Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(4): 1297-1301

Received: 25-05-2019
Accepted: 27-06-2019

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Economic returns and agronomic performance of different soybean based intercropping systems under Malwa condition of M.P.

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Abstract
A field experiment was conducted At All India Coordinated Research Project on Integrated Farming System, College of Agriculture, Indore during the kharif 2013-14 find out the effects of diversification and intensification on growth and yield of different soybean based intercropping system and their effect on economic viability as well as analyzing all treatment combination economically and find out the superior treatment combination for higher yield and profitability. Experiment was laid out in split plot design with three replication and total thirty two treatment combinations was done.. On the basis of result obtained from the experiment it is concluded that the soybean based intercropping + (Arhar + fodder sorghum) cropping system found to be most productive with minimum tillage,75% RDF and Mulching for achieving the Highest productivity and profitability (gross return, net return and B:C ratio) from per unit area. This study contributed to the understanding of how cropping system affect field productivity which given a basic for local farmer to select the suitable field management strategies.

Keywords: Conventional tillage, economics, maize/soybean based cropping systems, minimum tillage with mulching, system productivity

Introduction
Soybean is known as the “Golden bean” of the 21st Century. Though, soybean is a legume crop, yet it is widely used as oilseed. Due to very poor cook ability on account of inherent presence of trypsin inhibitor, it cannot be utilized as a pulse. Soybean has great potential as an exceptionally nutritive and very rich protein food. Majority of soybean area (about 52%) in India comes under M.P. Of this 95-98% area is located in MALWA region of the state. Soybean occupies the highest area and production amongst the oilseeds in M.P. In India soybean is grown in 10.5 million ha with total production of 11.5 million tonnes. In mp it is grown in 6.38 million ha with total production of 5.37 million tons (SOPA 2017) [10].

In, India there is a very limited scope for increasing area under crop production to meet to food and fodder requirements of increasing human population and existing animal heads. The only solution is to increase the crop productivity per unit area in a unit time this can be archived through scientific management of soil and water resources. Tillage and crop diversification are goingto play major role for addressing the challenges of decline in soil health, water-table, size of land holding and factor productivity and rise in cost of cultivation and risk in agriculture and above all climate change, which are the stumbling blocks in achieving livelihood security, especially of small holders. Minimum soil disturbance with organic soil cover and diversified crop rotations are gaining more attention to address these challenges (Gangwar *et al*. 2006) [4]. Crop diversification and intensification with intervention of legumes, spices, vegetables, high-value crops, employment-generating crops and value-addition are becoming popular among the small holders to increase their profitability. The traditional practice of growing these crops has some limitations with respect to sustaining of crop and soil productivity. Zero/minimum tillage with residue covers is being advocated or soil, organic matter, water, hydrothermal regulation and energy management over traditional tillage practice (Gangwar *et al*., 2006; Gill and Jat, 2007) [4, 5]. Minimum tillage appears to be more practical to insure optimum plant stand, effective weed control, to reduce the requirement of special implements for sowing under residue cover and to meet specific land configuration requirement of crops.

Materials and methods

The present investigations are carried out during kharif season 2013at the All India Coordinated Research Project on Integrated Farming System at College of Agriculture, Indore. to assess the effect of land configuration, integrated nutrient management and mulch on different cropping systems in malwa region in M.P Indore is located at latitude 22.43`N and longitude of 75.66'E.The rainfall of this region is mostly inadequate and erratic. The average annual rainfall is 964 mm. Experiment was a split plot design with 32 treatment combination comprising of
96 plots having three replication. Table 1 provided details and codes of the treatments. The treatments included four crops i.e. soybean (JS 9560) as sole cropstand maize (CM 138), sorghum (CSV 1862) their intercropping systems in row ratio 4; 2arhar (ICPH 2671) + sorghum (M Pchari) in 1; 1row ratio. The two tillage systems [Minimum tillage(T1) and Conventional Tillage (T2)] and four cropping systems [sole soybean (CS1), soy.+ maize(CS2), soy.+ sorghum (CS3),soy.+ arhar (CS4)]were "main" plots and INM [100% RDF treatment (F1) and 75% RDF+ 25% vermi-compost (F2)] and mulch treatments [No Mulch (M1) and Mulch (M1)] were taken

