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Yield indices and economics of maize as influenced by maize-based intercropping system in southern dry zone of Karnataka

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ABSTRACT

A field experiment was conducted during Kharif 2013 at Zonal Agricultural Research Station, VC Farm, Mandya to study the yield indices and economics of maize as influenced by maize-based intercropping system. Treatments consisted of sole crops and different row proportions of maize + intercrops (pigeonpea, soybean and field bean). Significantly higher maize equivalent yield (9863 kg/ha), land equivalent ratio (1.85), area time equivalent ratio (1.49), net returns (Rs 102371/ha) and B:C ratio (4.37) were recorded with paired row maize intercropped with pigeonpea at 45/75 cm spacing as compared to sole maize. Though intercropping resulted in significant reduction in the yield of sole crops it was better compensated by component crops in terms of total yield and income.

Keywords: Maize; maize equivalent yield; land equivalent ratio; B:C ratio.

INTRODUCTION

Intercropping of legumes with cereals is a recognized practice for economizing the use of nitrogenous fertilizers and increasing the productivity and profitability per unit area and time. One of the main reasons for higher yields in intercropping is that component crops are able to use growth resources differently and make better overall use of natural resources than grown separately (Willey 1979). A careful selection of crops having different growth habits can reduce the mutual competition to a considerable extent. Maize is an important crop in southern dry zone of Karnataka and the area under maize cultivation in the region is in the increasing trend.

The feasibility and economic viability of intercropping system largely depend on adoption of proper planting geometry, planting time, selection of

compatible crops and nutrient management. Thus the objective of intercropping is now more towards augmenting the total productivity per unit area of the land per unit time through inclusion of more than one crop in the same field though the prime objective being better utilization of environmental resources under rainfed ecosystem.

MATERIAL and METHODS

A field experiment was conducted at Zonal Agricultural Research Station, VC Farm, Mandya during Kharif 2013 situated between 11° 30' to 13° 05' North latitude and 76° 05' to 77° 45' East longitude with an altitude of 695 meters amsl. It falls under the Region III and southern dry zone of Karnataka (Zone VI). The soil of experimental site was sandy loam in texture, neutral in soil reaction and normal in electrical conductivity. The organic carbon content and available nitrogen of the soil were low and available phosphorus and potassium were medium (Table 1). The normal as well as actual weather data on total rainfall, temperature (maximum and minimum), relative humidity and daily bright sunshine hours prevailed during the period of crop growth (August 2013 to January 2014) are presented in Fig 1. Maize hybrid HEMA (NAH 1137) was sown with intercrops viz pigeonpea (BRG-2), soybean (JS-335) and field bean (HA-4) in August according to treatments. Farm yard manure was applied at the rate of 10 tons/ha to each plot three weeks prior to sowing. The recommended doses of fertilizers for maize (150 kg N, 75 kg P_2O_5 and 40 kg K_2O/ ha), pigeonpea (25 kg N, 50 kg P_2O_5 and 25 kg K_2O/ha), soybean (30 kg N, 80 kg P_2O_5 and 38 kg K_2O/ha) and fieldbean (25 kg N, 50 kg P_2O_5 and 25 kg K_2O/ha) were applied in the form of urea, single super phosphate and muriate of potash respectively as basal dose. In case of maize 50 per cent of N was applied as basal and remaining dose of nitrogen (75 kg/ha) was applied as top dressing at 40 DAS. In case of intercropping treatments fertilizers were applied in proportionate to the sole optimum population for main and intercrops separately. Experiment included thirteen treatments viz T_1 (paired row maize intercropped with pigeonpea at 30/90 cm spacing), T_2 (paired row maize intercropped with soybean at 30/90 cm spacing), T_3 (paired row maize intercropped with field bean at 30/90 cm spacing), T_4 (paired row maize intercropped with pigeonpea at 45/75 cm spacing), T_5 (paired row maize intercropped with soybean at 45/75 cm spacing), T_6 (paired row maize intercropped with field bean at 45/75 cm spacing), T_7 (maize + pigeonpea, 2:1), T_8 (maize + soybean, 1:1), T_9 (maize + field bean, 1:1); T_{10} (sole maize), T_{11} (sole pigeonpea), T_{12} (sole soybean) and T_{13} (sole field bean) laid out in randomized complete block design (RCBD) with three replications whereas statistical analysis was done only from T_1

to T_{10} by excluding T_{11}, T_{12} and $_{T13}$. These treatments were included only for calculation of yield advantage indices by using following formulae:

