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Original Research Article

Effect of various Tillage Practices on Soybean Productivity and Soil Moisture Dynamics under Rainfed Condition

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A B S T R A C T

A field experiment was conducted at Research farm, Agro Ecology and Environment Centre, Dr. P.D.K.V, Akolato study the effect of various tillage practices on soybean productivity and soil moisture dynamics under rainfed condition during *kharif* season 2019. The treatment comprising with T_1– Conservation Tillage (one blade harrow before sowing), T_2 – Conventional Tillage (one tyne + one blade harrow), T_3 – Subsurface Tillage (One Subsurface tillage at 90 cm horizontal distance + Two Tyne + blade harrow), T_4 – Economical Subsurface Tillage (One Subsurface tillage + one Tyne + one blade harrow). The treatments were evaluated in Randomized Block Design with five replications. The crop spacing was 45 cm x 5 cm. Crop was fertilized as per RDF (30:75:30 NPK kg ha^{-1}). Harvesting was done on the basis of physiological maturity of pods. The tillage practices showed the favorable effects on the growth and yield parameters as well as moisture content of soil in soybean crop. Subsurface Tillage recorded significantly highest grain (9.87 q ha^{-1}) and straw (10.31 q ha^{-1}) yield over rest of the treatments which record an increase of 65.88 % and 62.11% over the conservation tillage practice, respectively. Significantly highest plant height (63.90 cm), No. of branches per plant (9.35), No. of pods per plant (27) was recorded in Subsurface Tillage treatment over rest of the treatments. The maximum soil moisture content was maintained by the Subsurface Tillage at 90 DAS. The increasing soil moisture trend was observed from the 15 cm depth (13.93 %) to the 60 cm depth (22.99%) of soil at 90 DAS of soybean in Subsurface Tillage which was 56.51% and 54.08 % more than the Conservation Tillage.

Keywords

Tillage practices, Soybean, Moisture content, Yield, subsurface tillage, Conservation tillage

Introduction

Soybean (*Glycine max L.*) is one of the important oilseed as well as a leguminous crop. Soybean is called as a miracle "Golden bean" of the 21st century. It is an excellent source of protein and oil besides it contains high level of amino acids such as lysine, lucien, lecithin. Soybean contains approximately 40-45% protein and 18-22% oil and is a rich source of vitamins and minerals. Soybean contain40-45% protein hence called as the “Poor man’s meat”. The area covered under soybean in India during the year 2017 was 101.561 lakh ha which produced 83.504 lakh MT with productivity

of 822kg ha^{-1} whereas, in Maharashtra the area under cultivation was 34.48 lakh ha which produced 29.00 lakh MT of soybean grains with productivity of 84 kg ha^{-1}. In Vidharbha, area under soybean was 14.91 lakh ha with production of 12.21 lakh MT & productivity of 767 kg ha^{-1} (SOPA, 2017).

Fluctuations in soil moisture observed during the growth stages of crop were directly related to the occurrence and quantity of rainfall. In *kharif* season, most of the times, the crop was suffered due to want of moisture it's may be due to early withdrawal of mansoon or the dry spell occurrence during growth period of the crops. Thus it has become imperial to evolve a suitable cultivation practices which would improve the physical properties of soil and in turn help the crop to grow up to its potential especially focusing an major cropping system of the region.

Soil tillage choice is strategic to defining sustainable agricultural system because of its impact on soil properties. Tillage is the basic operation in farming. It is generally done to create a favorable condition for seed placement and plant growth. The black cotton soils of Vidarbha region (*Vertisol*) have the tendencies towards swelling and shrinkage depending on the availability of the moisture. Black cotton soil required a high energy input to disrupt hardpan layer and thus to promote improved root development and increased drought tolerance. Due to continuous cultivation of such soil at the same depth causes a built up of plough pan with the soil profile, hindering the infiltration of water and root penetration.

Under such type of soil the proper method and depth of cultivation plays an important role in improving the moisture retention and drainage properties of soil. Subsoiling was accomplished by using a subsoiler at a soil depth ranging from 30 to 40 cm which showed that it is beneficial to ecology (Guo, 2005).

