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Evaluation of Farmers vs. Improved Sorghum Production Technologies for Enhanced Productivity under Rainfed Conditions

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Abstract: One local variety (local landrace) and one improved variety of sorghum PARC SS-1 were subjected to farmers' production practice and improved production technology at National Agricultural Research Centre Islamabad, during the summer seasons of 1997 and 1998. Significant differences were found among the treatments for days to flowering, plant height, insect and disease score, grain and stover yields. Interaction only for grain yield was significant. Flowering was enhanced by three days when improved method of production was used. Where farmers' method was applied, flowering delayed by five days which shows that with application of inputs, flowering was enhanced. Plant height of both local and improved varieties was increased significantly with application of fertilizer and other inputs. The improved variety was more resistant (2.5) than the local variety (4.5) with regard to shootfly infestation. Similarly the improved variety was found more resistant (1.0) to foliar diseases than the local variety (4.0). Where either farmers' or improved variety was used with farmers' practice, the plots were heavily infested with weeds. When the same varieties were subjected to primextra herbicide at 0.75 kg ha^{-1} (ai) the weeds remained controlled as compared to the ones with no herbicide. When complete improved package of production technology (improved variety + recommended doses of fertilizers, insecticides, herbicides and optimum plant density) was adopted, it gave significantly higher grain (2472 kg ha^{-1}) and stover (21.3 t ha^{-1}) yields. The higher grain as well as stover yields, are thus attributed to the use of improved variety coupled with the recommended doses of inputs. The improved variety PARC-SS-1 yielded significantly higher grain yield of 1617 kg ha^{-1} and stover yield of 16.6 t ha^{-1} in comparison with local variety, which yielded grain yield of 671 kg ha^{-1} and stover yield of 8.2 t ha^{-1}. It shows that with the use of only improved variety one can get manifold grain as well as stover yields. The economic analysis showed that by adoption of improved production technology highest net income of Rs.14503 ha^{-1} was obtained when compared to the farmers' traditional method of cultivation.

Key words: Evaluation; *Sorghum bicolor* L; comparison farmers' and improved production practices

Introduction

With rapid increase in human population (3.2%) in Pakistan and expansion in poultry and livestock industries, sorghum (*Sorghum bicolor* L.) can support wheat, rice and other crops for food, feed and fodder, It is an important coarse grain crop especially in areas where drought is common. The present national yield of sorghum is 587 kg ha^{-1}, level which is far below than the potential yield ranging from 2500 to 3000 kg ha^{-1}. The gap can only be reduced by use of improved varieties coupled with improved package of production technology accessible and acceptable to the farmers for each ecological zone of the country.

Most of the farmers use their own seeds which are usually local mixed land races and low producers for both grain and fodder. They plant sorghum crop by broadcast method which results in un-even stand. They do not apply weedicides and insecticides resulting in poor yields due to excessive weeds and sever insect damage. They also do not use fertilizers and hence get poor yields due to depleted soil fertility. Studies conducted by Daftardar *et al*. (1982) revealed that the efficiency of applied nitrogen under improved technology was almost double than that of the conventional methods and the production level of grain and stover under improved technology were higher over those by the conventional method. Greer and Denman (1983) have reported that the use of herbicides along-with good cultural practices would help control weeds and make the crop production profitable. Dowler *et al*. (1983) reported that the most promising weed control method was the use of atrazine alone or in combination with metolachlor or pendimethalin as early post-emergence treatments.