$$\text{MEY (kg/ha)} = \text{Maize yield (kg/ha)} + \frac{\text{Intercrop yield (kg/ha) x price (Rs/kg)}}{\text{Maize price (Rs/kg)}}$$

$$\text{LER} = \frac{\text{Yab}}{\text{Yaa}} + \frac{\text{Yba}}{\text{Ybb}}$$

where Yab and Yba are the yields as intercrop of a and b; Yaa and Ybb are the yields of a and b in sole cropping

$$\text{ATER} = \frac{(\text{Rya x ta}) + (\text{Ryb x tb})}{\text{T}}$$

where Ry= Relative yield of species a and b

$$\text{ie} = \frac{\text{Yield of inter crop/ha}}{\text{Yield of sole crop/ha}}$$

t = Duration (days) for species a and b;
T= Total duration (days) of the intercropping system

RESULTS and DISCUSSION

Effect on yield indices

The data on yield indices of maize as influenced by maize-based intercropping system are represented in Table 2. Maize equivalent yield (MEY) was higher in paired row maize with soybean at 30 x 90 cm spacing and it was closely followed by paired row maize with pigeonpea at 45/75 cm spacing. Higher maize equivalent yield under intercropping systems can be attributed to yield advantages achieved in intercropping system. The result is in accordance with the findings of Lakra et al (2000) and Marer et al (2007). Intercropping of paired row maize with pigeonpea at 45 x 75 cm spacing recorded higher yield advantage of 85 per cent (1.85) over other intercrop combinations (1.12 to 1.69) as compared to sole maize and the same treatment also recorded higher area time equivalent ratio value (1.49). The obvious reason for large yield advantage in intercropping system could be that the component crops differed in their use of natural resources and utilized them more efficiently resulting in higher systems and yields per unit area than that produced by their sole crops. These results are in concurrence with those of Quiroz and Marin (2003).

Effect on economics

The data on economics of maize as influenced by maize-based intercropping system are represented in Table 3. Regardless of row spacing of maize and different intercrops (pigeonpea, soybean and field bean) all the maize based

Table 1. Physico-chemical properties of soil at the experimental site

Particulars	Value	Status
Physical properties		
Coarse sand (%)	51.40	--
Fine sand (%)	15.60	--
Silt (%)	17.60	--
Clay (%)	15.40	--
Soil textural class	Sandy loam	--
Chemical properties		
pH (2.5)	6.85	Neutral
EC (2.5) (dS/m)	0.30	Low
Organic carbon (%)	0.45	Low
Available N (kg/ha)	245.56	Low
Available P_2O_5 (kg/ha)	28.92	Medium
Available K_2O (kg/ha)	173.27	Medium

Table 2. Maize equivalent yield (MEY), land equivalent ratio (LER) and area time equivalent ratio (ATER) as influenced by spacing and intercrops in maize-based paired row intercropping system

Treatment	Yield (kg/ha)		MEY (kg/ha)	LER	ATER
	a	b			
T_1: PR-PP (30/90 cm)	8009	385	9050	1.66	1.32
T_2: PR-SB (30/90 cm)	7977	768	9897	1.69	1.44
T_3: PR-FB (30/90 cm)	6156	229	6917	1.12	1.09
T_4: PR-PP (45/75 cm)	8539	489	9863	1.85	1.49
T_5: PR-SB (45/75 cm)	7025	630	8584	1.47	1.38
T_6: PR-FB (45/75 cm)	6578	276	7495	1.22	1.19
T_7: Maize + pigeonpea (2:1)	7720	311	8563	1.52	1.20
T_8: Maize + soybean (1:1)	6842	600	8324	1.42	1.33
T_9: Maize + field bean (1:1)	6727	190	7359	1.16	1.14
T_{10}: Sole maize	6656	—	6656	—	—
T_{11}: Sole pigeonpea	—	861	2331	—	—
T_{12}: Sole soybean	—	1559	3856	—	—
T_{13}: Sole field bean	—	190	3962	—	—
SEm±	NA	NA	405	0.08	0.08
$CD_{0.05}$	—	—	1182	0.23	0.24

PR-PP: Paired row maize intercropped with pigeonpea, PR-SB: Paired row maize intercropped with soybean, PR-FB: Paired row maize intercropped with field bean, a: Maize yield, b: Respective intercrop and sole crop yield, NA: Not analysed

intercropping treatments recorded higher gross returns as compared to sole crop of maize or sole intercrops. Among different treatments paired row maize with pigeonpea at 45 x 75 cm spacing recorded higher gross returns (Rs 132715/ha) followed by paired row maize with soybean at 30/90 cm spacing (Rs 130690/ha).

