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Effect of land configuration and sowing date on growth, yield and economics of soybean (*Glycine max* L.) in *Kharif* season

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Abstract
The field experiment was carried out during *kharif* 2022 at Experimental Farm of Department of Agronomy, College of Agriculture, Latur to study the effect of land configuration and sowing date on growth, yield and nodulation of soybean (*Glycine max* L.) in *kharif* season. The soil of experimental plot was clayey in texture, low in available nitrogen (235 kg ha^{-1}), medium in available phosphorus (17.53 kg ha^{-1}), very high in available potassium (446 kg ha^{-1}) and slightly alkaline in (pH 7.8) nature.
The experiment was laid out in Split Plot Design with nine treatment combinations, consisting of three Land configurations *viz* Flatbed (L_1), Ridges and furrow (L_2), Broad bed furrow (L_3) and three sowing date as D_1 (8th July), D_2 (23rd July), D_3 (8th August). The gross plot size of each experiment unit was (5.4 m × 4.5 m) and net plot size was (4.4 m × 3.9 m) respectively. Sowing was done at respective sowing date as per the treatments by dibbling method at spacing 45 × 5 cm^2 with variety MAUS -158. The recommended dose of fertilizer 30:60:30 kg ha^{-1} was applied.
The result showed that on land configuration, broad bed furrow (L_3) recorded highest values of all growth attributes followed by ridges and furrow (L_2) and both land configuration treatments were found superior over flatbed method of sowing. Whereas, soybean was sown on 8th July (D_1) recorded maximum values of all plant growth attributes. The maximum plant height (47.80 cm plant^{-1}), seed yield (1709 kg ha^{-1}), straw yield (2389 kg ha^{-1}), GMR (₹ 67,505 ha^{-1}), NMR (₹ 24,475 ha^{-1}) and B: C ratio (1.56) observed with sowing of soybean on broad bed furrow (L_3). Higher growth and yield attributes, seed yield (1966 kg ha^{-1}), straw yield (2624 kg ha^{-1}), GMR (₹ 77,657 ha^{-1}), NMR (₹ 34,894 ha^{-1}) and B: C ratio (1.81) was observed with sowing of soybean on 8th July (D_1).

Keywords: Soybean, flat bed, ridges and furrows, broad bed furrow, sowing date

Introduction
Among all agricultural produces oilseeds are second largest produce next to the cereals within the segment of field crops and have been grown all over the world with consideration of more importance as they generate high economic turnover. Major oilseed grown crops are soybean, groundnut, sunflower, safflower, rapeseed and mustard. Among these soybean (34%), groundnut (27%), rapeseed and mustard (27%) contribute to more than 88% of total oilseeds production and 80% of vegetable oil with major share of mustard (35%), groundnut (25%) and soybean (23%). Soybean have prime importance next only to the groundnut and rapeseed.
The loss of yield can be avoided or minimized if good amount of water is stored in the soil during rainy days and utilized by the crop during moisture stress or dry spell and also facilitate the provision of drainage for excess rain water. For increasing crop production use of various modification 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.
Ridges and furrow system can be used to manipulate runoff and to reduce erosion. The ridges served as mini bunds and the furrow serve as small surface drains. This practice was very useful on flat lands with comparatively high rainfall. Soybean can thrive in any conditions but due to dry spell and heavy rainfall soybean seed yield drastically reduced, due to moisture stress at various physiological and morphological stages of plants are hampered.

Also land configurations are such agronomic practices which gives better yield with minimum resource availability.

We need to use improved technology for maximum production. High inputs required awareness and knowledge for handling and operation. Compared with the land layouts are easy to apply at field level with the help of desi plough by opening of furrow at different levels facilitate storage of water in rainy days, less soil erosion, seepage and runoff losses and water logging condition easily managed due to drainage providing by opening of furrows. Also due to moisture availability in dry spell maintain soil temperature. Therefore, keeping this all points of consideration research is carried out to study the effect of land configuration on growth, yield and nodulation of soybean also the effect of sowing date on growth, yield and nodulation of soybean in *kharif* season.

