Impact of Tillage on Growth, Productivity and Economics of Soybean Grown in Vertisols of Western Madhya Pradesh, India

ABSTRACT

The investigation entitled, "**Impact of Tillage on Growth, Productivity and Economics of Soybean Grown in Vertisols of Western Madhya Pradesh, India''** was conducted during the *kharif* season of the year 2019-20 in the Department of Soil Science and Agricultural Chemistry, RVSKVV, College of Agriculture, Indore. The objective of the experiment were to study the effect of tillage practices on the growth and productivity of soybean and to evaluate the effect of tillage on the economics and energy use efficiency of soybean. The experiment conducted in randomized block design and replicated five. There were four treatments T1-Sub Soiling (SS) + Sowing by precision seed drill, T2- Tillage by Cultivator twice (CT), T3- Deep Tillage by M.B. plough (DT) and T4- Reduced Tillage + Crop Residues (RT+CR 30 % of previous crop). The results indicated that T1-Sub Soiling (SS) recorded maximum value of growth parameters, yield attributes ,seed yield, test weight, seed weight plant^{-1}, Nodules Weight per plant, net returns and B:C which was statistically at par with treatment T2 Cultivator twice (CT). The overall conclusion drawn from the study is that due to continuous mechanization and use of heavy machinery a compact layer was observed in Vertisols at 20-30 cm soil depth which restricts root growth, reduces infiltration rate, thereby, causes water logging during rainy season. The poor soil aeration results in reduction in soybean productivity in Madhya Pradesh.

Key words – Tillage, sub soiling, soybean, growth parameters and growth.

INTRODUCTION

"Holistic management of arable soil is the key to dealing with the most complex, dynamic, and interrelated soil properties, thereby, maintaining sustainable agricultural production systems, the lone foundation of human civilization. Any management practice imposed on soil for altering the heterogeneous body may result in generous or harmful outcomes" (Derpsch, *et al*. 2010). "Unsuitable management practices cause degradation in soil health (depletion of organic matter and other nutrients) as well as decline in crop productivity" (Ramos *et al*. 2011). "Reducing disturbance of soil by reduced tillage influences several physically, (López-Garrido*et al.*2012), chemically, and biologically interconnected properties of the natural body". "Soil tillage is among the important factors affecting soil properties and crop yield. Among the crop production factors, tillage contributes up to 20% and affects the sustainable use of soil resources through its influence on soil properties" (Khurshid *et al.* 2006). "The judicious use of tillage practices overcomes edaphic constraints, whereas inappropriate tillage may cause a variety of undesirable outcomes, for example, soil structure destruction, accelerated erosion, loss of organic matter and fertility, and disruption in cycles of water, organic carbon, and plant nutrient, reduced root growth" (Lal and Stewart, 2013). Reducing tillage has a good impact on a number of soil properties, but unneeded and excessive tillage operations result in the opposite phenomena, which are detrimental to the soil. In order to control erosion, there is therefore currently a lot of interest in and emphasis on switching from excessive tillage to conservation and no-tillage approaches. In crop production, the purpose of tillage is to create optimal environmental conditions for seed germination and plant growth. However, intensive soil tillage can degrade soil structure due to the gradual loss of stable aggregates, resulting in soil erosion and compaction and low moisture availability for plants. Conservation tillage practises are important for promoting water capture and conservation in agricultural systems in arid and semiarid regions because they can help to avoid soil degradation due to compaction. Vertical tillage with tine-type implements and direct planters do not invert the soil and leave crop residues on the surface. When compared to conventional tillage, these types of conservation tillage reduce the intensity and frequency of soil disturbance. Different tillage methods have produced a wide range of results in terms of soil physical properties in some regions and soil conditions.

MATERIAL AND METHODS

In order to investigate the cumulative effect of various tillage practices Sub Soiling (SS), Tillage by Cultivator twice (CT), Deep Tillage by M.B. plough (DT) and T4- Reduced Tillage on the soybean crop a field experiment was conducted to study "**Impact of Tillage on Growth, Productivity and Economics of Soybean Grown in Vertisols of Western Madhya Pradesh, India**" was conducted during the *kharif* season of the year 2019-20 in the Department of Soil Science and Agricultural Chemistry, R.V.S.K.V.V., College of Agriculture, Indore. The treatment combinations comprising with T1-Sub Soiling (SS) + Sowing by precision seed drill, T2- Tillage by Cultivator twice (CT), T3- Deep Tillage by M.B. plough (DT) and T4- Reduced Tillage + Crop Residues (RT+CR 30 % of previous crop). The treatments were evaluated in Randomized Block Design with five replications. The normal spacing was kept row to row distance of 45 cm and plant to plant distance of 5 cm. Crop was fertilized as per RDF 20N: 60 P2O5: 30 K 2O kg/ ha. Optimum plant protection measures were adopted. Observations were taken on growth parameters, yield parameters and economics and energy use efficiency of soybean.

