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EVALUATION OF PLANTING PATTERN AND DENSITY EFFECTS ON SUNFLOWER: GROUNDNUT SOLE AND INTERCROP SYSTEM IN A SYSTEMATIC FAN DESIGN

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SUMMARY

A systematic fan design was adopted to study the performance of sunflower and groundnut at 26 density variables in sole and intercrop systems with two planting patterns at the Andhra Pradesh Agricultural University during summer 1983 and 1984 and kherif 1983. The yield density relationships were best fitted to the exponential model $Y = ab^x$ for either component. The two–row groundnut intercrop planting pattern to share 67% virtual area in sunflower densities of 35,467 to 162,134 plants/ha enhanced the total oilseed production over sole sunflower in the summer seasons. In kharif intercrop, yield total exceded the sole crop yield either or sunflower of groundnut. The three row groundnut intercrop planting pattern to share 75% virtual area in sunflower densities of 23,616 to 107,959 plants/ha produced more yield than either components in sole crop during the summer seasons as well as kharif. The most productive density of sunflower ranged from about 75,000 to 100,000 plants/ha for intercropping groundnut in a pattern to share 75% virtual area in summer or kharif.

Key words: Sunflower, groundnut, intercropping, yield, total oilseed production.

INTRODUCTION

In an attempt to overcome the deficit of vegetable oil in the country, groundnut cultivation has largely diffused into the non–conventional rabi and summer seasons in recent years (Rao, 1988). Sunflower is another oilseed crop that has shot into prominence for its adaptability to varied environments. It might perhaps be possible to further step up the total oilseed production per unit time and unit area by growing two crops in intercrop system at optimum density combinations and planting pattern. To this end it is essential to build up information on the yield–density relationship of the crops in sole and intercrop system with varying planting patterns. Systematic designs offer considerable scope to squeeze such first hand information from a large number of choices of different variables. Also they are much efficient in that they are less expensive, require less area, time, and effort which is not possibles through larger substantiating experiments in conventional designs. Therefore the experiment was conducted in a systematic fan or radial design adapted aftet Nelder (1962) and Bleasdale (1967).

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MATERIALS AND METHODS

The experiment was conducted on alfisols at the students' farm of the Andhra Pradesh Agricultural University, Rajendranagar, for two years in summer during 1983 and 1984 and once in kharif 1983. There were six treatments each with 26 density variables in plots forming a fan. There were thus 156 treatment combinations. These were laid out in four replications.

Treatments:

1. Sunflower with a range of narrow row width variables
2. Sunflower with a range of narrow row width variables + 2 rows of groundnut
3. Groundnut replacing sunflower + 2 rows of groundnut
4. Sunflower with a range of wide row width variables
5. Sunflower with a range of wide row width variables + 3 rows of groundnut
6. Groundnut replacing sunflower + 3 rows of groundnut.

The treatments 3 and 6 involved the sowing of groundnut in lieu of sunflower to have a precise comparison of its performance in intraspecific competition compared with that of the interspecific competition when grown in a similar set of planting.

The layout consisted of square shaped plots measuring 7.65 m on each side. Sowing was done along a non–stretchable flexible wire with markings at 22.5 ccm interval. One end of the wire was tied to a peg studded at the centre of four plots while the other end was swivelled round over the circumference forming a circle. Each fan within the quadrant of the circle with 12.02 m arc and an area of 45.98 m^2 formed a treatment (Fig.1). The wire was swung over the arc at 1.33 m distance forming 9 spokes or radii of sunflower/replaced groundnut for narrow row width treatments and at 2.0 m distance making 6 spokes for wide row treatments. In intercrop treatments, 2 or 3 rows of groundnut were interspersed by swinging the wire at 44 and 50 cm distance in the narrow and wide row width treatments respectively on the outer arc. There were 18 spokes of intercropped groundnut in both treatments. At harvest, plants from 2 peripheral arcs

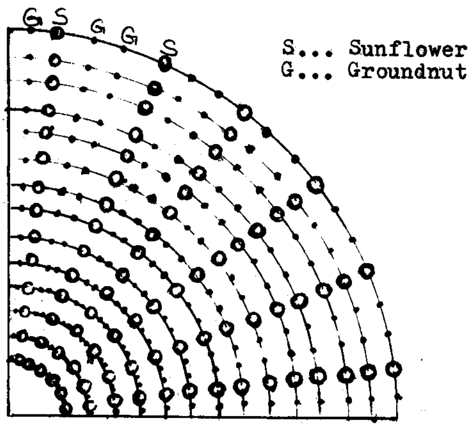

Fig.1 Layout of a systematic fan treatment

Table 1. Row width, area per plant and planting density per hectare of sunflower in narrow and wider row treatments

