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Production potentials of sunflower and pigeonpea under different soil depths

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Abstract

The studies on production potentials of sunflower and pigeonpea in sole and intercropping systems (2:1) under different soil depths were conducted during 1992-1995 in rainfed Alfisol watershed area at CRIDA, Hyderabad. The results indicated that sunflower and pigeonpea crops in sole and intercropping system responded positively to the increment in soil depth under rainfed environment. Response to soil depth in sunflower was higher than pigeonpea. Intercropping of sunflower and pigeonpea (2:1) is more stable and recorded higher seed equivalents and gross returns than respective sole crops over the years. The yield advantage in intercropping system increased with increase in soil depth upto 30 cm and decreased from 30-45 cm.

Key words: Sunflower, pigeonpea, intercropping, seed equivalents, net returns

Introduction

The yields of sunflower can be stabilized with intercropping of long duration pulse crop like pigeonpea. The potentials of sunflower based intercropping in rainfed environment are dependent on available soil moisture and nutrients stressed in a particular soil depth and type. Hence a study was conducted to investigate the interactive effects between soil depth, rainfall, and crop growth in Alfisols under rainfed environment.

Material and Methods

The experiment was conducted on an Alfisol watershed at Hayatnagar Research Farm of CRIDA, Hyderabad, India. The general physiography of watershed is characterized by gentle slopes (2-5%) with highest elevation of 520 m. The average soil depth in upper, middle and lower basins of micro- catchment was 8 cm + 4.3 cm (D_1), 15 cm + 4.5 cm (D_2) and 30 cm + 12 cm (D_3) respectively. Sole crops of sunflower (MSFH-8) and pigeonpea (LRG-30) and sunflower + pigeonpea (2:1) were grown in upper, middle and lower portions of the watershed area from 1992 to1995 during *kharif*. The pigeonpea in sole and intercropping systems was grown at 90 cm x 20 cm apart while sunflower was grown at 30 cm x 20 cm. Ten kg N and 30 kg P_2O_5 /ha was applied uniformly to both the component crops in different systems as basal. Sunflower in different cropping systems received an additional dose of 40 kg N/ha as top dressing in the form of urea at 30-45 and 60-75 days after sowing. These treatments were tested in randomized block design with four replications. The rainfall and potential evapo-transpiration were recorded daily and rainfall use efficiency (RUE) and moisture adequacy index (MAI) was calculated according to Mahendra Singh and Joshi (1997). Dry matter, leaf area index (LAI) and nitrogen uptake were recorded at different phenological stages of component crops. The yield and economic advantages were estimated through LER values and grain equivalents.

