RESEARCH ARTICLE

INFLUENCE OF CROP CONFIGURATION AND SEED RATE ON YIELD ATTRIBUTES, YIELD AND QUALITY OF SOYBEAN [*GLYCINE MAX* (L.) MERRILL]

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Abstract: A field experiment was carried out during *kharif* 2014 to investigate the effects of crop configuration and seed rates on yield and yield components of soybean. Experiment was conducted in the split plot design with four crop configuration (Broadcast method of sowing, Cross sowing 30 cm apart, Closed space sowing 20 cm apart and Recommended Spacing of sowing at 30 cm) as main plot and four seed rates (50, 65, 80 and 95 kg/ha) as sub plot. Results revealed that significantly higher number of pods and seeds per plant, seed and stover yield, Productivity rating index (PRI) and Production efficiency (PE) were obtained in recommended spacing of sowing at 30 cm. Crop sown with seed rate 95 kg ha^{-1} recorded significantly highest seed and stover yield, PRI and PE and was at par with 80 and 65 kg ha^{-1}. Number of seeds pod^{-1}, 100 seed weight, oil and protein content were not affected significantly by crop configuration and seed rates. Interaction between recommended spacing of sowing at 30 cm and 65 kg seed ha^{-1} gave highest seed yield which was at par with seed rate 80 and 95 kg ha^{-1}.

Keywords: Crop configuration, Seed rate, Soybean, Yield

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) designated as 'miracle bean' and it is one of the major oilseed crops in India. It contains 20 % cholesterol free oil and 40 % good quality protein. Soybean mainly on account of its dietic, industrial, agricultural and medicinal importance, its products have various uses. The Soya meal is an important human food and Soya flour is essential in the various preparations *viz*, bread, cakes, muffins, biscuits and pastry. As a medicament, the soybean is of great importance in diabetic dietary. It improves the fertility status of soil by fixing atmospheric nitrogen through the root nodules and leaf fall on the ground at maturity. The nodulated soybean plants can fix about 94 kg nitrogen ha^{-1} in one season (Sattar, 2001).

In India, soybean occupies an area of 10.91 m ha with the production and productivity of 10.37 million tonnes and 951 kg ha^{-1}, respectively (Anon., 2014). In India, Madhya Pradesh and Maharashtra are the leading producers of soybean. In Chhattisgarh, the total area under cultivation is 1.470 lakh ha with production of 1.345 lakh tonnes and average productivity of 915 kg. (Anon., 2014).

Among various factors influencing yield of soybean, Suitable method of sowing with optimum spacing and seed rate influences yield and yield attributing characters of soybean. Optimum row spacing would ensure proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, land as well as air spaces and water. Similarly seed rate is very important in context of maintaining optimum plant population. Too low and high plant population beyond a certain limit often adversely affects the crop yield. The relative equidistant plant distribution leads to increased leaf area development and greater light interception early in the season. This increases crop growth rate, dry matter accumulation and seed yield (De Bruin and Pedersen, 2008). In view of the above facts, present investigation was carried out to find a fair combination of suitable sowing method with optimum spacing and seed rate to achieve maximum productivity of soybean.

MATERIAL AND METHOD

The experiment was conducted at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh during *kharif* season of 2014. The soil of the experimental field was clay in texture with soil pH was neutral in reaction (7.2). The soil organic carbon content was medium (0.65%). The soil was low in available nitrogen (238.33 kg ha^{-1}), medium in available phosphorus (18.81 kg ha^{-1}) and high in available potassium (386.4 kg ha^{-1}). The field was uniformly fertilized @ 25:80:50 kg ha^{-1} through Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP), respectively, at the time of sowing. The variety of soybean used in the experiment was 'JS 97-52' (Jawahar Soybean 97-52). The experiment was laid in split plot design with three replications. The treatment comprised of four crop configuration in main plot *viz*. C_1: Broadcast method of sowing, C_2: Cross sowing 30 cm apart, C_3: Closed space sowing 20 cm apart and C_4: Recommended Spacing of

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sowing (30 cm) and four seed rates in sub plot *viz.* S_1: 50, S_2: 65, S_3: 80 and S_4: 95 kg ha^{-1}. The data on pods plant^{-1}, seeds pod^{-1} and number of seeds plant^{-1} were collected at the time of harvest. From the total produce of each plot, 100 seeds were counted and weighted 100 seed weight (g). The data on biological yield and seed yield were collected at the time of harvest. Harvest index, Productivity rating index (PRI) and Production efficiency (PE) were calculated by following formulae.

