DAF	Sugar %
Yield per 1.000 Plant (g)		0.812*	0.742**	0.210*	0.053	-0.336**	-0.032	0.630**	0.576**	0.813**	0.562**
Length of head (cm)		1.000	0.643**	0.111	0.023	-0.332**	-0.143	0.537**	0.445**	0.799**	0.572**
Seeds per head			1.000	0.139	0.255	0.054	0.102	0.497**	0.534**	0.655**	0.181*
1000- Grain weight (g)				1.000	0.003	0.124	0.411**	0.131	0.270**	0.057	0.020
Threshing%					1.000	0.333	0.322	0.013	0.020	0.032	-0.082
Maturity Index						1.000	0.551**	-0.295*	-0.239**	0.249**	-0.616**
Plant hight (cm)							1.000	-0.065	-0.040	0.031	-0.166
Leaves per plant								1.000	0.557*	0.622**	0.410**
L A U S L (cm^2)									1.000	0.542*	0.339**
%GLA 50DAF										1.000	0.642**
Sugar%											1.000

Table 2: Correlation coefficients for different characters in F2 generation-1994.

Character	Yield per plant (G)	Length of head (cm)	Seeds per head	1000-grain Weight (g)	Threshing %	Maturity Index	Plant Height (cm)	Leaves Plant	PerLAUSL (cm^3)	% GLA 50DAF	Sugar %
Yield per 1.000 plant(g)		0.6146**	0.6356**	0.0404	0.0277	0.2264**	0.0075	0.3398**	0.5292**	0.8199**	0.4428**
Length of head(cm)		1.000	0.4030*	0.0413	-0.1263	-0.4187**	0.6145**	0.4331**	0.4562**	0.6374**	0.5751**
Seeds per head			1.000	0.0143	0.1185	-0.03318	-0.0743	0.1011	0.4146**	0.5803**	0.1203
1000- Grain weight (g)				1.000	-0.1073	0.18493*	0.4293**	0.0926	0.1376	0.1419	-0.1096
Threshing%					1.000	0.30337**	0.1132	-0.3106**	-0.2136	-0.1470	-0.1272
Maturity Index						1.000	0.4671**	-0.4933**	-0.3615**	-0.4018**	-0.6973**
Plant Height (cm)							1.000	-0.1284	-0.1652	-0.0156	-0.2897**
Leaves per plant								1.000	0.4567**	0.4961**	0.4230**
L A U S L (cm^2)									1.000	0.6242**	0.2124*
%GLA 50DAF										1.000	0.5428**
Sugar%											1.000

actised among progeny of ICSV 107 X Pothwar 3-9, hile selection for the stay-green associated characters be actised in progeny of ICSV 219 X Pothwar 3-9.

eferences

ase, S. and D. K. Nanda, 1967a. Relation between leaf number and maturity in maize. American J. Bot., 52: 628.

ase, S. and D. K. Nanda., 1967b. Number of leaves and maturity classification in *Zea mays L.* Crop Sci., 7: 431-432.

lton, L.G., 1967. A positive regression of yield and maturity in sorghum. Crop Sci., 7: 271.

st M., P. B. Cox., G.L. Posler, M.B. Kirkham, A. Husain and K. Sartaj, 1992. Correlation of characters contributing to grain and forage yields and forage quality in sorghum (*Sorghum bicolor L*). Indian J. of Agric. Sci., 63: 92-95.

stin, J. D., 1972. Sorghum in seventies. IBH and Oxford New Delhi, pp: 214-246.

gannath, M.K., K. Krishnamurthy, B.G. Rajashekara, G. Raghunatha, A. Bommegowda and N. Venugopol, 1975. Path analysis for some growth parameters in sorghum. Curr. Sci., 44: 629.

by, J.S. and R.E. Atkins, 1968. Heterotic response for vegetative and mature plant characters in grain sorghum (*Sorghum bicolor L*) Moench. Crop Sci., 8: 335-339.

Kukadia, M.U., K.B. Desai, M.S. Desai, R.H. Patel and K.R.V. Raja, 1983 a. The genetic analysis of some quantitative characters in grain sorghum. Sorghum Newsletter, 26: 37.

Liang, G.H., 1987. Diallel analysis of agronomic characters in grain sorghum (*Sorghum vulgare*) Pers. Canadian J. Genet. Cytol., 10: 460-469.

McKee, G. W., H. J. Lee, D. P. Knievel and L. D. Hoffman, 1979. Rate of fill period for nine cultivars of spring oats. Agron. J., 71: 1029-1039.

Patel, R.H., K.B. Desai and S.P. Desai, 1983. Heritability estimates in grain sorghum. Sorghum Newsletter, 26: 89-90.

Ramasamy, P., S. Rajasekaran and D.M. Kadambavanasun, 1986. Estimation of heritability through parent-offspring analysis in sorghum (*Sorghum bicolor* L. Moench) crosses. Madras Agric. J., 73: 381-383.

Rana, B.S., B.C. Barah, H.P. Binswanger and N.G.P. Rao, 1984. Breeding optimum plant type in sorghum. Indian J. Genetics and Pl. Br., 44: 385-398.

Sanchez, C. H., 1969. The relationship between yield and moisture in S_1 maize lines. Plant Breeding Abst., 43: 153.

Singh, R.K. and B.D. Chaudhry, 1979. Biometrical methods in quantitative genetic analysis. Kalyani Publishers, Ludhiana, 40-49.

Saeed, M. and C.A. Francis, 1983. Yield stability in relation to maturity in grain sorghum. Crop Sci., 23: 683-687.