Rajput *et al*. (1983) have reported that the use of fertilizers significantly affected plant height, ear head length, weight of ear head and grain yield. Row spacing also significantly affected the ear head length, weight of ear head and grain yield, but no significant effect of row spacings on plant height was observed. The interaction of fertilizers and row spacings showed significant effect on weight of ear head and grain yield per unit area, while other yield contributing factors were not influenced significantly. Rafiq and Afzal (1988) have reported that greatest share to grain yield was contributed by fertilizer application followed by insecticide, weedicide and improved varieties. Improved varieties (IC-1039 and Pak-SS-II) were reported superior over the local variety (JS-263) by giving 80.0 and 39.2 percent higher grain yield, respectively. They reported that fertilizer application enhanced anthesis and increased plant height and number of panicles per plant significantly. Highest marginal rate of return was obtained by the application of fertilizer (119%) and insecticide (80.7%). Okoli *et al*. (1984) reported that herbicide application effectively controlled weeds and enhanced yield when compared with the check. Escasinas *et al*. (1977) from their study on effect of different population densities and nitrogen levels on the yield and yield components of sorghum have reported that application of nitrogen fertilizer increased plant height, leaf area index, panicle length, number of grains per panicle, weight of grains per panicle, grain and stover yields. Nagre *et al*. (1981) have reported that phosphate application significantly increased sorghum grain yield per unit area.

The present studies were undertaken to evaluate the performance of different agronomic traits under farmers' vs. improved sorghum production technologies for enhanced productivity.

Materials and Methods

One local variety (local landrace) and one improved variety of sorghum (PARC SS-1), were subjected to farmers' conventional method of cultivation and improved production technology to evaluate their performance. The trial was conducted using factors factorial arrangement in randomized complete block lay-out at the

National Agricultural Research Centre Islamabad during summer seasons of 1997 and 1998. The plot size was 7.5 m × 5.0 m, replicated three times.

The treatment were as under:

T_1 Farmers' variety + Farmers' practice.
T_2 Farmers' variety + Improved practice.
T_3 Improved variety + Farmers' practice.
T_4 Improved variety + Improved practice.

In case of T_1 seed of farmers' variety was sown by farmers conventional method of broadcasting on flat-ploughed land and the seed was incorporated into the soil by harrow followed by planking to cover the seed. In case of T_2, seed of the farmers' variety was sown in lines 75 cm apart by hand drill. Urea and DAP fertilizers at of 60 kg N ha^{-1} (half at sowing time and half at knee high stage) and 30 kg P_2O_5 ha^{-1} (all at sowing time) were applied. For control of weeds, primextra herbicide was sprayed at of 0.75 kg ha^{-1} (ai) just after sowing. Furadan 3G granules were applied at of 16 kg ha^{-1} (half at sowing time with the seed and half at six leaf stage by putting in whorls). The plant population was maintained at 120000 plants ha^{-1}. In case of T_3, seed of the improved variety PARC SS-1 was sown following farmers' conventional method of broadcasting and using no inputs, while in case of T_4, the improved variety was sown following improved package of production technology mentioned above. All cultural operations were carried out according to the treatment schedule and data on the following parameters were recorded.

1. Germination percent
2. Plant stand/plot
3. Days to 50% flowering
4. Plant height (cm)
5. Insect score (1-5)
6. Disease score (1-5)
7. Lodging percent
8. Grain yield (kg ha^{-1})
9. Stover yield (t ha^{-1})

For recording grain yield data central eight rows were harvested from each sub-plot and the heads were dried in the sun. These were then threshed and data recorded and subsequently converted to grain yield in kg ha^{-1}. The data so recorded were analyzed statistically by using two factors factorial ANOVA in MSTATC Computer Programme following Fisher and Yates (1938). Economic analysis was also run to know the profitability of each treatment.

Results and Discussion

For variables like days to flowering, plant height, stover yield, disease and insect score, the analysis showed that there was no interaction between the factors of variety and cultural practices, therefore, the results are presented using main effects.

Days to 50 percent flowering: Significant differences were found for days to 50 percent flowering among the treatments. When farmers' method was practiced, flowering delayed compared with improved method. When improved method was applied, flowering enhanced (Table 1). These results indicate that with the application of inputs, flowering was enhanced. Escasinas *et al*. (1977) have also reported earliness in maturity with nitrogen application, Narkhede *et al*. (1982) have reported enhanced flowering by 5-8 days when compared to the ones without fertilizer.

Plant height: Significant differences were observed for plant height among the treatments. Plant height of both local and improved varieties was increased significantly with application of fertilizer and other inputs (Table 1). These results are in agreement with Escasinas *at al.* (1977) who also reported increased plant height with application of fertilizers.