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

$$\text{Productivity rating index} = \frac{\text{Yield obtained from experimental plot (kg ha}^{-1})}{\text{Standard yield (kg ha}^{-1})}$$

$$\text{Production efficiency (kg ha}^{-1}\text{ day}^{-1}) = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Duration of the crop (days)}}$$

The seeds were ground for estimation of N and oil contents. Total nitrogen content of the seeds was determined by Kjeldahl method (Jackson, 1967). N values were multiplied by 6.25 to calculate total crude protein (TCP). The oil content was determined with the help of with the help of Socs plus solvent extractor using acetone as solvent. The percent of oil present in a sample was calculated with the help of following formula.

$$\text{Oil content (\%)} = \frac{W2-W1}{W} \times 100$$

Where,
W1 = Initial weight of beaker
W2 = Final weight of beaker (beaker + oil)
W = Weight of powdered sample (1 g)
All the data were recorded for different characters under investigation were analyzed by following analysis of variance procedures described by Gomez and Gomez (1984).

RESULT AND DISCUSSION

Yield attributes and yield

Maximum number of pods and seeds plant^{-1}, Seed yield and stover yield were recorded under treatment recommended spacing of sowing at 30 cm. Higher seed yield in this treatment is mainly due to higher number of pods and seeds plant^{-1} with adequate supply of space, soil moisture and nutrients while the lowest value of above parameters was recorded under treatment broadcast method of sowing. The placement of seed at improper depth could inhibit the germination of seeds which resulted in lower plant population and seed yield under broadcast method of sowing. These results are in agreement with Hamid *et al*. (2002), and Meena *et al*. (2013). Crop configuration did not show significant difference in Seeds pod^{-1}, 100 seed weight and harvest index.

Among the seed rates, 65 kg ha^{-1} recorded significantly maximum number of pods and seeds plant^{-1} but, it was found comparable with seed rate of 80 kg ha^{-1} and minimum was noted under seed rate 50 kg ha^{-1}. Significantly higher seed and stover yield was recorded under seed rate of 95 kg ha^{-1} but it was found at par with seed rate 80 kg ha^{-1} and 65 kg ha^{-1} while the minimum seed and stover yield was recorded under seed rate 50 kg ha^{-1}. Higher number of pods per unit land area and the more biomass production at higher seed rate is might be the reason for higher seed and stover yield under seed rate of 95 kg ha^{-1} respectively. Similar findings have been reported by Rajput and Shrivastava (1998), Hamid *et al*. (2002), Kumar and Badiyala (2005), Meena *et al.* (2013) and Vyas and Khandwe (2014). The seed rate did not influenced seed pod^{-1}, 100 seed weight and harvest index. Ram *et al*. (2011) also reported similar results.

Productivity rating index (PRI) and Production efficiency (PE)

As regards to crop configuration, recommended spacing of sowing at 30 cm gave significantly higher productivity rating index and production efficiency than other treatments. Higher seed yield under recommended spacing of sowing at 30 cm was the possible reason of higher Productivity rating index and production efficiency. On the other hand, the lowest productivity rating index and production efficiency recorded under treatment broadcast method of sowing.

As regards to seed rates, the significantly highest productivity rating index and production efficiency registered under seed rate 95 kg ha^{-1}. It might be due to higher seed yield under these treatments but was statistically at par with seed rate of 80 and 65 kg ha^{-1}. Significantly lowest productivity rating index and production efficiency was recorded under seed rate of 50 kg ha^{-1}. Siregar and Sumaryanto (2003) also opined that production efficiency of soybean was increased because of increase in seed yield.

Oil and protein content (%)

Different crop configuration and seed rates could not give significant impact on oil and protein content of seed. Similar results were also reported by Vyas and Khandwe (2014) and Lone *et al*. (2009) where oil and protein content was not significantly affected by spacing.