Material and Methods

The present field experiment was conducted during *kharif season* of 2022 at Agronomy section, College of Agriculture, Latur (Maharashtra**).** The average annual rainfall of Latur is 978 mm which receives mostly from 'South- West monsoon'. The experiment was laid out in Split Plot Design with three replications. The treatments were combination of three land configuration and three different sowing dates. The treatment in concern of two factors main factor is land configuration *viz*. L_1 (Flatbed), L_2 (Ridges and furrow), L_3 (Broad bed furrow) and sub factor is sowing date D_1: 8th July (27 MW), D_2: 23rd July (30 MW), D_3: 8th August (32 MW). The soil of experimental plot was clayey in texture, low in available nitrogen (235 kg ha^{-1}), medium in available phosphorous (17.53 kg ha^{-1}) and very high in available potassium (446 kg ha^{-1}). The soil was moderately alkaline in reaction having pH (7.8). The crop was provided with spacing of 45 cm × 5 cm (dibbling), plot size of 5.40 × 4.50 m. Standard cultivation practices followed uniformly in all experimental plots. Data obtained on various variables were analysed.

Results and Discussion

Effect of land configuration

The effect of land configuration was observed on important growth parameters *viz.* plant height (cm plant^{-1}), number of branches plant^{-1}, number of leaves plant^{-1}, leaf area plant^{-1}, number of nodules plant^{-1} and dry matter accumulation plant^{-1} (g).

Growth parameters

The plant height (cm) and dry matter accumulation plant^{-1} (g) increased at every stage of crop growth till maturity. The mean number of branches plant^{-1} increased up to 75 DAS and were constant at harvest. The number of functional leaves and leaf area plant^{-1} increased up to 60 DAS and then decreased towards maturity due to senescence of leaves.

The sowing of soybean on broad bed furrow (L_3) recorded significantly higher plant height (47.80 cm), number of branches plant^{-1} (9.30), number of leaves plant^{-1} (36.44), leaf area plant^{-1} (20.78 dm^2), dry matter accumulation plant^{-1} (19.04), number of root nodules plant^{-1} (31.15) and number of pod plant^{-1} (43.07) than the sowing of soybean on ridges and furrow (L_2) and it was found superior over flatbed (L_3). Similar results were recorded by Lakhera Vishnuprakash (2008) [9], Barfa Vinod (2016) [3] and Gupta *et al.* (2017) [6].

Yield and yield parameters

The effect of different land configuration found significant on yield and yield attributes. The maximum number of seeds pod^{-1} (3.09), number of seeds plant^{-1} (126.93), weight of pod plant^{-1} (11.76 g), weight of seeds plant^{-1} (8.27 g) and the highest test weight (112.14 g) were recorded with the sowing of soybean on broad bed furrow (L_3) than flatbed (L_1) and it was comparable with the ridges and furrow (L_3) method of sowing. The maximum seed yield (1709 kg ha^{-1}), straw yield (2389 kg ha^{-1}), biological yield (4098 kg ha^{-1}) and harvest index (41.70%) were found with the sowing of soybean on broad bed furrow (L_3) which was superior over sowing of soybean on flat bed method (L_1). Similar results were recorded by Lakhera Vishnuprakash (2008) [9], Barfa Vinod (2016) [3], Dhale S.Y (2017) [5] and Gupta *et al.* (2017) [6].

Economics

The higher gross monetary returns (Rs. 67,505 ha^{-1}) and net monetary returns (Rs. 24,475 ha^{-1}) were obtained by sowing of soybean on broad bed furrow (L_3) followed by sowing of soybean on ridges and furrow (L_2) and lowest GMR was recorded with sowing of soybean on flat bed (L_1). The highest B:C ratio (1.56) was obtained with the sowing of soybean on broad bed furrow (L_3) whereas, lowest B:C ratio (1.30) was obtained with the sowing of soybean on flat bed (L_1) method of sowing. Similar results were recorded by Lakhera Vishnuprakash (2008) [9], Barfa Vinod (2016) [3] Dhale S.Y (2017) [5] and Gupta *et al*. (2017) [6].

