STUDIES ON THE EFFECT OF MOISTURE REGIMES ON INTERCROPPING

K.C.S. REDDI
RESEARCH FELLOW

Report submitted to Training Program, ICRISAT on the research work carried by the author during the period October 15, 1977 to July 15th 1978.
A brief note of this report would also appear in Farming Systems Annual Report 1977-78.

CONTENTS

INTRODUCTION

Intercropping, a traditional cropping system is being preferred widely by farmers of the developing tropics (Specially in subsistance farming of Africa and Asia). Farmers also tend to shift from mixedcropping to monocropping as more farming inputs are available especially irrigation water (jodha, 1977). This shift may be due to the belief that intercropping is advantageous only in those areas where crop failures are common, where farmers go for farming for subsistance alone.

Fertiliser, one of the important input in crop production, did'nt take away the intercropping advantage when it was applied at high level (Reddy et al 1978 and ICRISAT unpublished data). Also, and interesting observation was made from these data was that the very marked increases in the absolute monetary advantage from the system because of increased yields.

With respect to the available water the information available is very little. The few publications on this subject are not in agreement with each other. Fisher (1977) reported from Kenya that maize/beans intercropping system gave an advantage under wet conditions rather than under dry conditions, further, many reports on cropping systems in humid tropical areas are in favour of inter cropping partly because of its higher productivity (Igbozurika,1971); where as Lakhani (1977) found exactly opposite trend in a fodder radish/sunflower intercropping combination in U.K.

With increasing availability of water in many dry areas this question whether intercropping can be advantageously practiced needs to be answered urgently. In an effort to udnerstand the crops behaviour in

sole and intercropping systems under different moisture regimes, this expt. was planned.

MATERIALS AND METHODS

Season:

The experiment reported here was conducted on both red (RWZ) and blacksoils (BI) with identical design and lay-out. The experiment was carried out during Rabi, 1977. The rainfall received during the growing season was 75 mm.

Soil and fertilization:

Red soil is shallow in depth and quite poor in fertility status, specially for phosphorus and Nitrogen. Blacksoil is comparitively deep and fertile. Both the soils were basally applied with 50 kg P205 and 20 kg N/ha through Diammonium phosphate uniformly. 40 kg N/ha was applied to cereals on 21st day through urea for both the experiments. At about 50 days after sowing red soil was given an additional uniform dose of 25 kg P205/ and 10 kg N/ha through Diammonium phosphate.

Expt material:

The varieties used were sorghum CSH 8R, pearlmillet PHB 14 chickpea JG 62, Groundnut TMV2, safflower C 438 and cowpea C 152.

Treatments and Design:

Moisture regimes:

There were two main treatments namely 'stress' and 'no stress'.

The intention here was to create two situations which provide measurable effects on yield. - (1) Maintanance of optimum soil moisture condition throughout the growing season and (2) growing the crops either on residual soil moisture (black soil) or with minimum irrigation requirement (red soil).

Red soil received two general irrigations for all the treatments and two additional irrigations were given to maintain no stress conditions; where as in black soil the crop was growing fairly well with the residual moisture and only one irrigation was given to maintain no-stress situation and no irrigation was given to stress treatments. Irrigations were given by Flooding method.

Crop mixtures:

Four crop mixture along with their respective sole cropsformed 8 sub-plot treatments. Details are given in Table 1.

Table 1.

Alfisol:

Treatment	Row arrangement	% of population (1) : (2)
1. Sorghum/Chickpea	1 : 2	50 : 100
2. Sorghum/Groundnut	1 : 2	50 : 100
3. Pearlmillet/Groundnut	1 : 2	50 : 100
4. Pearlmillet/Sorghum	1 : 1	50 : 50
Vertisol:		
1. Sorghum/Chickpea	1 : 2	50 : 100
2. Chickpea/Safflower	1 : 1	50 : 100
3. Sorghum/Cowpea	1 : 2	50 : 100
4. Sorghum/Safflower	1 : 1	50 : 50

Inter row spacing was constant in all the crops in all the treatments i.e. 30 cm where ever population pressure of the mixtures exceeded 100, there the component crop (s) intra-row spacing (s) were adjusted suitably (Table 2).

