Legume Res., 27 (1) : 1 - 10, 2004

EFFECT OF SOIL DEPTH ON PRODUCTIVITY OF MUNGBEAN AND PIGEONPEA UNDER RAINFED ENVIRONMENT

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ABSTRACT

The studies on productivity of mungbean and pigeonpea in sole and intercropping systems (2:1) under varying soil depths (*viz*, <15 cm, 15-30 cm and 30-45 cm) was conducted during 1992-95 in rainfed alfisol watershed. The results indicated that mungbean and pigeonpea in sole and intercropping systems responded positively with increment in soil depth under rainfed environment. The seed yield of sole mungbean was higher by 79 and 132 per cent in 15-30 cm and 30-45 cm soil depth respectively over < 15 cm. Pigeonpea in sole system enhanced the seed yield by 232 and 502 kg/ha in soils having depth ranging 15-30 cm and 30-45 cm respectively compared to limited soil depth of <15 cm. Intercropping of mungbean and pigeonpea (2:1) recorded higher mungbean seed equivalents, yield advantages and monetary returns, combined 'N' uptake and rainfall use efficiencies compared to the respective sole crops at corresponding soil depths over the years.

INTRODUCTION

In India, there is great competition for land between food and fodder production. There is very little scope for increasing production through horizontal expansion but there is a great scope of vertical expansion through intensive cropping. Intercropping is considered as one of the optimum resource utilization attempt for achieving maximum production per unit area per unit time.

Farmers in rainfed environment grow pigeonpea (*Cajanus cajan*) a multipurpose crop providing food, fodder, and fuel wood and shelter material either in sole or intercropping systems. Pigeonpea being a long duration crop with initial slow growth is considered good for intercropping with early maturing, non-leguminous and leguminous crops. (Patra and Chatterjee, 1986). Rainfed alfisols where this system is mainly practiced are generally degraded soils with poor native fertility and have serious limitation of soil depth leading to low water storage capacity. (Vittal *et al.*, 1990). Further the yield advantage in the system depends upon the total quantum and distribution of the rainfall and duration and intensity of dry spells. The topsoil depth and rainfall are therefore critical factors influencing the production potential of the system. Alfisols in Peninsular India vary considerably in depth and slope. The reduction in effective soil depth affects the phenological and morphological expression of crops due to soil moisture limitation. 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 (17^0-20'-02" N latitude and 78^0-35'-08" longitude). The general physiography of watershed is characterized by gentle slopes (2-5%) with highest elevation of 520 m. The watershed covering an area of 5 ha has three pediments consisting of upper, middle and lower portions. The inter bunded area of each pediment is covered with 0.5m^2 graded bund. The topsoil (A1) is loose grained and sub soil structure compact, weakly sub angular blocky. The soil is classified as an Alfisol according to the soil taxonomy and Levisol according to FAO legend. A topsoil survey was made by making pits upto 60-cm depth, at 20 sites in each strip on watershed line in small grid fashion (10 x

50 m). The average soil depth in upper, middle and lower basins of micro- catchment was 8.0 + 4.3 (D1), 15.0 cm + 4.5 cm (D2) and 30 cm + 12 (D3) respectively. Sole crops of pigeonpea (LRG 30) and mungbean (ML 267) and mungbean + pigeonpea (2:1) were grown in upper, middle and lower portions of the watershed area from 1992-1995 during *kharif*. The pigeonpea in sole and intercropping systems was grown at 90 x 20 cm apart while mungbean was grown at 30 x 10 cm. An amount of 10 kg N and 30 kg P_2O_5 per hactare was applied uniformly to both the component crops in different systems as basal. These treatments were tested in Randomized block design with four replications. Interculture and plant protection measures were undertaken as required. The rainfall and potential evapotranspiration were recorded daily and rainfall use efficiency (RUE) and moisture adequacy index (MAI) was calculated according to Mahandra Singh and Joshi (1997). Drymatter, leaf area index (LAI) and nitrogen uptake were recorded at different phenological stages of component crops. Seed yields of pigeonpea and mungbean were recorded in all four years. The yield and economic advantages were estimated through LER values and grain equivalents. (Mead and Willey, 1980).

RESULTS AND DISCUSSION

Rainfall Pattern: Mungbean in sole and intercropping systems received total amount of 360, 280, 151 and 500 mm of rainfall in 1992, 93, 94 and 95 respectively during its growth while component crop pigeonpea in sole and intercropping system received rainfall of 465, 580, 662 and 732 mm respectively during its growth period in 1992, 93, 94 and 95.

In 1992, mungbean in sole and intercropping 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 (7-8 WAS). Pigeonpea component in different cropping systems experienced severe moisture stress at flowering and grain formation stages. In 1993, mungbean component in the system experienced moderate stress at reproductive phase (7WAS) at 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.