Interaction effect

Interaction effects between crop configuration and seed rates were found to be significantly. Recommended spacing of sowing at 30 cm with seed rate of 65 kg ha^{-1} recorded sigificantly maximum seed yield as compared to other treatment combinations but was par with seed rate of 80 kg ha^{-1} and 95 kg ha^{-1}. Significantly lowest seed yield was noted under interaction of broadcast method of sowing with seed rate of 50 kg ha^{-1}.

CONCLUSION

The result of this study indicated that different crop configuration and seed rate significantly affected yield and yield characters of soybean. It can be concluded that soybean should be sown on recommended spacing of sowing (30 cm) with seed rate 65 kg ha^{-1} to obtain maximum yield of soybean under *Vertisols* of Chhattisgarh plains. Further experimentation is needed for confirmation of the results.

Table 1. Yield and yield attributing characters of soybean as influenced by crop configuration and seed rate

Treatment	Pods $plant^{-1}$ (No.)	Seeds pod^{-1} (No.)	Seeds $plant^{-1}$ (No.)	100 seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Crop configuration						
C_1- Broadcast method of sowing	59.86	2.42	165.11	9.10	1681	2450
C_2- Cross sowing 30 cm apart	73.73	2.55	195.80	9.49	2026	2903
C_3- Closed space sowing 20 cm apart	73.55	2.61	195.31	9.63	1923	2748
C_4-Recommended spacing of sowing (30 cm)	81.54	2.64	214.25	9.84	2311	3260
SEm±	**1.90**	**0.07**	**5.22**	**0.25**	**54**	**82**
CD (P=0.05)	**6.59**	**NS**	**18.08**	**NS**	**187**	**285**
Seed rate (kg ha^{-1})						
S_1- 50	67.75	2.56	175.68	9.38	1548	2310
S_2- 65	75.22	2.60	204.96	9.81	2092	2970
S_3- 80	74.48	2.58	199.03	9.41	2126	3037
S_4- 95	71.24	2.48	190.79	9.47	2174	3045
SEm±	**1.33**	**0.05**	**3.50**	**0.18**	**35**	**50**
CD (P=0.05)	**3.87**	**NS**	**10.22**	**NS**	**103**	**147**

Table 2. Harvest index, Productivity rating index (PRI), Production efficiency (PE) and quality of soybean as influenced by crop configuration and seed rate

Treatment	Harvest index (%)	Productivity rating index	Production efficiency (%)	Oil content (%)	Protein content (%)
Crop configuration					
C_1 - Broadcast method of sowing	40.63	1.12	14.00	17.56	31.84
C_2- Cross sowing 30 cm apart	40.96	1.35	16.88	17.92	32.65
C_3- Closed space sowing 20 cm apart	41.15	1.28	16.02	17.86	32.64
C_4-Recommended spacing of sowing (30 cm)	41.44	1.54	19.26	18.21	32.97
SEm±	**0.01**	**0.04**	**0.45**	**0.58**	**0.90**
CD (P=0.05)	**NS**	**0.12**	**1.56**	**NS**	**NS**
Seed rate (kg ha^{-1})					
S_1- 50	40.11	1.03	12.90	17.07	31.55

S_2- 65	41.29	1.39	17.43	17.49	33.01
S_3- 80	41.12	1.42	17.72	18.46	32.86
S_4- 95	41.66	1.45	18.11	18.53	32.69
SEm±	**0.01**	**0.02**	**0.29**	**0.42**	**0.73**
CD (P=0.05)	**NS**	**0.07**	**0.86**	**NS**	**NS**

Table 3. Interaction effect of crop configuration and seed rate on seed yield of soybean

Treatment	**Seed rate (kg ha^{-1})**				
	S_1-50	S_2-65	S_3-80	S_4-95	**Mean**
Crop configuration					
C_1 - Broad cast method of sowing	1365	1726	1734	1897	**1681**
C_2- Cross sowing 30 cm apart	1460	2100	2256	2287	**2026**
C_3-Closed space sowing 20 cm apart	1628	2030	2024	2010	**1923**
C_4- Recommended spacing of sowing (30 cm)	1741	2512	2493	2500	**2311**
Mean	**1548**	**2092**	**2126**	**2174**	
	SEm±	**CD (P=0.05)**			
Crop configuration	**54**	**187**			
Seed rate	**35**	**103**			
Interaction	**70**	**206**			

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