SORGHUMS

GRAIN-GRASS AGRONOMY: OPTIMUM PLANT POPULATION FOR YIELD TESTING

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Since the grain-grass plant type is substantially different from normal sorghum grown almost everywhere, there is great need to have more information on all agronomic aspects. Because of their early maturity, tillering habit and narrow leaves, population density trial was conducted in order to recommend the optimum population for grain yield testing of promising breeding material.

Material and Methods

Following three grain grasses representing the range of difference between normal and typical grain-grass sorghum and one hybrid check were planted:

1. GC 50: resembles typical grain-grass
2. GC 230: intermediate between 1 & 3
3. GC 430: intermediate between grain grass and normal sorghum
4. CSH-6: normal duration hybrid sorghum

The experiment was sown on 29 June, 1976 in flat black soil (BTS area) with 4 replications employing split plot design. Genotypes formed main plots and 7 population densities formed sub-plots (Table 1), with the population ranging from 10-200 plants/m^2. The rationale for using such high densities was that, the grassy sorghum resembling wheat, might produce as many as 200 heads/m^2.

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* Paper presented in the INTERNATIONAL SORGHUM WORKSHOP held during March 6-12, 1977

Row to row distance was constant (20 cm) for all levels of populations and plot size was 3 x 2 m. Fertilizer rate was same as we apply for normal sorghum (60 N, 60 P at planting, and additional top dressing with 40 N in the form of urea).

Central 8 rows covering 2 m row length (= 3.2 m^2) were harvested. From this area 10 plants were removed separately for simplified growth analysis.

Results and Discussion

Table 1 shows the summarized results from a split plot analysis of several variables.

1. Plant Density: Though the initial stand was perfect up to 8-10 leaf stage, in dense population, death of plants started from that stage up to flowering of main shoot, in case of grain grasses, and up to final leaf stage in CSH6. Table 1 shows the plant population initially planted and after thinning as well as final stand (plant) count. Based on final stand count only 4 distinct plant populations were present (Range: 99,800 - 727,500 plants/ha).

2. Grain Yield: Grain yield significantly increased with increase in plant density and there was no genotype x density interactions (Table 3). Table 2 shows the yield of grain grasses as well as checks. Note that in case of GC 50, the yield is not significantly different at different densities, because of its

ability to tiller profusely and produce more seeds/panicle under lowest population density. GC 230, has only two yield classes, with grain yield increasing rapidly from the lowest population to next and remaining almost constant. GC 430 which resembles CSH6 most amongst grain grasses, has 3 yield classes just as CSH6. In both these genotypes yield increases from 99,800 plants/ha to 623,200 plants/ha and then after almost remaining constant. Note that even at very high populations, the yield did not go down, since the plant stand itself levelled off at denser populations.

3. Fodder yield: Interestingly the fresh fodder yield was fairly constant among the entries, though weak interaction between entries and populations was noticed. The grain grasses were much less leafier than CSH6 and their stems were slender (though slightly shorter); since they also had more shoots per unit area, there is a possibility of grain grasses making better fodder.

4. Physiology of Grain Yield: Though the hybrid check was found slightly superior to grain grasses in almost all physiological parameters studied, grain grasses did show higher grain/leaf ratio, thus probably indicating their higher photosynthetic efficiency. If this high efficiency is maintained even under stress conditions, they can be expected to be very useful under dry conditions.

Conclusions: (1) The experimental grain grass varieties of different morphologies, showed that the optimum population for yield testing must be around 500,000/ha.

(2) Since the grain-grass plant type is plastic to great extent, the geometry of planting may not greatly influence the yield. Though this trial was conducted in 20 cm rows on flat land, when doubling the row spacing (but coupled with high intra-row spacing as well) may be adopted in routine yield trials of breeding material. In our existing 75 cm row system paired rows with 18-19 plants/m row length seem to be more practical.

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Table 1: Plant densities at planting and thinning and at harvest*

Population	Plant/m^2 at planting, also at thinning)	Intra-row spacing (cm)	Final stand count/m^2
P_1	10	50	9.98 a**
P_2	40	12.5	47.31 b
P_3	70	7.1	62.32 c
P_4	110	4.5	69.86 d
P_5	140	3.6	68.22 cd
P_6	170	2.9	73.51 d
P_7	200	2.5	72.75 d

1) F value for replications, genotype and interactions were not significant (see Table 2).