Arc No.	Narrow row width treatments			Wider row width treatments		
	RWns (cm)	An (cm^2)	PDn ha^{-1}	RWns (cm)	An (cm^2)	PDn ha^{-1}
1.	125.66	2819.51	35467	188.50	4234.36	23616
2.	121.73	2731.40	36611	182.60	4102.04	24738
3.	117.81	2650.93	37722	176.71	3969.72	25190
4.	113.88	2555.18	39136	170.82	3837.39	26059
5.	109.95	2467.07	40533	164.93	3705.06	26990
6.	106.03	2378.96	42035	159.04	3574.74	27989
7.	102.10	2290.85	43652	153.15	3440.42	29066
8.	98.17	2202.75	45397	147.26	3308.09	30228
9.	94.25	2114.64	47289	141.37	3175.77	31488
10.	90.23	2026.52	49345	135.35	3043.45	32857
11.	96.39	1938.42	51588	129.59	2911.12	34351
12.	82.47	1850.30	54045	123.70	2778.80	35987
13.	78.54	1762.19	56747	117.81	2650.93	37722
14.	74.61	1674.08	59734	111.92	2514.15	39774
15.	70.68	1585.97	63052	106.03	2381.83	41984
16.	66.76	1497.87	66761	100.14	2249.50	44454
17.	62.83	1409.75	70934	94.25	2117.18	47232
18.	58.90	1321.65	75662	88.36	1984.85	50381
19.	54.98	1233.54	81067	82.47	1852.53	53980
20.	51.05	1145.43	87303	76.58	1720.21	58132
21.	47.12	1057.32	94578	70.69	1587.88	62977
22.	43.20	969.21	103176	64.79	1455.56	68702
23.	39.27	881.09	113495	58.90	1323.24	75572
24.	35.34	792.99	126104	53.01	1190.91	83969
25.	31.42	704.88	141868	47.12	1058.59	94465
26.	27.48	616.77	162134	41.22	926.27	107959

RWns (cm) = Row width of sunflower at n^{th} arc in centimetres
An (cm^2) = Apparent area per plant at n^{th} arc in square centimetres
PDn ha^{-1} = Planting density per hectare

Table 2. Row width in the narrow and wider row treatments, apparent area per plant, planting density per hectare and virtual area per plant of groundnut

Arc No.	RWng (cm)				VAn (cm^2)	
	Narrow row treatment	Wider row treatment	An (cm^2)	PDn ha^{-1}	Narrow row treatment	Wider row treatment
1.	41.89	48.12	1413.71	70735	942.48	1060.28
2.	40.58	45.65	1369.65	73011	913.02	1027.15
3.	39.27	44.18	1325.45	75446	883.57	994.02
4.	37.96	42.71	1281.28	78046	854.12	960.88
5.	36.65	41.23	1237.10	80834	824.67	927.75
6.	35.34	39.76	1192.92	83827	795.21	894.62
7.	34.03	38.29	1148.74	87051	765.76	861.48
8.	32.72	36.82	1104.55	90534	736.31	828.35
9.	31.42	35.34	1060.36	94307	706.86	795.21
10.	30.08	33.84	1016.19	98406	677.40	762.08
11.	28.80	32.40	972.00	102880	647.95	728.95
12.	27.49	30.92	927.82	107779	618.50	695.81
13.	26.18	29.45	883.64	113168	589.05	662.68
14.	24.87	27.98	839.46	119124	559.60	629.55
15.	23.56	26.51	795.28	125741	530.14	596.41
16.	22.25	25.03	751.09	133139	500.69	563.28
17.	20.94	23.56	706.91	141460	471.24	530.14
18.	19.63	22.09	662.72	150893	441.79	497.00
19.	18.33	20.62	618.55	161668	412.33	463.87
20.	17.02	19.14	574.36	174106	382.88	430.74
21.	15.71	17.67	530.18	188615	353.43	397.61
22.	14.40	16.20	486.00	205761	323.98	364.47
23.	13.09	14.73	441.82	226336	294.52	331.34
24.	11.78	13.25	397.64	251483	265.07	298.20
25.	10.47	11.78	353.46	282917	235.62	265.07
26.	9.16	10.30	309.24	323362	206.17	231.94

RWns (cm) = Row width of groundnut between sunflower radii at n^{th} arc
An (cm^2) = Apparent area per plant at n^{th} arc in square centimetres
PDn ha^{-1} = Planting density per hectare
VAn (cm^2) = Virtual area per plant at n^{th} arc in square centimetres

and 2 spokes on each side of the fan were discarded as borders. Those with a crowded growth towards the centre were also left over. Mean yield data were gathered from plants harvested over 26 arcs for each density variable separately.

