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Effect of land configuration and crop residue management growth and yield of soybean (*Glycine max* (L.) Merrill

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Abstract
A field experiment was conducted at Experiment farm of Agronomy Department, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* 2019 to studies on land configuration and crop residue management on soybean (*glycine max* (L.) Merrill. The experimental plot was laid out in split plot design of fifteen treatment combinations replicated thrice. Where in main plot consist of three land configuration practices viz., (L_1) Flat bed, (L_2) Broad bed furrow, (L_3) Ridges & furrow and sub plot five treatment of crop residue management practices of (CR_1) Crop Residue @1.25 T/ha + 5 kg ha^{-1} decomposing microorganism, (CR_2) Crop Residue @1.25 T/ha + 10 kg ha^{-1} decomposing microorganism, (CR_3) Crop Residue @2.5 T/ha + 5 kg ha^{-1} decomposing microorganism. (CR_4) Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism and (CR_5) without crop residue. Broad bed furrow with Crop Residue @ 2.5 T/ha + 10 kg ha^{-1} decomposing microorganism was found significantly superior over the rest of treatments in respect of plant height, number of leaves, number of branches, leaf area, number of pod $plant^{-1}$ and dry matter. Broad bed furrow with Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism was found significantly superior over the rest of treatments in respect of yield attributes and seed yield and straw yield.

Keywords: Land configuration, crop residue management, decomposing microorganism, broad bed furrow, ridge and furrow, flat bed

Introduction
Soybean (*Glycine max* (L.) Merrill) is a leguminous crop originated in China and belongs to sub family papilionaceae with family leguminosae. It is originated in China and it was introduced in India in recent years. It is basically a pulse crop, but as it contains 20 per cent cholesterol free oil gained the importance as an oilseed crop. It is known as the 'Gold of Century' due to easy cultivation, low nitrogen requirement and high cost benefit ratio. In world USA, Brazil, China and Argentina after rank fifth in area and production of soybean in the world India. In India area, production and productivity of soybean during 2018 was 108.39 lakh ha, 114.83 lakh million tonnes and 1059 kg ha^{-1}, correspondingly. In Maharashtra area, production and productivity of soybean during 2018 was 36.39 lakh ha, 38.35 lakh million tonnes and 1054 kg ha^{-1}, respectively. Where as in Marathwada the area underneath soybean was 17.40 lakh ha with production of 18.22 lakh tonnes and productivity was 967 kg ha^{-1}. In Parbhani district the area under soybean was 2.20 lakh ha with production of 2.28 lakh tonnes and productivity was 1032 kg ha^{-1} (Anonymous, SOPA databank 2018 production Date-8/05/2019).

Land configurations have a major influence on soil aeration, moisture availability and temperature of soil which in turn affect the yield and quality of crop. The broad bed furrow and ridge and furrow are newly developed methods of soybean cultivation in India. Therefore, need to standardised land configuration for the cultivation of soybean in India. (Ram and Kler 2007) [9]. Reported that the broad bed furrow provides favourable environment for growth and development of the soybean crop under rained conditions. Land configuration is a potential tool for soil and moisture conservation. Appropriate land configuration like broad bed and furrow, ridges and furrow system increases crop yield due to increase in infiltration of water into soil profile and it becomes available to crop during prolonged monsoon break and control water crises in agriculture by the way 'more crop per drop'. At the same time there should be provision for drainage of excess rain water. Studies on soil management for increasing crop production revealed that use of various modifications of land configurations such as broad bed furrow, ridges and furrow for soybean in vertisol were superior over flat bed and recommended in watershed development for moisture conservation as well as for safe removal of excess rain water (Raut *et al.*, 2000) [10].

Among different conservation measures, straw mulching on soil surface to reduce evaporation rate and discourage the weeds is another water conservation practice in India. The combination of land configuration and straw mulching conserve the soil moisture and improve water use efficiency and grain yield. The recycling of crop residues has the benefit of converting the surplus farm waste into valuable products for gathering nutrient supplies of crops. It also maintains the soil physical and chemical condition and increase the overall ecological balance of the crop production system. Crop residues many roles in crop-production system decrease soil erosion from both wind and water, provide plant nutrients, act as a mulch to lessen the rate of soil water loss and change soil temperature. To conserve as much rain water as possible during less rainfall years and ways of overcoming excess moisture to improve growth and yield of soybean, land configurations like flat bed, broad bed furrow and ridges and furrow along with crop residues application plays important role.

