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Evaluation of remunerative foxtail millet (*Setaria italica* L.) based intercropping systems under late sown conditions

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ABSTRACT
A field experiment was conducted during late kharif, 2016 at S.V. Agricultural College Farm, Tirupati with three different times of sowing of foxtail millet (first fortnight of August, second fortnight of August and first fortnight of September) in combination with four intercropping systems (foxtail millet + pigeonpea (5 : 1), foxtail millet + castor (5 : 1), foxtail millet + black gram (3 : 3) and foxtail millet + cowpea (3 : 3)). The results of the experiment revealed that among the four intercropping systems sown at three times of sowing, foxtail millet + pigeonpea (5 : 1) sown during first fortnight of August recorded higher gross returns, net returns, benefit-cost ratio, land equivalent ratio, area time equivalent ratio and foxtail millet grain equivalent yield. The above parameters were at their lower value with intercropping system of foxtail millet + black gram (3 :3) sown during first fortnight of September. Sowing of foxtail millet + pigeonpea (5 : 1) intercropping system during first fortnight of August proved to be viable risk minimizing and remunerative strategy under late sown conditions.
Key words: *Foxtail millet, remunerative, intercropping system, returns*

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INTRODUCTION

Millets have been called ¨Nutri grains¨ since they are rich in micro nutrients like minerals and B complex vitamins. Small millets have gained their attention owing to their inherent capacity of early maturity, higher yields due to C_4 plant type, capacity to yield even in poor soil under low rainfall and poor management conditions; hence they are popularly known as ¨climate resilient¨ crops in Indian agriculture. Small millets provide much needed food and fodder security of the nation. Among minor millets, foxtail millet and barnyard millet have low glycemic index. Consumption of these grains has demonstrated positive health benefits among the diabetics and they are known as ¨wonder grains¨.

Foxtail millet can be planted when it is too late to plant most other crops. It keeps growing at 300 – 400 mm annual rainfall also in semi arid areas. Intercropping is an important aspect than sole cropping to address the issues of rainfed agriculture under changing climate scenario and it also helps in the maximization of productivity and profitability by efficient utilization of natural resources like land, light and water. Moreover, intercropping improves soil fertility through atmospheric nitrogen fixation with inclusion of legumes and helps in soil conservation through greater ground cover. To stabilize crop production and to provide insurance against aberrant weather situations in rainfed agriculture, intercropping of millets with pulses such as pigeonpea could be remunerative as well as viable risk minimizing agronomic means of sustainable venture. Especially the information on promising intercropping systems under delayed monsoon conditions has been lacking which is required for contingency planning. Hence, promising foxtail millet based intercropping systems were tested for their response to different times of sowing to evaluate their yield potentiality and profitability.

MATERIAL AND METHODS

A field experiment was carried out during late *kharif*, 2016 at S.V. Agricultural College Farm, Tirupati. The experimental soil was sandy loam in texture, slightly acidic in reaction (pH 6.1), medium in organic carbon (0.52 per cent) and low in available nitrogen (185 kg ha^{-1}), high in available phosphorus (28 kg ha^{-1}) and medium in potassium (204 kg ha^{-1}). The experiment was laid out in split-plot design with twelve

treatment combinations and replicated thrice. The treatments comprised of three times of sowing (first fortnight of August, second fortnight of August and first fortnight of September) and four intercropping systems (foxtail millet + pigeonpea (5 : 1), foxtail millet + castor (5 : 1), foxtail millet + black gram (3 : 3) and foxtail millet + cowpea (3 : 3)). Foxtail millet as well as intercrops were sown in lines, 30 cm apart by adopting all the standard package of practices. Recommended dose of fertilizer (50 kg N 30 kg P_2O_5 and 20 kg K_2O) was applied to foxtail millet only in all the treatments. The scheduled nitrogen was applied in two equal splits *viz.,* first half at the time of sowing as basal and remaining half as top dressing at 30 DAS. Sole crops of foxtail millet, pigeonpea, castor, black gram and cowpea were raised in unreplicated observational plots for evaluation of intercropping systems in terms of Land Equivalent Ratio (LER), Area Time Equivalent Ratio (ATER) and foxtail millet grain equivalent yield.

