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INFLUENCE OF PHYSIOLOGICAL PARAMETERS AND YIELD BY DIFFERENT MAIZE BASED CROPPING SYSTEM

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ABSTRACT
A field experiment was conducted during Kharif season 2011 under All India Co-ordinated Research Project on Forage Crop at Farm of Agriculture College, Jabalpur to study the "Resource utilization in fodder maize based-intercropping system". Sole maize resulted in highest seed yield (18.53 q/ha) and stover yield (150.37 q/ha). Among the intercropping systems maize + soybean was found better. The intercropping of maize with soybean, ricebean and cowpea with 1:1 and 1:2 ratios gave maximum maize equivalent yield than sole crop. The intercropping of maize with soybean 1:2 ratio posses the maximum energy interception (0.85), energy utilization (3.63), PAR interception (1104.11), PAR utilization (2100) and also gave the maximum LER 1.57 than sole maize.

INTRODUCTION

Maize (*Zea mays* L), which is the third most important cereal crop of world is an important cereal crop of world, is an important dual purpose crop used in human diet and animal feed. Maize has the potential to supply large amounts of energy- rich forage for animal diets, and its fodder can safely be fed at all stages of growth without any danger of oxalic prussic acid as in case of Sorghum (Dahmerdeh *et al*., 2009). Thus forage maize has become a major constituent of ruminant ration in recent time. Intercropping of cereals with legumes has been practiced by the small and medium scale farmers. Cowpea, Rice bean, Cluster bean, Faba bean, lathyrus are important forage legume crops grown in intercropping is recognized as a common cropping system throughout tropical developing country due to its advantages for yield increment, weed control (Poggio, 2005), insurance against crop failure, low cost of production and high monetary returns to the farmers (Ofori and Stern, 1987), improvement of soil fertility through the addition of nitrogen by fixing and transferring from the legume to the cereal (Ghosh *et al*., 2004). This indicates that the component crops probably have differing spatial and temporal use of environmental resources such as radiation, water and nutrients (Willey 1990). The state of Madhya Pradesh is one of the traditional and potential maize growing state, accounting for 13% of the total maize area and contributing equally to the maize production in the country. However, the production of maize in Madhya Pradesh is very low if compared to that of other maize- growing states. Therefore, it is need to identify best intercropping system which improve the productivity and resource use efficiency of maize based cropping system.

MATERIALS AND METHODS

A field experiment was conducted during Kharif season 2011 under "All India Co-ordinated Research Project on Forage Crop" at Farm of Agriculture College, Jabalpur to study the "Resource utilization in fodder maize based-intercropping system". The experiment was conducted in Randomized Complete Block Design (RCBD) with 10 treatments viz., T1 – Sole maize, T2 – Sole soybean, T3 – Sole ricebean, T4 – Sole cowpea, T5 – Maize + soybean (1:1), T6 – Maize + ricebean (1:1), T7 – Maize + cowpea (T1:1), T8 – Maize + soybean (1:2), T9 – Maize + ricebean (1:2) and T10 – Maize + cowpea (1:2), replication 3 times. Maize variety (African giant), soybean (JS-07-21-8), ricebean (JRB-05-22) and cowpea (Russian giant) were sown as per the treatments. These seed were sown in rows 60 cm for maize and 30 cm for soybean, ricebean and cowpea. The plot size was 5.40 m x 6m. The physiological parameters, yield attributes and yield were studied.

Light transmission ratio

It was given by Golinguai and Mappayad in 1969.

$$LTR = \frac{I}{I_0} \times 100$$

Where I = Light intensity at the base of crop canopy and I_0 = Total incoming radiation It can be calculated by lux meter.

Energy interception

It can be calculate by lux meter its values converted in terms of energy as per value given by Gastra 1963.

Energy utilization- It can be calculated as per formula given by Hayashi in 1969 at 30 and 60 DAS and then mean values were worked out.

$$EU = \frac{\text{Fixed energy}}{\text{Intercepted energy}}$$

(1 calorie / cm^2/min should [illegible] calorie/cm^2/ day)

Fixed energy can be calculated by taking 1g dry at equal to 4000 calorie.

