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Studies on Hybrid Sorghum Seed Production - Application of NPK at Different Levels and Combination on the Yield and Quality of CSH-5 Hybrid Seed*

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A field experiment conducted to find out the effects of application of N at 0, 100 and 200 kg/ha and P and K each at 72.5 and 145 kg/ha in different combinations on the growth of ms 2077-A (female parent of CSH-5) and yield and quality of CSH-5 hybrid seeds revealed, (i) hybrid seed yield varied from 1079 to 2392 kg/ha among the treatments; (ii) the bulk seeds could be separated into three size grades, of which 49.5 per cent was retained in 7x7 sieve; (iii) germination and seed vigour were associated with seed size and (iv) the thousand seed weight was influenced by the dose of P.

Improved agronomic practices play a major role in raising seed crops. Application of the major nutrients in required doses at the optimum stages of crop growth can improve the quality as well as yield of hybrid seeds. CSH-5 sorghum is a popular hybrid in Tamil Nadu and the production of seed in this hybrid is being done on a large scale around Coimbatore. The seed growers apply fertilizers on an arbitrary basis. Hence to evolve a cheap and economical dose combinations of NPK, experiments were conducted and the results discussed.

MATERIAL AND METHODS

A field trial adopting split plot design was laid out in the Kharif season of 1976. Application of P_2O_5 and K_2O was taken as the main plot and of N as sub-plot treatments. Nitrogen at three levels viz., O (No), 100 (N_1) and 200 (N_2) kg/ha; phosphorus and potash each at O (P_0, K_0), 72.5 (P_1, K_1) and 145.0 (P_2, K_2) kg/ha were tried. Full doses of P and K and half the dose of N were applied as basal dressing at the time of sowing the female parent (ms 2077-A) and the remaining dose of N, 30 days afterwards. The net plot size was 2.7 x 2.1 m. The experimental area was surrounded by four rows of male parent (CS 3541) as border rows. A planting ratio of 6:2 (male : female) and a spacing of 45 x 15 cm were adopted. The recommended cultural and plant protection measures were followed. Irrigations were given as and when necessary. Of the two rows of

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male parent, one was sown four days and the other seven days after sowing of the female parent.

In five randomly marked plants in each replication of the female parent, observations on (i) height of plant, (ii) number of leaves, (iii) diameter of culm and (iv) area of the fourth and flag leaves as on 80-th day and (v) days to half-bloom were recorded. Prior to harvest, observations on (vi) length and (vii) diameter of the peduncle and (viii) length and (ix) breadth of the panicle were recorded.

At the time of harvest, earheads of the male parent were harvested first and removed from the field. Afterwards, earheads from the five marked plants of the female parent were harvested. Then the remaining plants were harvested. The earheads were thrashed by hand and the seed from individual replication was dried and weighed. The seeds were size graded with sieves having 6x6, 7x7 and 8x8 square perforations per square inch and those retained by the above sieves were designated as G_1, G_2 and G_3 respectively. The percentage recovery of seeds in each grade was worked out on weight basis. The graded seeds from each replication were pooled treatment wise and grade wise and mixed thoroughly and samples were drawn to estimate the following: (i) 1000 seed weight; (ii) germination (ISTA, 1966); (iii) field emergence potential (ISTA, 1966); (iv) germination energy (Maguir, 1962) and (v) germination under brick grit (Hiltner and Ihssen, 1911). The vigour index was calculated from the length of root and shoot of 10 seedlings selected randomly from the germination test (Abdul-Baki and Anderson, 1973).

RESULTS AND DISCUSSION

Application of N, P and K at different levels and combinations did not influence the plant height significantly. The results are in conformity with those reported by Raheja and Krantz (1957) in sorghum; However, increase in plant height due to application of P in Sorghum has been reported by Kamalam, (1964). The treatment differences for number of leaves were not significant. Increase in the number of leaves due to application of N has been reported by Garg and Kayande, (1963).

Diameter of culm was not significantly influenced by any one of the nutrients but the interaction of NK has significantly altered the same. Influence of nitrogen application was pronounced when K was not applied. Garg and Kayande (1963) reported a positive response for N application. The area of 4th flag leaves ranged from 375.4 to 343.9 cm^2 and from 129.8 to 172.4 cm^2 respectively. But the treatment differences were not significant. Schumaker (1968) and Kachapur *et al*. (1976) repoted significant increase in leaf area for application of nitrogen.