Insect and disease score: Significant differences were observed for shootfly infestation and foliar diseases. With regard to shootfly infestation, the improved variety was more resistant (1.7) than the local variety (3.6). Similarly the improved variety was found more resistant (1.5) to foliar diseases than the local variety (3.7). However there was no significant difference between the local variety and improved variety when both the varieties were subjected to improved technology using furadan granules at 16 kg ha^{-1} (Table 2). These results are in line with the results reported by Natarajan and Chelliah (1981) who reported that soil application of carbofuran 3G (Furadan) was found to be the most effective insecticide for control of shootfly in sorghum.

Weeds biomass: Weeds biomass data presented in Table 2 show that where either farmers' variety or improved variety was used with farmers' practice, the plots were heavily infested with weeds right from the germination stage of the crop. When the same varieties were subjected to primextra herbicide at 0.75 kg ha^{-1} (ai), the weeds remained controlled as compared to the ones with no herbicide. The higher grain and stover yields are attributed to the application of primextra herbicide and improved cultural practices. These results are in line with Greer and Denman (1983) who concluded from their study that the use of herbicides along with good cultural practice would help control weeds and make the crop production profitable. Similar results have also been reported by Dowler *et al*. (1983).

Grain and stover yields: For grain yield, the interaction between the two factors was found to be significant at 2 percent level, therefore interaction means are presented in separately (Table 3) and discussed accordingly. Statistical analysis of grain and stove yields data showed significant differences among the treatments. When complete improved package of production technology

Table 1: Effect of farmers' and improved sorghum production technologies on flowering, plant height and grain yield under rainfed conditions at NARC, Islamabad

Treatments	Days to 50% flowering			Plant height (cm)			Grain yield (kg ha^{-1})		
	1997	1998	Mean	1997	1998	Mean	1997	1998	Mean
Farmers' variety	51.20	45.5	48.30	181.800	179.00	180.4	826.2	804.0	815.1
Improved variety	63.50	60.8	62.20	153.300	154.70	153.5	2182.3	2045.3	2113.80
Prob.	0.00	0.00	0.00	0.000	0.00	0.0	0.0	0.0	0.0
Farmers' Practice	59.20	53.0	56.10	163.700	162.20	162.9	1046.3	1029.0	1037.80
Improved Practice	55.50	53.3	54.40	170.500	171.10	171.0	1962.2	1820.2	1891.20
Prob.	0.003	-	0.071	0.001	0.015	0.0	0.0	0.0	0.0
Interaction	0.132	NS	NS	NS	NS	N5	NS	0.021	0.009
C.V. (%)	2.31	4.89	3.73	1.16	2.87	2.19	10.72	6.49	8.98

Table 2: Effect of farmers and improved sorghum technologies on stover yield, weed biomass. insect and disease score under rainfed condition at NARC, Islamabad

Treatments	Stover Yield (t ha^{-1})			Disease score (1-5)			Insect score (1-5)			Weeds biomass (kg ha^{-1})		
	1997	1998	Mean	1997	1998	Mean	1997	1998	Mean	1997	1998	Mean
Farmers' variety	82.10	21.3	14.8	3.3	3.8	3.6	3.8	3.7	3.7	933.3	836.4	884.9
Improved variety	19.70	19.9	19.8	2.0	1.4	1.7	1.5	1.6	1.5	328.8	324.5	326.7
Prob.	0.006	N5	NS	0.006	0.0	0.0	0.0	0.007	0.0	0.001	0.002	0.007
Farmers' practice	11.40	11.2	11.3	3.7	2.8	3.3	3.0	2.9	2.9	971.4	10125.3	5548.4
Improved practice	16.50	30.0	23.3	1.6	2.4	2.0	2.3	2.3	2.3	09.5	219.5	214.5
Prob.	0.001	NS	NS	0.001	NS	0.0	0.007	NS	0.043	0.000	0.003	0.007
Interaction	0.001	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.(%)	10.9	109.1	92.4	20.7	23.8	22.3	10.8	34.9	25.6	37.4	51.3	87.9