Result and Discussion:

Data presented in Table 1 and 2 revealed that the growth parameters of soybean crop were significantly affected by different treatments. The highest value of most of the growth parameters were recorded from the treatment T1-SS (Sub soiling) and the lowest in T3-DT (Deep Tillage). The results clearly revealed that the sub soiling enhances crop growth significantly, while other treatments were statistically at par with each other. Plant height showed variation as affected due to application of various treatments, the data presented in table 1 indicates that the highest plant height was observed in T1-SS 20.96, 40.69, 55.93 and 51.93 cm at 20, 40, 60 DAS and at harvest respectively. The lowest plant height was recorded in T3-DT 18.71, 27.58, 46.08 and 42.99 cm at 20, 40, 60 DAS and at harvest respectively which was found statistically inferior to all the treatments. The result given in the Table 1 shows that the lowest number of branches per plant were recorded in the treatment T3-DT 1.49, 5.42, 4.98 and 4.40 at 20, 40, 60 DAS and at harvest respectively which was found statistically inferior to all the treatments. The highest number of branches per plant were recorded in the treatment T1-SS 2.10, 7.08, 6.28 and 5.80 at 20, 40, 60 DAS and at harvest respectively. The application of different treatments, resulted in the significant differences among the treatments, higher number of pods per plant were observed in T1-SS (43.25) followed by T2-CT (31.28).Treatments T4- RT+CR 30 % of previous crop (27.02) which was at par with the treatment and T3-DT (27.46). The lowest dry weight per plant were recorded of treatment T3-DT (27.02) respectively.

Table.1 Effect of tillage on Plant Height (cm), No. of branches per plant, No. of pods /Plant.

Sym	Plant height (cm)	No. of branches per plant	No. of pods/

	20 DAS	40 DAS	60 DAS	At Harvest	20 DAS	40 DAS	60 DAS	At Harvest	plant
T1	20.9	40.6	55.9	51.93	2.1	7.0	6.28	5.80	43.2
T2	18.9	30.9	49.5	48.13	1.7	6.3	5.08	4.93	31.2
T3	18.7	27.5	46.0	42.99	1.4	5.4	4.98	4.40	27.0
T4	18.8	32.7	47.6	44.62	1.6	6.3	5.44	5.10	27.4
SEm (±)	0.12	1.01	.38	0.38	0.06	0.1	0.08	0.19	0.51
CD 5%	0.70	2.29	2.19	2.19	0.3	0.5	0.48	0.34	2.91

Table 2 Effect of tillage on Leaf Area Index and Dry Weight per plant

Sym	**Leaf Area Index**			**Dry Weight /Plant**			
	20 DAS	**40 DAS**	**60 DAS**	**20 DAS**	**40 DAS**	**60 DAS**	**At Harvest**
T1	28.3	52.4	60.7	1.27	2.33	20.7	11.66
T2	22.7	35.3	40.5	1.02	1.99	17.2	8.63
T3	20.7	33.7	30.7	0.95	1.94	16.9	8.15
T4	20.9	33.9	38.8	0.97	1.97	17.0	8.59
SEm (±)	0.35	0.48	0.24	0.01	0.59	0.18	0.09
CD 5%	1.99	2.73	1.40	0.07	0.13	1.02	0.69

Table 3 Effect of tillage on Total Dry Matter Yield ($kgha^{-1}$), Seed yield (kg/ ha), Test weight (gm), Seed weight/plant, Nodules Weight per plant (mg).

