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EFFECT OF PLANT SPACINGS ON YIELD AND CERTAIN OTHER CHARACTERS OF SUNFLOWER VAS. HO—I

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Abstract

A spacing trial with row spacings of 12", 24" and 30" and plant spacings of 6", 9" and 12" conducted with Sunflower variety HO-I for four years showed that closer spacings generally resulted in higher seed yield. Head diameter and seed yield per plant were the most affected characteristics and together with 'days to maturity' increased with wider spacings. Stem thickness, seed size and full seed percent were also higher in wider spacings. Days to flower wre not effected, while plant height tended to increase in closer spacings. Planting distance of 24"x12" representing 21,780 plants per acre was the optimum.

Introduction

Sunflower (*Helianthus annuus* L.) as a world oil crop is gaining importance as it is being introduced to a number of countries outside Eastern Europe. It is now the second major oil croo of the world after Soybean. In the Sind Province of Pakistan the crop holds good prospects. It has been found to fit well in the cropping pattern of the Province as a catch crop. In the South of Sind, the optimum season is autumn (August to October) whereas in the North, spring crop (February to May) has been found to do better (Sheikh & Chaudhry, 1974). Its large scale cultivation can lessen dependence on foreign imports of edible oils without affecting acreage under major crops. In the performance tests conducted so far with varieties mostly of Russian and American origin, variety HO-I has been found to be better adapted to different areas of the Province (Annon, 1974).

Of the agronomic factors, planting distance is one of the major contributors to performance of Sunflower crop. In order to compare the effects of different plant spacings on yield and other characters of variety HO-I, a spacing trial was conducted for four years at Agricultural Research Institute, Tandojam. The findings are reported below:

Material and Methods

The investigations were conducted on sunflower Variety HO-I for four years viz; 1968-69, 1969-70, 1971-72 and 1972-73 with 12", 24" and 36" row and 6", 12", and 18" plant spacings.

The design of the experiment was Factorial with net plot size of 6'x18' and four replications. The sowing was done by dibbling the seed. In 1968-69 the crop was sown in the first week of October whereas in the subsequent three years sowing was done in the third week of August. The fertilizer dose used was 90 lbs. N and 45 lbs. P_2O_5 per acre. A fortnight after germination necessary thinning was done keeping one seedling per hole. Earthing up was done after first irrigation. Five plants in each plot were selected at random and tagged before flowering. Data in respect of the plant characteristics were recorded on selected plants.

Days to flowering were recorded from the date of sowing to the date of flower-head marked by appearance of ray florets. Days to mature were calculated from the date of sowing to the date when the underside of the head turned yellow. Plant height (upto the base of the head) and head diameter were recorded at maturity. The heads after harvest were dried in the open and after threshing weight of seeds per head of selected plants was recorded and plot yield was converted to yield per acre. In addition, stem thickness (in cms.), seed index (100 seed weight) and full seed percent were also recorded on the selected plants during 1969-70. The data were subjected to usual statistical analysis.

Review of Literature

The planting distance in crops like Sunflower has immense effect on the seed yield and other characteristics and for different areas the suitable spacing would depend on a number of factors i.e. variety, soil fertility, rainfall, temperature etc. A number of studies have been conducted to find out the most suitable spacing on this crop in different countries.

Trepacev (1954) reported that by increasing the size of area per plant from 1800 to 4900 sq. cms. the oil content decreased from 44.5% to 41.8% while yield of green mass increased from 1730 kg. per hactare for 1800 sq. cms. to a maximum of 1900 kg. per hactare for 2800 sq. cms and then declined to 1680 kg. per hactare for 4900 sq. cms.

