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Performance of Ridge and Furrow System on the Growth and Yield Attribution of Soybean in Barwani District of M.P. India

A.L. Basediya[1*], Sunita Mishra[2], Rajesh Gupta[3], P. Kumar[4] and S.S. Basediya[5]

[1](Agril Engg), Krishi Vigyan Kendra (RVSKVV) Shivpuri (MP)-473551, India
[2]Krishi Vigyan Kendra (RVSKVV) Aron, Guna (MP), India
[3](Agril. Engg), Krishi Vigyan Kendra (RVSKVV) Mandsaur, India
[4]Krishi Vigyan Kendra (RVSKVV) Shivpuri, India
[5]College of Agriculture Engineering, J.N.K.V.V., Jabalpur, India

**Corresponding author*

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A B S T R A C T

The field experiment was conducted during the two consecutive *Kharif* season of 2011 and 2012 to study ridge and furrow in-situ conservation system for soybean crop at farmer's fields in Badwani district of Madhya Pradesh under Nimar agro-climatic region. Result showed that growth and yield contributing character *viz*. plant population, plant height, root length, root nodules, pods per plant, seed yield weight per plant, seed yield, straw yield and harvest index (%) found higher in ridge and furrow system compared to the normal flatbed sowing method which subsequently resulted in yield enhancement to the extent of 8-23 % for soybean crop. Economic analysis revealed that the net profit was recorded higher under ridge and furrow system compared to normal flatbed sowing. B: C ratio was recorded as 3.35 and 3.23 under ridge and furrow system while 2.83 and 2.77 under flat sowing system for the year of 2011 and 2012 respectively.

Introduction

Soybean (*Glycine max* L.) ranks first amongst oilseed crops in the world and it contributes nearly 25 per cent of worlds total oil and fat production. In India, soybean is topmost oilseed crop currently covering 11.23m ha area with expected production of 14.22 millions tones and productivity of 1266 kg per ha (Jadon, 2016). Madhya Pradesh is known as the "soybean state" of India, comprising 55% of the total national area 5.56 million hectare of soybean cultivation. Soybean has established its reorganization as both pulses and an oilseed crop. It is the cheapest and richest source of high quality protein containing 38-44% protein and 18-22% oil. It supplies most of the nutritional constituents essential for human health. Hence, soybean is called as wonder crop or golden bean or miracle bean. India is the third largest importer of soya oil in the world and is one of the major exporters of soya meal to the other Asian countries (Anonymous, 2013). The average annual rainfall in Barwani district assured 676 mm per annum. The rainfed agriculture suffers from a number of hydro-physical and socio-economic constraints,

which affect the productivity of rainy and post-rainy season crops. These include erratic and undependable rainfall, excess and deficient moisture with in a season, harsh thermal regime, soil loss, low level of input use and technology adoption and resource poor farmers (Gupta, 2002). Soybean is a major crop grown during the Kharif season in the rain fed areas of central India.

The flat-land cultivation system is popular in Nimar Agro-climatic zone of Madhya Pradesh state. The crop experiences moisture stress during the dry spell ranging from 15 to 21 days at any growth stage under rainfed conditions, resulting significant reduction in the yield. These yield losses are expected at higher level especially in early genotype with determinate types. At present for extensively cultivation of Kharif crop like soybean which faces the problem of water logging and poor aeration thereby affecting crop productivity adversely. Among all legumes soybean is most sensitive to soil moisture. After few showers the monsoon rains in July – August are usually heavy and frequent. Under such situation water logging is a common problem which affects early growth, root proliferation and final yield performance of crop. Excess and continuous rains may create bad drainage and restricts aeration, which results in non-availibility of plant nutrients and poor microbial activities. Extreme variability in the quantity, time and duration of rains expose the soybean crop to soil moisture deficit as well as excess moisture either on account of delayed monsoon, longer dry spells or early withdrawal mansoon has been identified as one of the major factors for poor performance of soybean crops (Tiwari,2014; Gupta et. al., 2018). During to extreme rainfalls events, soybean crop gets also affected by water logging problems due to improper drainage. Water logging adversely affects the growth of crops, primarily due to reduced oxygen supply to the roots

