RESEARCH REVIEW JOURNALS
Volume-03
Issue-11
November -2018

ISSN: 2455-3085 (Online)
RESEARCH REVIEW International Journal of Multidisciplinary
www.rrjournals.com [UGC Listed Journal]

Development of the Best Cropping System for the Malwa region of M.P.

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ARTICLE DETAILS

Article History
Published Online: 10 November 2018

Keywords
B:C ratio, Soybean, Wheat, Leaf Area

Abbreviations
kg/ha: Kilogram per hectare, T: treatment

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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* and *Rabi* season 2016-17 and 2017-18 with the objective to find out the effects of diversification and intensification on growth and yield of different crops and cropping system and their effect on economic viability as well as find out the best treatment combination for higher yield and profitability. Experiment was laid out in randomized block design with three replication and total nine treatment combinations was done. . On the basis of result obtained from the experiment it is concluded that the sole crop Soybean i.e. T_2 (Soybean) namely gave significantly higher values of all growth parameter Leaf Area, in *kharif* and T_1 (Wheat) in *rabi* and net returns and B:C ratio was found highest in T_3 (Soybean + Maize (4:2)- Wheat).

1. Introduction

Soybean is one of the pre-eminent crop in providing cheap and inexpensive protein (40%) and oil (20%) which determines the economic worth of the crop on the globe .Majority of soybean area (about 52 %) in India comes under Madhya Pradesh, of this 95-98% area is located in Malwa region of the state (SOPA 2017).In India soybean is grown in 10.5 million ha with total production of 11.5 million tonnes. In Madhya Pradesh it is grown in 6.38 million ha with total production of 5.37 million tons, and productivity 784 kgha^{-1}. (SOPA 2017).

Wheat (*Triticum aestivum* L.) is the main cereal crop and mainly grown in *rabi* season in India. Indian wheat is largely a medium protein, soft/medium hard and white bread wheat. Higher area coverage is reported from Madhya Pradesh in recent years. India ranks in third in the world in respect of production. The production of wheat is 97.11 million tons from 30.6 million ha (Anonymous, 2017).

2. Materials and Methods

The present investigation was carried out during *kharif* and *rabi* season 2016-17 and 2017-18 under All India Co-ordinated Research Project All India Coordinated Research Project on Integrated Farming System, RVSKVV, College of Agriculture; Indore(M.P.). Indore is situated in Malwa Plateau region in the western part of the state of Madhya Pradesh at an altitude of 555.5 meters above mean sea level (MSL). It is located at latitude 22.43^o N and longitude of 75.66^o E. It has subtropical climate having temperature range of 21^o C to 45^o C and 6^o C to 31^o C in summer and winter seasons, respectively. The rainfall in the region is mostly inadequate and erratic. Late commencement, early withdrawal of monsoon and occurrence of two to three dry spells during the rainy season are the common features. The annual average rainfall is 964 mm. The topography of the field was uniform with proper drainage. The soil of the experimental field was under medium black clay soil (Vertisols) (13.25% sand, 30.75% silt and 56.00% clay), neutral to alkaline in reaction (*p*H 7.5). The soil was low in organic carbon (0.40%), available nitrogen (186.7 kgha^{-1}), medium in available phosphorus (6.78 kgha^{-1}) and available potassium (562 kgha^{-1}), and electrical conductivity 0.23m mhos cm^{-1}. The experiment was conducted randomized block design with three replication and 9 treatments. The treatments includes 10 crops i.e Soybean (JS 20-34) Maize(KMH-25K45)Sorghum (CSH-18) Amaranthus in row ratio 4:2 in *kharif* and Wheat (RVSW 41-06), Gram(JAKI-9218), Mustard (Pusa bold) Cauliflower (Pusa snowball-1) Pea (KS-10 Kaveri) French bean (Deep shikha). The seed rate of soybean, Maize, Sorghum, Amaranthus, Wheat, Gram, Mustard, Cauliflower Pea, French bean was 90,25,12,2,120,100,6,120,60 kgha^{-1}; respectively. All the *kharif* and *rabi* crops were sown in the first week of July and first week of November respectively. The nutrients were applied @ 20 kg N, 60 kg P_2O_5 and 20 kg K_2O/ha as basal through urea, SSP and muriate of potash. All recommended practices were followed during crop-growing season.

The data recorded on different observations were tabulated and analysed statistically by using the techniques of analysis of variance (Fisher, 1958).

3. Results and Discussion

The sole crop soybean of T_2 (Soybean) in *kharif* and wheat of T_1 (Wheat) in *rabi* produced significantly higher values of leaf area/plant over various cropping systems. Similar findings were also recorded by Tetio –Kaglo (1988) ,Gulzar *et al.* (2001) and Khatri *et al.* (2014). The sole crop of soybean produced significantly higher leaf area/plant (Table – 1 and 2) as also was founded by Bhadoria,*et al* (1992). Difference in leaf area were obtained under sole crops owing to better micro-climatic due to less plant competition and in wheat due to higher nitrogen fixation by soybean due to intercropping system. The earlier findings of Yadava *et al.* (2005), Kumar *et al.* (2010), Baishya *et al.* (2014), Khargkharat *et al.* (2014), Bhatnagar and Pal (2014) and Solomon *et al.* (2014) also corroborate the present results.

