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Evaluation of yield and economics of soybean cultivation under different land configuration in Malwa region of Madhya Pradesh

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Abstract
The field experiment was carried out during two consecutive (*kharif* 2019 and 2020) at farmers field in the Dewas district of Madhya Pradesh. The experiment was laid out by the using of randomized block design (RBD) with eight replications. The treatments were consisting of three sowing methods as land configuration i.e. T_1- Sweep Blade type, T_2- Broad bed and furrow (BBF) and T_3- Furrow Irrigated Raised Bed System (FIRBS). Results reveled that among the different land configuration treatment, significantly higher plant height (50.8 cm) and number of branches/plant (4.29) was recorded under FIRBS method which was at par with BBF method (49.6 cm and 4.22, respectively). Similarly, the maximum pods/plant (29.21), seed yield/plant (11.33 g), 100-seed weight (11.0 g) and seed yield (1184 kg/ha) were recorded under FIRBS method it was found statistically similar with BBF method. The FIRBS and BBF method give 23.3 and 15.2 per cent higher yield over sweep blade type seed drill. The highest gross returns (Rs. 47365 /ha), net returns (Rs. 22974 /ha) and B: C ratio (1.94) was also noted with FIRBS method followed by BBF.

Keywords: BBF, FIRBS, land configuration, Malwa, soybean, yield

Introduction
Rainfed agriculture occupies 60% net sown area of the country, contributing 44% of total agriculture production with an average productivity of one tonne/ha and supporting 40% of the total production. Over 87% of coarse cereals and pulses, 55% of upland rice, 70% of oilseeds and 65% of cotton are cultivated under rainfed agriculture (Dhale *et al*., 2021) [3]. Among the rainfed crops, soybean (*Glycine max* L. Merrill) is one of the economical and valuable seed legumes which have 25% contribution in global edible oil. The spread of the soybean in different regions of the country resulted into parallel growth of the oilseed industries and also earning foreign exchange through export of soy-meal (Khandkar *et al*., 2019 and Rahangdale *et al*., 2021) [10, 15]. Currently Madhya Pradesh accounts for nearly 87% of the area under the crop in the country and contributes about 83% of the total national production. Madhya Pradesh is known as 'soy-state' (Morya *et al*., 2018 and Tomar *et al*., 2018) [13, 19]. Soybean mainly grown in the rainfed condition and it is important for the livelihood of small and marginal farmers. Soybean contributes 43 per cent to the total oilseeds and 25 per cent to the total oil production in India and ranks fourth in respect to production of soybean in the world (Tomar *et al*., 2018 and Kumawat *et al*., 2021) [19, 11]. The soybean crop presently covers an area of about 12 million hectares with a total production of about 14 million tones (Rahangdale *et al*., 2022) [14].

Vagaries of monsoon and prolonged dry spells affect crop growth and yield and significantly in Malwa region of Madhya Pradesh. Even under normal rainfall situation crop failures are occurring due to moisture stress due to occurrence of dry spells occurred particularly during critical crop growth stages (Verma *et al*., 2018) [20]. For sustainable production, suitable in-situ conservation practices may ensure higher productivity by saving the crops during limiting and non-limiting moisture condition through safe disposal of runoff or its retention for profile moisture as and when required. Hence, it is necessary to exploit the technologies for in-situ moisture conservation like tillage, land configurations, mulching etc. (Rajput *et al*., 2009 and Mohanty *et al*., 2017) [16, 12].

Among the in-situ moisture conservation methods, BBF (Broad bed furrow) approach is known for its water conservation, automated weeding, fertilizers placement, available moisture

conservation, decreased lodging, and enhanced crop stand. In-situ conservation makes the moisture available for the sown crop. In rainfed farming, appropriate equipment to conserve rain water *in-situ* is required to keep up adequate moisture during the various developing stages of the crop (Swapna *et al*., 2020a) [18]. Furrow irrigation raised bed (FIRB) farming system for wheat was originally developed in Maxico's Yaqui Valley, single row was planted on top of the each bed for crops like maize, soybean, cotton, sorghum, sunflower and dry bean; 1-2 rows per bed were planted for crop like chickpea and canola; but 2–4 rows were planted for wheat. Upland crops grown on soils in high rainfall areas (>1000 mm), mainly soybean and maize, were prone to temporary water-logging and anaerobic conditions (Rajput *et al.*, 2009 and Verma *et al*., 2018) [16, 20]. Jadav *et al.* (2021) [7] also reported that excess rainfall during recent years severely affects the *kharif* crops production, therefore, urgent needs to adopt new sowing techniques which can be mitigate adverse effect of climate change on soybean production. To keep in mind the rainfall variation, this study was conducted to evaluate soybean yield and economics performance under different land configuration.

Materials and Methods

The field experiment was carried out during *kharif* 2019 and 2020 at farmers field in Dewas district of Madhya Pradesh. The experimental area having clayey soil (clay 59.3%, silt 30.42% and sand 10.28%) with medium to deep in depth. Soil having pH of 7.4 and containing 0.44% organic carbon, available of nitrogen, phosphorus and potash in the soil were 189 kg/ha, 17.3 kg/ha and 265 kg/ha, respectively. The present experiment was laid out by the using of randomized block design (RBD) with eight replications. The treatments were consisting of three sowing methods as land configuration i.e. T_1- Sweep Blade type, T_2- Broad bed and furrow (BBF) and T_3- Furrow Irrigated Raised Bed System (FIRBS). The plot size was 10.0 m x 5.40 m. Seed rate for soybean was 80 kg/ha and row to row spacing was maintained at 45 cm. The recommended dose of 20:60:40 kg N: $_2O_5$: K_2O basal were applied as basal. JS 95-60 verity of soybean was sown for the experiment. Hand weeding was done to remove weeds from the experiment field. At 30 days after sowing, spray of Chloropyrifos 50% + Cypermethilin 5%@ 1.0 lit/ha was done for control pests. Normal annual rainfall of the area is 954.0 mm whereas during 2019-20 annual rainfall occurred 1565.4 mm. The rainfall pattern was too much deviate from the normal values.

