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valuation of Exotic and Local Cultivars of Sorghum (*Sorghum bicolor L*) for Yield, Maturity and Nonsenescence Associated Characters under Rainfed Conditions.

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ɔstract
e average performance of the exotic and local cultivars of sorghum over two locations for various characters alongwith ɜir analysis of variance reveal that the exotic line from ICRISAT ICSV 107 was the best among the exotic lines for being ȷhest in yield, number of seeds per head, head length and threshing percentage, while ICSV 219 was the best line having ɔre number of leaves, more leaf area of the upper six leaves per plant and sugar content. Among the local pure lines, t.3-9 was superior in plant height, 1000-grain weight, threshing percentage and earliest in maturity. The overall results ɔw that the nonsenescing (ICRISAT) types generally took 10-12 days longer to reach 50 percent flowering and averaged -56 cm shorter in height than the senescing types. The nonsenescing lines had significantly more number of leaves, USL, percent GLA 50DAF and sugar percentage from flowering through harvest.

troduction
ɹrghum (*Sorghum bicolor L*) Moench is an important food, ɛd and fodder crop worldwide and is grown throughout e tropical and temperate regions. It remains the staple ɔp for millions of people in the semi-arid regions of the ɔrld (Jhon 1992). With rapid increase in population .2%) of Pakistan, sorghum as a food grain crop can ɪpport wheat, rice and other food grain crops. A recent ɛw demand dimension has been opened up by its use in ɔultry feed production. The present national yield of ɹrghum is 593 kg ha $^{-1}$ (Agril. Statistics 1997-98) level hich is far below the potential (2500 to 3000 kg ha $^{-1}$). ɪe gap can only be reduced by developing varieties with ɛsirable characters for each ecological zone of the country. aturity is an important and complex consideration in ɹrghum breeding. To avoid yield reduction due to earliness ɪd yet fit a time frame, we need to develop genotypes hich utilize the time period most efficiently without ɑcrificing yield potentials. In earlier work, Hopper (1925) ɔund a range of 57 to 89 days from planting to flowering 16 varieties of different maturity groups. These ifferences were due to environmental conditions, date of lanting and varietal inheritance. Varieties with shorter eriod develop smaller areas of assimilating leaves and onsequently should be less productive (Shaw and Thom, 951a). Saeed and Francis (1983) have suggested to onsider seed weight and seed number when breeding for ield stability.

ı local sorghum cultivars, lack of stay-green character is ne of the factors affecting its acceptance by the farmers ecause they use sorghum as green fodder to feed their ivestock particularly at the end of the crop season when here is general scarcity of green fodder. A small degree of stay-green character in maize has been reported by Bhatti (1964) who has emphasized the importance of this character in maize breeding. Duncan *et al.* (1976) studied the characteristics and inheritance of nonsenescence in crosses of US and ICRISAT type sorghums. He reported that this characteristic is under the control of only one major factor or chromosome segment. In another study Duncan (1981) and Duncan (1984) have reported higher basal stem sugar content in stay-green sorghum genotypes compared with the nonstaty-green genotypes, especially during postanthesis growth.

Duncan *et al.* (1976) have reported that several characteristics were associated with nonsenescence in sorghum. The nonsenescing type generally took about two days longer to reach 50 percent anthesis and averaged 3 to 4 cm shorter in height than the senescing type. The nonsenescing type had a significantly larger stem diameter and maintained a higher sugar concentration in theawtem from anthesis through harvest. The nonsenescing type produced and maintained more green leaves and fewer senesced leaves per plant throughout the reproductive phase of growth, and as a result, this type expectedly produced a greater leaf area index (LAI) and the LAI was maintained for a longer period of time as was reflected by the leaf area duration (LAD).

Goldsworthy (1970) when compared a tall variety with a short variety of sorghum for leaf area duration and grain yield, found that the tall variety produced more dry weight after heading and had a larger leaf area duration than did the short variety, but its grain yield was not significant. Jaychandran *et al.* (1993), indicated that genotypes varied for time of onset rate of progress and final amount of leaf senescence. The best nonsenescent parents retained approximately 70 percent of the area of their upper six leaves green at 50 days after flowering (approximate harvest maturity), compared to 5-15 percent for the most senescent parents.

In view of the importance of early maturity and stay-green characters in sorghum breeding of dual-purpose (grain-cum-fodder) varieties should be considered a priority area in the breeding programme. Hence for incorporation of early maturity and stay-green associated characters in high yielding cultivar, the performance of the exotic and local adapted varieties for early maturity and stay-green characters is a pre-requisite for selection of the parents.

Materials and Methods
This research was a part of a study on inheritance of early maturity and nonsenescence in sorghum to investigate the performance of parental lines for early maturity and nonsenescence characters in cultivars introduced from

abroad and collected from within the country. The material consisted of three pure lines namely ICSV 107, ICSV 112 and ICSV 219 from ICRISAT and four local types lines namely Red Janpur, Bagdar, DS 75 and Pothwar 3-9. All these lines were planted at NARC Islamabad on July 06 and MMRI, Yousafwala on July 10, 1990 in a randomized complete block design with three replication at each location. At both the location normal cultural practices were followed throughout the season. Fertilizer was applied at the 60-30 NP kg ha $^{-1}$ 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 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. Data on following plant characters were recorded accordingly.