PAR interception- It can be calculated by using canopy analyzer its units is μmol/m^2/sec. It is calculated at 30 and 60 DAs and then the mean values were worked out.

PAR interception = Total incident PAR – Transmitted PAR

PAR utilization

It is again calculated at 30 and 60 DAS and then the mean values were worked out.

$$PAR = \frac{\text{Fixed energy}}{\text{Intercepted PAR}}$$

RESULTS AND DISCUSSION

The data pertaining to physiological parameters of different crops viz., maize, soybean, ricebean and cowpea under different treatments are given in Table 1.It is evident from the data that physiological parameters significantly varied due to different treatments.

PAR interception

The maximum PAR interception was seen in T_5 maize + soybean (1:1) which shows that T_5 gives the maximum productivity and it was significantly superior than T_6 followed by T_2, T_7, T_9, T_1, T_{10}, T_5 and T_4 but at par with T_8 maize + soybean (1:2).

PAR utilization

The maximum PAR utilization was observed in T_5 maize + soybean (1:1) which is significantly superior then T_8 maize + soybean (1:2) followed by T_2, T_7, T_9, T_1, T_{10}, T_3 and T_4.

Energy interception

The maximum energy interception was seen in T_5 maize + soybean (1:1) which signifies that T_5 gives maximum productivity. It was significantly inferior then T_8 maize + soybean (1:2) but significantly superior than rest of the treatment.

Energy utilization

The maximum energy utilization was found I nT_5 maize + soybean (1:1) i.e. 6.85 g/cal/cm^2/min followed by T_8 maize + soybean (1:2) i.e. 3.63 g/cal/cm^2/min. The minimum energy utilization was found in T_4 cowpea sole.

Light transmission ratio

The plot having maximum light transmission ratio gives minimum productivity. Among the different treatments T_4 i.e. cowpea sole have maximum light transmission ratio 40.98% followed by T_3 ricebean sole. The minimum LTR observed in T_5 maize + soybean (1:1) which shows that T_5 gives maximum productivity.

Yield, maize equivalent yield (MEY kg/ha) and land equivalent ratio (LER)

Yield of the crops is the consequence of various biotic and abiotic factors, which are responsible for changes brought about in the productivity. Yield is the ultimate character responsible for judging the suitability or superiority of one treatment over the other. The effectiveness of any treatment could be judged by the magnitude of changes in the productivity potential of a crop responded to different treatment in the experiment. Maximum yield (seed and straw) of maize was recorded in sole maize (T_1) due to increased growth parameters reflected in better yield in sole maize (T_1). Maximum yield (seed and stover) of soybean was recorded in sole soybean (T_2). Gode and Bodbe (1993) reported that soybean seed yield was 2.66 t/ha when grown alone and 0.58 t/ha when intercropped with sorghum. Similar result was found by Patel *et al.* (2000) and Mandal *et al.* (2014). Maximum yield (seed and stover) of ricebean was recorded in sole ricebean (T_3). The harvest index of ricebean was found maximum in sole ricebean (T_3).The yield (seed and stover) and harvest index of cowpea was found non significant, while the maximum yield was found in sole cowpea (T_3).

Maize equivalent yield (MEY)

Maize equivalent yield was an appropriate agronomical parameter to compare the performance (yield) of base crop (maize) to that of component crops (soybean, ricebean and cowpea) in intercropping. Maize + soybean (1:2) (T_8) was found superior to rested of the treatments with maximum MEY (49.49 q/ha). Raghuwanshi *et al.* (2002) and Choudhary *et al.*

Table 1: Effect of different treatments on physiological parameters (leaf transmission ratio, energy interception, energy utilization, PAR interception, PAR utilization) of maize, soybean, ricebean and cowpea