During 1994,mungbean experienced severe moisture stress during vegetafive phase (3-4 WAS) at all soil depths and during reproductive phase in medium and deep soils. Pigeonpea in sole and intercropping system experienced severe moisture stress at both vegetative and flowering stages at all soil depths.

Mungbean in sole and intercropping system experienced moderate moisture stress in shallow and medium soils and severe moisture stress in deep soils during early vegetative stage (2-3 WAS). in 1995. In pigeonpea severe moisture stress at the time of grain formation influenced its yield potential. (Fig. 1).

Soil depth in relation to crop growth and yields: Growth components *viz.*, leaf area index (LAI) and drymatter in mungbean and pigeonpea in sole and intercropping system increased significantly with increment in soil depth. In mungbean, in different cropping systems LAI increased upto 60 days after sowing (DAS) and later decreased while in pigeonpea LAI increased upto 75 DAS at all soil depths. At D3 (30-45 cm) total drymatter in sole mungbean increased by 44.3,35.6 and 18 per cent compared to soil depth of < 15 cm at 45, 60 and 75 DAS respectively in 1993. Similar results were noticed in 1994 and 1995. Sole pigeonpea at D3 (30-45 cm) recorded higher drymatter production by 143,195 and 104 per cent compared to soil depth < 15 cm