Fertilizers were applied as urea 90 kg N/ha to sunflower or groundnut replacing sunflower. Intercropped groundnut kernels were inoculated with the Rhizobium culture Nc 92. Phosphorus and potassium were applied at 40 kg P_2O_5 and K_2O/ha to either species. The crop was irrigated as and when necessary in summer seasons but with rain when grown in kharif.

Following relationships were made use of for working out the various parameters in the study (Table 1 and 2).

1. Arc length (LA): Distance between 2 radii of the sector at the point of intersection with the corresponding arc.

$$LA = \frac{d^\circ}{360} x^2 \pi r$$

2. Area of the fan or sector (As): Area of each fan forming quarter of a circle with desired radius.

$$As = \frac{d^\circ}{360} x^2 \pi r^2$$

3. Row width: Distance between the plants at the points of intersection of any 2 adjacent spokes on an nth arc

a. Row width of sunflower (RWns)

$$RWns = \frac{2 \pi rn}{N}$$

b. Row width of groundnut (RW ng)

$$RWng = \frac{RWns}{Sg + 1}$$

4. Area per plant: Size of area available to an individual plant in a crop community over unit area of land and the given planting density *per se*.

a. Apparent area per plant (An): Area actually occupied by a given crop irrespective of the area shared if any by the companion growth of the other species in the intercrop system.

$$An = (\pi r^2_{nmi} + \pi r^2_{nmi}) \times \frac{1}{N}$$

b. Virtual area per plant (VAn): Area in effect though not in fact irrespective of the optimum requirement.

$$VAn = (\pi r^2_{nmi} - \pi r^2_{nm3}) \times \frac{1}{NS_g}$$

c. Per cent shared area (SA): The imposed virtual area of the intercrop as per cent of the apparent area of the main crop.

$$S_A = \frac{VA_n}{A_n} \times 100$$

5. Planting density per unit area for an nth arc (PDn):

$$PD_n = \frac{PA}{A_n}$$

Where,

d° = Angle of the sector

r = Radius, r_{nmi} = Radius at mid point between the nth arc and next adjacent arc; r_{nmj} = Radius at mid point between the nth arc and previous adjacent arc.

$\pi = 22/7$

N = Number of radii or spokes of the crop in question in the circle.

N Sg = Number of radii or spokes of sunflower and groundnut in the circle.

PA = Unit area of planting.

Regression models were developed for mean yield data per plant and the density variables after Liu Li *et al.* (1984). The tests for identity of regression equations (F1), equality of intercepts (F2), and parallelism of the slopes (F3) for different treatments were performed as per the procedures outlined by Roy *et al.* (1959) and Steel and Torrie (1982).

RESULTS AND DISCUSSION

Sunflower component response

The yield–density relationship was exponential for sunflower grown in sole or intercrop system (Table 3). These responses accounted for 90– 98% of the total variance in the summer seasons. The estimated yield per plant was reduced from 28.78 to 10.28 g in 1983 and from 26.20 to 9.20 g in 1984 with increase in density from 35,467 to162,134 plants per hectare. When intercropped with two rows of groundnut, the yield was reduced from 22.18 to 9.80 and from 22.46 to 9.10 g in the two years. In wide row treatment with the range of density increasing from 23.616 to 107,959 plants per hectare, the sole crop yield was reduced from 31.63 to 13.36 g and from 25.69 to 11.97 g per plant. In the three row groundnut intercrop planting pattern, the corresponding reduction in yield of sunflower was from 31.10 to 12.25 g and from 23.29 to 10.86 g per plant. The low yield with rise in the density of sunflower is a phenomenon of intraspecific competition for resources. Plants crowd owing to their intimate planting and higher number per unit area, produce small sized flower heads with less grain and eventually yield low (Robinson *et al.* 1980; Miller *et al.*, 1984; Putnam *et al.*, 1990).

The tests for equality of intercepts (F2) of the regression equations showed that the sunflower yields in intercrop system were not significantly different from the sole crop in either planting pattern. This is an expected response since the coefficient 'a' represents the yield of sunflower in a non-competitive colony of plants. However, the regression coefficients were significantly different (F3) and thus the slopes of curves are not expected to be parallel. This implies that the rate of reduction in per plant yield of sunflower was also influenced by the interspecific competition in the intercrop system. Nevertheless, there were little differences in yield per plant of sunflower grown in sole and interdrop system across the range of density variables. The regression models were not identical (F1). Hence a commom estimate cannot be made for prediction of sunflower yield in sole and intercrop system and separate equations are to be modelled.

