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An Economical study of different tillage practices on growth and yield of soybean (*Glycine max* (L.) Merrill) under rainfed condition

Neetu Singh[1], Vandana Dwivedi[2], Meenakshee Dwivedi[3] and G.F.Ahmed[4]
[1&2] Department of Agronomy, College of Agriculture Rewa, JNKVV Jabalpur -482004, (MP).
[3] Department of Horticulture, JNKVV Jabalpur -482004, (MP)
[4] College of Agriculture , Powarkheda, JNKVV (M.P.)
***Corresponding Author:** singhneetu27585@gmail.com

ABSTRACT
Soybean crop requires higher investment mainly for proper tillage, efficient weed control and optimum nutrient management to harness its desirable production even under rainfed condition. But the farmers of the region are economically poor and they are unable to afford these higher inputs to mitigate these options for realizing the sustainable productivity from soybean. Several workers have emphasized that good economy from soybean could be achieved by reducing the cost of tillage through minimum tillage just to till the land once with light harrow for providing easiness in sowing. The treatments comprised three tillage systems (conventional tillage having 2 ploughing + levelling + interculture, low tillage having 1 ploughing + levelling + interculture and low tillage with alachlor weedicide 2 l/ha + interculture as the main plot treatment and 3 nutrient management (8 t FYM/ha, 4 t FYM/ha + N10P20 and N20P40 only) as the sub-plot design with three replications. Among the tillage systems, the low tillage (one ploughing + levelling) + weedicide + interculture and among the integrated nutrient management treatments, 4 t FYM/ha + N10P20 applied separately or in combination resulted in maximum net return as well as B:C ratio as compared to the other respective treatments as well as other combinations (interactions). The maximum net return values were Rs.31242, Rs.30885 and Rs.33702/ha, respectively. The B:C ratio also followed the same trend (2.49, 2.49 and 2.60, respectively).
Keywords: *Soyabean, B:C ratio, tillage..*

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INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is one of the *kharif* legume crop recognized as the efficient producer of protein as well as oil, which are the major components in the diet of vegetarian mass [1]. In Madhya Pradesh, soybean occupies the highest area and production amongst the oilseeds because of its wide adaptability to agro-climatic conditions and higher market value of the produce. Incorporation of FYM or other organic wastes alone or along with fertilizer improves the physio-chemical properties of the soil which simultaneously improves the productivity on sustainable basis and also economizes the use of fertilizers. For the proper recycling of organic wastes, conventional or minimum tillage practices have their own unique role as per requirement[1][2]. Several workers have emphasized that good soybean yields could be achieved by reducing the cost of tillage through minimum tillage just to till the land once with light harrow for providing easiness in sowing only. the tillage system can impact soil moisture status because it influences infiltration, runoff, evaporation, and soil water storage. With conventional tillage, weeds that compete with the crop plants for moisture and other growth resources are mechanically removed. On the other hand, conventional tillage can promote drought stress through low residue cover, increased runoff and reduced water filtration. By contrast, no-till and other conservation strategies affect soil water content through reduced runoff or erosion and improved residue cover. However, development of soil crusts that increase runoff and impede infiltration is more prevalent with conservation strategies. Although weed control in soybean by hand weeding is quite efficient, but it is time consuming, costly and tedious. However, mechanical or herbicidal weed control may be equally good to hand weeding with relatively quite less investment. Similarly, the use of locally prepared organic

manures viz. FYM or compost also fulfills the nutrient requirement of this crop by replacing the use of costly chemical fertilizers. The productivity of rainfed soybean is very low around 600 kg/ha. This crop requires high investment mainly for proper tillage, efficient weed control and optimum nutrient management to harness its desirable production even under rainfed condition [3].

MATERIAL AND METHODS

Present study split plot design has been used. The experimental details are given below

Design of the experiment	Split plot
No. of replication	3
No. of treatments	9
Total number of plots	27
Gross plot size	6.0 m x 3.0 m (18.0 m^2)
Net plot size	5.5 m x 2.4 m (13.2 m^2)
Number of rows per plot	10
Distance between replication	2 m
Distance between main plot	1 m
Distance between sub plot	0.50 m
Spacing between rows	30 cm
Total experimental area	34 m x 20 m (680 m^2)
Date of sowing	26 June 2011
Soybean variety	JS 335
Fertilizer dose	As per treatments
Seed rate	100 kg/ha

Treatments

Main plot treatments (3 tillage systems)

1. Conventional tillage (C.T.) + interculture = T1
2. Low tillage (50% of C.T.) + interculture = T2
3. Low tillage (50% of C.T.) + weedicide + interculture = T3

(Conventional tillage comprised of two-tractor cultivation followed by planking. In case of weedicide,Alachlor @ 2L/ha to be applied as pre emergence).