1. Days to 50 percent flowering
2. Plant height
3. Head length
4. Number of seeds per head
5. 1000-grain weight
6. Yield per plant
7. Threshing percentage
8. Maturity Index
9. Number of leaves per plant
10. Leaf area of upper six leaves (LAUSL)
11. Percent green leaf area 50 days after flowering(%GLA 50DAF)
12. Sugar percentage in stem

Statistical analysis for all the characters were run both on the data for individual location as well as for the data combined over two locations. The statistical analysis of average performance over two locations of the lines for various characters analysed according to Fisher (1950) and the comparison of treatment means, made by Duncan's multiple range test, are presented in Tables 1 to 4.

Results and Discussion

As is apparent from the data presented in Tables 1 and 2, the pure lines included in the present study exhibited a considerable range of differences for yield, maturity and stay-green associated characters. In all cases, the differences among the lines were found to be highly significant. Line ICSV 107 produced the highest grain yield of 33.37 gm per plant and was 50.66 percent higher than Pot. 3-9 the line at the lowest extremes, yielding only 18.04 gm per plant. The second high yielding line was ICSV 219 followed by ICSV 112, yielding 31.56 gm and 28.92 gm per plant, respectively.
Bagdar with a weight of 37.72 gm per 1000-grain weight, produced the heaviest seeds among the male parents followed by Pot. 3-9, giving a mean weight of 34.51 gm per 1000 grain weight. Among the exotic pure lines, ICSV 107 yielded 29.84 gm per 1000 grain weight. Rest of the lines were intermediate and the differences were not significant among them.
A fairly wide range of difference was exhibited by the female and male parents with regard to the number of seeds per head. The line ICSV 107 with a mean of 1221.50 seeds per head was the highest in number of seeds per head, followed by ICSV 219 with an average of 1197.13 seeds per head. Among the local pure lines, DS-75 produced 895.25 seeds per head followed by Bagdar (711.63 seeds per head).
ICSV 107 with 30.84 cm head length was better in head length compared with rest of the local and exotic lines but the difference among the female parents was not significant. Among the local lines, the head length of DS-75 was 22.53 cm. The other local lines did not differ significantly from each other.
A perusal of the data in Table 1 indicates that a narrow range of difference existed for threshing percentage of all the lines studied. Pot. 3-9 with a mean value of 79.47 had the highest threshing percentage and was followed by ICSV 107 with threshing percentage of 76.52.
A considerable range was observed in maturity index of different lines. ICSV 107 among the exotic lines was earlier with regard to maturity having maturity index of 123.50; while among the local lines Pot. 3-9 a local adapted pure line, was the earliest one with maturity index of 154.38. Red Janpur was the next early maturing line. ICSV 112 and ICSV 219 with respective values of 115.25 and 117.25, did not differ significantly from each other.
In case of plant height the local line Pot. 3-9 produced the tallest plants with an average value of 275.41 cm and was 61.28 percent taller than DS-75, which is at the lowest extreme with a mean of 156.81 cm. The exotic lines ICSV 107, ICSV 219 and ICSV 112 were not significantly different from each other. Pot. 3-9 and Bagdar also did not differ significantly from each other.
As regards number of leaves per plant (Table 3) the ICRISAT type lines were having more number of leaves than the local lines, except Bagdar which was at par with the ICRISAT types sorghum lines.
The same trend was observed in leaf area of upper six leaves (LAUSL). ICSV 219 was having the highest leaf area of 3353.13 cm^2 and that of Pot. 3-9 with lowest leaf-area of 2469.25 cm^2/plant. Percent GLA 50 DAF was highest in case of ICRISAT type line ICSV 219 with a mean value of 82.14 percent. The local lines were lacking this character and none of the lines exceeded 50.39 percent. Highest sugar of 14.73 percent was recorded in ICSV 219 followed by ICSV 107 with sugar percent of 12.94. The sugar percent in the local lines was recorded very low, which ranged from 4.55 to 5.24 percent. The sugar percent of Pot. 3-9 was recorded 5.15. There was no significant difference in sugar content of local lines.
The average performance over two locations of the lines for various characters alongwith their analysis of variance presented in Tables 1 to 4 reveal that the ICRISAT ICSV 107 was the best among the exotic lines for being highest in yield, number of seeds per head, head length and threshing percentage, while ICSV 219 was the best having more number of leaves, more leaf area of the upper six leaves per plant and sugar content. ICSV 112 showed significant performance with regard to yield nonsenescence traits in comparison with the local lines. Among the local pure lines, Pot.3-9 was superior

ble 1: Means of the pure lines for yield, yield components and stay-green character over two locations-1990-91.

