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Effect of moisture conservation practices on productivity and economics of finger millet and pigeon pea intercropping system in the dry zone of Eastern Karnataka

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ABSTRACT

A field experiment was conducted during *Kharif* season of 2013 to study the effect of moisture conservation practices on productivity and economics of finger millet + pigeon pea intercropping system under dry land situations at AICRP on Dryland Agriculture field unit, UAS, GKVK, Bangalore. The experiment consisted of multiple treatments such as mulching with maize residues, repeated inter-cultivation, green leaf manuring, tank silt application and their combination with a control replicated thrice in RCBD. Growth and yield attributes in both finger millet and pigeonpea was superior with green leaf manure + maize residue mulch as compared to control. Higher gross and net returns were observed in green leaf manure + maize residue mulch (Rs. 95026 ha^{-1} and Rs. 70118 ha^{-1}, respectively). Equivalent higher yield of finger millet yield was recorded in the same treatment compared to the control.

Key words: Economics, finger millet, moisture conservation, pigeon pea, productivity

INTRODUCTION

The main concept of intercropping is to get higher total productivity per unit area and time, besides equitable and judicious utilization of land resources and farming inputs including labour. One of the main reasons for higher yields in intercropping is that the component crops utilize the natural resources differently and efficiently than grown separately (Willey, 1979). The major constraint limiting crop production in finger millet + pigeon pea intercropping is the lack of assured supply of available soil moisture throughout the cropping season due to low and erratic distribution of rainfall. Lack of sufficient soil moisture hinders the crop growth affecting soil - plant water relations viz., reduced evapotranspiration, C fixation, uptake of water, nutrients *etc*. This complex situation brings the dryland production always unstable. Although, the finger millet and pigeon pea are reported to be tolerant to moisture stress, even short period of moisture stress during critical stages of growth, markedly reduces the yield. Soil and water conservation measures are aimed at management

of rain water, soil and vegetation in a manner that makes perceptible change with regard to water resources development for increasing land productivity on a sustainable basis (Arora *et al*., 2006). Field based soil and water conservation measures are essential for *in-situ* conservation of soil and water. *In-situ* moisture conservation practices are reported to provide an advantage in conserving the rainfall in soil profile and reducing the runoff, providing more opportunity time to infiltrate into soil, reducing evaporation losses and minimize the risk of uncertain rainfall. Measures to conserve soil moisture may therefore, help to improve the productivity of dryland crops.

MATERIALS AND METHODS

Experiment was conducted at AICRP on Dryland Agriculture field unit, UAS, GKVK, Bangalore. The centre is situated in the Eastern dry zone (zone-V) of Karnataka at 12°35' North latitude and 77°35' East longitude with an altitude of 930 m above the mean sea level. The experimental soil was red sandy clay loam, medium in organic carbon (0.55 %), slightly acidic in reaction (pH 5.7), normal EC (0.09 d Sm^{-1}), medium in available N (235 kg ha^{-1}), K (170 kg ha^{-1}), and high in available P (80 kg ha^{-1}). The field experiment carried in finger millet + pigeonpea (8:2) intercropping with moisture conservation furrow in between paired rows of pigeonpea laid out in randomized complete block design (RCBD) with 10 treatments (Mulching with maize residues, repeated inter-cultivation (3 times), green leaf manuring, tank silt application and their combination with a control) and 3 replications. The gross plot size was 6.6 m X 3.6 m and net plot size was 5.4 m X 3.0 m. Finger millet cv MR-1 and pigeon pea cv TTB-7 was sown during first week of July. Calculated quantity of *ex-situ* green manure (*Gliricidia sepium*) in T_4, T_6 and T_8 treatments, tank silt application in T5, T_7 and T_9 treatments were incorporated as per the treatment schedule. Fifteen days prior sowing and maize residue comprising rind and sheath of cob, straw was analysed for the nutrient status before mulching. Calculated quantity of sun dried maize residue was mulched in T_1, T_2, T_6 and T_7 as per the treatment detail on 20 DAS. In the treatment, T_3, T_8 and T_9 having repeated inter-cultivation, three inter-cultivations were adopted including the common inter-cultivation. Finger millet was harvested on 15th November 2013 and pigeon pea on 1st February, 2014.

Statistical analysis

The experimental data collected on various growth, yield and other aspects were subjected to Fisher's method of analysis of variance (ANOVA) as per methods outlined by Panse and Sukhatme (1967). Critical difference (CD) was calculated wherever the 'F' test was found significant. The data were analyzed and are presented with 5 per cent level of significance.