RESULTS AND DISCUSSION

Among the three different times of sowing evaluated, significantly higher gross returns, net returns and benefit-cost ratio were recorded with first fortnight of August, while lower gross and net returns and benefit-cost ratio were noticed when sowings were done during first fortnight of September. Intercropping system of foxtail millet + pigeonpea (5 : 1) recorded higher returns and benefit-cost ratio which was comparable with intercropping system of foxtail millet + castor (5 : 1), while intercropping system of foxtail millet + blackgram (3 : 3) recorded lower values (Table 1). These results are in conformity with findings of Gadhia *et al.* (1993), Shashidhara *et al.* (2000), Padhi *et al.* (2010), Choudhary *et al.* (2012), Nigade *et al.* (2012) and Ramachandrappa *et al*. (2016).

Land Equivalent Ratio (LER), Area Time Equivalent Ratio (ATER) and foxtail millet grain equivalent yield were significantly higher with August first fortnight sown intercropping systems, while the lower values were noticed with first fortnight of September sowings. Maximum LER, ATER and foxtail millet grain equivalent yields were observed with the intercropping system of foxtail millet + pigeonpea (5 : 1) and lower values were registered with the intercropping system of foxtail millet + black gram (3 : 3) (Table 2). These results corroborated with Gadhia *et al.* (1993), Gautam (1994), Maitra *et al.* (2000), Shashidhara *et al.* (2000) and Padhi *et al.* (2010).

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Table 1: Economics of the intercropping systems as influenced by times of sowing

Treatments	Gross Returns (₹ha^{-1})	Net Returns (₹ha^{-1})	B:C ratio
Times of sowing			
T_1 : I Fortnight of August	55185	34839	2.67
T_2 : II Fortnight of August	47586	27240	2.30
T_3 : I Fortnight of September	46495	26149	2.25
SEm+	1349.6	1349.6	0.065
CD (P=0.05)	5269	5269	0.25

Intercropping systems			
C_1 : Foxtail millet + pigeonpea (5 : 1)	77174	56490	3.73
C_2 : Foxtail millet + castor (5 : 1)	72821	52136	3.52
C_3 : Foxtail millet + black gram (3 : 3)	23452	3334	1.14
C_4 : Foxtail millet + cowpea (3 : 3)	25574	5676	1.24
SEm±	1557.9	1557.9	0.076
CD (P=0.05)	4630	4630	0.23
\Interaction			
C at T			
SEm±	2699.1	2699.1	0.131
CD (P=0.05)	NS	NS	NS
T at C			
SEm±	2698.5	2698.5	0.131
CD (P=0.05)	NS	NS	NS

Table 2 : Assessment of the intercropping systems as influenced by times of sowing

Treatments	Land equivalent ratio	Area time equivalent ratio	Foxtail millet grain equivalent yield (kg ha^{-1})
Times of sowing			
T_1 : I Fortnight of August	1.46	1.28	2956
T_2 : II Fortnight of August	1.35	1.19	2558
T_3 : I Fortnight of September	1.26	1.11	2494
SEm±	0.027	0.023	62.2
CD (P=0.05)	0.10	0.08	243
Intercropping systems			
C_1 : Foxtail millet + pigeonpea (5 : 1)	1.74	1.49	4139
C_2 : Foxtail millet + castor (5 : 1)	1.70	1.35	3848
C_3 : Foxtail millet + black gram (3 : 3)	0.85	0.85	1336
C_4 : Foxtail millet + cowpea (3 : 3)	1.15	1.07	1356
SEm±	0.025	0.024	66.9
CD (P=0.05)	0.07	0.07	199
Interaction			
C at T			
SEm±	0.055	0.044	124.4
CD (P=0.05)	NS	NS	NS
T at C			
SEm±	0.046	0.042	117.9
CD (P=0.05)	NS	NS	NS

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