Table 2.

Crop name	Ponulation as sole crop	Spacings as sole and as inter-crop with normal (100) population pressure.	as intercrop (with more population pressure).
Sorghum	1,48,000	30 cm x 22.5 cm	30 cm x 15 cm
Pearlmillet	1,48,000	30 cm x 22.5 cm	30 cm x 15 cm
Chickpea	4,44,444	30 cm x 7.5 cm	30 cm x 5 cm except in chickpea safflower combination i.e. 30 cm x 3.75 cm.
Groundnut	3,33,333	30 cm x 10 cm	30 cm x 6.6 cm
Cowpea	4,44,444	30 cm x 7.5 cm	30 cm x 5 cm
Safflower	83,000	30 cm x 40 cm	-

Design: The two moisture regimes, explained above, 'stress' and 'no-stress' were arranged in main plots which were 7 m wide by 24 m long. Each of these was then divided into 8 sub-plots of 3m x 7m for cropping systems treatments (4 mixtures and 4 soles). There were four replications in each of the soil.

Planting procedure:

Except Groundnut other crops were sown very closely. The resultaitant plants were initially thinned to get a single line at about 15 days age. Then a second thinning was done at about 21 days age to get correct number of plants as per plan.

Weeding: Regular weeding was carried out by hand keeping the plots virtually weed free through-out the season.

Plant protection:

Plant protection measures were taken regularly for all the crops but still black soil sorghum could not be saved from the ravage of shootfly and finally the crop was removed from the field. That resulted in the saving of only chickpea/safflower combination in this field (B1). Other crops received usual sprayings mostly as precautionary like BHC 10% dust and Metasystox 25EC spray to Groundnut, Dithane Z 78 to millet and Thiodan EC 35 to Sorghum, safflower and chickpea.

Experimental measurements:

Seed yields were determined by removing approximately 50 cm from the ends of the plots then harvesting a width of 1.8 m down the middle of the plot. For the various treatments, this gave the following number of harvest rows for each species.

All soles		6 rows each
Millet/G.Nut	:	2 rows of millet & 4 rows of G.Nut
Sorghum/G.Nut	:	2 rows of Sorghum & 4 rows of G.Nut
Sorghum/Millet	:	3 rows each
Sorghum/Chicknea	:	2 rows of sorghum and 4 rows of chickpea
Chickpea/Safflower	:	3 rows each

∴ Rest of the combinations could not be harvested owing to the reasons explained earlier under plant protection heading.

All earheads or pods from the harvest area were threshed and thoroughly dried in the oven before taking weighments. The number of plants of ea ı species with in the harvent area were also counted. The seed yield commonents we·e also determined by further sub-sampling with in the harvested area i.e. 10 plants of each of the species.

Results and discussion:

Results of experiment are discussed under two major heads, Alfisol and Vertisol.

ALFISOL: Out of the four crops studied on this soil, three crops viz., millet, groundnut and sorghum performed fairly well. The growth and yield data from the other crop i.e. chickpea are not much reliable due to its high variability.

To have a common comparison for all the treatments 'gross monetary returns' were calculated. LER was not considered as common comparison unit because half of the treatment values were same i.e. one.

All the systems, the four soles and their four combinations substantially responded to additional irrigation i.e. no stress situation compared to stress situation. Statistically the response was significant for most of the treatments and otherwise for others (Table 1).

Under 'stress' situation sorghum/groundnut intercropping gave maximum gross monetary returns followed by sorghum/millet and millet/groundnut. These three intercropping systems were on par with each other statistically.

Under 'no-stress' situation Groundnut sole gave maximum gross returns. This fact is increasing the doubts whether intercropping is advisable under irrigated conditions or not. But, in an experiment conducted at APAU, they got favourable returns from sorghum/soybean and sorghum/

groundnut combinations in comparison to their soles under irrigated conditions (APAU unpublished data). However, groundnut sole was on par with Sorghum/Groundnut (Table 1).