The loss in 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. Whereas, at the same time there should be provision for drainage of excess rain water. Under such condition soybean planted on ridges yielded considerably higher than planted on flat bed (Saraf and Ahlawat, 1975) and (Patil *et al.*, 2010). Studies on soil management for increasing crop production revealed that use of various tillage methods and modification of land configurations such as broad bed furrow, ridges and furrow for soybean in vertisols were superior over flat bed and recommended in watershed development for moisture conservation as well as for safe removal of excess rain water (Raut and Taware, 1997). The small change through land configuration in flat field conditions may help in improving the productivity of Kharif crops in Vertisols of Nimar region. There is a need for in-situ soil and water conservation and proper drainage technology in black soils. This technology has many advantages including in-situ conservation of rainwater in furrows, better drainage of excess water and proper aeration in the ridge and root zone. More than 300 farmers in Barwani district adopted the technology. Majority of the area under soybean –wheat based cropping system is in Central India and is covered under Vertisols and associated soils (Bhatnagar and Joshi 1999). These soils are potentially productive, if managed properly in terms of overcoming soil, water and nutrient management constraints.

Now, the only way to increases the production of soybean left is to make concerted efforts in improvement in productivity of crops. Besides, other techniques the *In-situ* conservation of rainwater at farm level by adopting holistic approach to the management of rainwater like broad-bed and furrow, ridge and furrow, tied ridging, raised and sunken

bed and compartmental bunding etc. by which crop productivity is substantially increased. Land treatments (raised sunken bed system, ridges and furrows, broad bed and furrows) increased *in situ* soil moisture conservation, minimized runoff, and soil erosion (Singh et.al., 1999 and Nagavallemma *et al.,* 2005) and increased the yield of principal crops grown in the region (Mandal *et al.,* 2005; Rajput *et al.,* 2009). Hari Ram *et al.,* 2012 concluded that raised bed, raised broad bed and ridge furrow sowing of soybean should be advocated over flatbed sowing mainly due to their ability to save irrigation water.

The strategy for soil moisture management is therefore; to maximize use of rainfall by increasing infiltration and moisture retention, encourage surface drainage and reducing runoff and soil erosion for getting high yield. In view of the above fact the study was undertaken. This paper presents the results of ridge and furrow system on growth and yield of soybean crop in Barwani district of MP.

Materials and Methods

The field experiment was conducted at the farmer's fields in Barwani district of Madhya Pradesh during Kharif seasons 2011 and 2012. The field study was performed with ridge and furrow system. To make the ridge and furrow system an extra punji is attached on the back tines of tractor operated seed-cum-fertilizer drill machine.

The width of panji depends upon the row to row distances. Sowing seeds by front line tines and covering them by soil took place by punji attached in back line tines. Thus lines of soybean automatically come over ridge favoured by formation of alternate furrows. This ridge and furrow system involves sowing of crop at a row spacing of 30 cm while in flat sowing method is done at a row 22 cm in medium black soil. The average rainfall of 562.2 and 469.9 mm received during the year 2011 and 2012 respectively. The soybean crop (variety JS 95-60) was sown for the study. The recommended fertilizer dose of 30 kg N and 60 kg P2O5/ha was applied as urea (46% N) and single superphosphate (16% P2O5) before sowing soybean.

The plant growth character and yield contributing data such as are plant height, root length, number of root nodules per plant, number of pods per plant, number of seeds per pod, seed yield per plant, seed yield and straw yield were recorded of soybean crop for sown by ridge and furrow system and flat sowing.

Harvest index is the ratio of economic yield (kg/ha) to biological yield (kg/ha) and multiplied by 100 to obtain its value in percentage. It indicates the efficiency of plant material to convert the photosynthate in to the economic yield and it is worked out as:

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological yield (kg/ha)}} \times 100 \quad (1)$$

Where, the biological yield = Seed yield + Stover yield

Economic analysis

Cost of cultivation

The cost of cultivation (Rs/ha) of each treatment was worked out by considering the price of inputs, charges for cultivation, labour and other charges.

Gross monetary returns

The gross monetary returns (Rs/ha) occurred due to different treatments in the present study were worked out by considering market prices of economic product, by product and crop residues during the experimental year.

Net monetary returns

The net monetary returns (Rs/ha) of each treatment were worked out by deducting the mean cost of cultivation of each treatment from the gross monetary returns gained from the respective treatments.