From the density variables in the narrow row treatment the sole optimum density was estimated at 123,152 and 122,067 plants per hectare to produce a maximum predicted

Table 3. Regression equations for seed yeild on planting density of sunflower

Treatment	lny = lna + bx		SE_b	r^2	F_1	F_2	F_3
	lna	b					
Summer 1983							
T_1	3.64789	–8.12000E–06x	2.48235E–09	0.95			
					19.82*	1.22	1314.15*
T_2	3.54012	–7.75000E–06x	5.13159E–09	0.97			
T_4	3.69059	–1.00142E–05x	6.84027E–07	0.90			
					2.33	60.24	266.23*
T_5	3.69408	–1.08750E–05x	5.94157E–07	0.94			
Overall					17.41**	15.32*	692.90**
Summer 1984							
T_1	3.54944	–8.19220E–06x	2.40769E–07	0.98			
					48.42*	37.88	690.05*
T_2	3.36460	–7.13343E–06x	3.36195E–07	0.95			
T_4	3.45282	–8.86835E–06x	5.43264E–07	0.92			
					22.57*	7.34	305.15*
T_5	3.35804	–8.88666E–06x	4.70521E–07	0.94			
Overall	–	–	–	–	44.64**	15.05*	452.27**
Kharif 1983							
T_1	2.38837	–8.08589E–06x	7.27289E–07	0.84			
					4.98	0.08	165.72
T_2	2.40831	–9.56396E–06x	6.46149E–07	0.91			
Pooled	2.39834	–8.82493E–06x	5.25264E–07	0.85			
T_4	2.43335	–8.55631E–06x	6.36667E–07	0.89			
					10.68	1.33	95.00
T_5	2.35939	–9.56453E–06x	1.15247E–06	0.75			
Pooled	2.39637	–9.06042E–06x	7.79880E–07	0.74			
Overall					5.15*	0.44	127.64**

F_1 = Test for identity of the regression equations
F_2 = Test for the equality of intercepts
F_3 = Test for parallelism

Table 4. Exponent functions of seed yield estimated optimum density (X_{opt}) and yield (Y_{max} kg ha^{-1}) of sunflower

Treatment	Yield plant^{-1}(g) y = a exp(bx)		X_{opt}	Y_{max} kg ha^{-1},
	a	exp(bx)		
Summer 1983				
T_1	38.3935	exp(–8.12000E–06x)	123152	1739.08
T_2	34.47105	exp(–7.75000E–06x)	129032	1636.24
T_4	40.06848	exp(–1.00142E–05x)	99858	1471.94
T_5	40.20856	exp(–1.08750E–05x)	91954	1360.16
Summer 1984				
T_1	34.79382	exp(–8.19220E–06x)	122067	1562.44
T_2	28.92192	exp(–7.13343E–06x)	140185	1491.36
T_4	31.58934	exp(–8.86835E–06x)	112760	1310.39
T_5	28.73281	exp(–8.88666E–06x)	112528	1189.44
Kharif 1983				
T_1	10.89571	exp(–8.08589E–06x)	123672	495.71
T_2	11.11516	exp(–9.56396E–06x)	104559	427.54
Pooled	11.00489	exp(–8.82493E–06x)	113315	458.75
T_4	11.39699	exp(–8.55631E–06x)	116872	490.00
T_5	10.58449	exp(–9.56453E–06x)	104552	407.10
Pooled	10.98323	exp(–9.06042E–06x)	110370	445.95

yield of 1739 and 1562 kg/ha (Table 4). With two row groundnut intercrop planting pattern, the density requirement of sunflower was slightly raised to 129,032 and 140,185 plants per hectare, respectively. The maximum yield was also slightly lowered to 1636 and 1491 kg per hectare. Thus 95% of the yield maxima in sole crop was realised from intercrop system with 5.9% higher density in 1983 and 85% yield with 4.5% more density in 1984.

In density variables with wide row treatments, sole optimum density of sunflower was 99,858 and 112,760 plants per hectare with predicted maximum yield response of 1472 and 1310 kg/ha. With three rows groundnut intercrop planting pattern, the yield maxima were 98 and 81% (1472 and 1310 kg/ha) of the sole crop but with 7.9 and 0.2% less density (91,954 and 112,528 plants/ha). The plots of yield per hectare also indicate that the yield of sunflower was little affected in the intercrop system in either planting pattern across the range of density variables (Fig.2).