Sym	**Total Dry matter Yield ($kgha^{-1}$)**	**Seed Yield (kg/ ha)**	**Test weight (gm)**	**Seed weight/plant (gm)**	**Nodules Weight per plant (mg)**
T1	2149	1567	15.84	12.83	718
T2	1359	976	13.88	10.42	576
T3	1291	936	13.69	9.81	492
T4	1348	961	13.77	9.85	549
SEm (±)	24.98	24.58	0.12	0.51	14.02
CD 5%	140.83	138.55	0.87	0.77	79.07

Almost similar trend was observed in case of all the growth parameters and yields attributing characters through such as seed yield per, dry matter yield per plant. Seed weight per plant, test weight, nodules per plant. Seed yield data also revealed that the treatment T1- SS was found effective in increasing seed yield and dry matter yield significantly as compared to other tillage treatments. This might be due to better soil –plant water relationship in case of sub-soiler which was found effective in providing better drainage conditions as compared to other treatments. Which resulted in better root growth, plant growth there by higher yields. Similar findings were also reported by Mrabet 2011, Doty et al. (1975), It is inferred from the study that sub soiling helps in root development of soybean as it was higher as compared to other tillage treatments that is conventional tillage, deep tillage and reduced tillage with crop residue application. These differences in crop yield might be attributed to tillage depth, the effect on the soil granular structure, the depth to which the root of the crop was restricted and variations in the water and nutrient supply to the crop (Lin et al. 2016)

Figure 1: Effect of different treatments of tillage on Energy Balance

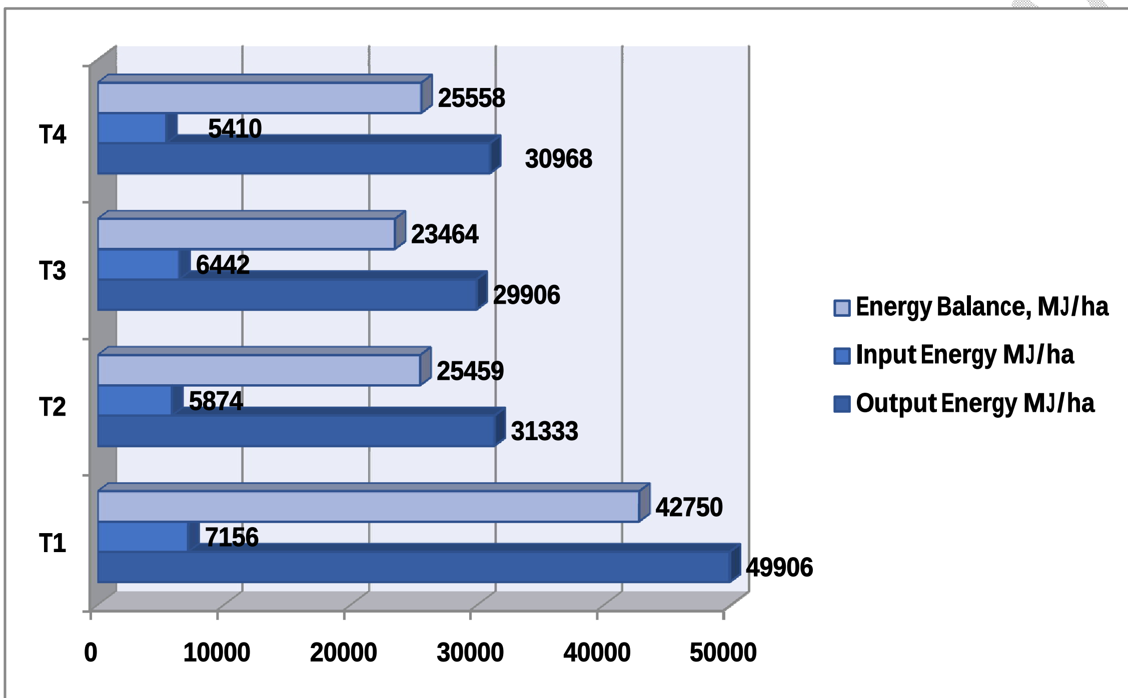

Figure 2: Effect of different treatments of tillage on Energy efficiency.