Table 1: Details and Codes of the Treatments

S.N.	Treatments	Combination
1	T1CS1F1M1	minimum tillage + sole soybean +no mulch + 100% RDF
2	T1CS1F1M2	minimum tillage + sole soybean + mulch +100% RDF
3	T1CS1F2M1	minimum tillage + sole soybean + no mulch +(75% RDF+25%vermi)
4	T1CS1F2M2	minimum tillage +sole soybean + mulch +(75% RDF+25%vermi)
5	T1CS2F1M1	minimum tillage + (soybean +maize) + no mulch + 100% RDF
6	T1CS2F1M2	minimum tillage + (soybean+maize) + mulch +100% RDF
7	T1CS2F2M1	minimum tillage + (soybean +maize) + no mulch +(75% RDF+25%vermi)
8	T1CS2F2M2	Minimum tillage+ (soybean+maize) +mulch +(75% RDF+25%vermi)
9	T1CS3F1M1	minimum tillage + (soybean+Sorghum) + no mulch + 100% RDF
10	T1CS3F1M2	minimum tillage + (soybean+Sorghum) + mulch +100% RDF
11	T1CS3F2M1	minimum tillage + (soybean+Sorghum) + no mulch +(75% RDF+25%vermi)
12	T1CS3F2M2	minimum tillage + (soybean+Sorghum) + mulch +(75% RDF+25%vermi)
13	T1CS4F1M1	minimum tillage + (Arhar+ sorghum) + no mulch + 100% RDF
14	T1CS4F1M2	minimum tillage + (Arhar+ sorghum) + mulch +100% RDF
15	T1CS4F2M1	minimum tillage + (Arhar+ sorghum) + no mulch +(75% RDF+25%vermi)
16	T1CS4F2M2	minimum tillage + (Arhar+ sorghum) + mulch +(75% RDF+25%vermi)
17	T2CS1F1M1	Conventional tillage + sole soybean +no mulch + 100% RDF
18	T2CS1F1M2	Conventional tillage + sole soybean + mulch +100% RDF
19	T2CS1F2M1	Conventional tillage + sole soybean + no mulch +(75% RDF+25%vermi)
20	T2CS1F2M2	Conventional tillage +sole soybean + mulch +(75% RDF+25%vermi)
21	T2CS2F1M1	Conventional tillage + (soybean +maize) + no mulch + 100% RDF
22	T2CS2F1M2	Conventional tillage + (soybean+maize) + mulch +100% RDF
23	T2CS2F2M1	Conventional tillage + (soybean+maize) + no mulch +(75% RDF+25%vermi)
24	T2CS2F2M2	Conventional tillage+ (soybean+maize) +mulch +(75% RDF+25%vermi)
25	T2CS3F1M1	Conventional tillage + (soybean+ Sorghum) + no mulch + 100% RDF
26	T2CS3F1M2	Conventional tillage + (soybean+Sorghum) + mulch +100% RDF
27	T2CS3F2M1	Conventional tillage +(soybean+ Sorghum) +no mulch +(75% RDF+25%vermi)
28	T2CS3F2M2	Conventional tillage + (soybean+Sorghum) + mulch +(75% RDF+25%vermi)
29	T2CS4F1M1	Conventional tillage + (Arhar+ sorghum) + no mulch + 100% RDF
30	T2CS4F1M2	Conventional tillage + (Arhar+ sorghum) + mulch +100% RDF
31	T2CS4F2M1	Conventional tillage + (Arhar+ sorghum) + no mulch +(75% RDF+25%vermi)
32	T2CS4F2M2	Conventional tillage + (Arhar+ sorghum) + mulch +(75% RDF+25%vermi)

Soil of experimental site was deep black cotton. In order to find out the inherent fertility status of the experimental field, representative soil samples were collected from the experimental field. Soil samples were taken randomly with the help of auger up to a depth of 0-30 cm after the land preparation but prior to sowing of soybean. The samples were air dried, sieved through 2 mm sieve and used for chemical analysis. The initial soil samples were analyzed as per standard procedures and contain the following status of available nutrients the available N was low (196.60 kg/ha), P was medium (16.5kg/ha), K was high (423.24kg/ha), and available S was Normal (10.2ppm). Therefore the recommended dose of fertilizer (RDF) were maintained on the basis of initial status of available nutrients in the experimental soil to carry out the present investigation. To determine status of organic carbon (%) as described by Walkley and Black (1934); soil N based on Subbiah and Asija (1956) [10] method; soil P based on Olsen (1954) [8] method; and soil K based on Jackson (1973) [6] method. Soybean Equivalent yield– observations on individual crop yields were recorded and yield obtained from different crops were converted into soybean equivalent yield by multiplying yield with prevailing farm gate price of produce and divided by price of soybean. Treatment wise cost of cultivation was calculated based on inputs cost. Different variable cost items and labour charges at prevailing market price during 2013-14.

$$\text{SEY} = \frac{\text{Yield of other crop (kg/ ha)x Price of other crop}}{\text{Price of Soybean}}$$

Crop was worked out using the MSP and prevailing prices at farm gate, where MSP is not available and expressed Rs /ha. The net returns were computed by subtracting the cost of cultivation from gross returns and expressed Rs /ha. The benefit cost ratio for different treatments was calculated by dividing the net returns by the cost of cultivation of that treatment. Monetary efficiency of the system was worked out by dividing the net returns of the cropping system with total field durations of the crops in the system.