Rene & Olteanu (1959) found that the optimum distance of 70x70 cms. with 2 plants/pocket and 60x40 cms. with single seed per pocket gave yields of 3,311 kg and 3218 kg per hectare, respectively. Optimal planting density was reported to be 41 to 45 thousand plants per hectare; the increase beyond which brought no increase in yield but reduced the quality of the crop. Sarpe & Olteanu (1962) obtained direct correlation between biological seed yield (expressed by seed yield per plant, seed weight and percentage of kernel) and the nutritional area available to plants.

Derco (1962) found that the optimum spacing for variety *Bucianska* was 60x30 cms. equivalent to 55,555 plants per hactare. He also reported that for nutritional area of 1200 to 3000 square cms. per plant the growing period was 133 and 139 days respectively. In another investigation Dered (1963) compared spacings of 50x50, 60x60 and 70x70 cms. with three plants per hole on Sunflower and found that the best spacing was 60 × 60 cms. with two plants per hole.

Lukasev (1963) observed that spacing of 90x90 cms. with three plants per hill to give 30 to 40 thousand plants per acre gave yields comparable with spacing of 70x70 cms. with two plants per hill and concluded that the former method facilitated the cultivation and reduced labour requirements. Dumitrescu & Pinzaru (1966) reported optimum plant densities for varieties VNIIMK-8931, and SMENA to be 60,000 plants per hactare for 100 cms rows and 50.000 per hactare for 80 cms rows.

Lofgren (1970) studied the effect of row spacings of 20, 30 and 40 inches and populations of 15, 20, 25, 30, 35 and 40 thousand plants per hactare on a number of characters of four Sunflower varieties. Although the most suitable spacing varied

with the varieties, generally the higher populations gave higher seed yield, reduced seed size and head diameter. Narrow row widths increased seed yield and also affected head size and seed index.

While comparing different nitrogen levels and plant spacings of 15, 30 and 46 cms in one meter rows, Massey (1970) obtained increase in seed yield, seed weight per head, seed size, head diameter, plant height and stem diameter with 56 kg. per hactare nitrogen over non- treated. However it did not affect number of leaves per plant. Different spacings did not affect plant height and number of leaves per plant. Wider plant spacings reduced seed yield, increased seed weight per head, seed size and head and stem thickness of variety Perodovik.

Results and Discussion

In the present studies the minimum spacing was 12″×6″ and maximum 36″×18″ inches which represent respectively plant populations of 9,680 and 87,120 per acre.

The yield data and other plant characters are given in Table numbers 1 to 7. The seed yield data are highly significant for two years, 1968-69 and 1971-72; the differences being non-significant for the years 1969-70 and 1972-73. In the former case both the plant as well as row spacings show highly significant differences, whereas the interaction (rows × plants) is non-significant. Among the row spacings 12″ and 24″ spacings and among plants 6″ and 12″ spacings do not differ from each other significantly. Row spacing of 36″ on the one hand and 18″ plant spacing on the other result in significantly lower yields than closer spacings, showing that these row and plant spacings result in sizeable reduction in the seed yield. The pooled analysis for four years show highly significant differences due to row spacings and significant for plant spacings.

Mean seed yield (maunds per acre)

Plant Spacings	Row spacings			
	12″	24″	36″	Mean
6″	17.8	15.7	15.0	16.2
12″	17.2	17.3	14.9	16.5
18″	15.6	15.1	11.0	13.9
Mean	16.9	16.0	13.6	
L.S.D. for Row Spacings:		@0.05 = 1.9 0.01 = 2.6		
L.S.D. for Plant Spacings:		@0.05 = 1.9 0.01 = N.S.		
ROWS x PLANTS:		N.S. (± 1.1)		

Spacings 12"x6", 12"x12" and 24"x12" have all given yields of more than 17 maunds per acre. The latter spacing representing 21,780 plants per acre should be preferable in view of the lower number of plants to be managed. Derco (1962) reported similar spacing to be optimum for variety Bucianska.

Seed yield is composed of a number of variable characters and thus would have reduced effect due to the spacings compared with the contributing factors. This is evident from the data given in respect of single plant seed weight and head diameter which show highly significant differences for all the years.