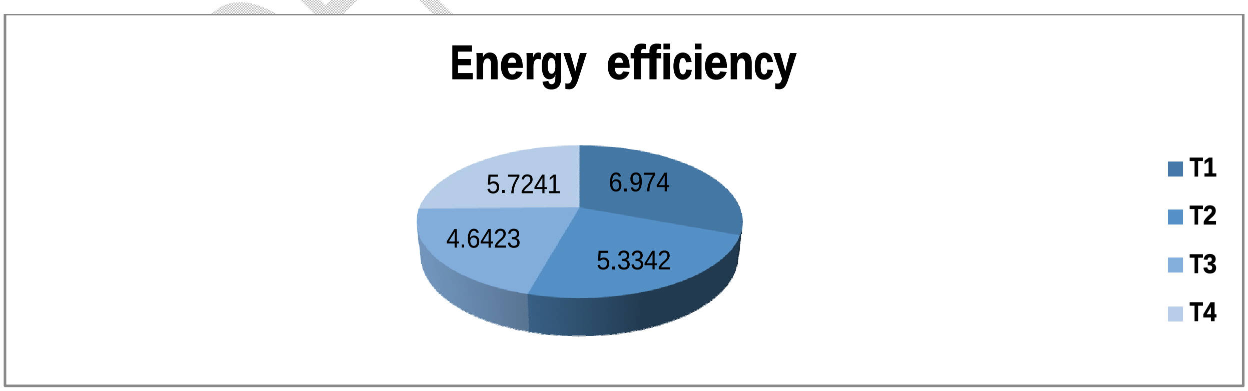

Table 4: Effect of Different Treatments on the economic of various treatments.

Treatment	Cost of Cultivation (Rsha-1)	Gross Return, (Rs/ha)	Net return, (Rs/ha)	B:C
T1-SS	22000	62680	40680	1.85
T2-CT	18000	39040	21040	1.17
T3-DT	21000	37440	16440	0.78
T4-RT+CR	19000	38440	19440	1.02

Due to better crop yield higher monitory return and B: C ratio was obtained in case of sub soiling as compared to other treatments. Similar results were also reported by Ishaq *et al.*, (2001).

Conclusion:

The overall conclusion drawn from the study is that due to continuous mechanization and use of heavy machinery a compact layer was observed in Vertisols at 20-30 cm soil depth which restricts root growth, reduces infiltration rate, thereby, causes water logging during rainy season. The poor soil aeration results in reduction in soybean productivity in Madhya Pradesh. Growth parameters show significant evident increase in plant height, number of branches, number of pods per plant, leaf area index, nodules per plant. The subsoiling gave significantly better crop growth as compared to T2-CT, T3-DT and T4-RT+CR. Yield attributing characters of soybean were improved significantly by the use of sub soiling. The significantly higher soybean seed yield was recorded in treatment T1-SS (1567 kgha-1) which gave 63- 67% higher yield as compared to T1-CT, T3-DT and T4-RT+CR. The seed yield was found at par in case of conventional tillage, deep tillage and reduced tillage+ crop residue in corporation. The sub soiling was found energy conserving and economically more feasible. The highest gross returns and net returns was obtained from the treatment T1-sub soiler but lowest was found in Case of treatment T3-Deep Tillage. The highest B: C was obtained in case of treatment T1-Sub Soiler and lowest in case of treatment T3- Deep Tillage.

References

Derpsch, R., Friedrich, T., Kassam, A., and Hongwen, L. (2010).Current status of adoption of no till farming in the world and some of its main benefits. *Int J. Agric. Biol. Eng.***3**(1):16-22.

Doty, C.W.; Campbell, R.B. and Reicosky, D.C. (1975). Crop response to Chiseling and irrigation in soils with compact A horizon. *Transactions of the ASAE,* 18 :668-672.

Garrido, L., Deurer, M., Madejón, E., Murillo, J. M. and Moreno, F. (2012) .Tillage influence on biophysical soil properties: the example of a long-term tillage experiment under Mediterranean rainfed conditions in South Spain. *Soil till. Res.* vol. **118**: 52–60.

Ishaq, M., Ibrahim, M., Hassan, M., Saeed and Lal, R. (2001).Subsoil compaction effects on crops in Punjab, Pakisthan. *Soil.Till. Res.* 60(**3-4**):153-161.

Khurshid, K., Iqbal, M., Arif, M.S. and Nawaz, A. (2006). Effect of Tillage and Mulch on Soil Physical Properties and Growth of Maize. *Int.J.Agric. Biol.* **8**(5): 593- 596.

Lal, R. and Stewart, B.A.Eds. (2013). Principles of Sustainable Soil Management in Agroecosystems, **20**, CRC Press.

Lin, P.; Qi, H.; Li, C.F. and Zhao, M.(2016) Optimized tillage practices and row spacing to improve grain yield and matter transport efficiency in intensive spring maize. *Field Crops Research.* 198: 258-268.

Marbet (2011) Effect of residue Management and Cropping Systems on Wheat Yield Stability in a Semiarid Mediterranean clay soil. *Ameri.J.plant.Sci*.2(**02**):202-216.

Ramos, M. E., Robles A. B., Sánchez-Navarro A. and González-Rebollar J. L. (2011).“Soil responses to different management practices in rainfed orchards in semiarid environments.” *Soil till. Res.* **112**(1):85–91, 201