Subsoiling will not overturn the top soil but disturbs and breaks the low layer, which result in improving the permeability of soil water, creating a "water reservoir" underneath the soil surface, increasing the efficiency of rainwater use and improving the ability of water conservation in arid area. Subsequently, subsoiling can minimize the effect of drought and lead to an increase in crop yield (Gao *et al.,* 1995, Mohanty *et al.,* 2007). Wang *et al.,* (2004) found that in comparison with traditional tillage, subsoiling technique caused an increase in winter wheat yield by 703.6 kg ha^{-1} (increase rate 18.8%) and water use efficiency was also increased by 16 percent.

The amount of moisture the soil retains under a given condition is closely related to porosity and size of voids as well as properties of the soil particles. The soil moisture is modified by tillage through particle to particle contact and porosity of the soil. The root growth and its proliferation are directly related to water availability in soil profile. Thus soil moisture can greatly impact nutrient transformation, its release from organic forms, its uptake by roots and subsequent translocation and utilization by plant.

Hence, it is important to quantify the changes in soil moisture content as influenced by various tillage practices. It is well known that the degree of tillage operations highly affects the soil moisture content, even though the soil is having same physical properties.

Moreover, tillage implement can also affect the soil denseness resulting in the rate of movement of water at soil air interface and subsequently within the soil.

Materials and Methods

In order to investigate the cumulative effect of various tillage practices viz, conservation tillage, Conventional tillage, subsurface tillage, Economical subsurface tillage on the soybean crop of Vidarbha region special reference to local agro climatic conditions, a field experiment was conducted to study the Effect of various tillage practices on yield, yield attributes and moisture content of soil at 90 DAS of Soybean under Rainfed condition with Soybean variety JS-335 during *Kharif* season 2019 at Research farm, Agro Ecology and Environment Centre, Dr. P.D.K.V, Akola. The treatment combinations comprising with T_1 – Conservation Tillage (one blade harrow before sowing), T_2 – Conventional Tillage (one tyne + one blade harrow), T_3 – Subsurface Tillage (One Subsurface tillage at 90 cm horizontal distance + Two Tyne + blade harrow), T_4 – Economical Subsurface Tillage (One Subsurface tillage + one Tyne + one blade harrow).

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 (30:75:30 NPK kg ha^{-1}). Optimum plant protection measures were adopted. Observations were taken on growth characters, yield and yield attributes as well as moisture content of soil.

The determination of mechanical and chemical composition of the soil revealed that the soil of experimental field was silty clay loam in texture having pH 7.8. The fertility status of field was medium in organic carbon (5.76 g kg^{-1}), low in available N (180 kg ha^{-1}), low in available phosphorus (15.08 kg ha^{-1}) and high in available potash (307kg ha^{-1}).

Results and Discussion

A perusal of data on Table 1 revealed that the growth attributing characters like plant height and No. of branches per plant were significantly influenced with various tillage practices.

Significantly maximum plant height (63.93 cm) and highest No. of branches per plant (9.35) were recorded in Subsurface Tillage over rest of the treatments. Similar tread was observed in yield attributing character i.e. Number of pods per plant of soybean. Significantly maximum No. of pods per plant (27) were recorded in Subsurface Tillage treatment followed by Economical subsurface tillage.

The subsurface tillage successfully supplied the available moisture and nutrients to the plants through the prolific root system which took place after subsoiling causing overall plant development vegetatively and reproductively (Gole, 2012).

Similarly, the data in Table 1 showed that the statistically significant impact of various tillage practices was observed on Grain and straw yield of soybean. Significantly highest Grain (9.87 q ha^{-1}) and Straw (10.35 q ha^{-1}) yield was recorded in Subsurface Tillage treatment over rest of the treatments, which was 65.88 % and 62.11% more as compared to Conservation tillage. This might be due to maintained soil moisture content by subsurface tillage practices during critical growth stage of soybean which increases the availability of nutrients to growing crop, that's led to the overall improvement in growth attributes of soybean and its positive effect on yield attributing character i.e. number of pods per plant was more and ultimately increased to produce maximum grain yield as compared to conservation tillage practices.

Table.1 Effect of various tillage practices on growth, yield and yield attributes characters of Soybean crop under rainfed condition during 2019-20

Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	48.48	5.70	16.00	5.95	6.36
T_2	55.61	7.80	19.41	6.57	6.88
T_3	**63.94**	**9.35**	**27.00**	**9.87**	**10.35**
T_4	60.87	8.45	22.65	7.10	8.16
CD @ 5%	0.71	0.52	0.99	0.22	0.29

Table.2 Effect of various tillage practices on plant height of Soybean.