Sub plot treatments (3 nutrient supply systems)

1. 8 tonne FYM/ha = F1
2. 4 tonne FYM/ha + N10P20 through fertilizer = F2
3. N20P40 through fertilizer = F3

Treatment combinations: Nine

T1F1	T2F1	T3F1
T1F2	T2F2	T3F2
T1F3	T2F3	T3F3

Economics of the treatments

The cost of soybean production for all the treatment combination was worked out on the basis of input cost and market price of produce. The average was calculated for different treatments. Net income per hectare was calculated by deducting the cost of production per hectare from price of produce. The benefit : cost ratio was calculated by dividing the gross income of the treatment by the total expenditure for that treatment.

Gross monetary return = value of grain + value of straw

Gross return (Rs./ha) =Cost of produce (grain & straw)

Net monetary return (Rs./ha)= Gross monetary return(Rs./ha) – Total Cost of cultivation

$$\text{B.C. ratio} = \frac{\text{Gross monetary return}}{\text{Total Cost of cultivation}}$$

RESULT AND DISCUSSION

Among the tillage systems, the low tillage (one ploughing + levelling) + weedicide + intercultural and among the integrated nutrient management treatments, 4 t FYM/ha + N10P20 applied separately or in combination resulted in maximum net return as well as B:C ratio as compared to the other respective treatments as well as other combinations (interactions). The maximum net return values were Rs.31242, Rs.30885 and Rs.33702/ha, respectively [4, 5]. The B:C ratio also followed the same trend (2.49, 2.49 and 2.60, respectively). The integrated nutrient management (4 t FYM + N10P20) gave the maximum net return when combined with each of the tillage systems. Thus, the second best combination was

conventional tillage + interculture with 4 t FYM + N10P20 (Rs.32001/ha net return and 2.54 B:C ratio). The economics of the various treatments were estimated as shown in table I to IV. The data on the net return per hectare and benefit: cost ratio are presented in Table V and VI . The low tillage having one ploughing + levelling + weedicide + interculture recorded the maximum net return upto Rs.31242/ha and B:C ratio 2.49. This was followed by conventional tillage (two ploughings + levellings) + interculture (Rs.28630/ha) with B:C ratio (2.39) and then the lowest net return (Rs.25414/ha) and B:C ratio (2.27) were recorded in case of low tillage having one ploughing + levelling + interculture only [6, 7]. In case of nutrient management, 4 t FYM N10P20 resulted in highest net return (Rs.30885/ha) and B:C ratio 2.49, followed by N20P40 (Rs.27931/ha net return and 2.46 B:C ratio) and then 8 t FYM/ha (Rs.26471/ha net return and 2.19 B:C ratio). Amongst the treatment interactions, the best interaction was one + ploughing + levelling + weedicide + interculture combined with 4 t FYM/ha + N10P20 which gave the maximum net return upto Rs.33702/ha with B:C ratio upto 2.60. This was, however followed by conventional tillage + interculture combined with the same integrated nutrient management i.e. 4 t FYM/ha + N10P20, the net return being upto Rs.32001/ha with same B:C ratio upto 2.54. In contrast to this, the lowest net return [Rs.23815/ha and B:C ratio (2.10)] was recorded in case of low tillage (one ploughing + levelling) + interculture combined with 8.0 t FYM. Application of inorganic source of nutrients (N20P40) only was found equally economical as compared to that of inorganic source of nutrients (N20P40) combined with conventional tillage + interculture (Rs.27867 to Rs.27931/ha) with B:C ratio 2.45 to 2.46 [8, 9].

Table-I: Prevailing market rates (Rs.)