To be more clear, each of the combination was discussed seperately hereunder.

Millet/Groundnut:

LER of intercropping system millet/groundnut was more than its soles both under stress and no-stress situation; the difference was significant under stress situation; and non significant under no stress situation (Table 2a). LER of intercropping system under stress situation was statistically more than under no-stress situation. This might be due to the dominance of millet, the component crop, over its associated crop groundnut under no stress situation which resulted in poor performance of groundnut. This was evident from the millet response as sole and as intercrop with groundnut; as a sole there was only 25% yield increment from stress to no stress whereas as an intercrop the increment was nearly 29% (Table 2a). While groundnut showed more response than millet as a sole crop but showed absolutely no response when intercropped with millet (Table 2a).

This shows that, this combination needs further exploration for suitable row pattern and genotypes. Possibly a less dominating millet and a bit moreresisting groundnut genotypes may prove better.

Various growth and yield characters studied are analyzed and presented in Table 3(a) and 3(b) for millet and groundnut respectively.

Millet:

Almost all the characters studied have shown significant or

or non-significant increase in their values from stress to no stress except a few which were just similar under both the situations like earhead lenth, 000 grain weight and harvest index.

STRESS:

Under Stress conditions characters like plant height, earhead lenght, 1000 grain weight, per plant yield do not vary much between sole and intercrop. whereas dry fodder yield, population, total dry matter yield decreased significantly when intercropped with groundnut. Anyway, the important characters like [1]effective tillers/plant and [2]effective heads/plant have shown significantly higher values when intercropped with groundnut than as sole crop. That resulted in significantly higher harvest index for intercropped millet compared to its sole.

NO STRESS:

All the characters studied behaved just similar to the way they behaved under stress situation except that effective heads/plant did not vary significaly between the systems as they did under stress situation. That finally resulted in comparable LER's between stress and no stress situation for this crop.

Groundnut:

Unlike in millet several characters studied did not vary statistically between stress and no-stress situation; they are number of seeds/plant, 100 seed weight, per plant yield, populations, harvest index and %

---

1 Effective tillers/plant: Tillers which gave earheads.

2 Effective heads/plant: Heads filled at least 20% of its area with mature seed.

kernels. Plant height was the only character that varied significantly between stress and no-stress situations; with higher values being on no-stress situation both as sole and intercrop. Important plant character like dry fodder yield, total dry matter yield and kernel yield responded significantly as a sole crop but not as an intercrop to additional irrigations, which finally resulted in poor LER contribution from groundnut to millet/groundnut intercrop system when intercropped and allowed no-stress (table 2).

No statistical difference was observed between sole and intercrop groundnut for the characters plant height, number of seeds/plant, 100 seed weight, per plant yield and % of kernels. All the other characters studied showed significant reduction in their values when intercropped which finally resulted in poor LER contribution from groundnut to millet/groundnut intercrop system (Table 2).

Millet/sorghum.

A very good LER advantage was observed for this combination both under stress and no-stress situation, with stress being on higher side. Differences between these two situations was not significant. Both the sole crops yields increased from stress to no stress. When intercropped under no-stress, only millet showed increase in its yield but not sorghum. Moreover sorghum showed a decreasing trend (Table 2(b). This shows that millet dominated the system, taking advantage of increasing water availability. Within the regimes intercropped millet contributed more than 50% of its sole but sorghum showed only one third of its sole (Table 2b). Yield components may offer some explanation for this trend.

From millet/groundnut and millet/sorghum combinations it could be seen that millet is taking advantage of better situations and suppressing

the associated crop to the maximum extent. Hence, there is need to find out a millet genotype which would not supress the associated crop to that extent.

The growth and yield components of intercropped millet and sorghum were shown in Tables 3(a) and 3(b) respectively.

Millet:

All the characters studied in intercropped millet were on par under stress and no-stress situation, and that was the reason for almost similar yields under both the situations. LER contributions differed owing to the differences in their soles.