Effect of sowing date

Growth parameters

The plant height (cm) and dry matter accumulation (g plant^{-1}) increased at every stage of crop growth till maturity. Number of branches plant^{-1} increased up to 75 DAS and were constant at harvest. The number functional leaves and leaf area increased up to 60 DAS and then decreased towards maturity due to senescence of leaves. Sowing of soybean on D_1 (8th July) recorded significantly higher plant height (48.79 cm), number of branches plant^{-1} (9.34), number of leaves plant^{-1} (37.51), leaf area plant^{-1} (19.63 dm^2), number of root nodules plant^{-1} (30.76), dry matter accumulation plant^{-1} (18.74 g) and number of pods plant^{-1} (42.50 g) than the sowing of soybean on D_2 (23rd July) and it was found superior with late sowing of soybean on D_3 (8th August). Similar results were recorded by Kumar and Badiyala (2005) [8], Pawan Patel (2008) [12], Hakimullah Azizi (2014) [7], Mukesh Kumar (2016) [11] and Zole S. A (2018) [18].

Yield and yield attributes

The effect of sowing date found significant on yield and yield attributes. The maximum number of seeds pod^{-1} (3.21), number of seeds plant^{-1} (123.90), weight of pod plant^{-1} (12.45 g), weight of seeds plant^{-1} (8.06 g), seed yield (1966 kg ha^{-1}), straw yield (2624 kg ha^{-1}), biological yield (4590 kg ha^{-1}) and harvest index (42.84%). The highest test weight (112.69 g) were recorded with the sowing of soybean on D_1 (8th July) followed by sowing of soybean on D_2 (23rd July) and lowest test weight (109.16 g) was observed in sowing of soybean on D_3 (8th August). Similar results were recorded by Billore *et al.* (2000) [4], Pederson and Joseph (2004) [13], Robinson *et al.* (2008) [17], More, U. M. (2012) [10] and Rehman *et al.* (2014) [16].

Economics

The higher gross monetary returns (Rs. 77,657 ha^{-1}) and net monetary returns (Rs. 34,894 ha^{-1}) were obtained by the sowing of soybean on D_1 (8th July) and it was significantly superior over the sowing of soybean on D_2 (23rd July) and D_3 (8th August). The

highest B:C ratio 1.81 was obtained with the sowing of soybean on D_1 (8th July) whereas lowest B:C ratio 1.09 was obtained with the sowing of soybean in D_3 (8th August). Similar results were recorded by Raghuwanshi Sadhana (2016) [14], Mukesh Kumar (2016) [8], Zole S. A (2018) [18] and Abdullah Saqib (2021) [1].

Interaction effect

The effects of interaction between different land configuration and sowing date on growth and yield attributes, quality and economics of soybean were non-significant.

Table 1: Effect of land configuration on growth and yield of soybean on different sowing dates during *kharif* season

