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EFFECT OF PLANT DENSITY AND MOISTURE STRESS ON PRODUCTIVITY OF SUNFLOWER

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ABSTRACT

A field experiment with varied plant densities and moisture stress periods was conducted with rainfed sunflower (MSFH-8) during *kharif*, 1992 and 1993. The results showed that moisture stress during flowering and seed formation was more harmful than during vegetative phase in influencing the growth and yield of sunflower. Among different plant densities, there was no variation in seed yield of sunflower with population range from 56 to 111 thousand plants/ha in rainfed Alfisols. Thinning of plant density from 111 thousand to 28 thousand during moisture stress at vegetative and flowering reduced the seed yield as well as growth and uptake of nutrients. Hence, 56 thousand plants/ha at sowing is advantageous to get stable yields in rainfed environment. Altering plant densities during dry spells had no advantage as mid-season correction in sunflower.

Sunflower is an important oilseed crop gaining popularity in rainfed Alfisols. It is grown as an alternative contingent crop to castor under delayed sowing conditions. But the yield of sunflower in rainfed situations often fluctuates because of intermittent moisture stress. The effect of moisture stress on the productivity of sunflower can be minimized by selecting drought tolerant genotypes, adjustments in time of sowing, seed soaking and other management practices like altering plant densities by thinning particularly during drought spells. Hence, an attempt was made to study the effect of varied plant densities at different moisture stress periods on the growth mechanism and yield of sunflower.

MATERIALS AND METHODS

A field experiment was conducted with sunflower (MSFH-8) on an Alfisol of Hayathnagar Research Farm of the Central Research Institute for Dryland Agriculture during the rainy seasons of 1992 and 1993. The moisture holding capacity of the soil was 10 per cent by volume with available nitrogen 190 kg/ha, available phosphorus 10 kg/ha and available potassium 220 kg/ha. The experimental soil was sandy loam in texture with a pH of 6.9. The crop was sown during 2nd week of July of 1992 and 1993 with recommended dose of fertilizers. The treatments consisted of different plant densities, *viz.*, 111, 56, 34 and 28 thousand plants/ha with varied

inter-and intra-row spacings and these treatments were replicated four times in a randomized block design. Whenever the available soil moisture depleted to 50 per cent, the population of 111 thousand plants/ha was thinned to 56, 34 and 28 thousand plants/ha, respectively once during early stress (before 45 DAS) and also during mid-stress (45 - 90 DAS). In addition, stress-free treatments were also maintained for comparative study. The observations on dry matter, leaf area index and nutrient uptake were recorded during different growth stages of crop in both the years.

Sunflowr crop received about 346 mm and 499 mm of rainfall in 1992 and 1993, respectively with 15 days dry spell as mid-stress in 1992 and 13 days as early stress in 1993.

Rainfall use efficiency (RUE) was calculated as yield obtained per unit mm of rainfall (kg/ha/mm of rainfall).

Results and Discussion

Plant densities in relation to moisture stress

In 1992, the sunflower experienced more than 12 days of dry spell at flowering stage. At that time the plant density of 111 thousand/ha was thinned to 56, 34 and 28 thousand/ha. Among the thinned plant densities, 34 and 28 thousand/ha showed seed yield reduction by 47 and 95 per cent compared to 56 thousand plants/ha. The plant densities of 56, 34 and 28 thousand/ ha maintained from flowering gave seed yield reduction by 28, 56 and 63 per cent as compared to 111 thousand plants/ha maintained from sowing.

During 1993, sunflower crop experienced moisture stress during vegetative phase only. Plant densities of 56, 34 and 28 thousand maintained from vegetative phase gave seed yield reduction by 26, 39 and 46 per cent, respectively over 111 thousand plants/ha maintained after sowing. Among thinned plant densities during moisture stress at vegetative phase (0-30 DAS), sunflower with 34 and 28 thousand plants/ha decreased the seed yield by 16 and 27 per cent over 56 thousand plants/ha.

