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Effect of mechanization and land configuration on yield of soybean (*Glycine max* (L.) Merrill)

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Abstract
An Agronomic investigation "Effect of mechanization on productivity, growth, yield and economics of soybean" (*Glycine max* (L.) Merill)" was carried out at Experimental farm, of AICRP for dryland Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* 2019. The experiment was conducted which consisted of three treatments of mechanization practices as main plots and three treatments of moisture conservation as sub plots constituting six treatment combinations which were replicated thrice in split plot design. The three mechanization practices of full mechanization (M_1), partial mechanization (M_2) and no mechanization (M_3) were tested with three moisture conservation practices i.e. Broad bed furrow (S_1), ridges & furrow (S_2), flat bed (S_3) in the investigation. The gross and net plot sizes were 4.5 m x 18 m and 3.6 m x 15 m, respectively. The crop was sown as per treatments with recommended spacing of 45 cm x 5 cm. The growth parameters were influenced by various treatments of mechanization practices. The growth parameters like plant height, number of functional leaves plant^{-1}, leaf area plant^{-1}, number of branches plant^{-1}, total dry matter accumulation plant^{-1} were significantly higher in mechanization practices of full mechanization (M_1) treatment followed by partial mechanization (M_2) and no mechanization (M_3). The growth parameters were influenced by various moisture conservation. Broad bed furrow (S_1) recorded highest plant height (cm), maximum number of functional leaves plant^{-1}, leaf area plant^{-1}, number of branches plant^{-1} and total dry matter accumulation plant^{-1}.
The interaction effects between mechanization practices and moisture conservation not significantly influenced the growth and yield of soybean Thus to achieve higher soybean yield may be sown with full mechanization and broad bed furrow method.

Keywords: Mechanization, moisture conservation, labour shortage, soybean yield

1. Introduction
Soybean (*Glycine max* (L.) Merill) is also called as wonder crop. It is native of Asia and it has been under cultivation in China since 2838 B.C. It belongs to the family leguminaceae and sub family Papilionaceae. Soybean is basically a pulse crop but is gaining importance as an oilseed crop too. Soybean is of paramount important in human and animal nutrition, because it is a major source of edible vegetable oil and high protein feed as well as food in the world.
Mechanization is the common practice in most agricultural land. However, in the past two decades or so, several development in the field of agriculture have dictated drastic changes in mechanization practices. First availability of herbicides capable for controlling most of the major weed has become available at the reasonable cost. This development reduced the need for cultivating and even ploughing in some cases. Second, drastic increases in fuel cost forced tractor- dependent farmers to seek means of reducing their tillage operation cost. Third, the increasing environmental awareness has forced a re-evaluation of soil erosion as source of off-site water pollution.
The term mechanization needs to be viewed for its broader purpose, namely, enhancing safe and sustainable productivity of land and labour. Actually, an agriculture mechanization strategy should be part of an agriculture technology strategy which in turn should be a part of an overall agriculture development strategy. The introduction of machinery to substitute for labour (labour saving) is a common phenomenon associated with the release of labour for employment in other sector of the economy or to facilitate cultivation of a larger area with the same labour force. The purpose of mechanization is also to produce more from the existing land, using machinery as a complimentary input, required to achieve higher land productivity. During recent years, a continuous shift of rural population towards services sector for better working conditions, increasing urbanization and migration of villagers in search of greater opportunities, rise of rural entrepreneurs, etc. has resulted into the shortage of agriculture labour.

The labour scarcity being felt as a major impediment in agriculture, this study has probed into its magnitude, impacts, causes and possible solutions in the Cuddalore district of Tamil Nadu. The study has revealed that prevalence of acute labour scarcity in the district has affected the productivity levels of almost all crops and is even leading towards the permanent changes in the cropping pattern. The important reasons identified for the labour scarcity include higher wages in other locally-available jobs, seasonal nature of agricultural jobs and presumption of an agricultural job to be of low esteem. The level of adoption of labour-saving implements and technologies by the farmers is very low for the reasons of higher cost, lack of skill and smaller size of holdings. The study has suggested that agricultural extension system of the district / state / country should be geared-up, to bring out farmers from the conventional methods of cultivation and to educate them on adoption of labour-saving implements and technologies. Also, a community level approach should be encouraged among farmers for adopting / availing highly expensive labour-saving technologies and implements cooperatively. In addition, agricultural jobs should be made more remunerative by increasing the wages at least at par with other jobs available locally. (Prabakar *et al.* 2011) [18]