With regard to number of days to half bloom application of P at 145 kg/ha induced early flowering by 2 days over Po. The interaction of NK was also significant indicating thereby that availability of N was more important than K, since the effects of N was more perceptible in the absence of K. Campbell and Pickett, (1968) have

TABLE I. Effect of application of NPK at different levels on culm diameter, days to half bloom, peduncle diameter and hybrid seed yield in the female parent of CSH-5 Sorghum

	P0			P2			P2					
	N0	N1	N2	N0	N1	N2	N0	N1	N2			
Culm Diameter (cm)										Comparison	SE	CD
P0	1.99	1.99	2.10	1.78	2.13	2.05	1.98	2.22	1.97			
K1	2.00	1.97	1.93	1.96	1.87	1.97	2.00	1.95	2.07	N at K	0.04	0.12
K2	2.07	1.97	2.05	2.05	1.91	2.09	2.10	1.97	2.10	K at N	0.06	0.17
Number of days to half bloom												
K0	69	68	68	70	69	64	68	70	69			
K1	71	72	71	67	69	70	70	67	69	N at K	0.6	1.7
K2	70	70	71	69	65	67	67	65	65	K at N	0.8	2.3
										P	0.6	1.8
Peduncle diameter (cm)												
K0	1.1	1.0	1.2	1.1	1.0	1.1	1.1	1.1	1.1			
K1	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.1	N	0.01	0.04
K2	1.1	1.1	1.1	1.0	1.2	1.1	1.1	1.1	1.1			
Seed Yield (Kg/ha)												
K0	1638	2212	1513	1913	1079	1945	1566	1249	1095			
K1	1824	1561	1892	1812	1492	1859	1174	2001	1878	N at P	122.3	350.9
K2	1818	1778	1307	1741	1292	1397	1921	2392	1714	P at N	148.1	435.4

reported application of N induces early flowering in sorghum.

No significant difference could be observed in the length of peduncle due to the treatments. The length varied from 36 to 42 cm. With regard to diameter of peduncle, application of N significantly increased the same. According to Tatwadi and Choudhari (1976), nitrogen application reduced the peduncle length in sorghum. In the present study, the length and breadth of panicle was varying from 28.4 to 32.4 cm and from 5.1 to 6.3 cm respectively though the treatment differences were not significant.

The hybrid seed yield ranged from 1079 to 2392 kg/ha. The treatment differences were not significant except for the interaction of NP. The wide variations in seed yield may be due to variations in the flowering of female parent when compared to the male parent. Hybrid seed yield is dependent upto not only on the agronomic practices followed but also on the pollination efficiency as well as proper nicking of the parental lines involved. It was evident that application of N and P induced early flowering. The response of the female parent to the doses of N and P might have been more than that of the male parent and the flowering duration

TABLE II. Effect of application of N, P and K at different levels (i) on seed recovery percentage (ii) 1000 seed weight and (iii) germination energy of CSH-5 hybrid seed

		P0			P1			P2					
		N0	N1	N2	N0	N1	N2	N0	N1	N2			
Seed Recovery (%)											Comparison	SE	CD
G1	K0	23.31	8.73	17.70	20.72	22.41	10.34	15.77	11.45	13 22			
	K1	16.57	15.54	14.85	29.02	17.30	7 43	17.17	35.52	13.71			
	K2	17.73	9.30	17.95	31.49	13.79	38 92	12.09	16.64	23.78			
G2	K0	43.81	54.26	51.57	52.15	39.79	53.85	54.15	56.80	51.56			
	K1	51.72	60.03	59.10	39.57	54.38	54.57	51.43	27.37	55.82			
	K2	56.23	52 66	49.12	43.93	44.90	26.41	55.83	52.58	42.45	G	0.42	1.20
G3	K0	30.76	35.19	28.50	26.18	34.73	33.32	28.42	25.32	33.43			
	K1	30.01	21.34	22.16	30.42	23.93	37.08	29 28	28.21	28.27			
	K2	25.42	36.30	30.44	22.79	37.96	34.96	34.23	30.43	28 47			
1000 Seed weight (g)													
G1	K0	29.00	27.21	19.42	28.07	29.17	28.03	27.75	28.00	27.93			
	K1	27.95	26.91	28.45	28.34	27.89	28.86	28.15	30.88	26.47	G & P	0.20	0.55
	K2	27.97	28.93	29.02	27.59	28.64	26 59	27.53	27.69	29.84			
G2	K0	25 07	24.48	24 39	25.22	25.50	25.35	26.61	25.70	24.85			
	K1	26 72	24.63	25 97	26.17	24.44	25.63	24.90	24.93	25.65	PK interaction	0.34	0.95
	K2	24.31	24 37	25.42	22.06	25.80	24.57	24.81	27.90	27.20			
G3	K0	19.25	18.54	18.74	18.71	19.38	20.53	22.03	19.00	19 31			
	K1	18.82	19.28	19.50	19.96	18.03	18.77	19.07	18.65	19.15			
	K2	18.92	17.70	20.77	17.05	20.53	19.15	19.30	21.24	20.08			
Germination Energy													
G1	K0	16 67	15.17	14.43	13.02	17.50	13.41	15.00	14.89	15.01			
	K1	16.21	13 35	17.02	16.53	16.82	15.89	15.52	17.68	15.75			
	K2	17.71	14.81	15.97	17.22	16.40	16.98	16.06	15.96	15.44			
G2	K0	14.47	15 22	14.01	9.64	16.00	18.04	12.95	11.63	14 47			
	K1	14.38	17.19	13.95	15.37	15.67	15.17	14.73	16.89	15.79	G	0.29	0.51
	K2	13.34	16.10	16.86	18.31	15.53	16.56	14.58	13.46	16.59	NK interaction	0.51	1.40
G3	K0	14.72	13.05	17.70	12.32	15.65	14 32	13.46	13.17	12.01			
	K1	13.45	13.91	14.68	14.10	13.95	13.00	12.43	13.95	12 51			
	K2	16.16	11.66	13.64	15.72	13.45	13.75	13.19	12.09	13.35			