TABLE 1. Seed yield in maunds per acre.

Spacings	fPopulation per acre	1968-69	1969-70	1971-72	1972-73	Average
12 × 6	87,120	16.3	14.1	23.1	17.7	17.8
12 × 12	43,560	15.9	15.1	19.8	18.2	17.2
12 × 18	29,040	11.9	14.1	16.9	19.6	15.6
24 × 6	43,560	13.6	14.7	18.3	16.2	15.7
24 × 12	21,780	13.2	18.0	17.6	20.5	17.3
24 × 18	14,520	11.4	14.8	15.0	19.1	15.1
36 × 6	29,040	14.1	15.7	14.7	15.6	15.0
36 × 12	14,560	10.1	16.4	13.9	19.3	14.9
36 × 18	9,680	8.3	13.6	7.3	14.8	11.0
L.S.D. for ROWS	@0.05		1.55	N.S	3.08	N.S
	0.01		2.10	(± 0.77)	4.18	(± 3.63)
L.S.D. for PLANTS	@0.05		1.55	N.S	3.08	N.S
	0.01		2.10	(± 0.77)	4.18	(± 3.63)
ROWS X PLANTS			N.S	N.S	N.S	N.S
			(± 0.91)	(± 1.37)	(± 1.83)	(± 6.29)

The effect of plant competition is evident from the data in respect of head diameter (Table—2) which increases progressively with decrease in plant population from 11.1 cm for population of 87, 120 to 19.0 cm for 9,680 plants per acre. The row and plant spacings are highly significant for all the years. The data would indicate that among the plant spacings 6" spacing reduces the head diameter appreciably because of far greater plant competition. Plant spacings of 12" and 18" however do not show such big difference. The head diameter is associated closely

TABLE 2. Head diameter in cms.

Spacings	Population per acre	1968-69	1960-70	1971-72	1972-73	Average
12 × 6	87,120	12.7	8.4	13.5	9.9	11.1
12 × 12	43,560	17.8	9.4	15.0	10.9	13.3
12 × 18	29,040	16.8	11.2	16.8	13.2	14.5
24 × 6	43,560	15.5	11.2	15.0	11.2	13.2
24 × 12	21,780	18.8	13.2	16.0	14.0	15.5
24 × 18	14,520	21.1	15.0	16.5	16.0	17.1
36 × 6	29,040	18.5	12.2	17.3	14.5	15.6
36 × 12	14,560	19.0	16.3	17.3	16.5	17.3
36 × 18	9,680	25.4	15.2	17.5	18.0	19.0
L.S.D. for ROWS		@0.05	2.0	1.3	.9	1.1
		0.01	2.8	1.7	1.3	1.5
L.S.D. for PLANTS		@0.05	2.0	1.3	.9	1.1
		0.01	2.8	1.7	1.3	1.5
ROWS X PLANTS		N.S	N.S	N.S	N.S	
		(± 1.1)	(± 0.8)	(± 0.6)	(± 0.6)	

with the seed weight per plant which is 21.2 grams for population of 87, 120 and 56.6 grams for population of 9,680 (Table—3). Out of the three years for which data are available the differences are highly significant for two years for rows as well as plant spacings and significant for one year in each case. The rows appear to have greater effect on head diameter than plant spacings. The effect of spacing on head diameter and seed weight per plant is similar to that reported earlier (Lofgram, 1970; Massay, 1970). The relationship between head diameter and seed yield per plant for various levels of populations is shown graphically (Fig. 1).

Data regarding days to maturity (Table—4) show that out of three years the values are highly signihcant for rows and for plants during 1960-70 and highly significant for rows only, during 1968-69, suggesting that the population intensities do effect the maturity of the crop which takes longer to mature at lower population levels. Derco (1972) reported similar effect of spacings on maturity of Sunflower. The crop during 1968-69 has taken much longer to mature compared with the crop in subsequent years. This is because the sowing was done in October during 1968-69 instead of normal sowing time (August) which has resulted in late maturity. Al-

TABLE 3. Single Plant seed Weight (grams).