Within the same moisture regime, intercropped millet yield components were better than its sole crop and that was the reason for higher contribution of LER from millet to millet/sorghum cropping systems.

Sorghum:

Between moisture regimes the differences were not significant but an increasing trend was observed for all the characters from stress to no stress both in sole and intercropped systems except number of seeds/plant in intercropped sorghum. That resulted finally in significant yield differences in sole sorghum and not in intercropped sorghum (Table 2b).

Under both the regimes number of seeds per plant and total dry matter yield were significantly less when intercropped compared to its sole and that resulted in poor LER contribution through grain yield from sorghum to sorghum/millet intercropping system.

Sorghum/groundnut:

LER advantage of this system was quite good under stress conditions and even less than one under no stress situations. The differences

were statistically significant (Table 2a). Under stress conditions, groundnut contributed substantially to the total LER whereas under no stress conditions its contribution was barely 50% of the total. That was due to poor response of Groundnut to moisture regimes when intercropped and otherwise when it was grown as sole. But the absolute yield was more here than under stress situation. The reason for poor LER under no-stress situation was neither of the two crops could take advantage of the better resources available when intercropped and both of them as soles could do so. The growth and yield components of sorghum and groundnut were given in tables 3(b) and 3(c) respectively.

Sorghum:

Almost all the component values increased from stress to no stress except number of seeds per plant and that made the yield differences non-significant between stress and no-stress intercropped sorghum. Under both regimes, number of seeds per plant, total dry matter yield and dry fodder yield were significantly less in intercropped sorghum compared to its sole.

Groundnut

All the yield components were on par in intercropped Groundnut between stress and no-stress situations and that was the reason for same pod yield under both the regimes.

Within the regimes intercropped groundnut had significantly less dry fodder yield, populations, total dry mater yield and non-significantly less number of seeds per plant compared to its sole. That was the reason for poor groundnut yield when intercropped both under stress and no-stress situations.

Sorghum/chickpea

As explained earlier chickpea did not come up well in this experiment. Hence this combination was not discussed in detail.

Any way, a few observations were made. That is, in conformity with other combinations LER data, here also the LER was more under stress situation and much less under no stress situation. And sorghum intercropped in chickpea did better than when it intercropped with millet or groundnut, probably due to poor competition from chickpea (Table 2d and 3e).

Vertisol:

Out of the several combinations studied only safflower/chickpea survived. Rest of the combinations could not be assessed due to the failure of sorghum.

Chickpea/Safflower:

This combination very peculiarly did not gave LER advantage either under stress situation or under no-stress situation. The absolute yields of both the crops as sole and intercrops and also under stress and no-stress situations were quite reasonable. The crop was also quite uniform on the field and was really impressive. Still probably due to a bad row arrangement or population pressure it did not gave much advantage. Chickpea yields were quite less when intercropped, probably due to more competition from associated safflower. This is evident from the increase of safflower LER contribution from stress to no-stress and vise-versa in chickpea (Table 4). The various characters studied showed same response i.e. no difference between moisture regime and safflower yield components showed increasing trend when intercropped and vise-versa the chickpea components (Table 5(a) and 5(b).

Conclusion:

From the experiment explained above the following conclusion could be drawn (1) LER advantage is consistently disappearing with the increase in moisture availability (2) Millet/groundnut and Millet/Sorghum combinations appearing quite promising (3) Suitable population pressure, row arrangement and genotypes needs to be explored under no-stress conditions.