Plant densities in relation to crop growth and yield

Among the plant densities 111, 56, 34 and 28 thousand/ha maintained at sowing, the sunflower with 111 thousand plants/ha recorded highest seed yield of 1092 and 1438 kg/ha in 1992 and 1993, respectively under rainfed environment (Table 1). There was no significant variation in seed yield of sunflower with population of 111 to 56 thousand plants/ha in both the years. The sunflower with 111 thousand plants/ha in stress-free environment registered an additional seed yield of 618 kg/ha and also monetary gains of Rs 5567/ha compared to the rainfed sunflower over the years. Plant densities of 34 and 28 thousand/ha reduced the seed yield by 25 and 41 per cent, respectively compared to 111 thousand plants/ha.

The dry matter, leaf area index and nutrient uptake were recorded highest in 111 thousand plants/ha followed by the 56 thousand plants/ha in both years. At harvest, the plant densities of 56, 34 and 28 thousand/ha gave dry matter reduction by 5, 45 and 53 per cent, respectively over 111 thousand plants/ha in rainfed sunflower (Table 2). Similarly, a decrease

Table 1. Influence of plant densities and time of moisture stress on productivity of sunflower

Plant density ('000/ha)	Yield (kg/ha)						RUE of seed (kg/mm/ha)			Gross returns (Rs/ha)			Reduction (-)/ increment (+) in seed yield		
	Seed			Sticks											
	1992	1993	Mean	1992	1993	Mean	1992	1993	Mean	1992	1993	Mean	1992	1993	Mean
A. Rainfed															
At sowing															
111	1092	1438	1265	1238	1361	1300	3015	3048	3032	9828	12942	11385	--	--	--
56	1013	1380	1197	1120	1243	1182	2.92	3.00	2.96	9117	12420	10769	-7.23	-4	-5.6
34	560	1039	950	796	815	806	2.48	2.21	2.35	7740	9351	8546	-21.3	-28	-24.7
28	605	890	748	650	733	692	1.75	1.29	1.52	5445	8010	6728	-44.6	-38	-41.3
Thinned during early stress (vegetative phase)															
56	--	1057		--	1096		--	2.56		--	9513		--	-27	
34	--	879		--	760		--	2.13		--	7911		--	-38	
28	--	770		--	628		--	1.86		--	6930		--	-46	
Thinned during mid-stress (flowering phase)															
56	785	--		840	--		2.26	--		7065	--		-28.1	--	
34	536	--		546	--		1.55	--		4824	--		-50.9	--	
28	402	--		410	--		1.16	--		3618	--		-63.0	--	
B. Stress-free															
	1805	1962	1884	1690	1720	1705	4.04	3.82	3.93	16245	17658	16952	+65.0	+36	50.5
CD at 5%															
	96	89		55	92		--	--		120	148		--	--	

Table 2. Influence of moisture stress and plant densities on growth components of sunflower

Plant density ('000/ha)	Dry matter (g/m^2)								Leaf area index						
	1992 (days after sowing)				1993				1992 (days after sowing)			1993			
	45	60	75	At harvest	45	60	75	At harvest	45	60	At harvest	45	60	75	At harvest
A. Rainfed															
At sowing															
111	217	523	809	911	230	536	703	996	1.89	2.57	0.94	1.66	2.62	1.80	0.65
56	183	481	698	869	210	502	692	946	1.68	2.23	0.73	1.27	2.01	1.42	0.43
34	185	338	409	429	180	416	560	610	1.28	1.68	0.42	0.76	1.70	1.05	0.31
28	130	239	387	393	140	380	482	515	1.00	1.43	0.30	0.64	1.63	0.98	0.20
Thinned during early stress															
56	--	--	--	--	160	480	515	680	--	--	--	0.86	1.62	1.36	0.38
34	--	--	--	--	138	410	480	518	--	--	--	0.62	1.28	0.98	0.29
28	--	--	--	--	110	307	402	468	--	--	--	0.41	0.98	0.60	0.14
Thinned during mid-stress															
56	--	324	423	551	--	--	--	--	--	1.40	0.40	--	--	--	--
34	--	195	318	340	--	--	--	--	--	1.17	0.31	--	--	--	--
28	--	189	288	303	--	--	--	--	--	0.96	0.23	--	--	--	--
B. Stress-free															
	220	780	1099	1326	250	820.0	1120	1400	2.00	3.00	0.96	1.96	2.80	1.65	0.86