Same trend was followed by former treatments with respect to net returns (Rs 102371, 99666 and 91385/ha respectively) and benefit/cost ratio (4.37, 4.21 and 4.01 respectively) in comparison to other treatments (Table 3). The consequence of higher gross and net returns resulted in higher B:C ratio as the MEY of component crops in intercropping was more as compared to their sole stands with the higher yields and prices. Similar findings were observed by Mohankumar et al (2012) and Singh and Thenua (2014).

CONCLUSION

From the present investigations it can be concluded that intercropping of paired row maize with pigeonpea at 45 x 75 cm spacing is more productive and remunerative than sole crop of maize or

Table 3. Economics of maize equivalent yield as influenced by spacing and intercrops in maize based paired row intercropping system

Treatment	MEY (kg/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
T_1: PR-PP (30/90 cm)	9050	30344	121729	91385	4.01
T_2: PR-SB (30/90 cm)	9897	31024	130690	99666	4.21
T_3: PR-FB (30/90 cm)	6917	30849	92138	61289	2.99
T_4: PR-PP (45/75 cm)	9863	30344	132715	102371	4.37
T_5: PR-SB (45/75 cm)	8584	31024	114368	83344	3.69
T_6: PR-FB (45/75 cm)	7495	30849	100612	69763	3.26
T_7 : Maize + pigeonpea (2:1)	8563	30344	115243	84899	3.80
T_8 : Maize + soybean (1:1)	8324	31024	110569	79545	3.56
T_9 : Maize + field bean (1:1)	7359	30849	98475	67626	3.19
T_{10}: Sole maize	6656	28549	89738	61189	3.14
T_{11}: Sole pigeonpea	2331	17350	31222	13872	1.80
T_{12}: Sole soybean	3856	17829	47453	29624	2.66
T_{13}: Sole field bean	3962	18950	48586	29636	2.56

PR-PP: Paired row maize intercropped with pigeonpea, PR-SB: Paired row maize intercropped with soybean, PR-FB: Paired row maize intercropped with field bean

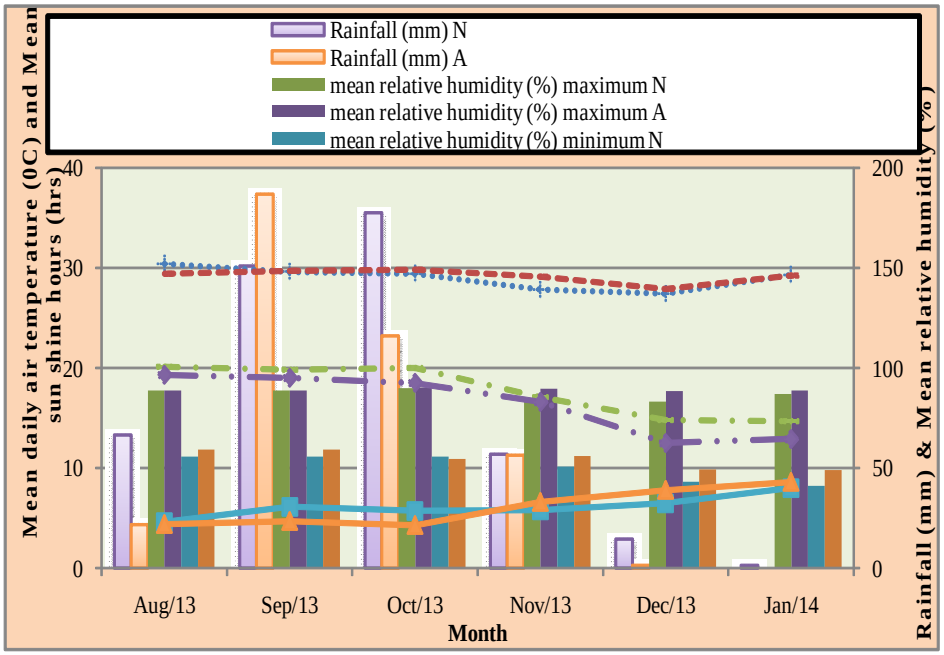

Fig 1. Weather conditions at Zonal Agricultural Research Station, VC Farm, Mandya during the crop growth period 2013-14

sole intercrops and other intercropping systems under southern dry zone of Karnataka.

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