RESULTS AND DISCUSSION

Growth parameters

Different soil moisture conservation practices such as green leaf manuring, maize residue mulch, tank silt application, repeated inter-cultivation operation and combination of these significantly influenced the growth parameters of finger millet and pigeon pea. In finger millet, combination of green leaf manure with maize residue mulch treatment showed significantly taller plants, higher leaf area and total dry matter accumulation (T_6: 98.6 cm, 1600.00 cm^2 $hill^{-1}$ and 86.00 g $hill^{-1}$) as compared to control (86.0 cm,1100.00 cm^2 $hill^{-1}$ and 58.89 g $hill^{-1}$, respectively). The increase in the dry matter production and accumulation in both green leaf manure and tank silt with maize residue mulch treatment might be due to higher plant height and leaf area compared to control treatment. These results are in close conformity with the results of Singh and Rana (2006); Patil *et al*. (2011) in sorghum. In case of pigeonpea green leaf manure with maize residue mulch treatment recorded higher plant height (Table 1) and total dry matter

accumulation (132.0 cm and 195.1 g plant^{-1}) as compared to control (100.7 cm and 137.0 g plant^{-1}). Which is ascribed to the better nutrient availability in the early stage of crops, which might favoured initial establishment and rapid growth of photosynthetic area. Further, mulches helped in maintaining microclimate besides its decomposition add nutrients in soil.

Yield parameters

Higher finger millet ear weight (39.83 g hill^{-1}) and test weight (3.43 g) recorded in green leaf manuring with maize residue mulch (Table 2) and it was on par with tank silt with maize residue mulch treatment (38.60 g hill^{-1} and 3.43 g respectively). Significantly higher grain yield per hill was registered with tank silt along with maize residue mulch treatment (32.71 g hill^{-1}) and it was on par with green leaf manuring with maize residue mulch treatment (32.40 g hill^{-1}). Lower grain yield was recorded in control (25.93 g hill^{-1}). Seed yield of pigeon pea per plant differed significantly due to different moisture conservation practices. Green leaf manure with maize residue mulch treatment recorded higher seed weight (43.81 g plant^{-1}) and test weight (13.02 g). Lower seed weight (28.21 g plant^{-}1) and test weight (11.80 g) was noticed in control. The significant improvement in yield components in both green leaf manure and tank silt along with maize residue mulch treatment might be attributed to beneficial effect of green leaf manure, tank silt and maize residue mulch on physical and chemical properties of the soil, besides supplying essential nutrients to plant growth. This also could be attributed to ability of plants to absorb the required moisture and nutrient as per its requirement resulting in better yield component and grain yield of pigeon pea. Similar results were found by Anon. (2012) in moong bean ; Karunakaran and Behera (2013) in soybean.

Finger millet equivalent yield and economics

Higher gross and net returns were observed in green leaf manure with maize residue mulch with Rs. 95026 ha^{-1} and Rs. 70118 ha^{-1} respectively (Table 3). Green leaf manure with maize residue mulch treatment recorded higher finger millet equivalent yield (4460 kg ha^{-1}) followed by tank silt with maize residue mulch treatment (4244 kg ha^{-1}) and tank silt along with repeated inter-cultivation(4244 kg ha^{-1}). Lower finger millet equivalent yield was noticed in control (3503 kg ha^{-1}). Increased gross and net returns were due to the higher finger millet equivalent yield (4460 kg ha^{-1}) in green leaf manure treatment compared to control. Higher finger millet equivalent yield might be due to availability of sufficient moisture and nutrients to the crop compared to control. The higher B: C ratio of 3.32 was noticed in maize residue @ 5 MT ha^{-1} mulch treatment followed by maize residue mulch @ 2.5 MT ha^{-1} and green leaf maize residue @ 5 MT ha^{-1} mulch treatment (3.29 and 2.82, respectively). Lower B:C ratio in green leaf manure with repeated inter-cultivation and tank silt with repeated inter-cultivation were due to higher cost of cultivation (Rs.25608 ha^{-1} and Rs.25608 ha^{-1}) compared to the other treatments. Similar results were also obtained in sorghum crop (Sharma *et al.,* 2004 and Devaranavadagi *et al.,* 2004).

CONCLUSION

Green leaf manure along with maize residue mulch treatment improved the yield of finger millet and pigeon pea followed by tank silt along with maize residue mulch treatment. Combination of soil moisture conservation practices performed better followed by their effect on isolation for productivity of finger millet + pigeon pea intercropping and conservation of natural resources compared to control. Economic analysis shows superiority of maize residue @ 5 MT ha^{-1} followed by maize residue mulch 2.5 MT ha^{-1} and combination of green leaf manure + maize residue mulch @ 2.5 MT ha^{-1}. This practice also helps in improvement of soil physical, chemical and biological properties due to addition of organic matter into the soil. Therefore application of green leaf manure with maize residue mulch or tank silt with maize residue mulch is a recommendable option for improving the productivity of finger millet + pigeon pea intercropping system under deficit rainfall situation.