Land configuration is the combination of soil management and the potential to improve the productivity of alfisols and vertisols in the semi arid tropics. The land configuration treatment were FB (flat bed-traditional practices), Ridges and furrow and BBF (broad bed furrow) are applied to field for better water conservation, increase soil fertility and productivity of cropping system. Proper land configuration is known for increasing moisture intake, storage and resultant yield. The broad bed and furrow help in providing more opportunity for in situ soil water conservation in rainfed Agriculture.

2. Materials and Methods

A field experiment was conducted during *kharif* 2018-19 at All India Co-ordinated Research Project on Dryland Agriculture, V.N.M.K.V, Parbhani. The soil was medium deep black and well drained. The topography of the experiment field was fairly uniform and leveled. Soil samples up to 30 cm were randomly collected from different locations of field before start of the experiment during *kharif* 2019. The results of the soil analysis revealed that, the soil of the experimental plot was clayey in texture, low in available nitrogen (198.40%), medium in available phosphorus (13.89%), high in available potassium (480.10%) and slightly alkaline in reaction. The soil was moderately alkaline in reaction (8.00 pH). In general, weather conditions were favourable for plant growth and no severe pest and diseases noticed during experimentation. The study involved six treatment combinations two factors *viz*., mechanization plot (MP) and moisture conservation practice (MC) with two treatments. Sowing was completed as per treatments. The fertilizer dose of 30:60:30NPK kg ha^{-1} was applied at the time of sowing. The package of recommended practices was adopted to maintain the crop.

Table 1: Yield attributes of soybean as influenced by various mechanization and moisture conservation treatments

Treatment	Days After Sowing				
	Wt of pod/plant(g)	No of seeds/plant	Wt of seeds/plant(g)	No of seeds/pod	Seed index(g)
Main plot treatment (Mechanization)					
(M_1)=Full Mechanization	13.96	63.65	6.95	1.93	12.30
(M_2)=Partial Mechanization	11.92	55.66	6.09	1.79	11.60
(M_3)=No Mechanization	8.66	38.79	4.45	1.65	11.28
S.E m±	0.43	1.29	0.33	0.11	0.06
C.D at 5 %	1.53	4.57	1.17	1.12	0.25
Sub plot treatment (Moisture conservation)					
(S_1)=Broad bed furrow	13.43	54.97	6.96	1.98	12.39
(S_2)=Ridges and furrow	11.36	52.53	5.55	1.83	11.45
(S_3)= Flat bed	9.76	50.60	4.98	1.56	11.35
S.E m±	0.25	1.09	0.20	0.09	0.04
C.D at 5 %	0.75	3.27	0.61	0.29	0.37
Interaction (MXS)					
S.E m±	0.56	2.01	0.44	0.17	0.12
C.D at 5 %	NS	NS	NS	NS	NS
General mean	11.51	52.70	5.83	1.79	10.78

Weight of pods plant^{-1} and number of seeds plant^{-1} (Table 1) were the highest when the soybean crop was adopted with mechanization practices (M_1) full mechanization than other mechanization practices i.e. (M_2) partial mechanization and (M_3) no mechanization. The higher growth attributes followed by more synthesis and translocation of food material to the source might have resulted in bold seed size and thus, more weight of pods plant^{-1}.

Effect of mechanization practices on seed weight plant^{-1} was found to be significant. (M_1) full mechanization recorded highest Seed weight than (M_2) partial mechanization and (M_3). no mechanization. The overall better growth, development with the support of conserved soil moisture and better drainage and good aeration after having rainfall storms might have reflected in higher seed weight plant^{-1}. The similar results were reported by Asewar *et al.*, (2019) [1].

Effect of mechanization practices on seed weight plant^{-1} was found to be significant. (M_1) full mechanization recorded highest Seed weight than (M_2) partial mechanization and (M_3). no mechanization. The overall better growth, development with the support of conserved soil moisture and better drainage and good aeration after having rainfall storms might have reflected in higher seed weight plant^{-1}. The similar results were reported by Asewar *et al.*, (2019) [1].