Treatments	Plant Height (DAS)				Plant Height Increase over T_1 (%)			
	20	**40**	**60**	**80**	**20**	**40**	**60**	**80**
T_1	14.65	30.92	43.30	46.95	--	--	--	--
T_2	15.13	34.25	45.53	53.07	3.27	9.47	5.15	13.52
T_3	**20.45**	**40.20**	**50.59**	**60.16**	**39.59**	**30.05**	**16.24**	**30.39**
T_4	16.80	37.28	47.39	56.99	14.67	20.57	9.45	21.90
CD @ 5%	1.55	**1.64**	1.14	1.52	-	-	-	-

Table.3 Effect of various tillage practices on soil moisture content at 90 DAS.

Treatments	Soil Moisture (%)				Increase in moisture over T_1 (%)			
	15 cm	**30 cm**	**45 cm**	**60 cm**	**15 cm**	**30 cm**	**45 cm**	**60 cm**
T_1	8.90	11.59	13.10	14.92	--	--	--	--
T_2	10.42	13.84	15.34	17.27	17.07	19.41	17.09	15.75
T_3	**13.93**	**17.82**	**19.96**	**22.99**	**56.51**	**53.75**	**52.36**	**54.08**
T_4	11.71	15.63	17.64	20.16	31.57	34.85	34.65	35.12
CD @ 5%	0.52	0.42	0.77	0.66				

Gole (2012) reported that the yield increase due to subsoiling over conventional tillage treatment was to the tune of 23.66 % and it was to an extent of 82.39%against the conservation tillage practices. The values of plant growth, yield attributes and yield of soybean were significantly increased with treatment of subsoiling as compared to other tillage treatments.

The yield increase due to subsoiling treatment over zero tillage treat was to the tune of 77%. Significantly highest value of GMR, NMR and B:C ration were recorded with very deep tillage treatment consisting of subsoiling (Bobade, 2014). Increasing trend in the plant height of soybean crop was recorded from 20 DAS to 80DAS.

The data in Table 2 showed that the Subsurface Tillage recorded significantly maximum plant height of 20.45, 40.20, 50.59 and 60.16 cm at 20, 40, 60 and 80 DAS, respectively over rest of the treatments, which showed 39.59%, 30.05%, 16.24% and 30.39 % more plant height over Conservation tillage, respectively. The lowest plant height was recorded in treatment Conservation

Tillage as 14.65, 30.90, 43.30 and 46.76 cm at 20 to 80 DAS, respectively. Borghai (2008) reported that the highest average plant height of cotton was associated with subsoiling that resulted in yield increase up to 13.5%.Subsoiling showed significant effect on plant height that was attributed to increased moisture content available for plant growth.

The moisture content of the soil was influenced by the various tillage practices. The soil moisture content was recorded at various depth of the soil at 15, 30, 45 and 60 cm. A perusal of data on Table 3 showed increasing trend of soil moisture content due to various tillage practices from Conservation Tillage to Subsurface Tillage after that it was decreased in Economical Subsurface Tillage. The Subsurface Tillage recorded significantly maximum soil moisture content of 13.93, 17.82, 19.96 and 22.99% at 15, 30, 45 and 60 cm depth of the soil which showed 56.51, 53.75, 52.36 and 54.08 % increase in moisture content over Conservation tillage practices, respectively, at 90 DAS of the soybean crop. The observation revealed that the moisture content at various depth was found to be maximum in Subsurface tillage treatments might be due to good soil tilth, lower soil bulk density and high porosity.

Mikki and Mohamed (2008) also recorded the highest moisture content in deep tillage than the shallow tillage. Manian *et al.,* (1999) reported that the deep tillage played important role in root growth and increased moisture content. Gole (2012) observed that sub soiling improves the soil physical properties i.e. mean moisture content, soil porosity, infiltration rate, mean weight diameter and hydraulic conductivity under the rainfed cotton + black gram cropping system. Evans *et al.,* (1996) reported the significant increase in moisture content of soil by sub soiling. Similarly, the results are in conformity of Soltanbadi *et al.,* (2008), Shamsabadi *et al.,* (2009), Wang *et al.,* (2009), Veronica *et al.,* (2012).

From the present study, it can be concluded that the subsurface tillage (One Subsurface tillage at 90 cm horizontal distance + Two Tyne + blade harrow) practice showed the significant increase in the growth and yield attributing characters which showed ultimate increase in the grain and straw yield of the soybean crop. The subsurface tillage improved the moisture content of soil at 90 DAS of soybean crop.

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