In kharif, the yield was reduced from 8.18 to 2.92 in sole crop and from 7.92 to 2.36g in intercrop system at higher densites in the narrow row treatment. In the wide row treatment, the yield was reduced from 9.31 to 4.47 g in sole crop and from 8.44 to 3.71 g/plant in intercrop system. The intercepts, regression coefficients, and the equations were not significantly different for yield estimates in sole and intercrop system. Inter-

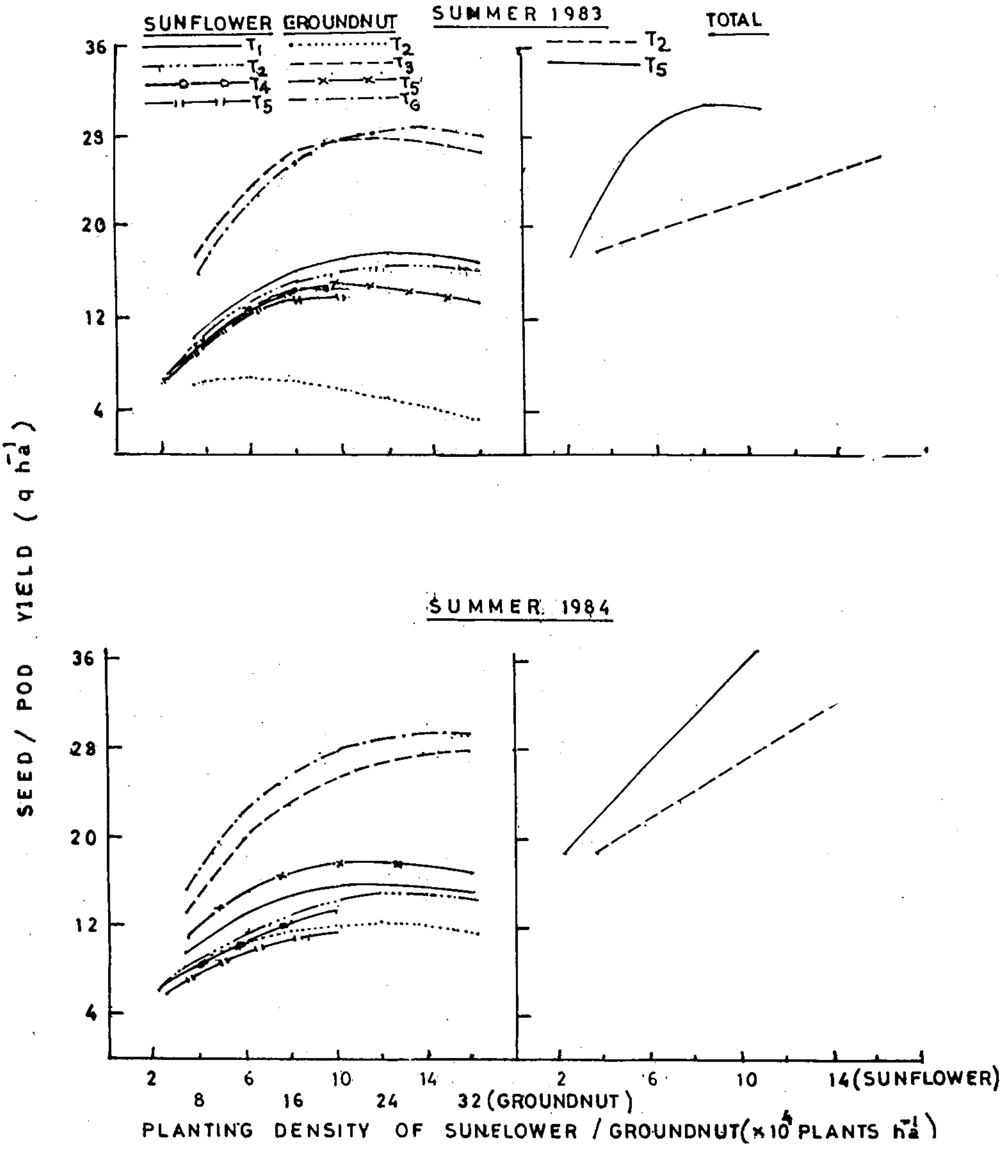

Figure 2. Seed/pod yield per hectare of sunflower/groundnut as influenced by plant population in sole and intercrop system

specific competition thus does not seem to have occurred in this season owing to poor growth of either component due to unfavourable climate.