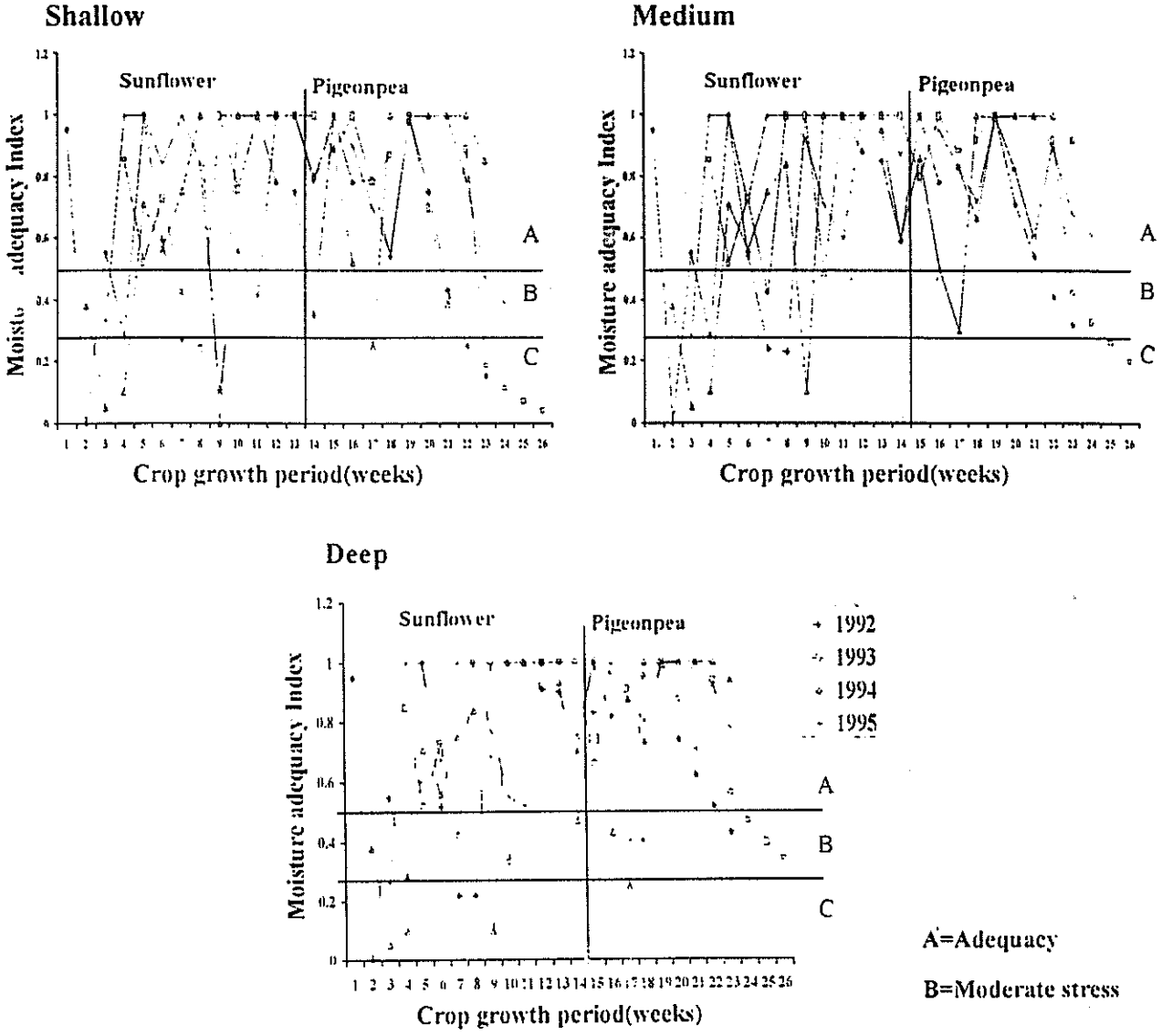
Results and Discussion

Rainfall pattern: The sunflower crop received an amount of 380,515,294 and 501 mm of rainfall in 1992,93,94 and 95 respectively during its life cycle while component crop pigeonpea received 465,644,631 and 733 mm, respectively during 1992,93,94 and 95.

During 1994, crops of sunflower and pigeonpea in sole and intercropping system experienced severe moisture stress at both vegetative and flowering stages at all soil depths.

Yield of sunflower was considerably reduced due to severe moisture stress at the time of grain filling and continuous rainfall during flowering in 1995. Distribution of rainfall was more favourable for sunflower in deeper soils. In pigeonpea severe moisture stress at the time of grain formation influenced its yield potential. However, 40 mm of rainfall received during the month of November helped increase the yields of pigeonpea (Fig 1).

Fig 1: Influence of soil depth on moisture availability in Sunflower and Pigeonpea