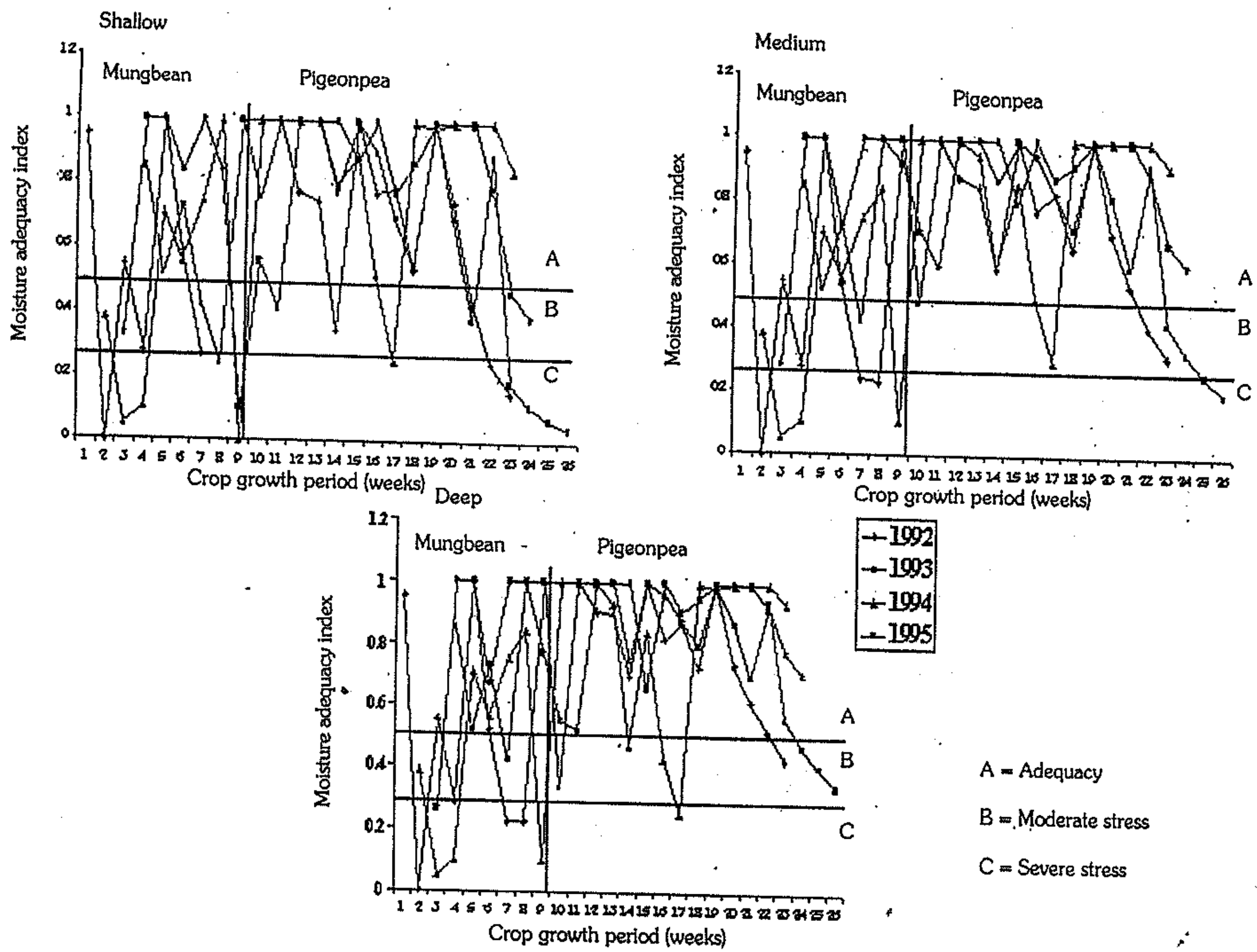
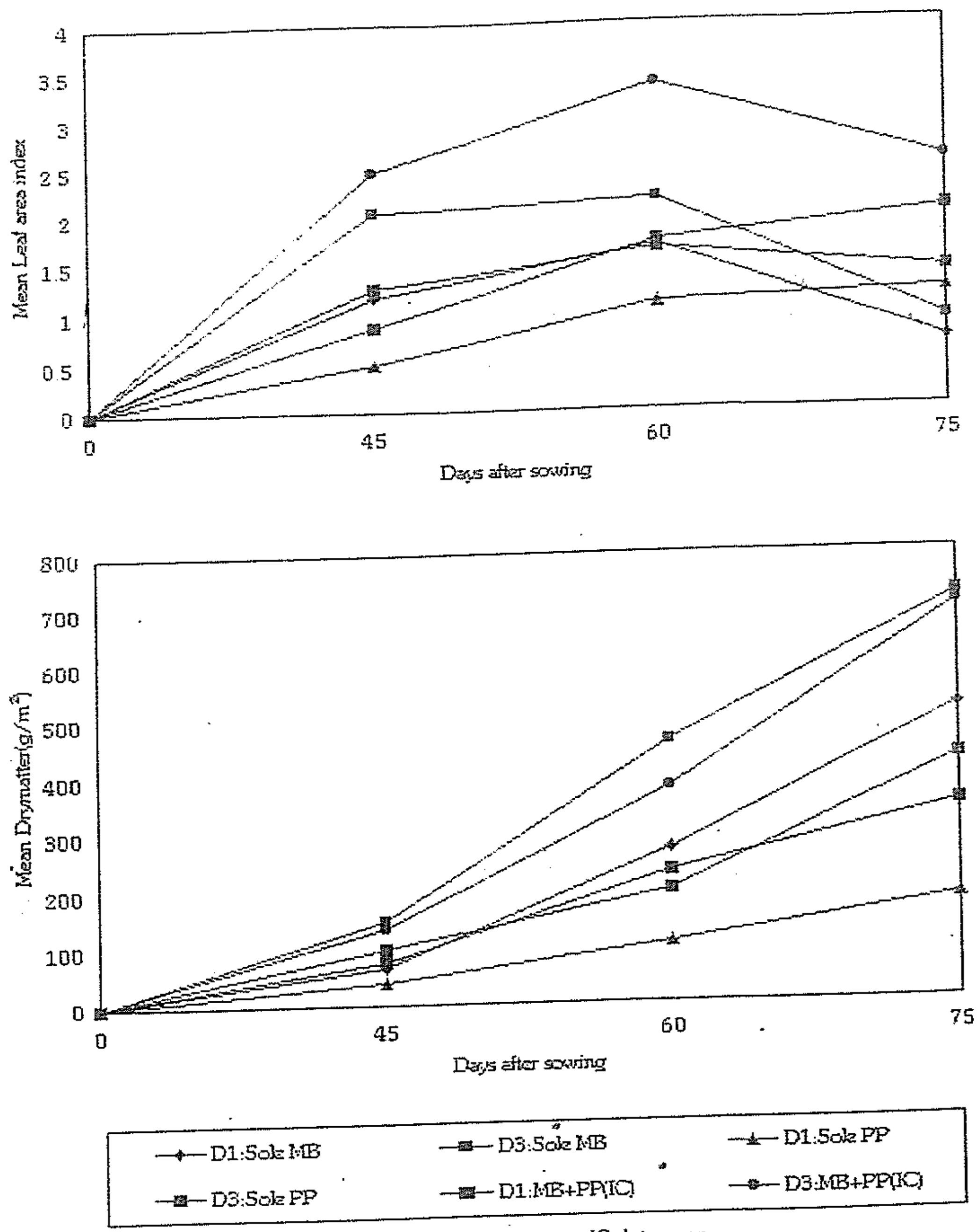


Fig. 1. Influence of soil depth on moisture avalibility in mungbean and pigeonpea



MB=Mungbean; PP=Pigeonpea; IC=Inter crop
D1:<15cm; D3:30-45cm

Fig. 2. Effect of soil depth on growth components of mungbean and pigeonpea in sole and intercropping systems (93-95)

at 45,60 and 75 DAS respectively in 1993. Similar increment in drymatter production in sole pigeonpea was observed in 1994 and 1995. Mungbean and sunflower in intercropping system produced higher combined LAI and drymatter as compared to the respective sole crops at different growth stages in all years. It indicates efficient use of rainfall and light interception by component crops leading to the production of photosynthates necessary for higher biomass production. (Fig. 2). Similar increase in LAI at 60-75 DAS was reported by Nam *et al*, 1993 in *Cajanus cajan*.