Materials and Methods

The experiment was laid out in field at PG Research Farm of Agronomy Department, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season of 2019. The experimental field was levelled and well drained. The soil of experimental field was medium deep black, clay in texture, medium in organic carbon, low in available nitrogen (195.50 kg ha^{-1}), phosphorus (12.90 kg ha^{-1}) and high in potash (470.70 kg ha^{-1}). The environmental condition prevailed during experimental period was favorable for normal growth and development of soybean crop.

The experiment was carried out in split plot design with three replications consisting of fifteen treatment combinations. The land configuration practices consisted of Flatbed (L_1), Broad bed furrow (L_2), Ridges & furrow (L_3) and five treatments on crop residue management practices of Crop Residue @1.25T/ha+5 kg ha^{-1} decomposing microorganism (CR_1), Crop Residue@ 1.25 T/ha +10 kg ha^{-1} decomposing microorganism (CR_2), Crop Residue @ 2.5 T/ha + 5 kg ha^{-1} decomposing microorganism (CR_3), Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism (CR_4) and without crop residue (CR_5) were included in the investigation. Sowing was done on 27 June, 2019 in various land configurations with recommended seed rate. In case of flatbed sowing was done with Tractor drawn ferity seed drill at 45cm X 5cm. The broad bed furrow planter was used for preparation of (broad bed furrow) and planting. In case of ridges & furrows, the ridges & furrows were prepared and sowing was undertaken at 45cm X 5cm distance. Crop residue application and decomposing microorganism spraying was done after 21 DAS of crop. The treatment was done by using chopped crop residues with spraying decomposing microorganism**.** (CR_1) The treatment was done by using chopped crop residues @ 1.25T/ha with spraying decomposing microorganism 5 kg/ha. (CR_2) The treatment was done by using chopped crop residues @1.25T/ha with spraying decomposing microorganism 10 kg/ha. (CR_3) The treatment was done by using chopped crop residues @2.5T/ha with spraying decomposing microorganism 5 kg/ha. (CR_4) The treatment was done by using chopped crop residues @2.5T/ha with spraying decomposing microorganism 10 kg/ha. (CR_5) The treatment was done without crop residues and decomposing microorganism.

Result and Discussion

Effect of land configuration on growth of soybean

The effect of land configurations observed to be profound at all the stages of crop growth on plant height (Table 1). Treatment L_2(broad bed furrow produced more plant height than L_3 (Ridges & furrow), and L_1 (Flatbed). This might be due to favorable seed bed, aeration, more conservation of water in broad bed furrow and initial vigorous growth resulted in more height of the crop. These results are conformation with the results of Jadhav *et al.*, (2017) [3].

Treatment L_2 (Broad bed furrow) proved superior over all the treatments in producing more number of leaves $plant^{-1}$. This might be due to height and further vigorous growth and accordingly more photosynthesis in Broad bed furrow. Similar results were obtained by Rudrawar (2007) [11].

Number of branches $plant^{-1}$ differed with the different treatments (Table 1). Land configuration L_2 (broad bed furrow) recorded the maximum number of branches $plant^{-1}$ at all the stages of crop growth than L_3 (Ridges & furrow) and Treatment L_1 (Flatbed) recorded the lowest number of branches $plant^{-1}$. This might be due to the more plant height and vegetative growth of the plants grown on broad bed furrow. Moreover, the space available for side rows on broad bed furrow was more than that of ridges & furrows and flatbed system. This was supported by more water conservation and vigorous branching in plants raised on broad bed furrow. Similar results were reported by Karande (2006) [5].

