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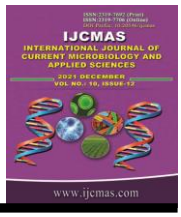

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Studies on Effect of Sub-Soiling on Runoff, Soil loss and Soybean Yield Potential under Rainfed Condition

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A B S T R A C T

Marathwada region of Maharashtra state is basically a rainfed region. Soybean is a major crop grown particularly in *kharif* season. The monsoon behavior has become very uncertain during recent past. The rainfall, its uneven distribution and prolonged dry spells during *kharif* season affect the crop productivity particularly in Marathwada region. Therefore, effective management of rainwater for its *in-situ* conservation is the key point for sustaining productivity. Sub-soiling may be one of the technique for reducing runoff and soil loss and to increase the grain yield. Therefore, an experiment was conducted to study the effect of sub soiling on runoff and soil loss and also to increase the crop yield. It is concluded that subsoiling in alternate year or every year with horizontal spacing of 1.5 m or 2.0 m is found suitable with respect to yield advantage and reduction in runoff and soil loss. The minimum runoff and soil loss were observed under sub soiling at every year followed in sub soiling in alternate year whereas maximum runoff and soil loss were observed in sub soiling in once in three year. Among sub soiling spacing treatments, minimum runoff and soil loss were observed in sub soiling at 1.5 m spacing and sub soiling at 2.0 m spacing whereas maximum runoff and soil loss were observed in subs soiling at 3.0 m spacing.

Introduction

Soybean is called as a golden bean belongs to legume family. The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh, and Chattisgarh. Despite having made rapid stride for both coverage and total production, soybean still suffers on productivity front. There are a number of constraints, pertaining to climate, production, and technology aspects. Most of the area under soybean cultivation is a rainfed. Erratic behaviour of monsoon affecting the production potential. Soybean has become an important oilseed crop in India in a very short period with approximately 10-million ha area under its cultivation. There has been an unprecedented growth in soybean area which was just 0.03 m ha in 1970 and has reached to 9.30 million ha

in 2010. The mean national productivity has increased from 0.43 t/ha in 1970 to 1.36 t/ha in 2010

Productivity of soybean can be increased by sub-soiling techniques. Sub-soiling can be found effective in rainwater conservation and yield enhancement. Sub-soiling was accomplished by using a sub-soiler at a soil depth ranging from 30 to 40 cm which showed that it is beneficial to ecology. Subsoiling facilitates downward water movement and enhances drainage so as to induce deeper penetration and consequently better root growth (Gajri *et al.,* 1991). Annual sub-soiling reduced bulk density by 4.9% compared with no-till control plots on silty loam soils. Sub-soiling can increase soil porosity and decrease the soil bulk density up to 3-4% (Solhjou and Niazi, 2001).

Soybean is grown on 13 lakh ha area in Marathwada region of Maharashtra state. Majority of the small and marginal farmers are preferring to grow soybean during *kharif* season. The average productivity of soybean varies depending of monsoon behavior. Occurrence of frequent dryspells affects the productivity of soybean in the region. Marathwada region of Maharashtra state comprises 8 districts with average annual precipitation of 807 mm. Though the majority area falls under assured rainfall zone, it is characterized by 2-3 prolonged dry spells during crop growth. In Marathwada region, Situations of deficit rainfall in last decade aggravated the situation of dryland agriculture and resulted in reduced crop production and productivity and overall socioeconomic condition of farmers.

Materials and Methods

The experiment was initiated in the year 2018-19 to 2020-21 for a period of three years and conducted on research farm of All India Coordinated Research Project for Dryland Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani (Maharashtra).

The average rainfall of the region is 892 mm. The soils of the area are medium black The experiment was laid out in split plot with 4 replications The experimental plot size was 4.5 m x 5.0 m and soybean was sown at 45 x 10 cm spacing. The recommended dose of fertilizer i.e. FYM 5 t ha^{-1}& (30:60:30 NPK Kg/ha) was applied.

The experiment was executed with three main treatments viz., S_1 - Sub soiling in every year, S_2 - Sub soiling in alternate year and S_3 - Sub soiling once in three years with five sub treatments viz., D_1 -Sub-soiling at every 1.0 m horizontal distance, D_2-Sub-soiling at every 1.5 m horizontal distance, D_3-Sub-soiling at every 2.0 m horizontal distance, D_4-Sub-soiling at every 2.5 m horizontal distance and D_5 -Sub-soiling at every 3.0 m horizontal distance. Soybean was sown using tractor drawn seed drill.

Automatic stage level recorders with H-flume and stilling basin were installed for measurement of runoff and soil loss under different treatments.