Results and Discussion

The findings of present investigation that yield attributing character and yield in soybean were affected by cropping system INM, Tillage and Mulch. Soybean equivalent yield are estimated and analysed statistically. The mean value were given in table 2. Based on observation recorded that minimum tillage gave higher value of soybean equivalent yield than conventional tillage due to efficient utilization of nutrient and moisture and yield. These results were in confirmation with finding of Ali *et al*. (2015) [1]. Data revealed that under different intercropping system (arhar+fodder sorghum) found significantly superior soybean equivalent seed yield. All the intercropping was found to be most profitable as compared to sole crop of soybean. Application of 75% RDF +25% vermi-compost significantly increased the soybean equivalent seed yield over 100% RDF these results were in confirmation with finding of Ramesh *et al*. (2009) as well as the maximum yield was registered with mulch treatment than no mulch. These results were in confirmation with finding of Wei Shengli *et al*. (2010)

Table 2. Soybean Equivalent Seed Yield (kg/ha) and Soybean Equivalent Straw Yield (kg/ha) of different treatments as influenced by tillage, cropping system, INM and mulch.

Treatments	Soybean Equivalent Seed Yeild (kg/ha)	Soybean Equivalent straw Yeild (kg/ha)
1.) Tillage		
Minimum tillage (T1)	1263	3104
Conventional tillage (T2)	1216	3026
SEm	2.47	5.97
Cd at 5%	6.84	16.53
2.) Cropping system		
Soybean sole (CS1)	741	1737
Soybean + maize (CS2)	1162	2809
Soybean + sorghum(CS3)	1038	3085
Sorghum + Arhar(CS4)	2017	4629
SEm	7.19	11.20
Cd at 5%	19.91	31.02
3.) INM		
i) 100% RDF (F1)	1112	2941
ii)75% RDF+25% vermicompost	1367	3189
SEm	7.59	8.25
Cd at 5%	21.02	22.85
4.) Mulch		
i) No Mulch(M1)	1147	2989
ii) Mulch with wheatstraw (M2)	1333	3140
SEm	7.59	8.25
Cd at 5%	21.02	22.85

Tillage, cropping system, INM and mulch interaction was found significant and The treatment combination was higher to all over the combination.

Table 3: Soybean, equivalent seed yieldas influenced by interaction between (Tillage X cropping system X INM and mulch).

Main/sub/sub		F1		F2		Mean
		M1	M2	M1	M2	
T1	CS1	580	713	808	951	763
	CS2	986	1142	1229	1413	1192
	CS3	871	1010	1099	1256	1059
	CS4	1684	2036	2112	2316	2037
T2	CS1	551	691	745	888	719
	CS2	948	1089	1144	1343	1132
	CS3	842	979	1046	1203	1017
	CS4	1674	1998	2036	2285	1996
Mean	1017	1207	1277	1456		
	Tillage X cropping system X INM X mulch					
Sem	30.36					
CD5%	84.09					

Table 3 showed that soybean equivalent yield was found statistically higher under the treatment combination T16 (T1CS4F2M2), T1 (Minimum tillage) + CS4 (Arhar + fodder sorghum) + F2 (75% RDF +25% vermi-compost) + M2 (mulch treatment) which was followed by T15 (T1CS4F2M2). And the lowest soybean equivalent yield was recorded under the treatment combination T17 (T2CS1F1M1), T2 (Conventional tillage) + CS1 (sole soybean) + F1 (100% RDF) +M1 (No Mulch).

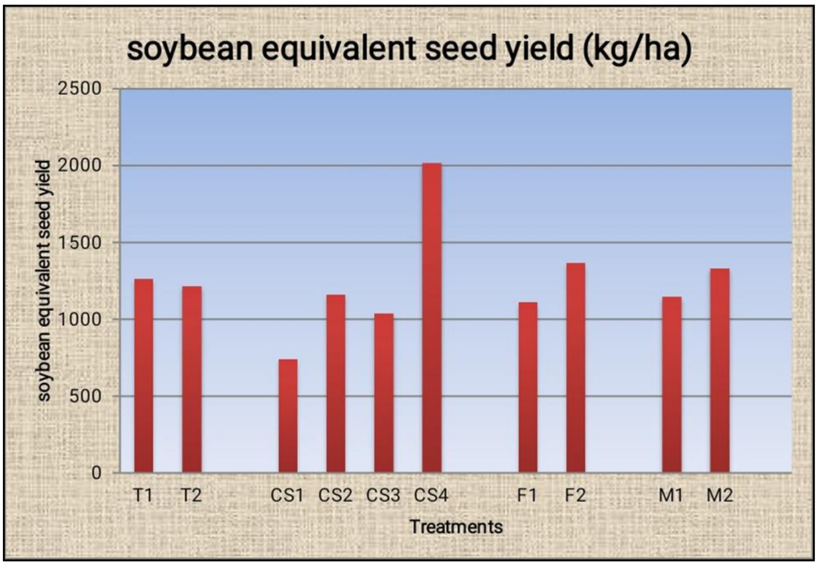

Fig 1: Effect of different treatments on mean soybean equivalent seed yield (kg/ha)