Spacings	Population per acre	1968-69	1969-70	1971-72	Average
12 × 6	87,120	19.8	15.0	28.9	21.2
12 × 12	43,650	26.9	19.8	34.6	27.1
12 × 18	29,040	26.9	33.7	50.5	37.0
24 × 6	43,560	19.6	31.7	49.6	33.6
24 × 12	21,780	22.7	42.5	55.8	40.3
24 × 18	14,520	46.8	59.2	60.1	55.4
36 × 6	29,040	30.3	37.4	62.9	43.5
36 × 12	14,560	34.0	72.9	62.4	56.4
36 × 18	9,680	43.1	62.4	64.3	56.6
L.S.D. for ROWS		@0.05	8.8	9.6	7.6
		0.01	N.S	13.0	10.5
L.S.D. for PLANTS		@0.05	8.8	9.6	7.6
		0.01	11.9	13.0	N.S
ROWS X PLANTS		N.S	N.S (± 5.1)	N.S (± 5.6)	(± 4.5)

though days to flowering are not at all affected by different spacings (Table—5) data regarding height of the plant provide some evidence of the effect of spacings especially the plant spacings (1972-73). The narrow plant spacings result in taller plants due to greater plant competition. The effect of different spacings on plant height however appears to be weak.

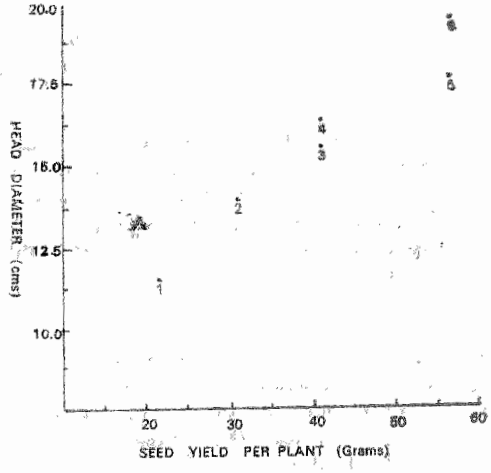

Figure 1. Relation ship between head size and seed yield per plant at different population levels (average of 3 years data).
1 = 87,120, 2 = 43,560, 3 = 29,040, 4 = 21,780, 5 14,560, 6 = 9,680 Plants per Acre).

TABLE 4. Maturity Days.

Spacings	Population per acre	1968-69	1969-70	1971-72	Average
12 × 6	87,120	119.2	89.5	85.7	98.1
12 × 12	43,560	116.5	91.8	85.7	98.0
12 × 18	29,040	120.3	93.1	86.0	99.8
24 × 6	43,560	117.5	93.5	86.2	99.1
24 × 12	21,780	121.1	95.5	86.5	101.0
24 × 18	14,520	119.3	97.7	85.7	100.9
36 × 6	29,040	123.7	94.7	85.7	101.3
36 × 12	14,560	121.2	96.3	86.2	101.2
36 × 18	9,680	122.2	97.6	8615	102.1
L.S.D. for ROWS		@0.25	2.28	1.80	N.S
		0.01	3.10	2.45	(± 0.21)
L.S.D. for PLANTS		@0.05	N.S	1.80	N.S
		0.01	(± 0.78)	2.45	(± 0.21)
ROWS X PLANTS			N.S	N.S	N.S
			(± 1.35)	(± 1.07)	(± 0.36)

TABLE 5. Flowering Days.