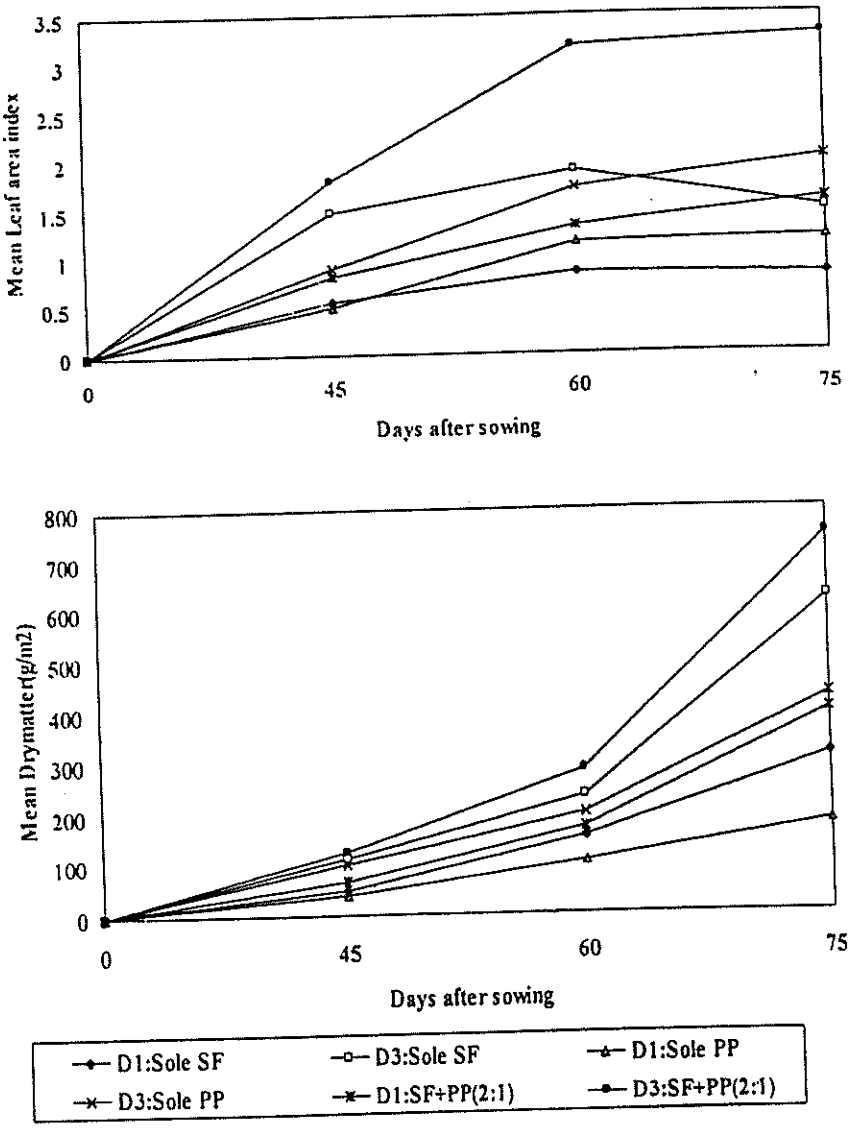


Soil depth in relation to crop growth and yields: In 1992, sunflower in different cropping systems experienced severe moisture stress at all soil depths during early vegetative phase i.e.2-3 weeks after sowing (WAS) and in medium and deep soils during reproductive phase (7-9 WAS). Pigeonpea component in different cropping systems experienced severe moisture stress at flowering and grain formation stages.

In 1993, sunflower component in different cropping systems underwent severe moisture stress at 3 WAS in shallow soil depths while moderate stress was experienced at reproductive phase (7WAS) in all soil depths. Pigeonpea suffered moderate and severe moisture stress during 1993 at vegetative and pod formation stages respectively at shallow soil depth. In medium and deep soils moderate stress was noticed at reproductive stage of the crop.

The growth components *viz.*, LAI and drymatter in sunflower and pigeonpea in sole and intercropping systems increased significantly with increment in soil depth. In sunflower, in different cropping systems LAI increased up to 75 days after sowing (DAS) and later decreased; while in pigeonpea LAI increased upto 120 DAS at all soil depths. Pigeonpea and sunflower in intercropping system produced higher combined LAI and drymatter as compared to the irrespective sole crops at different growth stages in all years. It indicated efficient use of rainfall and light interception by component crops (Fig 2).