Groundnut component response

Groundnut yield per plant decreased with increase in planting density in a similar frashion as that of sunflower (Table 5). It was reduced from 24.29 to 8.20 g in 1983 and from 19.05 to 8.57 g in 1984 summer seasons. In kharif, low yield was realized. It was reduced from 3.69 to 2.44 g/plant with increase in density from 70.735 to 323,362 plants/ha. Yield at these densities ranged from 22.34 to 8.67 g and from 21.51 to 9.0 g/plant in summer seasons and from 4.31 to 2.59 g/plant in kharif by planting the crop as in wide row treatment of sunflower.

Intercropping had a severe effect on groundnut production in all density combinations with sunflower. Pod yield was reduced from 8.25 to 1.00 g and from 11.79 to 3.48

Table 5. Regression equations for pod yield on planting density of groundnut

Treatment	lny = lna + bx		SE_b	r^2	F_1	F_2	F_3
	lna	b					
Summer 1983							
T_2	2.70285	–8.37508E–06x	8.12346E–07	0.82			
					387.58**	42.80	125.32
T_3	3.49425	–4.29599E–06x	2.13477E–07	0.95			
T_5	2.98937	–4.90210E–06x	2.25003E–07	0.95			
					274.21**	41.22	277.24*
T_6	3.37123	–3.74427E–06x	2.65802E–07	0.90			
Overall					287.52**	30.34**	153.89**
Summer 1984							
T_2	2.80781	–4.81292E–06x	4.96727E–07	0.98			
					148.13*	15.98	102.02
T_3	3.17098	–3.16423E–06x	2.55640E–07	0.87			
T_5	3.03535	–4.31168E–06x	3.20588E–07	0.89			
					129.24**	20.29	170.37
T_6	3.31271	–3.44855E–06x	2.81713E–07	0.87			
Overall					108.68**	15.30*	125.82**
Kharif 1983							
T_2	1.65725	–3.65040E–06x	2.73077E–07	0.89			
					12.17	14.92	91.64
T_3	1.42052	–1.63154E–06x	3.14543E–07	0.54			
Pooled	1.54142	–2.65898E–06x	2.54062E–07	069			
T_5	1.38218	–1.59292E–06x	1.89019E–07	0.76			
					49.58*	29.64	80.25
T_6	1.60448	–2.01887E–06x	1.83751E–07	0.84			
Overall					21.42**	13.64*	88.09**

Table 6. Exponent functions of seed yield estimated optimum density (X_{opt}) and yield (Y_{max} kg ha^{-1}) of sunflower

Treatment	Yield $plant^{-1}$(g) y = a exp(bx)		X_{opt}	Y_{max} kg ha^{-1}
	a	exp (bx)		
Summer 1983				
T_2	14.92224	exp(–8.37508E–06x)	119401	655.46
T_3	32.92550	exp(–4.29599E–06x)	232775	2819.49
T_5	19.87321	exp(–4.90210E–06x)	203994	1491.32
T_6	29.11436	exp(–3.74427E–06x)	267074	2860.50
Summer 1984				
T_2	16.57361	exp(–4.81292E–06x)	207774	1266.80
T_3	23.83097	exp(–3.16423E–06x)	316032	2770.61
T_5	20.80819	exp(–4.31168E–06x)	231928	1775.37
T_6	27.45953	exp(–3.44854E–06x)	289976	2929.25
Kharif 1983				
T_2	5.24487	exp(–3.65040E–06x)	273942	528.56
T_3	4.13927	exp(–1.63154E–06x)	612917	933.34
Pooled	4.67121	exp(–2.65892E–06x)	376084	646.27
T_5	3.98360	exp(–1.59292E–06x)	627777	919.99
T_6	4.97526	exp(–2.01887E–06x)	495326	906.58

g/plant in the two row groundnut intercrop planting pattern in the summer seasons. No interspecific competition seems to have prevailed in kharif. The yield was reduced from 4.05 to 1.60 g at higher densities. The competitive effect of sunflower was relatively less severe in the three row groundnut intercrop planting pattern. The pod yield was reduced from 14.05 to 4.06 g and from 15.33 to 5.16 g/plant in the summer seasons. In kharif, it was reduced from 3.56 to 2.39 g/plant.

The intercepts were equal for groundnut yield in sole and intercrop system while the regression equations were not identical for the summer seasons. The slope of regression in the three row intercrop planting pattern of groundnut differed significantly in the first year. In kharif, the intercepts were equal, slopes were parallel, and the regression equations were identical.