The plant growth character and yield contributing data such as plant height, number of branches/plant, number of pods/plant, seed yield/plant seed index and seed yield (kg/ha) were recorded at harvest of crop. The cost of cultivation, net returns and benefit: cost ratio (B: C ratio) were calculated by using prevailing prices of inputs and outputs. The standard error of means (S Em ±) and least significant difference (LSD) at 5% probability (P=0.05) were used to compare the treatments and draw valid conclusions.

Results and Discussion

Effect of land configuration on growth characters

The growth characters i.e., plant height and number of branches/plant was significantly affected by different land configuration methods (Table 1). Significantly higher plant height (50.8 cm) and number of branches/plant (4.29) was recorded under furrow irrigated raised bed system (T_3) which was statistically comparable with broad bed furrow (49.6 cm and 4.22, respectively). While the lowest plant height and branches/plant was observed in sweep blade type seed drill (45.0 cm and 3.87, respectively). The increase in growth parameters was mainly due to proper drainage of excess rainfall through furrows. Dhakad *et al*. (2019) [1] concluded that FIRB method gave better growth characters of soybean in comparison to conventional seed drill. Similar findings were also made in line with Verma *et al*. (2018) and Gurav *et al*. (2022) [20, 5].

Table 1: Pooled data for two years of Growth and yield attributes of soybean as influenced by different land configuration

Treatments	Plant height (cm)	Number of branches /plant	Number of pods /plant	Seed yield/ plant (g)	100-seed weight (g)	Seed yield (Kg/ha)	% increase
T1-Sweep Blade type Seed Drill	45.0	3.87	23.08	9.94	9.9	960	0.0
T2-Broad Bed Furrow (BBF)	49.6	4.22	28.21	10.94	10.6	1106	15.2
T3-Furrow Irrigated Raised Bed System (FIRBS)	50.8	4.29	29.21	11.33	11.0	1184	23.3
SEm (±)	0.69	0.06	0.79	0.16	0.12	1083	-
CD at 5%	2.01	0.17	2.28	0.47	0.35	16.4	-

Table 2: Pooled data for two years of soybean economics influenced by different land configuration

Treatments	Cost of Cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C Ratio
T1-Sweep Blade type Seed Drill	23551	38400	14849	1.63
T2-Broad Bed Furrow (BBF)	23941	44250	20309	1.84
T3-Furrow Irrigated Raised Bed System (FIRBS)	24391	47365	22974	1.94
SEm (±)	-	-	646	0.03
CD at 5%	-	-	1870	0.08

Effect of land configuration on yield attributing characters and yield

Seed yield of soybean as affect by various land configuration methods (Table 2). Highest seed yield of soybean (1184 kg/ha) was recorded under FIRBS (T_3) method and it was closely followed by BBF (T_2) 1106 kg/ha were registered 23.3 and 15.2 per cent higher seed yield over control, respectively. This could be because, in comparison to other planting methods, porous media supplied the accurate balance of air and water for the development of the soybean crop. Due to the FIRBS and BBF, additional yield contributing characters such as no. of pods/plant and 100-seed weight have all increased significantly, resulting in increased seed yield. This supported our results. Dhakad *et al*. (2020) [2] shows that yield enhancement to the extent of 33.3% for soybean in raised bed planting over others. Jain (2019) [8] also revealed that planting

soybean on broad bed furrow system enhances the productivity by 21.19 per cent as compared to farmer's practice (flatbed planting). These findings are compatible with Swapna *et al*. (2020b) and Gurav *et al*. (2022) [17, 5].

Effect of land configuration on economics

The economics of soybean were influenced significantly by different land configuration practices (Table 2). Among the various treatment, significantly highest cost of cultivation (Rs. 24391), gross returns (Rs. 47365 /ha), net returns (Rs. 22974 /ha) and B:C ratio (1.94) were recorded with FIRBS method which was at par with BBF method (Rs. 23941 /ha, Rs. 44250 /ha, Rs.20309 /ha and 1.84, respectively). This was mainly due to higher seed yield was obtained. Jha *et al*. (2014) revealed that that net returns and B:C ratio were higher for the raised bed than other method combinations. In another study Gupta *et al.* (2018) also found higher net return of 25792 Rs/ha with B:C ratio of 2.36 under FIRB drill as compared to lower net return 18735 Rs/ha with B:C ratio of 2.00 for soybean cultivation under conventional seed drill. These findings are in conformity with Hari *et al*. (2013), Dhale *et al*. (2021) and Gurav *et al*. (2022) [3, 5, 6].

Conclusion

It can be concluded that higher productivity with maximum net return of soybean can be achieved by FIRBS and BBF land configurations under *Malwa* region of Madhya Pradesh. These techniques also proved as climate smart technique for growing of soybean under rainfed condition.

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