Fig 2: Mean growth parameters of sunflower and pigeonpea as influenced by soil depth in different cropping systems



SF=Sunflower
PP=Pigeonpea

D1:<15 cm
D3:30-45 cm

The seed yield of sunflower in sole and intercropping systems significantly increased with increase in soil depth (15-45 cm) in the watershed. The seed yield of sunflower was higher by 147 and 225% in 15-30 and 30-45 cm soil depth, respectively over the soil depth of 15 cm. The influence of soil depth on seed yield of sole sunflower was highest in 1993 followed by 1994 due to better distribution of rainfall for sunflower. The influence of soil depth on productivity of pigeonpea was slightly less when compared to sunflower. On an average, the seed yield of sole pigeonpea was enhanced by 232 and 502 kg/ha in soils having depth ranging 15-30 and 30-45 cm, respectively compared to <15 cm depth. The influence of soil depth on pigeonpea was highest in 1994 and 1995 due to better distribution of rainfall. The seed yields of sunflower and pigeonpea in intercropping system was significantly influenced by deeper soil depth of 30-45 cm; while the yields with shallow and medium soil depth were statistically on par (Table 1). Significant increase in seed yields of chickpea, soybean and sorghum, pearl millet and castor were noticed due to variation of soil depth due to higher moisture and nutrient use efficiencies (Piara Singh *et al.*, 1999).

Table 1 Influence of soil depth on yield of sunflower and pigeonpea in sole and intercropping systems

		Sunflower seed yield (kg/ha)					Pigeonpea seed yield (kg/ha)				
		1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean
Sole Crop	D_1	179	312	470	401	341	130	145	318	830	356
	D_2	291	1126	1300	677	845	200	190	741	1222	588
	D_3	375	1845	1694	950	1211	350	206	890	1986	858
Intercrops	D_1	143	204	277	260	221	105	120	202	440	217
	D_2	203	909	1204	435	437	162	145	475	856	410
	D_3	259	1314	1462	630	916	220	162	523	1283	547
CD (P=0.05)		18	62	52	44	NS	66	39	41	70	NS
Depths		22	76	63	54	288	60	33	36	61	199
Crops x Depths		31	109	NS	76	NS	104	66	71	122	NS

tercropping of sunflower and pigeonpea recorded higher sunflower seed equivalents at all soil depths compared to sole crops over the years. At shallow soil depth (<15 cm) sunflower and pigeonpea intercropping systems produced higher sunflower seed equivalents of 37 and 16%, 35 and 74% in medium soil depths (15-30 cm) and 27 and 58% in deeper soils (30-45 cm) than sole crops of sunflower and pigeonpea, respectively. In 1992, sunflower seed equivalents were significantly higher in intercropping than sole crop at all soil depths while in 1993 intercropping of sunflower and pigeonpea seed equivalents were on par with respective sole crop seed equivalents at all soil depths. However, in 1995, where the rainfall distribution was favourable to both sunflower and pigeonpea, sunflower seed equivalents in sole pigeonpea and intercropping were higher compared to sole sunflower at all soil depths (Table 2). This was due to better seed yield of sunflower and pigeonpea in intercropping because of their temporal complementarity (Gouri *et al.*, 1997).

Nitrogen uptake: The nutrient uptake in different cropping systems showed that nitrogen uptake in seed of sunflower and pigeonpea in sole and intercropping systems increased with increase in soil depth. Sole sunflower grown at D_3 recorded higher nitrogen uptake by 305 and 53% compared to the sole sunflower at D_1 and D_2 soil depths respectively; while sole pigeonpea recorded higher nitrogen uptake by 217 and 87 % compared to sole pigeonpea grown at soil depth ranging < 15cm and 15-30cm, respectively. Among the intercropping systems, sunflower+pigeonpea (2:1) raised at D_3 recorded 295 and 56 % more nitrogen uptake than that of system raised at shallow (D_1) and medium soil depth (D_2) respectively.

Rainfall use efficiency: Intercropping of sunflower+ pigeonpea (2:1) at shallow soil depth increased RUE of seed by 9 and 58 % compared to sole sunflower and pigeonpea. At medium soil depth, intercropping system (sunflower+pigeonpea 2:1) recorded higher RUE of seed by 14 and 146 % compared to respective sole crops of sunflower and pigeonpea. At deeper soil depth, increment of RUE of seed was noticed by 22 and 86 % in intercropping system when compared to sole crops of sunflower and pigeonpea system. (Nam *et al.*, 1993).