Weight of pods plant^{-1} and number of seeds plant^{-1} (Table 1) were the highest when the soybean crop was adopted with moisture conservation method (S_1) broad bed furrow than other land configurations i.e. (S_2) ridges & furrow and (S_3)

flat bed. The higher growth attributes followed by more synthesis and translocation of food material to the source might have resulted in bold seed size and thus more weight of pods plant^{-1}. The effect of moisture conservation on yield attributes are in line with the reports of Asewar *et al.*, (2017) [2], Joshi *et al.*, (2018) [10].

Effect of moisture conservation on seed weight plant^{-1} was found to be significant. (S_1) broad bed furrow recorded highest seed weight plant^{-1} than (S_2) ridges & furrow and sowing on (S_3) flat bed. The overall better growth, development with the support of conserved soil moisture might have reflected in higher seed weight plant^{-1}. The similar results were reported by Negi *et al*. (2018) [16], Khamblkar *et al.*, (2014) [13], Meena *et al.*, (2013) [14].

Table 2: Seed, straw, biological yield (kg ha^{-1}) and harvest index of soybean as influenced by various treatments

Treatment	Days After Sowing			
	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Main plot treatment (Mechanization)				
(M_1)= Full Mechanization	2098	3076	5172	40
(M_2)=Partial Mechanization	1789	2676	4463	40
(M_3)=No Mechanization	1385	2376	3758	36
S.E m±	69	63	136	
C.D at 5 %	243	223	481	
Sub plot treatment (Moisture conservation)				
(S_1)= Broad bed furrow	1916	2895	4797	39
(S_2)=Ridges and furrow	1698	2619	4318	38
(S_3)= Flat bed	1658	2614	4279	38
S.E m±	53	56	95	
C.D at 5 %	158	168	285	
Interaction (MXS)				
S.E m±	119	109	82	
C.D at 5 %	NS	NS	NS	
General mean	1757	2709	4465	38

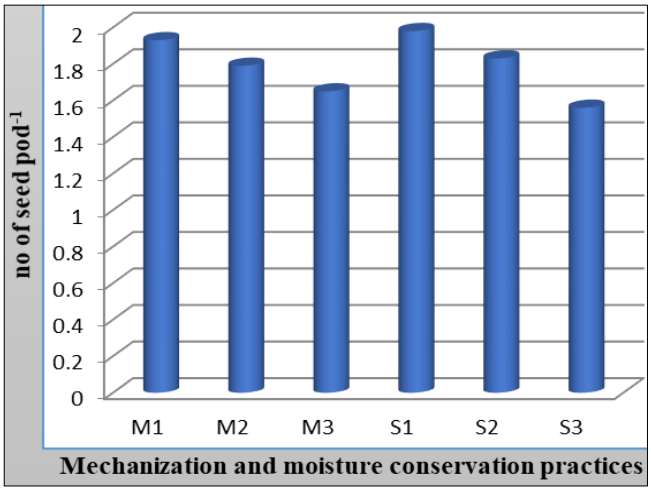

Fig 1: Number of seed pod $^{-1}$ of soybean as influenced by various treatments

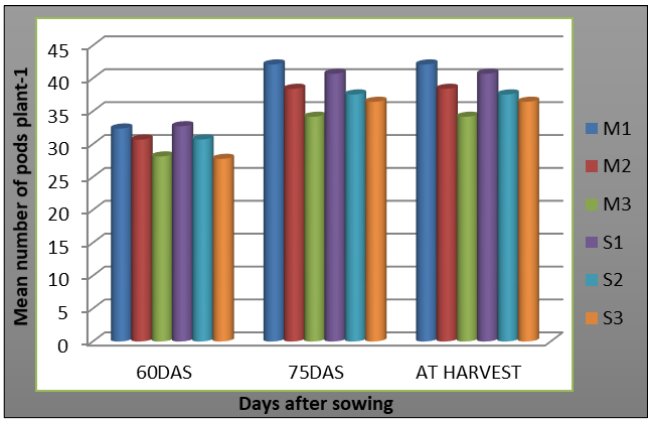

Fig 2: Mean number of pods plant^{-1}as influenced by various treatments in soybean