The maximum predicted yield per hectare was 2819 kg in 1983 and 2860 kg in 1984 realised with a respective sole optimum density of 232,775 and 267,074 plants (Table 6). But in the two row intercrop planting pattern, yield did not improve beyond 119,401 and 203,994 plants/ha in the two years. The maximum pod yield per hectare was limited to 655 and 1491 kg at these densities. In the wide row treatment, sole optimum density was 316,032 and 289,976 plants/ha while the maximum expected yield was 2771 and 2929 kg/ha. In the three row intercrop planting pattern, the crop yields were raised to 1267 and 1775 kg/ha with an optimum density of 207,774 and 213,928 plants/ha. In kharif, the optimum density requirement was very high both in sole and intercrop system.

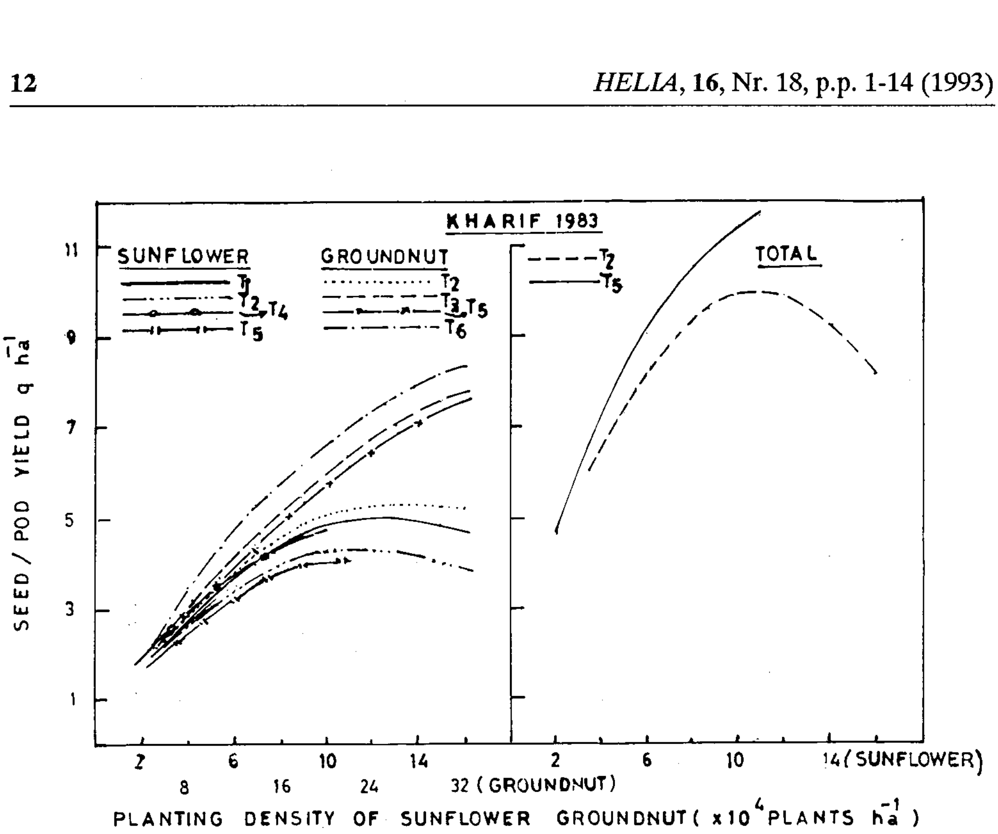

Figure 3. Seed/pod yield per hectare of sunflower/groundnut as influenced by plant population in sole and intercrop system

Total intercrop yield response

The total yield response of oilseeds with two row groundnut intercrop planting pattern was linear to high density cominations in the summer seasons (Fig.2). The total yield increased from 17.39 to 24.42 g/ha in 1983 and from 18.52 to 35.0 q ha^{-1} in 1984. Yield from sole sunflower with corresponding increase in density from 35.467 to 162,134 plants/ha was raised from 10.21 to 16.68 and from 9.29 to 14.92 q ha^{-1}. Thus the total intecrop yields were in excess of sole sunflower at any level of planting density. But the yield of groundnut increased from 17.18 to 26.51 and from 13.50 to 27.71 q/ha at densities increasing from 70,735 to 323,362 plants/ha. The intercrop yield advantage was thus 32–12% in the second year only.