Table 3: Interaction of variety x production package on grain yield (kg ha^{-1}) of sorghum during 1997

	Farmers' practice	Improved practice
Farmers' variety	815.1000	1037.8000
Improved variety	1891.2000	2113.8000
Interaction	0.0209	0.0011
C.V.(%)	10.7900	6.4900

Table 4: Cost of production according to farmer's technology

	Units (Rs.)	Rate (amount)	Total
Ploughing	2	160	320
Sowing	1 man day	35	75
Sorghum seed	40 kg	10	400
Harvesting	5 man days	75	375
Threshing	5 man days	75	375
Ninowing	4 man days	75	300
Misc. Expenditure	-	-	200
Total:			2045

Table 5: Cost of production of sorghum (per hectare) according to improved package of technology

Cost	Unit	Rate (Rs)	Amount (Rs)
Ploughing	2	160	320
Sowing (by hand drill)	4 man days	75	300
Sorghum seed	25 kg	20	500
Fertilizer (Urea)	2 bags	360	720
Tiger DAP)	1-1/2 bags	520	780
Fertilizer application	1 man days	75	75
Furadan	16 kg	71.50/kg	1144
Suradan application	2 man days	75	160
Primextra (Herbicide)	1.5 Litre	625.00/KG	938
Primextra application	2 man days	75	160
Pbinning	4 man days	75	300
Siumicidin	1.5 Litre	775	1162
Siumicidin application	3 man days	75	225
Birds scaring	15 man days	75	1125
Harvesting	5 man days	75	375
Threshing (Thresher)	10 litres fuel	25	250
	2 man days	75	150
Vinnowing	2 man days	75	150
	Total cost (Rs/ha)		8814

Table 6: Economic analysis of farmers vs improved sorghum production technology evaluated at narc, Islamabad during 1997 and 1998

Treatments	Variety used	Practice applied	Gross Income (Rs/ha)	Variables Cost(Rs/ha) (Rs/ha)	Net Income	Increase over farmer's Technology due to:		
						IV	IP	IV + IP
IV × FP	Local	Farmer's Practice	8769	2045	8724	-	-	-
IV × IP	Local	Improved Practice	16325	8714	7611	-	887	-
IV × FP	PARC-SS-1	Farmer's Practice	20316	2445	17871	11147	-	-
IV × IP	PARC-SS-1	Improved Practice	30041	8814	21227	-	-	14503

(improved variety + recommended doses of fertilizers, insecticides, herbicides and optimum plant density) was adopted, it gave significantly higher grain (1891 kg ha^{-1}) and stover (23.28 t ha^{-1}) yields. When farmers' traditional method of production was practiced, it produced lowest grain (1038 kg ha^{-1}) and stover (11.3 t ha^{-1}) yields. The higher grain and stover yields, are thus attributed to the use of improved technology. These results are in agreement with the results reported by Rafiq and Afzal (1988), Usman (1972), Okoli *et al*. (1984) and Chaudhary *et al*. (1984), who also reported significant grain and stover yields with application of recommended doses of fertilizers, herbicides and insecticides. While comparing the local and improved varieties the improved variety PARC SS-1 yielded significantly higher grain (21 14 kg ha^{-1}) and stover (19.80 t ha^{-1}) in comparison with local variety, which gave 815 kg ha^{-1} grain and 14.77 t ha^{-1} stover yields, respectively. It shows that with the use of only improved variety one can get manifold grain as well as stover yields. Rafiq and Afzal (1988) have also reported significantly higher grain and stover yields from the improved varieties than the local ones. These results are also in line with the findings of Bhosale *et al*. (1984) who got significant grain yields from improved sorghum varieties, CSH-1 and CSH-6.

The economic analysis presented in Table 4, 5 and 6, showed that by adoption of improved production technology highest net income of Rs.14503 ha^{-1} was obtained when compared to the farmers' traditional production technology. The highest net benefit/return is due to the improved variety coupled with improved/recommended production technology.

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