S. No.	Items of expenditure	Rate (Rs.)
1	Tractor ploughing (one) + planking/ha	600
2	Labour charges per day	160
3	Soybean seed (100 kg)	3500
4	DAP fertilizer	10.24/kg
5	Endosulphan	290/lit
6	Alachlor liquid (Lasso)	370/lit
7	Soybean grain (sale rate)	3500/q
8	Soybean straw (sale rate)	60/q
9	FYM	500/tones
10	Tractor charges	250/hour

Table-II: Cost of cultivation (Rs/ha) excluding the cost involved under each treatment combination

S. No.	Items of expenditure	Rate (Rs.)
1	Layout and preparation of drainage channels (5 labours)	800
2	Plant protection	
	(a) Endosulphan (1250 ml)	380
	(b) Application of insecticides (2 labours)	320
3	Harvesting charge (25 labour)	4000
4	Threshing & cleaning charges	
	(a) Tractor (2 hours)	500
	(b) 10 labour	1600
5	Land revenue	50
6	Miscellaneous	500
7	Thirum fungicide	40
8	*Rhizobium japonicum* culture	50
	Total	**8240**

Table III: Costs involved under each treatment combination

S. NO	Particulars	Quantity	Cost (Rs.)	Total cost (Rs/ha)
T1F1	Land preparation	2 Nos.	1200	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (FYM)	8 tonnes	4000	
	Application of fertilizer	3 labour	480	
	Interculture operation	25 labour	4000	**13980**
T1F2	Land preparation	2 Nos.	1200	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (FYM+DAP)	4 tonnes+50 kg	2000+512	

	Application of fertilizer	3 labour	480	
	Interculture operation	25 labour	4000	**12492**
T1F3	Land preparation	2 Nos.	1200	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (DAP)	100 kg	1024	
	Application of fertilizer	3 labour	480	
	Interculture operation	25 labour	4000	**11004**
T2F1	Land preparation	1 No.	600	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (FYM)	8 tonnes	4000	
	Application of fertilizer	3 labour	480	
	Interculture operation	25 labour	4000	**13680**
T2F2	Land preparation	1 No.	600	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (FYM+DAP)	4 tonnes+50 kg	2000+512	
	Application of fertilizer	3 labour	480	
	Interculture operation	25 labour	4000	**11892**
T2F3	Land preparation	1 No.	600	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (DAP)	100 kg	1024	
	Application of fertilizer	3 labour	480	
	Interculture operation	25 labour	4000	**10404**
T3F1	Land preparation	1 No.	600	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (FYM)	8 tonnes	4000	
	Application of fertilizer	3 labour	480	
	Cost of herbicides	2 litres	740	
	Application of herbicides	1 labour	160	
	Interculture operation	25 labour	4000	**14280**
T3F2	Land preparation	1 No.	600	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (FYM+DAP)	4 tonnes+50 kg	2000+512=2512	
	Application of fertilizer	3 labour	480	
	Cost of herbicides	2 litres	740	
	Application of herbicides	1 labour	160	
	Interculture operation	25 labour	4000	**12792**
T3F3	Land preparation	1 No.	600	
	Cost of seed	100 kg	3500	
	Sowing cost	5 labour	800	
	Cost of fertilizer (DAP)	100 kg	1024	
	Application of fertilizer	3 labour	480	
	Cost of herbicides	2 litres	740	
	Application of herbicides	1 labour	160	
	Interculture operation	25 labour	4000	**11304**

Table IV: Details of calculation of net income per hectare

Treatment	combination	Grain yield (q/ha)	Cost of grain (Rs./ha)	Straw yield (q/ha)	Cost of straw (Rs./ha)	Gross income (Rs./ha)	Cost of cultivation (Rs./ha)	Extra cost of the treatment (Rs./ha)	Total expenditure	Net income	Benefit: cost ratio
T_1F_1	100%CT+Int.+8t FYM	13.24	46340	31.72	1903	48243	8240	13980	22220	26023	2.17
T_1F_2	-----do---.+4t FYM+$N_{10}P_{20}$	14.46	50610	35.38	2123	52733	8240	12492	20732	32001	2.54
T_1F_3	-----do---.+$N_{20}P_{40}$	12.92	45220	31.52	1981	47111	8240	11004	19244	27867	2.45
T_2F_1	50%CT+Int.+8t FYM	12.47	43645	29.83	1790	45435	8240	13380	21620	23815	2.1
T_2F_2	-----do---.+4t FYM+$N_{10}P_{20}$	12.93	45255	30.5	1830	47085	8240	11892	20132	26953	2.34
T_2F_3	-----do---.+$N_{20}P_{40}$	12.09	42315	30.06	1804	44119	8240	10404	18644	25475	2.37
T_3F_1	50%CT+Int.+8t FYM+weedicide	14.26	49910	36.4	2184	52094	8240	14280	22520	29574	2.31
T_3F_2	-----do---.+4t FYM+$N_{10}P_{20}$	14.98	52430	38.4		54734	8240	12792	21032	33702	2.6
T_3F_3	-----do---.+$N_{20}P_{40}$	13.71	47985	33.5	2010	49995	8240	11304	19544	30451	2.56