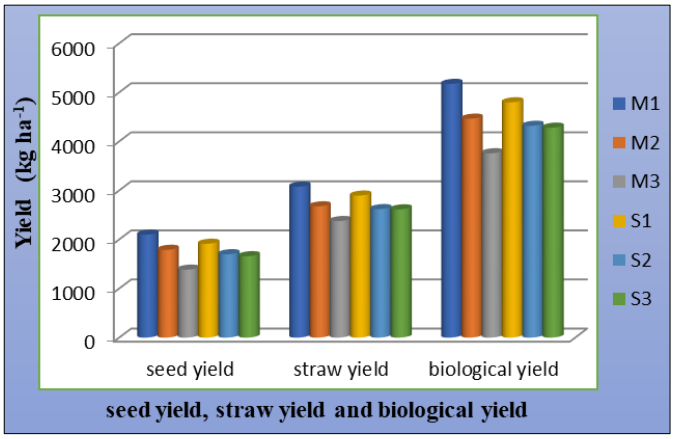

Fig 3: Seed, straw and biological yield of soybean as influenced by various treatments

Full mechanization method of planting had profound effect on seed, straw and biological yields (kg ha^{-1}) as presented in Table 2. The increase in seed yield kg ha^{-1} was attributed to increased growth parameters and yield attributes of soybean. This might be due to more favoured overall growth and yield attributing characters due to favourable seed bed, better aeration, scope for more space, light interception, benefit of more conserved moisture in furrows and its support at critical growth stages like flowering, pod initiation and development. This ultimately resulted in higher values of yield attributing characters and which in turn resulted in higher yields of soybean crop. This results correlate with the work of Nagavallemma *et al.*, (2005) [15], Gooma *et al.*, (2009) [7], Khambalkar *et al.*, (2014) [20], Waghmare *et al.*, (2013) [20], Avval *et al.*, (2010) [3].

Biological yield was influenced significantly by the mechanization practices. Treatment (M_1) full Mechanization (M_1) recorded maximum biological yield followed by

treatments (M_2) partial mechanization and (M_3) no mechanization. Similar trend was observed in case of straw yield ha^{-1}. Similar results were reported by Asewar *et al*., (2019) [1]. Significantly higher moisture content in per cent and higher stored moisture (mm) was observed with the (M_1) Full mechanization than treatments (M_2) partial mechanization and (M_3) no mechanization at soil depth of 0-45 cm. The results are in line with the results of Bhutada *et al.*, (2020) [6] Patel and Varshney (2007) [17], Jadhav *et al.*, (2011) [9], Baig *et al.*, (2014) [4].

The interaction effect of mechanization and moisture conservation on growth parameters like plant height, mean number of branches plant^{-1}, mean number of leaves plant^{-1}, leaf area plant^{-1} and total dry matter accumulation plant^{-1}was found to be non significant.

Broad bed furrow method of planting had profound effect on seed, straw and biological yields (kg ha^{-1}). The increase in seed yield kg ha^{-1} was attributed to increased growth parameters and yield attributes of soybean. This might be due to more favoured overall growth and yield attributing characters due to favourable seed bed, better aeration, scope for more space, light interception, benefit of more conserved moisture in furrows and its support at critical growth stages like flowering, pod initiation and development. This resulted in higher values of yield attributing characters and which in turn resulted in higher yields of soybean crop. This results correlate with the work of Khanpara (2003) [12], Kantwa *et al.*, (2006) [11], Verma *et al.*, (2017) [19] and Basediya *et al*., (2018) [5].

Biological yield was influenced significantly by the moisture conservation. Treatment (S_1) broad bed furrow recorded maximum biological yield followed by treatments (S_2) ridges & furrow and (S_3) flat bed. Similar trend was observed in case of straw yield ha^{-1}. Similar results were reported by Meena *et al*., (2013) [14], Gore *et al.*, (2017) [8].

Conclusions

On the basis of this study, the better results were found in full mechanization (M_1) along with Broad bed furrow (S_1) on yield attributing characters of soybean as compared to no mechanization along with conventional method i.e flat bed. It is concluded that full mechanization along with Broad bed furrow found most suitable for increasing soybean yield and productivity mainly due to the soil moisture stored sustain the crop during crop growing period. The conclusions are drawn on the basis of one year experimentation. Hence, need further experimentation for confirmation of the results.

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