TABLE III. Effect of application of N, P and K at different levels on germination (Roll towel and Brick grit) and field emergence in graded seeds of CSH-5 hybrid (Transformed values of percentages)

		P0			P1			P2			Comparision	SE	CD
		N0	N1	N2	N0	N1	N2	N0	N1	N2			
Roll Towel													
G1	K0	63.2	69.8	62.1	69.8	69.9	65.3	60.7	72.3	64.8			
	K1	66.5	69.0	68.1	66.9	66.4	62.1	67.2	65.0	60.0			
	K2	64.6	61.4	59.4	67.3	81.9	70.7	66.4	60.7	59.4			
G2	K0	60.7	67.3	70.6	68.1	58.7	64.0	67.3	68.1	70.4	G	0.90	2.48
	K1	67.7	70.5	61.1	71.6	61.8	60.0	62.7	62.8	78.2	PK	1.55	2.48
	K2	67.5	63.5	61.5	69.8	67.3	65.0	65.3	71.6	63.1	interaction		
G3	K0	61.5	63.2	65.0	58.3	62.1	62.1	58.7	61.4	62.7			
	K1	58.9	68.1	58.7	62.9	53.5	57.8	58.4	63.1	59.4			
	K2	61.9	55.6	53.5	56.6	62.0	67.3	63.1	61.0	66.5			
Brick grit													
G1	K0	65.7	50.1	58.6	65.8	62.4	54.0	59.4	63.6	50.9			
	K1	61.4	65.7	61.5	64.9	65.0	59.4	62.4	64.6	59.6			
	K2	61.1	62.1	64.3	61.7	65.0	69.0	60.2	59.7	61.7			
G2	K0	62.2	61.4	64.6	60.2	63.5	61.6	71.6	61.8	71.1			
	K1	66.7	58.3	55.0	69.9	57.0	58.1	63.5	63.2	62.9	G	0.88	2.45
	K2	60.7	60.0	65.1	64.3	61.4	71.6	60.0	68.9	64.2			
G3	K0	55.0	55.7	56.8	56.7	64.3	63.5	59.2	52.6	70.3			
	K1	60.0	52.0	50.8	57.6	53.2	56.2	53.8	59.2	60.7			
	K2	56.8	54.7	58.7	60.1	60.4	56.8	61.4	53.2	58.4			
Field emergence													
G1	K0	60.7	62.2	63.7	63.5	65.7	71.7	70.7	64.3	62.6			
	K1	64.6	63.3	65.0	59.4	63.5	66.5	60.0	63.7	65.7			
	K2	60.2	59.1	63.5	61.6	62.6	64.6	61.7	61.7	70.2			
G2	K0	58.8	64.6	62.1	56.9	63.6	63.6	56.8	60.4	52.6			
	K1	60.0	63.2	63.5	57.4	61.1	58.1	56.9	60.7	63.6	G	1.02	2.33
	K2	64.4	59.1	64.2	60.1	63.5	57.0	60.8	64.9	67.1			
G3	K0	58.1	60.0	57.3	54.1	56.7	58.7	62.1	56.9	50.8			
	K1	59.5	57.5	53.5	55.0	59.5	55.9	58.1	56.9	60.0			
	K2	59.4	57.3	62.8	55.3	58.7	58.1	58.7	56.2	62.1			

there by would have widened overlapping the period of the male parent. In other words, nitrogen application would have increased the interval between the flowering periods of female and male parents, thus, bringing down the yield. Seshadri and Peter (1972) found that hybrid sorghum gave lower yield under 200 kg N/ha than under O kg N/ha.