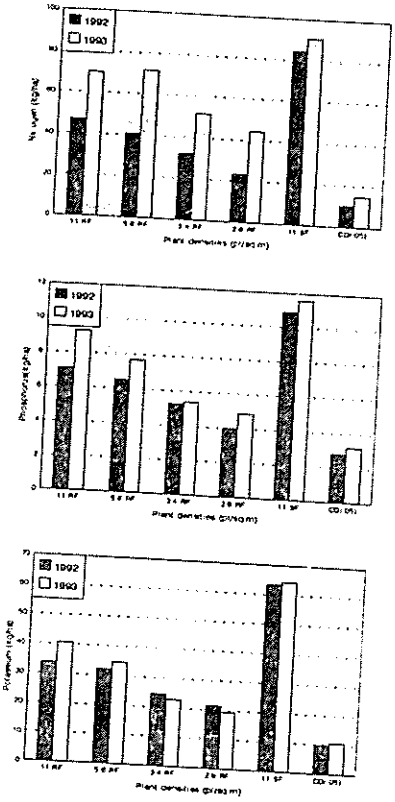

Fig. 1. Nutrient uptake in sunflower as influenced by different plant densities

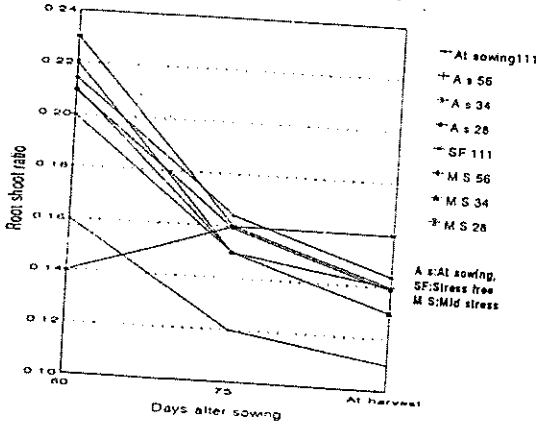

Fig. 2. Root-shoot ratio as influenced by plant densities and stress

in leaf area index by 27, 54 and 68 per cent was noticed with 56, 34 and 28 thousand plants/ha, respectively. The nutrient uptake (Fig. 1) increased significantly with increasing plant densities in all the years. The sunflower with a population of 111 thousand plants/ha and stress-free conditions gave higher nitrogen, phosphorus and potassium uptake at harvest by 42, 38 and 72 per cent than rainfed conditions. Higher growth and nutrient uptake were noticed in 1993 than 1992 because of variation in rainfall. The root-shoot ratio among different populations decreased as the crop growth advanced in both the years. The root-shoot ratio decreased with increasing plant densities too (Fig. 2).

The increased seed yield and biomass of sunflower with higher plant densities was due to higher total dry matter, leaf area index per unit area at all growth stages in both the years. Higher growth components with higher plant densities were the result of better utilization of rainfall in favourable environment and moisture from deeper layers with increased root system during dry spells. Higher nutrient uptake with better utilization of moisture as expressed by rainfall use efficiencies resulted in higher yield. The growth components per plant basis increased with decreasing plant densities in both the years. But this increase at lower plant densities could not be compensated with the yields obtained at higher plant densities of 56 to 111 thousand plants/ha because of suboptimal population (Narwal and Malik, 1985; Rao and Reddy, 1985).

Hence, it can be concluded that 56 thousand plants/ha maintained from

sowing are optiumum to get stable yield and income under rainfed environment. Higher plant density of 111 thousand though advantageous in favourable environment, plant density of 56 thousand plants/ha was at par with it in favourable environment and showed least reduction in stressed environments as well. There was no advantage of altering plant densities by thinning during intermittent dry spells on the crop growth of sunflower.

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