Yield and Monetary advantages

Net returns: Sunflower+ pigeonpea (2:1) in sole and intercropping systems provided increased net returns/ hectare with increment in soil depth over the years (Table 2). The sole sunflower raised at 30-45 cm soil depth increased the net returns/hectare from Rs. 670/- to Rs. 8600/- per ha as compared to the crop raised at <15 cm (D_1) and 15-30 cm (D_2), respectively. On an average intercropping of sunflower+ pigeonpea (2:1) recorded higher net returns/ hectare (Rs. 8483/ha) as compared to sole crops of sunflower (Rs.4856/ha) and pigeonpea (Rs.3731/ha).

Table 2 Influence of soil depth on sunflower seed equivalents, net returns and RUE in sole and intercropping systems

Treatment	Sunflower seed equivalents (kg/ha)					Net returns (Rs/ha)					RUE (kg/ha/mm)				
	1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean
Sole Sunflower															
D_1	179	312	470	401	341	-926	496	1700	1411	670	0.47	0.61	1.19	0.80	0.77
D_2	291	1126	1300	677	849	-254	7004	10000	4447	5299	0.77	2.19	3.30	1.35	1.90
D_3	375	1845	1694	950	1216	250	12760	13940	7450	8600	0.99	3.58	4.30	1.90	2.69
Sole Pigeonpea															
D_1	172	145	318	979	404	-960	-840	180	5205	896	0.28	0.24	0.48	1.13	0.53
D_2	266	190	741	1442	660	-400	-480	4410	10497	3507	0.43	0.32	1.12	1.66	0.88
D_3	466	206	890	2343	976	800	-352	5900	20811	6790	0.75	0.40	3.0	2.70	1.70
Sunflower + Pigeonpea (2:1)															
D_1	283	324	479	779	466	-802	96	1290	5300	5884	0.61	0.60	1.01	1.12	0.84
D_2	416	1049	1678	1445	1148	14	5892	13290	11841	7759	0.88	2.01	3.77	2.03	2.17
D_3	552	1476	1985	2144	1539	814	9308	16350	20751	11806	1.15	2.82	4.50	4.62	3.27
CD (P=0.05) Crops	30	48	40	62	NS	180	384	295	782	NS	0.08	0.27	0.11	0.09	0.65
Depths	30	48	40	62	368	180	384	385	782	2858	0.08	0.27	0.11	0.09	0.65
Crops x Depths	52	83	68	109	NS	NS	565	679	1501	NS	NS	0.47	0.18	0.16	NS

Land Equivalent Ratio (LER): LER values worked out on the basis of corresponding soil depth indicated that, intercropping of sunflower with pigeonpea (2:1) on an average recorded higher yield advantages by 42 % compared to the sole cropping of pigeonpea and sunflower over the years. The yield advantages with intercropping system increased with increment of soil depth upto 30cm and decreased from D_3 soil depth. At shallow soil depth, the yield advantage based on corresponding soil depth was highest in 1992 followed by 1993.At medium (D_2) and higher (D_3) soil depth, the yield advantage was highest during 1993 and 1994. Considering the maximum soil depth, intercropping of sunflower+pigeonpea (2:1) at 30-45 cm only gave the yield advantage to the tune of 39% compared to the sole crops of sunflower and pigeonpea. At shallow (D_1) and medium soil depth (D_2) sole cropping systems were found to be advantageous than intercrop system (Fig 3).