The profound effect of land configuration methods on leaf area was found at all the growth stages. It was observed that treatment L_2 (Broad bed furrow) had maximum leaf area $plant^{-1}$ (dm^2) than L_3 (Ridges & furrow) and L_1 (Flatbed). This might be due to overall favorable growth and more number of functional leaves produced in treatment L_2 (Broad bed furrow) which in turn resulted in more leaf area $plant^{-1}$. The similar results are reported by Rudrawar (2007) [11].

At all the stages of crop growth, land configuration L_2 (broad bed furrow) recorded the maximum number of pods $plant^{-1}$ over the treatments L_3 (Ridges & furrow) and L_1 (Flatbed). Increase in number of pods $plant^{-1}$ due to proper growth of crop, which might have resulted in greater translocation of food material to the reproductive part, which also reflected towards superiority in yield attributing characters. The increased number of branches and more reproductive growth and conversion of flowers in pods with the support of more conserved soil moisture at peak period of pod initiation might have resulted in increased number of pods per plant. Similar results were observed by Bhadre *et al.*, (2019) [2]. Total dry matter accumulation (g) $plant^{-1}$ increased rapidly up to 75 DAS and gradually decreased thereafter till maturity (Table 1). Land configurations method L_2 (broad bed furrow) recorded more dry matter accumulation than L_3 (ridges & furrow) and L_2 (flatbed) in soybean. This is due to luxurious growth and higher growth attributes recorded in broad bed furrow than rest of the land configurations and thus overall growth reflected in higher dry matter in broad bed furrow. The similar results were observed by Karande (2006) [5].

Effect of land configuration on yield and yield attributes of soybean

Yield attributing characters like number of pods/plant, weight of pods/plant and weight of seed/plant (g) and seed yield of soybean showed remarkable improvement by adopting different land configuration method (Table 2). The broad bed furrows planting method was most efficient for increase in yield and yield attributing characters i.e. number of pods/plant (33.29), weight of pods/plant (6.79g) and weight of seed/plant (5.70) and seed yield (2221 kg/ha) than flatbed planting but it was at par with the ridges and furrows. This might be due to more favored overall growth and yield attributing characters due to favorable 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 Patel *et al.,* (2009) [6]. At all the stages of crop growth, land configuration L_2 (Broad bed furrow) recorded the maximum number of pods plant^{-1} over the treatments L_3 (Ridges & furrow) and L_1 (Flatbed). Increase in number of pods plant^{-1} due to proper growth of crop, which might have resulted in greater translocation of food material to the reproductive part, which also reflected towards superiority in yield attributing characters. The increased number of branches and more reproductive growth and conversion of flowers in pods with the support of more conserved soil moisture at peak period of pod initiation might have resulted in increased number of pods per plant. Similar results were observed by Kadam (2015) [4]. Weight of pods plant^{-1} in (Table 1) indicate that the highest values were obtained when the soybean crop was sown with land configuration method of L_2 (Broad bed furrow) than other land configurations i.e. L_3 (Ridges & furrow), and L_1 (flatbed). 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}. These effect are in line with the reports of Jadhav *et al.,* (2017) [3]. Broad bed furrow (L_2) method of planting had profound effect on seed and straw yield. 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 favored overall growth and yield attributing characters due to favorable 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 Bhadre *et al.,* (2019) [2].

Effect of crop residue management practices on growth of soybean

The effect of crop residue management practices observed to be profound at all the stages of crop growth (Table 1). Significant differences were observed in various growth and yield attributing characters, seed and straw yields ha^{-1} due to various crop residue practices. Treatment CR_4 (application of Crop Residue @2.5 T/ha +10 kg ha^{-1} decomposing microorganism) produced more plant height rest of over treatments. This might be due to favorable seed bed, aeration, more conservation of water due to crop residue practices and initial vigorous growth resulted in more height of the crop. These results are conformation with the results of Jadhav *et al.,* (2017) [3].

Application of Crop Residue @ 2.5 T/ha + 10 kg ha^{-1} decomposing microorganism (CR_4) produced more leaves plant^{-1} than application of Crop Residue @ 2.5 T/ha + 5 kg ha^{-1} decomposing microorganism (CR_3), Crop Residue @1.25 T/ha + 10 kg ha^{-1} decomposing microorganism (CR_2) and Crop Residue @1.25 T/ha + 5 kg ha^{-1} decomposing microorganism (CR_1). Treatment where crop residue were not added (CR_5) recorded lowest values. This might be due to overall favorable growth and more number of functional leaves. Similar results were obtained by Shelar and Khanekar (2013) [12].