Treatments	Growth attributes						Yield attributes				
	Plant height (cm)	No. of branches plant^{-1}	No. of leaves plant^{-1}	Leaf area plant^{-1}	Dry matter plant^{-1}	No. of nodules plant^{-1}	Number of seeds pod^{-1} (g)	Seed yield plant^{-1} (g)	Pod yield plant^{-1} (g)	Number of seeds plant^{-1}	Test weight (g)
Land configuration (L)											
L_1- Flat bed	37.31	6.45	25.88	14.08	15.73	20.82	2.40	5.38	9.53	95.94	109.86
L_2- Ridges and furrow	46.16	8.34	32.25	17.53	18.09	27.40	2.89	7.13	10.45	120.03	111.32
L_3- Broad bed furrow	47.80	9.30	36.44	20.78	19.04	31.15	3.09	8.27	11.76	126.93	112.14
S.E (m) ±	1.82	0.34	0.43	0.37	0.43	1.05	0.08	0.38	0.38	2.41	0.93
C.D at 5%	7.18	1.36	1.69	1.48	1.67	4.15	0.35	1.51	1.51	9.47	NS
Sowing date (D)											
D_1- 8th July (27 MW)	48.79	9.34	37.51	19.63	18.74	30.76	3.21	8.06	12.45	123.90	112.69
D_2- 23rd July (30 MW)	46.36	8.37	31.17	17.45	17.64	26.61	2.85	7.24	10.73	118.31	111.46
D_3- 8th Aug (32 MW)	36.12	5.87	25.89	15.32	16.48	21.99	2.33	5.47	8.56	100.69	109.16
S.E (m) ±	1.51	0.28	0.83	0.41	1.39	1.01	0.11	0.27	0.37	2.95	0.96
C.D at 5%	4.66	0.88	2.55	1.27	4.29	3.11	0.34	0.84	1.15	9.11	NS
Interaction (L × D)											
S.E (m) ±	2.93	0.49	1.61	0.71	0.80	1.75	0.19	0.47	0.64	5.12	1.67
C.D at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	43.75	8.03	31.52	17.46	17.62	26.46	2.79	6.92	10.58	114.30	111.10

Table 2: Effect of land configuration on yield and economics of soybean on different sowing dates during *kharif* season

Treatments	Yield attributes				Oil content (%)	Oil yield (kg/ha)	Economics			
	Seed yield (kg/ha^{-1})	Straw yield (kg/ha^{-1})	Biological yield (kg/ha^{-1})	Harvest index (%)			Gross monetary returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C Ratio
Land configuration (L)										
L_1- Flat bed	1361	1966	3328	40.90	18.28	249	53759	41230	12529	1.30
L_2- Ridges and furrow	1641	2331	3971	41.37	18.53	307	64859	44030	20829	1.47
L_3- Broad bed furrow	1709	2389	4098	41.70	19.69	323	67505	43030	24475	1.56
S.E (m) ±	34	29	64	-	0.30	8.35	1379	-	1379	-
C.D at 5%	137	115	252	-	NS	NS	5415	-	5415	-
Sowing date (D)										
D_1- 8th July (27 MW)	1966	2624	4590	42.84	18.95	359	77657	42763	34894	1.81
D_2- 23rd July (30 MW)	1561	2223	3785	41.27	18.87	299	61659	42763	18896	1.44
D_3- 8th Aug (32 MW)	1185	1838	3023	39.22	18.67	222	46807	42763	4071	1.09
S.E (m) ±	49	52	100	-	0.39	8.03	1947	-	1947	-
C.D at 5%	151	160	310	-	NS	NS	6001	-	6001	-
Interaction (L × D)										
S.E (m) ±	85	90	174	-	0.962	13.92	3373	-	3373	-
C.D at 5%	NS	NS	NS	-	NS	NS	NS	-	NS	-
General mean	1570	2229	3799	41.21	18.83	293	62041	42763	19278	1.44

Fig 1: Field View Experimental plot

Conclusion

This study demonstrates that broad bed furrow (L3) is the most effective land configuration for enhancing soybean growth, yield, and economic returns. Compared to flat bed (L1) and ridges and furrow (L2) methods, broad bed furrow consistently achieved superior results in plant height, dry matter accumulation, pod and seed yield, and overall profitability. Additionally, early sowing on 8th July (D1) significantly outperformed later sowing dates in terms of growth parameters, yield attributes, and economic returns. The interaction between land configuration and sowing date did not show significant effects, suggesting that broad bed furrow combined with early sowing is generally the best approach for optimizing soybean production in the kharif season. This research highlights the importance of adopting appropriate land management practices and timely sowing to maximize soybean productivity and profitability.

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