Table 1. Effect of moisture conservation practices on growth parameters of finger millet and pigeon pea

Treatment	Finger millet			Pigeonpea	
	Plant height (cm)	Leaf area (cm^2 $plant^{-1}$)	TDMP (g $hill^{-1}$)	Plant height (cm)	TDMP (g $hill^{-1}$)
T_1: Mulching with maize residue @ 2.5 MT ha^{-1}	90.8	1289.00	72.72	115.0	152.3
T_2: Mulching with maize residue @ 5 MT ha^{-1}	92.0	1216.67	76.33	115.7	162.4
T_3: Repeated inter-cultivation (3 times)	89.3	1181.00	65.90	112.5	141.9
T_4:Green leaf manuring @ 10 MT ha^{-1}	92.1	1277.33	74.90	127.7	170.8
T_5: Tank silt @ 10 MT ha^{-1}	91.3	1324.00	74.55	117.7	164.7
T_6: T_4 + T_1	98.6	1600.00	86.00	132.0	195.1
T_7: T_5 + T_1	97.0	1402.00	83.60	119.7	191.9
T_8: T_4 + T_3	93.9	1375.33	77.00	129.7	175.3
T_9: T_5 +T_3	92.0	1320.00	77.68	119.0	167.6
T_{10}: Control (Recommended practice)	86.0	1100.00	58.89	100.7	137.0
S.Em.±	1.48	39.74	0.83	3.9	1.3
CD (P=0.05)	4.44	118.08	2.60	11.7	4.0

TDMP- Total dry matter production

Table 2. Effect of moisture conservation practices on yield parameters of finger millet and pigeon pea

Treatment	Finger millet			Pigeonpea	
	Ear weight (g $hill^{-1}$)	Grain weight (g hil^{l-1})	1000 grain weight (g)	Seed weight (g $plant^{-1}$)	100 Seed weight (g)
T_1: Mulching with maize residue @ 2.5 MT ha^{-1}	37.72	27.60	3.20	30.00	12.10
T_2: Mulching with maize residue @ 5 MT ha^{-1}	38.00	27.83	3.25	32.21	12.61
T_3: Repeated inter-cultivation (3 times)	32.57	25.97	3.15	28.51	12.01
T_4:Green leaf manuring @ 10 MT ha^{-1}	35.73	28.23	3.23	36.20	12.62
T_5: Tank silt @ 10 MT ha^{-1}	38.05	28.77	3.37	35.22	12.4
T_6: T_4 + T_1	39.83	32.40	3.43	43.81	13.02
T_7: T_5 + T_1	38.60	32.71	3.43	43.20	12.50
T_8: T_4 + T_3	37.33	27.50	3.23	37.80	12.60
T_9: T_5 +T_3	38.35	28.33	3.33	36.01	12.62
T_{10}: Control (Recommended practice)	31.05	25.93	3.10	28.21	11.80
SEm±	0.62	0.86	0.05	0.60	0.30
CD (P=0.05)	1.83	2.54	0.15	1.80	0.90

Table 3. Economics of finger millet + pigeon pea intercropping system as influenced by different moisture conservation practices

Treatments	FM grain yield (kg ha^{-1})	PP seed yield (kg ha^{-1})	FMEY (kg ha^{-1})	Gross returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C
T_1: Mulching with maize residue @ 2.5 MT ha^{-1}	3621	223	4100	87199	20308	66891	3.29
T_2: Mulching with maize residue @ 5 MT ha^{-1}	3744	241	4223	89906	20808	69098	3.32
T_3: Repeated inter-cultivation (3 times)	3292	185	3771	79831	21008	58823	2.80
T_4:Green leaf manuring @ 10 MT ha^{-1}	3740	251	4219	89763	24258	65505	2.70
T_5: Tank silt @ 10 MT ha^{-1}	3734	244	4213	89064	24258	64806	2.67
T_6: $T_4 + T_1$	3981	273	4460	95026	24908	70118	2.82
T_7: $T_5 + T_1$	3765	264	4244	90242	24908	65334	2.62
T_8: $T_4 + T_3$	3760	260	4239	89901	25608	64293	2.51
T_9: $T_5 + T_3$	3765	252	4244	90375	25608	64767	2.53
T_{10}: Control (Recommended practice)	3024	146	3503	74340	19658	54682	2.78
S.Em.±	132.78	4.10					
CD (P=0.05)	394.51	12.30					

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