Economics of different treatments

Study of the data on gross return, net return and B:C ratio were significantly affected by tillage, INM and mulch practices From the point of economic viability or economic utility of treatments was concerned the highest B:C ratio was observed in the treatment T16 (minimum tillage + arhar +sorghum intercropping with 75% RDF +25% *vermi* compost and mulch). The significant highest value of gross and net return observed (85561 Rs/ha 64070 Rs/ha) were observed respectively in treatment T16 these value were closely followed by their respective value as recorded for Treatment T15 (minimum tillage + arhar +sorghum intercropping with 75 % RDF +25% vermi compost and no mulch).The lower value of B: C ratio observed in treatment T17 (conventional tillage + sole soybean + 100% RDF + no mulch treatment) due to obvious reason of low yield it could not be effective economically.

Table 4: Effect of tillage, cropping system, INM and mulch on economics of different treatments

S. No.	Treatment	Cost of cultivation	Gross return	Net return	B : C ratio
1	T1CS1F1M1	14188	22665	8477	1.60
2	T1CS1F1M2	16189	27118	10929	1.68
3	T1CS1F2M1	16526	30171	13645	1.83
4	T1CS1F2M2	18526	34652	16126	1.87
5	T1CS2F1M1	15991	38107	22116	2.38
6	T1CS2F1M2	17741	43489	25748	2.45
7	T1CS2F2M1	18585	46301	27716	2.49
8	T1CS2F2M2	20335	52150	31815	2.56
9	T1CS3F1M1	15686	35728	20042	2.28
10	T1CS3F1M2	17436	40595	23159	2.33
11	T1CS3F2M1	18306	43417	25111	2.37
12	T1CS3F2M2	20056	48280	28224	2.41
13	T1CS4F1M1	17254	64868	47614	3.76
14	T1CS4F1M2	19154	75990	56836	3.97
15	T1CS4F2M1	19791	78879	59088	3.98
16	T1CS4F2M2	21491	85561	64070	3.99
17	T2CS1F1M1	14859	21596	6737	1.45
18	T2CS1F1M2	16859	26436	9577	1.57
19	T2CS1F2M1	17196	28196	11000	1.64
20	T2CS1F2M2	19196	32683	13487	1.70
21	T2CS2F1M1	16661	36701	20040	2.20
22	T2CS2F1M2	18411	41692	23281	2.26
23	T2CS2F2M1	19255	43627	24372	2.27
24	T2CS2F2M2	21005	49934	28929	2.38
25	T2CS3F1M1	16356	34453	18097	2.11
26	T2CS3F1M2	18106	39402	21296	2.18
27	T2CS3F2M1	18976	41620	22644	2.19
28	T2CS3F2M2	20726	46257	25531	2.23
29	T2CS4F1M1	17924	64048	46124	3.57
30	T2CS4F1M2	19824	74363	54539	3.75
31	T2CS4F2M1	20461	76123	55662	3.72
32	T2CS4F2M2	22161	84516	62355	3.81

27	T2CS3F2M1	18976	41620	22644	2.19
28	T2CS3F2M2	20726	46257	25531	2.23
29	T2CS4F1M1	17924	64048	46124	3.57
30	T2CS4F1M2	19824	74363	54539	3.75
31	T2CS4F2M1	20461	76123	55662	3.72
32	T2CS4F2M2	22161	84516	62355	3.81

Sale price of Soybean 30/-kg, Maize 13.5/-kg, Sorghum 12 /-kg, Arhar 35/-kg Sale price of Soybean straw 3.2 /-kg, Maize 1.5 /-kg, Sorghum 1.5 /-kg, sorghum cherry 2.0/-kg, Arhar0.8 /-kg.

Conclusion

On the basis of result obtained from the experiment it is concluded that he soybean based intercropping + (arhar + fodder sorghum) cropping system found to be most productive with minimum tillage, 75% RDF Mulching was more profitable and productive treatment combination for soybean under rainfed situation of malwa plateau of M.P. For achieving the Highest productivity and profitability (gross return, net return and B: C ratio) from per unit area was found to be association with the treatment combination (treatment T 16). it is just due the higher production and less cost of cultivation. This study contributed to the understanding of how cropping system affect field productivity which given a basic for local farmer to select the suitable field management strategies.

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