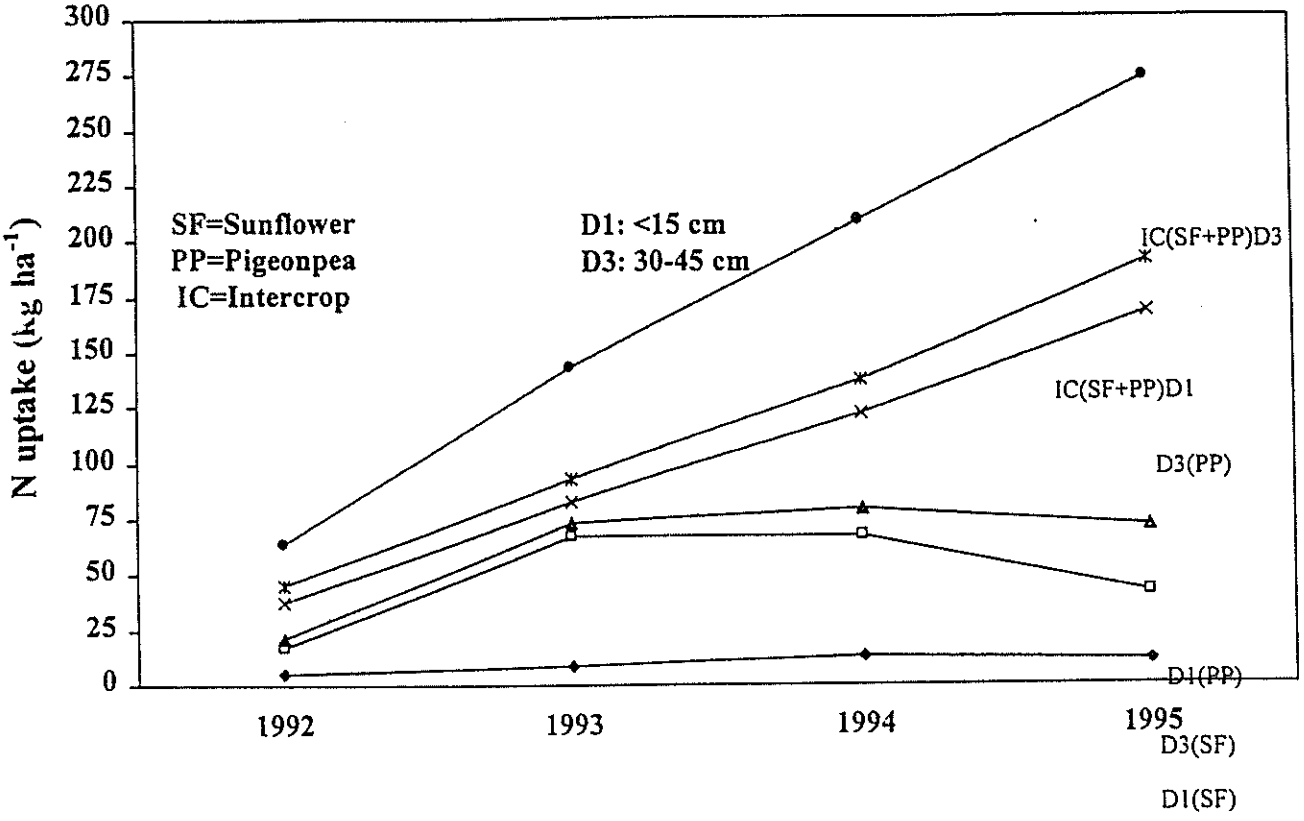


Fig 3: Effect of soil depth on Nitrogen uptake in sunflower and pigeonpea in sole and intercropping systems

References

Gouri .V., Bucha Reddy, B. and Bhaskar Reddy, B. 1997. Effect of intercropping with legumes on yield and economics. *Journal of Oilseeds Research*, 14(2): 318-320.

Mahendra Singh, and Joshi, N. L. 1997. Pearl millet based cropping systems in relation to plant population and moisture availability. *Annals of Arid Zone*, 36(1): 37-42.

Nam, N. H., Chauhan, Y.S., and Johansen, C. 1993. Comparison of extra short duration pigeonpea with short season legumes under rainfed conditions on Alfisols. *Experimental Agriculture*, 29 : 307-316.

Piara Singh, Alagarswamy, G., Pathak, P., Wani, S. P., Hoogenboom, G. and Virmani, S. 1999. Effect of soil depth and land farm on light interception, water balance and crop yields. *Field Crop Research*, 63(3) 211-224.