2) L.S.D. for the means at .05 probability level is 6.97

** 1) Treatment means within columns with similar letters are not significantly different at 0.05 level according to Duncan's multiple range test

2) Difference between P_3 & P_4 is very small

Table 2: Split plot analysis for different variables: F-ratios

	F ratio			
	Genotype	Density	Interaction	CV (%)
1. Plant/m²	1.9*	65.93**	0.73	17.3
2. Grain yield (kg/ha)	16.[illegible]**	[illegible]**	1.32	14.5
3. Days to 50% flowering	[illegible]	[illegible]	0.[illegible]	1.0
4. Grain filling days	3.2[illegible]	0.89	0.[illegible]	2.4
5. Stover weight (fresh field weight)	1.91	1.93	1.99*	17.2
6. Leaf dry weight as % of total dry weight/plant	3.31*	[illegible].17	2.18*	3[illegible].6
7. Plant height	59.[illegible]	3.24**	1.01	5.9
8. Heads/plant	61.[illegible]*	62.3*	10.34*	27.2
Heads/m²	36.87**	26.47**	1.11	.7
9. Harvest index (%)	5.63*	1.14	1.07	1[illegible].3
10. Grain/leaf ratio	5.95*	6.59	1.34	1[illegible].0
11. Seeds/plant	6.0[illegible]*	[illegible].3**	1.61	[illegible]
12. Seeds/m²	3.50	1[illegible].79**	0.89	[illegible].5
13. Seed size gm/1000 seeds	316.5[illegible]*	2.38*	1.3	6.3
14. [illegible]	133.95**	1.39*	1.[illegible]	3
16. Dry weight of plant	1[illegible].3**	57.07**	4.6	27.7
17. Seasonal productivity rate kg/ha/day	6.45*	6.66**	1.07	19.7
18. Seasonal crop growth rate kg/ha/day	7.[illegible]*	17.64**	1.37	17.9
19. Head filling rate kg grain/ha/day in GS3	12.07**	6.74**	1.07	19.3
Degrees of freedom:				
Treatment Source x Error Source	3 x 9	3 x 72	18 x 72	
F value 5%	3.86	2.23	1.75	
1%	6.99	3.07	2.2	

Table 3. Table of means for days to flower, days in GFS (grain filling), harvest index, grain-leaf ratio

	Days to flower	Grain filling days	Harvest index ( )	Grain/leaf ratio (g grain/g leaf dry weight
DC 50	41.6	30.1	30.3	39
230	44.6	31.7	35.1	31
440	47.6	31.4	31.2	30
CSH6	57	33.0	28.1	270
LSD (5%)	0.7	1.9	4.2	181

Table 4 Means for grain yield, plant height, ears/m^2, ears/plant, seed number/plant and seed size

	Population	Grain yield kg/ha	Plant height (cm)	Ear heads/ m^2	Ear heads/ plant	Seed no / plant	1000 seed wt (g)
GC [illegible]	P1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3	1341	[illegible]	120	[illegible]	519	[illegible]
	4	1925	156	113	1.3	433	17.9
	5	1660	153	120	1.3	537	17
	6	2177	113	133	2.1	426	17.9
	7	2301	150	120	1.6	644	11.3
Mean		1376	135	119	2.0	625	17.7
GC 230	P1	1054	134	47	4.7	82	17.3
	2	1393	143	73	1.5	477	13.1
	3	2102	138	96	1.6	611	14.3
	4	2311	148	97	1.3	562	17.8
	5	1909	132	117	1.7	376	12.9
	6	2103	137	113	1.6	412	13.4
	7	2161	134	133	1.7	434	13.6
Mean		2017	131	97	2.1	544	13.0
GC 430	P1	1717	143	37	3.8	1568	14.9
	2	2472	150	93	2.1	744	11.7
	3	2756	142	91	1.7	61	11.2
	4	2733	145	93	1.3	711	12.1
	5	2513	133	102	1.7	632	11.6
	6	2329	143	113	1.7	729	12.1
	7	2640	149	122	1.6	642	10.9
Mean		2483	171	93	2.0	869	11.7
CSH6	P1	2821	17	11	1.1	1566	17.7
	2	3324	126	47	1.0	740	13.0
	3	3579	136	52	1.1	579	19.6
	4	3465	143	66	0.9**	509	19.1
	5	3153	138	65	0.9	491	20.9
	6	3799	139	61	0.9	512	20.3
	7	3235	179	63	0.9	445	18.7
Mean		3343	184	54	1.0	643	19.0
Overall Mean		[illegible] 23661					
LSD at 0.05% level for means							
a) Within entry		685	9	26	0.8	294	1.4
b) Of different entries		774	12	27	0.7	314	1.4

In CSH6 at higher populations stand count excluded counts of ear heads/unit area. A few plants reached final leaf stage, but no earhead was found emerging.