Benefit: Cost ratio

The benefit: cost ratio of each treatment was calculated by dividing the gross monetary returns by the mean cost of cultivation

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Growth and yield attributing characteristics of soybean

Growth and yield attributing characteristics of soybean are presented in Table 1. Table revealed that the plant growth and yield parameters were found better in ridge and furrow system as compared to normal flatbed sowing. Its due to proper drainage of excess rainfall through furrows. Similar results were reported by Ralli and Dhingra (2003) and he found that the higher nodule count under ridge sowing when compared with flat sowing for soybean crop.

The plant population/m^2 ranged 17-18 % higher on planting soybean using ridge and furrow seed cum fertilizer drill machine as compared to planting on flat land with normal seed drill. The lowest number of root nodules per plant was recorded under flatbed sowing; however, highest number of root nodules per plant was produced under ridge and furrow system. The highest productivity of 1564 kg/ha observed in the ridge and furrow system where as it was found lowest under normal flatbed sowing (1271 kg/ha) for year 2011 and same trend was observed in the year 2012 also. Similar result was reported by Verma (2008) for productivity of soybean in Vertisols. He reported that ridge and furrow sowing and broad bed and furrow sowing produced significantly higher growth parameters, yield and yield attributes and root parameters as well. He found higher seed and straw yield under modified land configurations as compared to the traditional planting system. Jat and Singh (2003) reported higher biological yield from land configuration treatment as compared to conventional system. Ram *et al.,* (2011) also concluded that ridge and furrow sowing of soybean should be advocated over flatbed sowing mainly due to their ability to save irrigation water. Kumari and Rao (2005) reported that the crop growth rate and net assimilation rate were higher when crops are planted on ridge and furrow or bed planting system for mustard. Jadav *et al.,* (2012) and Dhakad *et al.,* (2014 and 2015) found higher growth parameters, yield and yield attributes parameters in ridge and furrow system over flat sowing system in soybean. Similar trends reported by Bhargav *et al.*, (2013).

Economics analysis

Economic analysis of soybean is presented in Table 2. It reveals that higher net return of Rs 32920 per ha with B: C ratio of 3.35 is recorded in ridge and furrow system whereas, the lowest net return of Rs 24660 per ha with and B: C ratio of 2.82 was recorded under normal flatbed sowing for year 2011 and same trends observed during year 2012. Similar results reported by Jain and Dubey (1998); Jat and Singh (2003); Verma (2008), Bhargav *et al.,* (2013) and Dhakad *et al.,* (2014 & 2015). They concluded that the higher gross as well as net monetary returns were recorded under ridge and furrow planting as compared conventional system.

Table.1 Growth character and field attributes of soybean

Parameters	Ridge and furrow system		Normal flatbed sowing		% change over control in 2011	% change over control in 2012
	Kharif 2011	Kharif 2012	Kharif 2011	Kharif 2012		
Plant population (No./m^2)	46.4	48.2	39.4	40.6	17.77	18.72
Plant height (cm) at harvest	68.4	70.2	61.4	60.8	11.40	15.46
Root length (cm) at 60 DAS	24.8	25.6	19.2	20.2	29.17	26.73
Number of root nodules per plant at 60 DAS	30.8	31.2	25.2	26.6	22.22	17.29
Number of pods per plant	49.43	50.22	36.1	37.38	36.93	34.35
Seed yield weight per plant (g)	5.84	5.86	4.85	4.99	20.41	17.43
Seed yield (kg/ha)	1564	1510	1271	1395	23.05	8.24
Straw yield (kg/ha)	1821	1705	1490	1596	22.21	6.83
Harvest index (%)	46.20	45.81	46.03	46.64	0.37	0.70

Table.2 Economics analysis of soybean production

Parameters	Ridge and furrow system		Normal flatbed sowing		% change over control in 2011	% change over control in 2012
	Kharif 2011	Kharif 2012	Kharif 2011	Kharif 2012		
Net returns (Rs/ha)	32920	31300	24660	24000	33.50	30.42
Benefit: cost ratio	3.35	3.23	2.82	2.77	18.79	16.61

On the basis of this study, the better results of two consecutive years were found in ridge and furrow planting system on the growth and yield characters of soybean as compared to conventional method of sowing i.e. normal flatbed sowing. It is concluded that ridge and furrow sowing of soybean should be advocated over flatbed sowing mainly due to the soil moisture stored sustains the crop during dry spells.

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