Table 1

Gross monetary returns Rs/ha

	Stress	No stress	Mean
Sorghum sole	2510	3420	2965
Chickpea sole	510	1725	1120
Groundnut sole	2570	3860	3215
Millet sole	2115	2635	2375
Sorghum/chickpea	1765	2390	2075
Sorghum/groundnut	3195	3520	3360
Sorghum/millet	2780	3110	2945
Millet/groundnut	2755	3185	2970
Mean	2275	2980	

LSD for comparisons of means within groups at 5% - 488.8

LSD fro comparisons of means of different groups at 5% - 529.4

CV in whole plots: 13.5

CV in sub-plots : 13.0

Market prices considered: Sorghum fodder Rs. 85/quintal
Fodder Rs. 0/quintal
Chickpea grain Rs.210/quintal
G'nut pods Rs.150/quintal
Millet grain Rs.105/quintal

Table 2(a)

MILLET/GROUNDNUTS

Seed yields (kg/ha) and LER

	Stress		No stress	
	Yield	LER	Yield	LER
Treatments				
Millet sole	2013	1.00	2508	1.00
Groundnut sole	1712	1.00	2573	1.00
Millet/groundnut (50:100)				
1 row millet	1408	0.7	1802	0.72
2 rows groundnut	850	0.5	861	0.33
Total LER		1.2		1.05

Millet yields:

LSD at 5% within groups	520
between groups	517
CV in main plots	12.5
Sub-plots	17.9

Groundnut yields:

LSD at 5% within groups	312
between groups	290
CV in main plots	7.7
Sub-plots	14.1

Millet/groundnut LER:

LSD at 5% within groups	0.16
between groups	0.15
CV in main plots	5.7
Sub-plots	10.0

Table 2(b)

MILLET/SORGHUM

Seed yields (kg/ha) and LER

	Stress		No stress	
	Yield	LER	Yield	LER
Treatments:				
Millet sole	2013	1.00	2508	1.00
Sorghum sole	2695	1.00	3374	1.00
Millet/sorghum (50:50)				
1 row millet	1594	0.79	2005	0.80
1 row sorghum	1190	0.44	1089	0.29
Total LER		1.23		1.09

	LSD at 5%		CV in main plots	CV in sub-plots
	Within groups	Between groups		
Millet yields	520	517	12.5	17.89
Sorghum yields	295	290	6.76	10.37
Millet/sorghum LER	0.23	0.29	16.7	14.5

Table 2(c)

SORGHUM/GROUNDNUT

Seed yields (kg/ha) and LER

	Stress		No stress	
	Yield	LER	Yield	LER
Treatments:				
Sorghum sole	2695	1.00	3374	1.00
Groundnut sole	1712	1.00	2573	1.00
Sorghum/groundnut (50:100):				
1 row sorghum	1380	0.51	1620	0.44
2 Rowsgroundnut	1277	0.74	1342	0.52
Total LER		1.25		0.96

	LSD at 5%		CV in	
	Within groups	Between groups	Main plots	Sub plots
Sorghum yields	295	290	6.76	10.37
Groundnut yields	312	290	7.71	14.13
Sorghum/groundnut LER	0.17	0.17	7.4	10.7

Table 2(d)

SORGHUM/CHICKPEA

Seed yields (kg/ha) and LER

	Stress		No stress	
	Yield	LER	Yield	LER
Treatments:				
Sorghum solo	2695	1.00	3734	1.00
Chickpea solo	244	1.00	821	1.00
Sorghum/chickpea (50:100):				
1 row sorghum	1625	0.6	1950	0.52
2 rows chickpea	131	0.54	273	0.34
Total LER		1.14		0.86

	LSD at 5%		CV in	
	Within groups	Between groups	Main plots	Sub-plots
Sorghum yields	295	290	6.76	10.37
Chickpea yields	355	338	39	56
Sorghum/chickpea LER	0.5[illegible]	0.64	36	36

Table(3a) - GROWTH CHARACTERS AND YIELD COMPONENTS OF MILLET UNDER STRESS AND NO-STRESS SITUATION AS A SOLE AND AS AN INTERCROP

	Plant height (cms)		Dry fodder yield (q/ha		Effective tillers/plant		Effective heads/plant		Earhead length (cm)	
	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress
Millet sole	132.1	153.65	24.23	30.51	2.25	2.73	2.62	4.33	13.64	17.89
Millet in groundnut	132.25	145.55	12.13	16.98	3.28	3.53	4.00	4.55	13.90	13.90
Millet in sorghum	138.25	152.30	19.33	20.25	2.83	3.73	4.25	4.88	19.53	19.01
LSD at 5% within groups	10.96		5.36		0.7		1.11		1.97	
Between groups	20.80		5.91		0.94		1.64		3.83	
CV in main plots	10.31		15.5		19.23		26.23		14.4	
Sub-plots	7.11		17.0		15.03		17.54		6.82	