The seed yield of sole mungbean in sole and intercropping systems significantly increased with increase in soil depth (15-45 cm) in the watershed. The seed yield of mungbean was higher by 79 and 132 per cent in 15-30 and 30-45 cm soil depth respectively over the soil depth of 15cm. The influence of soil depth on seed yield of sole mungbean was highest in 1995 followed by 1993 and 1994 due to better distribution of rainfall for mungbean. The influence of soil depth on productivity of pigeonpea was slightly less when compared to mungbean. On an average, the seed yield of sole pigeonpea was enhanced by 232 and 502 kg ha^{-1} 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 for pigeonpea. The seed yields of mungbean and pigeonpea in intercropping system was significantly influenced by deeper soil depth of 30-45 cm; while the yields at shallow and medium soil depth were statistically on par. (Table 1). Significant increase in seed yields of chickpea, soybean and sorghum, pearlmillet and castor were noticed due to variation of soil depth due to higher moisture and nutrient use efficiencies. (Vittal *et al.*, 1990, Jadhav *et al.*, 1996 and Piara Singh *et al.*, 1999).

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

	Mungbean seed yield (kg/ha)					Pigeonpea seed yield (kg/ha)				
	1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean
Sole crops										
D1	425	588	529	347	472	130	145	318	830	356
D2	610	1033	787	945	844	200	190	741	1222	588
D3	780	1161	1041	1388	1093	350	206	890	1986	858
Intercrops										
D1	370	300	230	246	287	105	120	202	440	217
D2	520	686	706	745	745	162	145	475	856	410
D3	621	692	763	1266	1266	220	162	523	1283	547
CD (P=0.05)										
Crops	22	173	46	66	173	66*	39	41	70	NS
Depths	27	212	56	81	142	60*	33	36	61	199
Crops x Depths	38	NS	79	NS	NS	104	66	71	122	NS

Intercropping of mungbean and pigeonpea recorded higher mungbean seed equivalents at all soil depths compared to sole crops over the years. At shallow soil depth (<15cm) mungbean and pigeonpea intercropping systems produced higher mungbean grain equivalents of 9 and 38 per cent, 30 and 78 per cent in medium soil depths (15-30 cm) and 22 and 48 per cent in deeper soils (30-45 cm) than sole crops of mungbean and pigeonpea respectively. In 1992, mungbean seed equivalents were significantly higher in intercropping and sole crops at all soil depths while in 1993, intercropping of mungbean and pigeonpea seed equivalents were significantly higher at shallow and deep

Table 2. Influence of soil depth on mungbean seed equivalents, gross returns and RUE in sole and intercropping systems

	Mungbean seed equivalents (kg/ha)					Gross returns (Rs./ha)					RUE of seed (kg/ha/mm)				
	1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean	1992	1993	1994	1995	Mean
Sole Mungbean															
D1	425	588	529	347	472	3400	4704	5290	4164	4390	1.18	2.10	3.50	0.69	1.87
D2	610	1033	787	945	844	4880	8264	7865	11340	8087	1.70	3.69	5.21	1.89	3.12
D3	780	1161	1041	1388	1093	6240	9288	10410	16656	10649	2.17	4.15	6.90	2.78	4.00
Sole Pigeonpea															
D1	130	145	318	896	372	1040	1160	3180	11205	4146	0.28	0.24	0.48	1.13	0.53
D2	200	190	741	1320	613	1600	1520	7410	16497	6756	0.43	0.32	1.12	1.66	0.88
D3	350	206	890	2145	898	2800	1648	8900	26811	10039	0.75	0.40	3.00	2.70	1.70
Mungbean+Pigeonpea (2:1)															
D1	475	420	432	721	512	3800	3360	4320	8892	5093	1.25	1.28	1.83	1.09	1.36
D2	682	831	1181	1670	1091	5456	6648	11810	20496	11103	1.79	2.70	5.39	2.66	3.14
D3	841	854	1286	2339	1330	6726	6832	12860	32513	14733	2.20	2.75	5.84	4.28	3.76
CD (P=0.05)															
Crops	26	61	40	185	275	207	491	397	940	3558	0.065	0.21	0.26	0.13	0.83
Depths	26	61	40	185	275	207	491	397	940	NS	0.065	0.21	0.26	0.13	0.83
Crops x Depths	45	106	69	NS	NS	358	850	687	1628	NS	0.112	0.37	0.45	0.23	NS