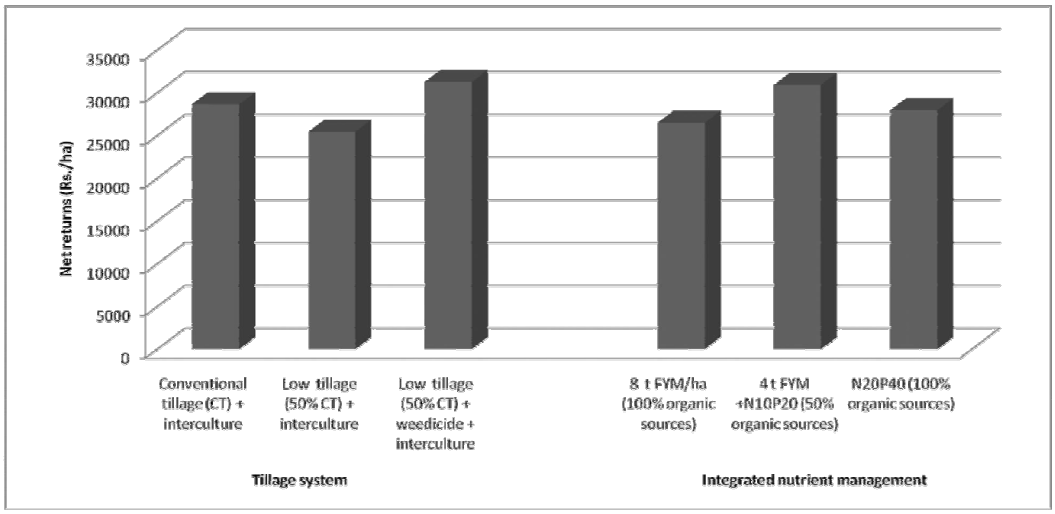

Fig:1 Net returns of soybean as influenced by tillage systems and integrated nutrient management

Table V: Net return (Rs/ha) as influenced by tillage systems, integrated nutrient management and their interactions

Tillage systems	Nutrient management			Mean
	8.00 tFYM/ha	4.00 t FYM+ N10P20 per ha	N20P40 through fertilizer/ha	
Conventional tillage (CT) + interculture	26023	32001	27867	**28630**
Low tillage (50% CT) +interculture	23815	26953	25475	**25414**
Low tillage (50% CT) +weedicide + interculture	29574	33702	30451	**31242**

Table VI: B:C ratio as influenced by tillage systems, integrated nutrient management and their interactions

Tillage systems	Nutrient management			Mean
	8.00 t FYM/ha	4.00 t FYM+N10P20 per ha	N20P40 through fertilizer/ha	
Conventional tillage (CT)+ interculture	2.17	2.54	2.45	**2.39**
Low tillage (50% CT) +interculture	2.1	2.34	2.37	**2.27**
Low tillage (50% CT) +weedicide + interculture	2.31	2.6	2.56	**2.49**
Mean	**2.19**	**2.49**	**2.46**	

CONCLUSION

The result from the present investigation conclude that the adoption of low tillage (one plugging + leveling) + pre-emergence weedicide alachlor 2 lit/ha along with integrated nutrient management (4 t FYM/ha + N10P20) resulted in significantly higher grain yield 14.98 q/ha and net return of Rs.33702/ha from soybean var. JS 335 under rainfed condition. Therefore, this treatment combination proved the most beneficial for the soybean growers of Kymore plateau (agro-climatic sub-zone) of Madhya Pradesh.

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