re Lines	Yield per plant (g)	Length of head (cm)	Seeds per head	1000-grain Weight (g)	Threshing %	Maturity Index
SV 107	33.37a	30.84a	1221.50a	29.84b	76.52ab	123.50d
SV 112	28.92b	28.08a	1097.13b	25.90b	71.13b	115.25e
SV 219	31.56a	28.43a	1197.13a	26.93b	71.90b	117.25e
t. 3-9	18.04d	19.76b	633.75d	34.51a	79.47a	154.38a
d Janpur	20.17c	18.09b	655.00d	29.53b	75.32ab	144.88b
gdar	23.78c	16.56b	711.63d	37.72a	70.92b	136.50c
-75	23.81c	22.53b	895.25c	25.71b	71.38b	134.13c

eans with the same letters are not significantly different according to Waller-Duncan multiple range test (K ratio = 100).

ble 2: Means of the pure lines for yield, yield components and stay-green character over two locations-1990-91.

re Lines	Plant Height (cm)	Leaves per Plant	L A U S L ((cm^2)	%GLA 50DAF	Sugar%
SV 107	173.74c	14.71a	3322.75b	75.73b	12.94b
SV 112	162.29c	14.19a	3259.50b	73.92b	12.15b
SV 219	178.16c	15.40a	3353.13a	82.14a	14.73a
t. 3-9	275.41a	10.86b	2469.25c	37.66e	5.15c
d Janpur	226.94b	11.16b	2558.50c	42.68d	5.24c
gdar	258.91a	13.80a	3003.38b	50.39c	5.04c
-75	156.81d	12.95b	3002.13b	47.46c	4.55c

eans with the same letters are not significantly different according to Waller-Duncan multiple range test (K ratio = 100).

ble 3: Analysis of variance of pure lines over two locations-1990-91.

urce of iation:	Df	Yield per plant (g)	Length of head (cm)	Seeds per head	1000-grain Weight (g)	Threshing %	Maturity Index
cations	1	123.76*	111.16	1921.14	69.15*	130.19*	1292.16**
o(Loc)	4	25.77	5.97	20187.12	7.67	2.09	5.78
or	3	4.45	11.88	12294.38	5.37	3.85	17.16**
es	6	266.75**	254.92**	521586.27**	172.07**	66.46**	1681.39**
c X Lines	6	35.04**	3.47	13418.52	4.39	24.41**	8.45
or	36	4.82	5.57	8865.19	5.30	5.57	7.08

Significant at 5% level. ** Significant at 1% level.

ble 4: Analysis of variance of pure lines over two locations-1990-91.

urce of iation:	Df	Plant Height (cm)	Leaves per Plant	L A U S L (cm^2)	%GLA 50DAF	Sugar%
cations	1	2767.85**	2.84	500283.02*	55.84*	0.39
p(Loc)	4	119.75	1.84	16699.30	2.43	0.96
or	3	53.30	2.38	50533.83	3.71	0.28
es	6	18919.69**	24.10**	1030264.23**	2620.78**	161.61**
c X Lines	6	1197.50**	1.11	99596.73**	20.31**	3.06
ror	36	42.97	0.89	12606.38	4.82	0.74

Significant at 5% level. ** Significant at 1% level.

nt height, 1000-grain weight, threshing percentage and rliest in maturity. Bagdar which was an intermediate grain elding line, though ranked first in 1000-grain weight and cond in plant height, was very low in threshing rcentage.

eferring to the analysis of variance of the lines over two cations (Tables 3,4), locations were significantly different r yield per plant, 1000-grain weight, threshing rcentage, maturity index, plant height, leaves per plant, AUSL and percent GLA 50DAF. There were highly gnificant differences in the lines for all the traits studied. he lines x location interaction was also significant for yield er plant, threshing percentage, plant height, LAUSL and percent GLA 50DAF. The overall results show that the nonsenescing (ICRISAT) types generally took 10-12 days longer to reach 50 percent flowering and averaged 45-56 cm shorter in height than the senescing types. The nonsenescing lines had significantly more number of leaves, LAUSL, percent GLA 50DAF and sugar percentage from flowering through harvest.

As the nonsenescing lines maintained more green leaves and more green leaf area and fewer senesced leaves per plant throughout the reproductive phase of growth, this type expectedly produced a greater leaf area index which was maintained for a longer period of time and was reflected by the leaf area duration. Similar observations have been reported by Jagannath *et al.* (1975). They were of the opinion that yield in sorghum was more directly correlated with leaf area duration and grain leaf ratio, while Goldsworthy (1970) when compared a tall variety with a short variety of sorghum for leaf area duration and grain yield, found that the tall variety produced more dry weight after heading and had a larger leaf area duration than did the short variety, but its grain yield was not significant. The nonsenescing type maintained a higher chlorophyll content right from six leaf stage till harvesting. The senescence type showed decrease in chlorophyll content during its growth period. Duncan *et al.* (1976) have also reported similar results from their study on characteristics of senescence and nonsenescence types of sorghum which are in agreement with the results reported here-in.

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