Spacings	Populations per acre	1969-70	1971-72	1972-73	Average
12 × 6	87,120	69.9	63.0	76.0	66.6
12 × 12	43,560	59.5	64.0	76.5	66.7
12 × 18	29,040	64.2	63.2	78.2	68.5
24 × 6	43,560	63.2	63.0	77.0	67.7
24 × 12	21,780	60.4	61.7	75.0	65.7
24 × 18	14,520	62.2	64.0	72.5	66.2
36 × 6	29,040	61.4	64.5	77.5	67.8
36 × 12	14,560	60.3	60.7	75.0	65.3
36 × 18	9,680	61.2	65.5	75.0	67.2
L.S.D. for ROWS		@0.05	N.S	N.S	N.S
		0.01	(± 0.63)	(± 0.85)	(± 0.74)
L.S.D. for PLANTS		@0.05	1.83	N.S	N.S
		0.01	N.S	(± 0.85)	(± 0.74)
ROWS X PLANTS			N.S	N.S	N.S
			(± 1.79)	(± 1.47)	(± 1.29)

TABLE 6. Plant height in cms.

Spacings	Populations per acre	1968-69	1969-70	1971-72	1972-73	Average
12 × 6	87,120	150	143	141	160	148.5
12 × 12	43,560	159	140	145	141	146.2
12 × 18	29,040	143	139	150	149	145.2
24 × 6	43,560	146	153	148	159	151.5
24 × 12	21,780	141	149	142	155	146.7
24 × 18	14,520	144	155	145	144	147.0
36 × 6	29,040	150	148	140	162	150.0
36 × 12	14,560	126	162	146	153	146.7
36 × 18	9,680	138	150	145	137	142.5
L.S.D. for ROWS	@0.05	N.S	10.5	N.S	N.S	
	0.01	(± 5.2)	—	(± 1.81)	(± 2.81)	
L.S.D. for PLANTS	@0.05	N.S	N.S.	N.S	8.2	
	0.01	(± 5.2)	(± 3.6)	(± 1.81)	11.1	
ROWS X PLANTS		N.S	N.S	N.S	N.S	
		(± 8.86)	(± 6.2)	(± 3.12)	(± 4.86)	

TABLE 7. Stem thickness, seed size and full seed percentage during 1969-70.

Spacings	Population per acre	Stem Thickness (cm)	Weight of 100 seeds in (grams)	Full seed percentage
12 × 6	87,120	1.20	3.41	77.2
12 12	43,560	1.53	4.38	82.8
12 × 18	29,040	1.55	4.26	82.7
24 × 6	43,560	1.43	4.32	84.5
24 × 12	21,780	1.72	5.18	88.0
24 × 18	14,520	1.98	6.20	93.9
36 × 6	29,040	1.67	4.84	86.3
36 × 12	14,520	1.81	6.66	95.1
36 × 18	9,680	2.50	6.72	95.9
L.S.D. for ROWS	@0.05	0.18	0.67	3.9
	0.01	0.25	0.91	5.3
L.S.D. for PLANTS	@0.05	0.18	0.67	3.9
	0.01	0.25	0.91	5.3
ROWS X PLANTS		N.S.	N.S.	N.S.
		(± 0.10)	(± 0.40)	(± 2.32)

Different spacings in the present investigations seem to exert considerable effect on stem thickness, seed size and full seed percent as is clear from the data for 1969-70 (Table 7). All these characters increase with increase in plant spacing. The differences are highly significant for rows as well as for plants. Stem thickness and seed size are reported to have been effected by spacings (Lofgram, 1970; Massey, 1970). The increase in full seed percent with decrease in plant population may be explained by the fact that higher population levels result in poor nutrition to plants.

Since yield is the most important character when suitability of a particular spacing has to be judged it is quite evident that the spacings 12″×6″, 12″×12″ and 24"x12" i.e. populations of 87, 120; 43, 560; 21, 780 plants per care give about equal yields but the last spacing would seem to be the most suitable in view of the fact that the closer spacings would result in increased production cost without any corresponding increase in the seed yield. The spacings wider than 24"x12" on the other hand result in appreciable reduction in yield.

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