Results and Discussion

Soybean yield

Effect of Sub soiling years

The effect of sub soiling years on mean soybean yield was found to be significant. The mean soybean yield recorded by treatment S_2 i.e. sub soiling in alternate year was significantly higher (961 kg/ha) and it was found to be significantly higher than S_1 i.e. sub soiling in every year and at per with S_2 i.e. sub soiling in once in three year.

Effect of Subsoiling horizontal distance / spacing

The effect of subsoiling horizontal distance / spacing on soybean yield was found to be significant. The soybean yield recorded by treatment D_2 i.e. subsoiling at every 1.5 m horizontal distance was significantly higher (1024 kg/ha) and it was found to be significantly higher than rest of the treatments except that it was found at par with subsoiling at every 2.0 m horizontal distance.

Runoff and soil loss

Treatment wise runoff and soil loss were measured with the help of automatic stage level recorders combined with H-flume and stilling basin during crop growth period. Data on mean runoff and soil loss are presented in Table 2.

Runoff

On an average minimum runoff of 178mm was observed under sub soiling at every year followed in sub soiling in alternate year whereas maximum runoff of 202mm was observed in sub soiling in once in three year.

Among sub soiling spacing treatments, minimum runoff of 156mm was observed in sub soiling at 1.5 m spacing and sub soiling at 2.0 m spacing whereas maximum runoff of 253mm was observed in subs soiling at 3.0 m spacing.

Table.1 Soybean grain yield during 2018-19 to 2020-21

Treatments	Seed yield kg / ha			
	2018-19	2019-20	2020-21	Mean
Main Plots: Sub soiling rotation / years: (03)				
S_1 - Sub soiling in every year	857	805	1093	918
S_2 - Sub soiling in alternate year	802	965	1117	**961**
S_3 - Sub soiling once in three years	801	1050	988	946
SE ±	60	78	32	57
CD at 5%	184	234	98	172
Sub plot : Subsoiling horizontal spacing :(5)				
D_1- Subsoilingatevery 1.0 m horizontal distance	860	785	1038	894
D_2 - Subsoilingatevery 1.5 m horizontal distance	941	1022	1109	**1024**
D_3 - Subsoilingatevery 2.0 m horizontal distance	862	985	1098	981
D_4 - Subsoilingatevery 2.5 m horizontal distance	834	850	980	888
D_5 - Subsoilingatevery 3.0 m horizontal distance	755	815	952	840
SE ±	46	56	26	43
CD at 5%	138	168	79	129
Interaction effect (S x D)				
SE ±	72	112	30	71
CD at 5%	218	336	88	214
Mean		907	1047	

Table.2 Mean Runoff (mm) and mean soil loss (t/ha) as influenced by sub soiling schedule and Spacings

Treatments	D1 1.0 m	D2 1.5 m	D3 2.0 m	D4 2.5 m	D5 3.0 m	Mean
Runoff, mm						
S_1 - Sub soiling in every year	155	148	150	202	234	**178**
S_2 - Sub soiling in alternate year	165	159	155	217	252	**189**
S_3 - Sub soiling once in three years	172	163	162	238	274	**202**
Mean	**164**	**156**	**156**	**219**	**253**	**190**
Soil loss, tons/ha						
S_1 - Sub soiling in every year	3.05	2.79	2.85	3.56	4.13	**3.28**
S_2 - Sub soiling in alternate year	2.89	2.32	2.42	3.21	3.85	**2.94**
S_3 - Sub soiling once in three years	2.81	2.20	2.36	3.26	3.79	**2.88**
Mean	**2.92**	**2.44**	**2.54**	**3.34**	**3.92**	**3.03**

Soil Loss

On an average minimum soil loss of 2.88 tons/ha was observed under sub soiling at once in three years followed in sub soiling alternate year whereas maximum soil loss of 3.28 tons/ha was observed in sub soiling in every year. Among sub soiling spacing treatments, minimum soil loss of 2.44 tons/ha was observed in sub soiling at 1.5 m spacing followed by sub soiling at 2.0 m spacing whereas maximum soil loss of 3.92 tons/ha was observed in subs soiling at 3.0 m spacing. Therefore, it is observed that sub soiling in alternate years with a spacing of 1.5 m proved to be the best combination in reducing runoff and soil loss and thus effective rainwater conservation.

Sub-soiling reduced the runoff but did not significantly reduce the soil erosion after equilibrium had been reached between water application and runoff rates. However, the sub-soiled treatments did reduce the amount of runoff for the first runoff event after tillage (Jasa and Dickey, 1991). Similar results were obtained in the present study.

Sub soling in alternate year or once in three years with horizontal spacing of 1.5 m or 2.0 m is found suitable for higher grain yield and also to reduce runoff and soil loss.

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