Intercrop planting pattern with three rows of groundnut showed a quadratic yield response in 1983 while it was linear in 1984. The total oilseed production increased from 17.95 to 31.07 q/ha and from 18.97 to 36.60 q/ha in the two years. The yield of sunflower ranged from 7.47 to 14.42 and from 6.07 to 12.92 q/ha. The yield of groundnut ranged from 15.08 to 28.03 and from 15.21 to 29.10 q/ha. Thus the intercrop yield advantage was 140.3–115 and 211.5–183.3% over sunflower. The intercrop system also produced 13.6–10.8% and 24.7–25.8% more yield than groundnut. The predicted response curves indicate that intercropping groundnut in the three row planting pattern was superior to the two row pattern while the yield gap widened at high density combinations. This response owes primarily to the more virtual area per plant of the intercrop component at any density level of sunflower.

In kharif, the total yield responses were quadratic following substantial improvement over sunflower or groundnut (Fig.3). The total yield increased from 6.02 to 10.08 q/ha across densities ranging from 35,467 to an estimated optimum of 108,920 plants/ha in the two row intercrop planting pattern. For densities ranging from 23616 to 107,959 plants/ha in the three row intercrop planting pattern the yield increased from 4.84 to 11.67 q/ha. The sole crop of sunflower yielded low both in the narrow (2.90 – 4.73 q/ha) and wide (2.20 – 4.82 q/ha) row treatments. The unfavourable climate also had a severe effect on groundnut. It yielded 2.61–7.89 q/ha and 0.84 – 3.05 q/ha for two or three row planting pattern as in intercrop system.

The study indicates that the total oilseed production can be increased substantially by the expedient of intercropping groundnut to share 75% virtual area in sunflower planting densities ranging from 75,000 to 100,000 plants/ha both in summer and kharif seasons.

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EVALUACION DEL MODO DE PLANTACION Y EFECTOS DE DENSIDAD EN EL GIRASOL; CACAHUETE SOLO E INTERCALADO EN UN DISEÑO SISTEMATICO EN ABANICO

RESUMEN

Un diseño sistematico en abanico fue adoptado para estudiar el comportamiento del girasol y el cacanuete con 26 variables de densidad en sistema gultivo único y asociado con dos modos de plantación en la Universidad de Andhra Pradesh durante el verano 1983 y Karif 1983. La relación rendimiento densidad se ajustaron mejor al modelo exponencial Y=abx para cualquier componente. El modo de plantación de dos hileras de cacahuetes intercaladas para compartir el 67% del area virtual en densidades de 35.467 a 162.134 plantas/Ha incrementaron la producción total de semilla oleaginosa respecto al girasol solo en las estaciones de verano. En Kharif el rendimiento total de cultivos asociados excedieron el rendimiento de cultivo único tanto de girasol como de cacahuete. El modo de plantación, de tres hileras de cacahuete interalado para compartir el 75% del area virtual en la densidad ddel girasol de 23.616 a 107.959 plantas/Ha, produjo más rendimiento que cualquiera de los componentes un cultivo único durante las estaciones de verano así como un Kharif. La densidad maás productiva del girasol varió desde alradedor de 75.000 a 100.000 plantas/Ha., para intercalarlas con el cacahuete de forma que compartió el 75% del área virtual del verano o Kharif.

EVALUARTION DES EFFETS DU MODÉLE DE SEMIS ET DE LA DENSITÉ SUR LE TOURNESOL ET L'ARCHIDE EN CULTURE PURE ET ASSOCIATION AVEC UN PLAN D'EXPIRIENCE "FAN DESIGN" SYSTÉMATIQUE

RÉSUMÉ

Un dispositif sistématique ("FAN design") a été adopté pour étudier les performances du tournesol et de l'arachide pour 26 modalités de densitiés en culture poure et en association (plantation en interligne), avec deux schéma de plantation, à l'Université d'Agriculture de Andhra Pradesh, durant les étés 1983 et 1984 et durant la saison du kharif 1983. La relation rendement - densité a été ajustée au modèle exponentiel Y=ab x pour chaque composante. Le dispositif de plantation à deux lignes d'arachide en interligne, conçu pour occuper 67% de la surface virtuelle dans des densités de tournesol de 34,467 à 162,134 plantes/ha, a augmenté la production totale de graines oléagineuses en comparaison avec la culture pure de tournesol durant les saisons d'été. Durant le kharif, la production en culture associée dépasso les productions on culture pure soit de tournesol soit d'arachide. Le dispositif à trois rangs d'arachide en interligne conçu pour occuper 75% de la surface virtuelle dans des densités de tournesol de 23,616 à107,959 plantes/ha donne plus de productivité que les autres composantes en culture pure durant les saisons d'été comme durant le kharif. La densité la plus productive du tournesol s'établit entre 75,000 et 100,000 plantes/ha pour une plantation n interligne d'arachide conçue pour occuper 75% de la surface virtuelle, durant l'été comme au kharif.