S. No.	Treatment	Leaf transmissionratio (%)	Energy interception (cal/cm^2/min)	Energy utilization (gcal/cm^2/min)	PAR interception (μmol/m^2/sec)	PAR Utilization (cal/μmol/m^2/sec) X 10^{-7}
1.	Maize (Sole)	26.70	0.55	2.89	576.44	466.00
2.	Soybean (Sole)	20.89	0.61	3.23	1026.00	829.00
3.	Ricebean (Sole)	34.86	0.42	1.67	352.99	60.00
4.	Cowpea (Sole)	40.98	0.35	1.56	274.94	44.00
5.	Maize + Soybean (1:1)	16.06	0.92	6.85	1107.99	2100.00
6.	Maize + Ricebean (1:1)	19.66	0.69	3.23	1073.01	978.00
7.	Maize + Cowpea (1:1)	24.68	0.58	3.03	978.61	588.00
8.	Maize + Soybean (1:2)	19.09	0.85	3.63	1104.11	1543.00
9.	Maize + Ricebean (1:2)	26.70	0.55	2.96	719.16	520.00
10.	Maize + Cowpea (1:2)	31.22	0.43	1.70	436.95	62.00
	SEm ±	-	0.04	0.38	83.18	168.89
	CD (5%)	-	0.13	1.10	241.16	489.64

Table 2: Effect of different treatments on seed yield, stover yield and harvest index of maize, soybean, ricebean and cowpea

S. No.	Treatment	Seed yield (q/ha)				Stover yield (q/ha)				Harvest index (%)			
		Maize	Soybean	Ricebean	Cowpea	Maize	Soybean	Ricebean	Cowpea	Maize	Soybean	Ricebean	Cowpea
1.	Maize (Sole)	18.53				150.37				10.97			
2.	Soybean (Sole)		24.50				82.51				22.89		
3.	Ricebean (Sole)			13.51				70.51				16.07	
4.	Cowpea (Sole)				10.23				71.53				12.51
5.	Maize + Soybean (1:1)	14.70	18.52			145.71	66.70			9.16	21.73		
6.	Maize + Ricebean (1:1)	11.20		9.23		127.83		60.74		8.05		13.19	
7.	Maize + Cowpea (1:1)	13.37			7.15	141.68			58.48	8.62			10.89
8.	Maize + Soybean (1:2)	12.56	22.25			135.83	78.00			8.46	22.194		
9.	Maize + Ricebean (1:2)	9.56		11.63		86.16		66.96		9.98		14.80	
10.	Maize + Cowpea (1:2)	12.25			8.25	113.97			62.09	9.70			11.72
	SEm±	0.056				5.63				0.008			
	CD (5%)	0.174				17.37				0.024			

Table 3: Effect of different treatments on MEY, Production efficiency and LER of maize

S. No.	Treatment	Maize Equivalent Yield (q/ha)	Production efficiency (kg/ha/day)	LER
1.	Maize (Sole)	18.53	15.44	01
2.	Soybean (Sole)	40.67	36.97	01
3.	Ricebean (Sole)	19.72	16.43	01
4.	Cowpea (Sole)	20.46	17.05	01
5.	Maize + Soybean (1:1)	45.44	37.86	1.54
6.	Maize + Ricebean (1:1)	24.67	20.55	1.28
7.	Maize + Cowpea (1:1)	27.67	23.05	1.41
8.	Maize + Soybean (1:2)	49.49	41.24	1.57
9.	Maize + Ricebean (1:2)	26.54	22.11	1.37
10.	Maize + Cowpea (1:2)	27.75	23.15	1.46
	SEm±	2.77	2.40	0.02
	CD (5%)	8.03	6.96	0.06

(2014) reported that the intercropping systems, soybean and sorghum at 1:2 ratio resulted in the highest Maize equivalent yield (1982 kg/ha).

Land equivalent ratio (LER)

Land equivalent ratio is another useful agronomical parameter for measurement of utilization of land by intercropped crops. The highest LER (1.57) was recorded in maize + soybean (1:2) T_8 which was superior to LER value of 1 in sole stands. The values of LER indicate that land utilization was efficient in the intercropping systems from the point of all agronomical characteristics. Patil and Joshi (2002) also found soybean + pigeon pea 4:2 row proportion best with respect to higher net returns, LER, SEY. Kalaghatagi *et al*. (1995) obtained higher LER of 2.02 with intercropping of pearl millet + pigeon pea in the row proportion of 4:2 followed by 1.68 with 1: 1 ratio of pearl millet + pigeon pea.

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