The seeds could be graded into three sizes of which G_1 (7x7 retained) recorded the maximum recovery of 49.5 per cent. The interactions of GP, GK and GN were highly significant. Application of P at 72.5 kg/ha and of K at 145 kg/ha levels increased the recovery of large seeds by 5.6 and 4.2 percent respectively, whereas, application of nitrogen at 100 kg/ha

TABLE IV. Effect of application of N, P and K at different levels on (i) length of root and (ii) vigour index of CSH. 5 hybrid seed

		P0			P1			P2					
PNG	K	N0	N1	N2	N0	N1	N2	N0	N1	N2	Comparison	SE	CD
Root length (Cm)													
G1	K0	13.10	12.50	13.11	14.74	12.64	12.87	12.39	12.73	13.31			
	K1	12.80	12.03	12.19	12.69	12.91	12.39	14.97	12.31	13.80			
	K2	11.09	12.11	13.13	12.87	11.47	12.59	12.75	11.72	13.01			
G2	K0	10.62	13.21	12.31	12.77	12.74	12.73	13.70	12.89	12.77	G	0.16	0.44
	K1	12.40	11.42	11.05	12.39	11.39	12.14	11.68	10.67	12.95	P	0.16	0.44
	K2	11.91	11.47	12.50	12.08	12.54	11.63	13.80	14.17	12.00			
G3	K0	12.05	10.84	11.48	10.00	12.59	11.73	12.05	11.68	12.72			
	K1	11.87	10.10	12.14	13.07	11.91	11.98	11.15	12.58	10.71			
	K2	10.79	11.47	11.80	10.52	10.54	11.24	11.30	11.64	13.15			
Vigour Index													
G1	K0	2443	2663	2256	2763	2427	2410	2104	2620	2349			
	K1	2352	2474	2401	2419	2442	2315	2799	2193	2172	G	42.7	116.0
	K2	2361	2040	2163	2430	2760	2546	2297	2072	2089			
G2	K0	1762	2428	2393	2426	2070	2420	2407	2503	2513			
	K1	2337	2433	2901	1618	2020	2040	2163	2035	2870			
	K2	2312	2171	2142	2466	2422	2220	2374	2690	2283			
G3	K0	2219	2053	2337	1900	2188	2110	2030	2068	2268			
	K1	1865	2363	1988	2250	1820	1870	1902	2159	1924			
	K2	2027	1883	1704	1906	2080	2207	2274	1997	2413			

and 200 kg/ha have reduced the recovery of large seeds by 3.60 and 2.80 per cent respectively.

Seed size exerted significant differences on the seed quality parameters studied except for shoot length and dry matter production of seed crop. The effect of P application on 1000 seed weight and root length was significant. The interaction effects of PK on thousand seed weight and germination and of PN and KN on 1000 seed weight and the latter on germination energy were also significant.

Larger the size, greater was 1000 seed weight (Table III). Sivasubramanian and Ramakrishnan (1974) have reported similar results. Application of P at 145 kg/ha increased the 1000 seed weight by 0.628 g over control. The seed weight increased when K was applied in conjunction with P.

Larger seeds recorded higher germination than smaller seed (Table III). Presence of higher proportion of shrivelled and immature seeds resulting from incomplete seed development (Croker and Barton, 1953) may be the reason for

poor germination in small seeds. Kalingarayar (1976) in sorghum have reported positive association between seed size and germination. Significant increase in seed germination was observed in the treatment $P_1 K_2$.

Emergence of seedlings through a layer of brick grit indicated the physiological stamina of the seeds (Isley, 1957). In the present study, the top two grades of seeds have registered higher percentage of emergence than the smaller seeds (Table III) which was in agreement with the results of Kalingarayar (1976).

Larger seeds registered 1.14 cm more root length than the smaller ones (Table IV). Shoot length varied from 14.60 to 17.82 cm. A linear relationship between seed size and seedling growth was reported by Jones (1918) in barley and Whalley *et al.* (1966) in grasses.

The association between seed size and dry weight of seedlings was not perceptible inspite of the variation from 0.11 to 0.18 g. Boyd *et al.* (1971) in barley, Gelmond (1972) in cotton and Ries and Everson (1973) in wheat have reported positive association between dry weight of seedlings and seed size. Abdul-Baki and Anderson (1973) in soybean brought out the concept of vigour based on the germination percentage and the mean total length of seedlings. Large size seeds registered higher vigour index value than small ones. Kathiresan (1976) obtained similar results in sunflower. Thus, the studies have clearly indicated that in hybrid seed production while the seed yield is highly influenced both by the pollination efficiency and of the availability of nutrients, seed quality is largely determined by the later.

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