	1000 grain wt. (gms)		Population (%)		Per plant yield (gms)		Total dry weight (q/ha)		Harvest index	
	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress
Millet sole	7.8	7.88	98	100	16.45	23.35	48.08	62.4	41.82	40.23
Millet in groundnut	7.59	7.64	87.5	94.3	17.30	25.90	29.45	38.98	47.83	46.15
Millet in sorghum	7.73	7.66	95.5	99.66	19.60	20.72	36.93	43.93	42.83	45.4
LSD at 5% within groups	1.24		6.31		4.8		3.6		5.73	
Between groups	1.49		7.27		5.3		9.6		5.25	
CV in main lots	11.15		3.9		14.2		12.05		4.35	
Sub-plots	10.5		4.6		15.12		12.89		8.44	

Table (3b) - GROWTH AND YIELD COMPONENTS OF GROUNDNUT UNDER STRESS AND NO-STRESS SITUATIONS WHEN GROWN AS SOLE AND AS INTERCROP

Treatments	Plant height (cms)		Dry fodder yield (kg/ha)		No. of seeds/ plant		1000 seed wt. (gm)		Per plant yield	
	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress
Groundnut sole	23.7	31.5	1840	2164	23	25	34.4	36.3	7.5	7.9
Groundnut in millet	24.4	28.6	1372	1256	28	31	33.7	35.2	8	9
Groundnut in sorghum	28.1	31.6	851	776	19	21	32.0	34.0	5.4	6
LSD 5% within groups	3.0		227		7		9.2		2.3	
Between groups	3.2		190		7.1		11.0		3.0	
CV in main plots	5.7		2.5		13.8		18.6		26.2	
CV in sub-plots	7.0		10.7		18.7		17.5		20.2	

	Populations (000)		Total dry wt. (kg/ha)		Harvest index		Kernel yield (kg/ha)		% of kernels	
	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress
Groundnut sole	266	204	3553	4738	33	37	1178	1745	68	68
Groundnut in millet	160.5	159.5	2222	2117	25	25	552	532	65.5	62.3
Groundnut in sorghum	174	191	2128	2118	37	40	792	852	62.3	63.5
LSD 5% within groups	37		320		6.0		247		12.4	
Between groups	35.5		314		6.5		302		13.7	
CV in main plots	7.4		5.0		10.5		13.91		4.6	
CV in sub-plots	11.9		7.4		11.		17.02		12.4	

Table (3c) - GROWTH CHARECTERS AND YIELD COMPONENTS OF SORGHUM UNDER STRESS AND NO-STRESS SITUATION AS A SOLE AND AS A INTERCROP

	Plant height (cm)		Dry fodder yield (kg/ha)		1000 grain height (gm)	
	Stress	No stress	Stress	No stress	Stress	No stress
Sorghum Sole	98	105.5	2709	3067	28.9	30.3
Sorghum in Chickpea	93	105.5	1355	1960	33.7	36.7
Sorghum in Groundnut	91.4	107.5	1181	1597	30	35.7
Sorghum in Millet	108	120	1157	1181	30.6	36.3
LSD at 5% within groups	10.7		639		3.6	
Between groups	15.8		1207		4.5	
CV in main plots	11.4		24		9.1	
CV in sub-plots	7.0		24		7.3	

	Per plant yield (cm)		Total dry weight (kg/ha)		Harvest index	
	Stress	No stress	Stress	No stress	Stress	No stress
Sorghum Sole	28	39	6242	7995	44	45
Sorghum in Chickpea	47	46	3693	4710	44	42
Sorghum in Groundnut	25.5	45	3242	4031	43	41
Sorghum in Millet	22	30	2853	2898	42	39
LSD at 5% within groups	9.4		759		10	
Between groups	15.5		1431		13.6	
CV in main plots	34		26		22.5	
CV in sub-plots	18		11.5		15.8	

Table 4.