Number of branches plant^{-1} was significantly affected with the different crop residue management treatments (Table 1).Treatment (CR_4) (application of Crop Residue @2.5 T/ha+10 kg ha^{-1} decomposing microorganism) produced highest number of branches plant^{-1} than (CR_3) (Crop Residue @2.5 T/ha + 5 kg ha^{-1} decomposing microorganism) followed by treatment (CR_2) (Crop Residue @1.25 T/ha + 10 kg ha^{-1} decomposing microorganism) and (CR_1) (Crop Residue @1.25 T/ha + 5 kg ha^{-1} decomposing microorganism). This might be due to the more plant height and vegetative growth of the plants and more water conservation. Similar results were reported by Patil *et al.,* (2010) [7].

Treatments (CR_4) application of Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism produced in producing higher Leaf area plant^{-1} than (CR_3) Crop Residue @2.5 T/ha + 5 kg ha^{-1} decomposing microorganism followed (CR_2) Crop Residue @1.25 T/ha + 10 kg ha^{-1} decomposing microorganism and (CR_1) Crop Residue @1.25 T/ha + 5 kg ha^{-1} decomposing microorganism and (CR_5) control recorded lowest. This might be due to overall favorable growth and more number of functional leaves produced in treatment. The similar results are reported by Patil *et al.* (2010) [7].

At all the stages of crop growth treatments application of Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism (CR_4) produced significantly higher number of pods plant^{-1}having at par values with application of Crop Residue @2.5 T/ha + 5 kg ha^{-1} decomposing microorganism (CR_3) and found superior other treatments. Increase in number of pods plant^{-1} due to superior growth of crop, which might have resulted in greater translocation of food material to the reproductive part, which also reflected towards superiority in yield attributing characters. The increased number of branches and more reproductive growth and conversion of flowers in pods with the support of more conserved soil moisture at peak period of pod initiation might have resulted in increased number of pods plant^{-1}. Similar results were observed by Pradhan *et al.,* (2018) [8]. Treatment (CR_4) application of Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism produced higher total dry matter plant^{-1} than (CR_3) (Crop Residue @ 2.5 T/ha + 5 kg ha^{-1} decomposing microorganism) over rest of treatment. Whereas, treatment (CR_5) (without crop residue) recorded lowest values. This is due to luxurious growth and higher growth attributes recorded. The similar results were observed by Shelar and Khanekar (2013) [12].

Effect of crop residue management practices on yield and yield attributes of soybean

The effect of crop residue management practices observed to be profound at all the stages of crop growth. Significant differences were observed in various growth and yield attributing characters, seed and straw yields ha^{-1} due to various crop residue practices

At all the stages of crop growth treatments application of Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism (CR_4) produced significantly higher number of pods plant^{-1}having at par values with application of Crop Residue @2.5 T/ha + 5 kg ha^{-1} decomposing microorganism (CR_3) and found superior overall other treatments. Increase in number of pods plant^{-1} due to superior growth of crop, which might have resulted in greater translocation of food material to the reproductive part, which also reflected towards superiority in yield attributing characters. The increased number of branches and more reproductive growth and conversion of flowers in pods with the support of more conserved soil moisture at peak period of pod initiation might have resulted in increased number of pods plant^{-1}. Similar results were observed by Pradhan *et al.*, (2018) [8]. Weight of pods plant^{-1} and number of seeds plant^{-1} were higher, when the soybean crop was given Treatment CR_4 (application of Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism) over the rest of treatments. 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}. Jadhav *et al.*, (2017) [3]. Seed yield, straw yield (kg ha^{-1}) as presented in Table (1) showed significant differences due to application of different crop residue treatments. Treatment CR_4 (application of Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism) produced higher Seed yield, straw yield over rest of treatments. 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 favored overall growth and yield attributing characters due to favorable 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 Pradhan *et al.*, (2018) [8].