All the intercropping were found to be most profitable as compared to their sole crops. The highest net returns (Rs. 136063) and B:C ratio (3.22) (Table –3) was found in T_3 (Soybean + maize(4:2)-wheat) over rest of the cropping system in *kharif* and *rabi* season. These results are in line with the finding of Mikic *et al.* (2015).

4. Conclusion

On the basis of foregoing results, it can be concluded that the soybean based intercropping followed by wheat cropping system were found to be more productive for achieving the higher productivity and profitability from unit land area under cropping systems.

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TABLES

Table 1 Effect of diversification, intensification and land configurations on mean leaf area per plant (cm^2) of *kharif* crops

S.N	Treatment	20 DAS		40 DAS		60 DAS		At harvest	
		MC	IC	MC	IC	MC	IC	MC	IC
1	T_1 (Soybean)	199.2		366.4		588.0		551.5	
2	T_2 (Soybean)	203.4		382.7		601.4		587.5	
3	T_3 (Soybean + Maize (4:2)	196.2	429.2	337.5	728.2	583.7	1191.8	530.6	1154.7
4	T_4 (Soybean + Maize(3:2) +Sunhemp (Green manure)	195.4	397.4	310.0	696.4	511.3	1137.6	494.9	556.1
5	T_5 (Soybean + Sorghum (3:2) + Sunhemp (Green manure)	190.4	302.5	284.2	780.9	465.9	1096.3	444.3	1065.8
6	T_6 (Soybean + Amaranthus (3:2)	179.9	201.2	292.8		476.7		453.7	
7	T_7 (Soybean + Maize (4:2)	191.5	437.6	304.9	736.6	512.4	1124.6	483.9	1101.6
8	T_8 (Soybean + Maize (Cob) (4:2)	194.1	418.4	313.4	717.4	518.3	1137.4	491.8	1111.5
9	T_9 (Soybean + Maize (1:1)	189.9	416.5	296.7	715.5	494.8	1108.6	479.6	1080.3

Table 2 Effect of diversification, intensification and land configurations on mean leaf area per plant (cm^2) of *Rabi crops*

S.N	Treatment	20 DAS		40 DAS		60 DAS		At harvest	
		MC	IC	MC	IC	MC	IC	MC	IC
1	T_1 (Wheat)	95.6		263.7		500.2		470.5	
2	T_2 (Gram)	238.1		619.5		832.6		804.9	
3	T_3 (Wheat)	96.9		246.6		506.9		484.6	
4	T_4 (Gram + Wheat (3:2)	228.5	85.4	584.1	207.6	774.9	480.9	751.6	457.9
5	T_5 (Gram + Mustard (3:2)	231.2	45.6	592.8	330.1	786.7	496.7	761.4	477.5
6	T_6 (Cauliflower + Wheat (3:2)	1622.7	84.5	3005.6	197.3	4126.0	464.9	6097.4	446.9
7	T_7 (Pea (Vegetable)	68.2		117.6		254.1		483.6	
8	T_8 (Wheat + Gram(1:1)	92.7	200.8	234.9	575.6	487.1	740.4	463.8	684.5
9	T_9 (Wheat + Frenchbean (Vegetable)(1:1)	92.9	207.6	228.1	376.9	469.7	692.7	445.3	718.7

Table 3 Effect of diversification, intensification and land configurations on gross return (kg ha^{-1}), on cropping systems

Treatments	Net returns (Rs ha^{-1})	B:C Ratio
T_1 (Soybean) -(Wheat)	100478	2.67
T_2 (Soybean)-(Gram)	62021	2.23
T_3 (Soybean + Maize (4:2) - (Wheat)	136063	3.22
T_4 (Soybean + Maize (3:2) + Sunhemp (Green manure) -(Gram + Wheat (3:2)	102437	2.90
T_5 (Soybean + Sorghum (3:2) + Sunhemp (Green manure) -(Gram+Mustard(3:2)	47054	1.82
T_6 (Soybean + Amaranthus (3:2)- (Cauliflower + Wheat (3:2)	62255	1.79
T_7 (Soybean + Maize (4:2)-(Pea (Vegetable)	75842	2.45
T_8 (Soybean + Maize (Cob) (4:2)-(Wheat + Gram(1:1)	112438	2.90
T_9 (Soybean + Maize (1:1)-(Wheat + Frenchbean (Vegetable)(1:1)	103451	2.77
S.E.m±	696.85	0.114
C.D.(at 5%)	2089.17	0.342