CHICKPEA/SAFFLOWER

Seed yield (kg/ha) and LER

Treatments	Stress		No stress	
	Yield	LER	Yield	LER
Chickpea sole	1468	1.00	1562	1.00
Safflower sole	2053	1.00	1943	1.00
CHICKPEA/SAFFLOWER (50:100)				
1 Row Chickpea	659	0.45	609	0.39
1 Row Safflower	1114	0.54	1208	0.62
Total LER		0.99		1.01

	LSD at 5%		CV in	
	Within groups	Between groups	Main plots	Sub-plots
Chickpea yields	260	288	13	14
Safflower yields	311	337	11	12.7
Chickpea/Safflower LER	0.16	0.26	17.8	10.0

Table 5a - GROWTH CHARACTERS AND YIELD COMPONENTS OF CHICKPEA UNDER STRESS AND NO-STRESS SITUATION AS SOLE AND AS INTERCROP

Treatments	Total dry wt. (kg/ha)		No. of filled pods		No. of seeds per plant		Per plant yield (gm)		Harvest index	
	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress
Chickpea sole	2723	3357	19	24	20	25	3.0	3.6	54	47
Chickpea in Safflower	1237	1221	10	15	13	15.7	2	2.4	53	50.5
LSD at 5% with in groups	5.2		9.7		10.7		1.75		5.4	
Between groups	4.7		10.4		13.4		2.0		7.1	
CV in main plots	7		27		28		25		8.5	
Sub-plots	14.5		32		23		25		6.6	

Table 5b - GROWTH CHARACTERS AND YIELD COMPONENTS OF SAFFLOWER UNDER STRESS AND NO-STRESS SITUATION AS SOLE AND AS INTERCROP

	No. of branches/plant		No. of primary branches/plant		No. of secondary branches/plant		No. of flowers/plant		No. of seed/plant	
	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress	Stress	No stress
Safflower sole	18	17	7.45	7.3	10.1	9.8	18.6	18	287	321
Safflower in Chickpea	23	23	8.8	8.5	13.4	13.9	22.6	23.6	348	345
LSD at 5% with in grouns	5		1.65		3.6		5.1		165	
Between groups	4.8		1.7		3.5		4.5		168	
CV in main plots	9		10.7		12.3		6.6		21.8	
in sub-plots	16		13.6		18.8		15.4		29.2	

	Total dry matter yield (kg/ha)		Per plant yield (gm)		Harvest index	
	Stress	No stress	Stress	No stress	Stress	No stress
Safflower sole	6209	6553	17.7	17.4	33	29.7
Safflower in Chickpea	3765	4008	20.2	19.4	30	30.1
LSD at 5% with in groups	11.6		10.6		3.9	
Between groups	13.14		10		4.2	
CV in main plots	14.5		18		7	
in sub-plots	15.0		32		7.9	

BIBLIOGRAPHY

FISHER, N.M. 1977. Studies in mixed cropping. 1. Seasonal differences in relative productivity of crop mixtures and pure stands in the Kenya Highlands. Exptl. Agric. 13: 177-184.

IGBOZURIKE, M.U. 1971. Ecological balance in tropical agriculture. Geographical Review, 61: 519-529.

JODHA, N.S. 1977. Resource base as a determinant of cropping patterns. Occasional paper - ICRISAT Economics Department.

LAKHANI, D.A. 1977. A crop physiological study of mixtures of Sunflower and fodder Radish.

Ph.D. thesis, Reading University, England.

REDDI, K.C.S., HUSSAIN, M.M & KRANTZ, B.A. 1978.
Effect of N levels and spacing on sorghum intercropped with Pigeonpea and mungbean under semi-arid conditions. Paper presented at AICSIP workshop held at UAS, Dharwar Campus on April 17-19, 1978.