Interaction effects
The interaction effect of land configurations and crop residue management practices in growth, yield and yield attributes of soybean was found to be non-significant.

Table 1: Effect of land configuration and crop residue management on growth of soybean

Treatment	Plant height (cm)	Number of functional leaves plant^{-1}	Number of branches plant^{-1}	leaf area plant^{-1} (dm^2)	Number pod plant^{-1}	dry matter (g) plant^{-1}
Land configuration (L)						
L_1-Flat bed	39.59	19.73	3.63	15.70	26.97	9.46
L_2-Broad bed furrow	47.39	23.08	4.81	19.29	33.29	13.42
L_3-Ridges & furrow	45.79	22.13	4.54	18.84	31.74	12.41
S.E. ±	0.81	0.61	0.18	0.74	0.38	0.75
C.D. at 5%	3.17	2.39	0.70	2.88	1.48	2.93
Residue management (CR)						
CR_1-Crop Residue @1.25 T/ha +5 kg ha^{-1} decomposing microorganism	41.14	20.64	4.07	16.67	30.27	10.73
CR_2-Crop residue @1.25 T/ha + 10 kg ha^{-1} decomposing microorganism	42.67	20.99	4.15	16.98	30.71	10.92
CR_3-Crop Residue @2. 5 T/ha +5 kg ha^{-1} decomposing microorganism	48.18	23.24	4.64	19.08	31.26	12.96
CR_4-Crop residue @2.5 T/ha +10 kg ha^{-1} decomposing microorganism	49.18	24.07	4.77	20.42	32.32	13.61
CR_5-Without crop residue	40.94	19.31	4.00	16.57	28.76	10.59
S.E. ±	1.40	0.78	0.15	0.65	0.46	0.54
C.D. at 5%	4.07	2.26	0.45	1.89	1.34	1.58
Interaction (L × CR)						
S.E. ±	2.42	1.34	0.27	1.12	0.80	0.94
C.D. at 5%	NS	NS	NS	NS	NS	NS
G. mean	47.31	21.65	4.33	17.94	30.66	14.76

Table 2: Effect of land configuration and crop residue management on Yield and yield attributing character of soybean

Treatment	Number pod plant^{-1}	Weight of pods plant^{-1} (g)	Weight of seeds plant^{-1} (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Land configuration (L)					
L1-Flat bed	26.97	5.60	4.41	1683	2698
L2-Broad bed furrow	33.29	6.79	5.70	2221	3423
L3-Ridges & furrow	31.74	6.30	5.21	2026	3193
S.E. ±	0.38	0.16	0.20	52	59
C.D. at 5%	1.48	0.63	0.78	240	233
Residue management (CR)					
CR_1-Crop Residue @1.25 T/ha +5 kg ha^{-1} decomposing microorganism	23.95	5.61	4.88	1866	3011
CR_2-Crop residue @1.25 T/ha + 10 kg ha^{-1} decomposing microorganism	23.75	5.92	4.94	1904	3041
CR_3-Crop Residue @2. 5 T/ha +5 kg ha^{-1} decomposing microorganism	26.26	7.04	5.71	2210	3464
CR_4-Crop residue @2.5 T/ha +10 kg ha^{-1} decomposing microorganism	27.22	7.63	5.88	2314	3530
CR_5-Without crop residue	23.06	4.92	4.14	1557	2476
S.E. ±	0.62	0.23	0.22	79	100
C.D. at 5%	1.82	0.65	0.65	234	293
Interaction (L × CR)					
S.E. ±	1.08	0.39	0.39	137	174
C.D. at 5%	NS	NS	NS	NS	NS
G. M	24.85	6.23	5.11	1976	3105

Conclusion
Based on experiment concluded that broad bed furrow with Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism was found significantly superior over the rest of treatments in respect of plant height, number of leaves, number of branches, leaf area, number of pod plant^{-1} and dry

matter. Broad bed furrow with Crop Residue @2.5 T/ha + 10 kg ha^{-1} decomposing microorganism was found significantly superior over the rest of treatments in respect of yield attributes and seed yield and straw yield.

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