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Research Communication

Productivity and profitability of soybean (*Glycine max*) as influenced by different fertility levels and seed rates under mid-hill conditions of Himachal Pradesh

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2016 at Palampur, Himachal Pradesh, to evaluate the optimum dose of fertilizers and seed rates of 'HIMSO 1685' of soybean [*Glycine max* (L.) Merr.]. The experiment was laid out in split-plot design, comprising 2 genotypes ('HIMSO 1685' and 'Harasoya') and 2 seed rates (75 and 100 kg/ha) in main-plots and 4 fertility levels [0, 75, 100 and 125% of recommended dose of fertilizer (RDF)] in sub-plots. The soil of experimental site was silty clay loam, acidic, low in available nitrogen, and medium in available phosphorus and potassium. The highest values of primary branches/plant, number of pods/plant and 1,000-seed weight were recorded in 'HIMSO 1685' and at 100% RDF. Significantly higher yields, productivity, gross and net returns, benefit: cost and profitability were recorded in 'HIMSO 1685' sown with 75 kg/ha seed rate and at 100% RDF. The treatment, 100% of recommended dose of fertilizer and 75 kg seed/ha were found to be the best agronomic practices for obtaining higher productivity and profitability of 'HIMSO 1685' soybean under mid-hill conditions of Himachal Pradesh.

Key words : Fertility levels, Productivity, Profitability, Seed rates, Soybean

Soybean is one of the most important oil and protein crops in the world. It is traditionally grown on a small scale in Himachal Pradesh, the Kumaon Hills of Uttarakhand, Eastern Bengal, the Khasi Hills, Manipur, the Naga Hills and parts of central India covering Madhya Pradesh. It has great nutritional value that is why it is ideal complement to the cereal-based Indian diet. In India, soybean has emerged as a main oilseed crop. Starting with a meager area of 0.03 million ha in 1970, the crop has expanded with an unprecedented pace and has touched the figure of 10.9 million ha area with a production of 10.4 million tones with average yield of 959 kg/ha (SOPA, 2014a). In Himachal Pradesh, it occupied an area of 0.6 thousand ha with a production of 0.9 thousand tonnes and the average yield of 1,429 kg/ha (Directorate of Land Records, 2014b).

Fertility level and seed rate play a key role in enhancing productivity and profitability of the crops. Application of optimum dose of fertilizers increases the yield of soybean. The low and declining soil fertility are the main causes of low productivity of most of the cultivated lands and crops including soybean. The seeding rate or plant population is one of the most important factors when it comes to profitability for the producer. Cost of technologies is increasing rapidly. With these increases, producers must be more economically disciplined and aware of modern crop production technology. 'HIMSO 1685' is a new promising genotype of soybean. It is more resistant to frogeye spot, pod blight and bacterial pustules as compared to 'Harasoya' which is susceptible to frogeye leaf spot and moderately resistant to pod blight. For exploiting its full yield potential, it was important to find out optimum agronomic practices, particularly dose of fertilizers and seed rate. Considering the above-mentioned facts, the present investigation was carried out to evaluate the effect of fertility levels and seed rates on new genotype of soybean under mid-hills conditions of Himachal Pradesh.

The field experiment was conducted during the rainy season of 2016 at the Research Farm, Department of Agronomy, Forages and Grassland Management, Chaudhary Sarvan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur (32°6' N, 76°3' E, 1,290.8 m above mean sea-level), Himachal Pradesh. Palampur falls

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under mid-hill sub-humid zone of the state and is endowed with mild summers (March to June) and cool winters with high rainfall mainly during monsoon (June to September). The weekly maximum and minimum temperature ranged from 23.5 to 31.6°C and 9.9 to 19.5°C, respectively. The mean relative humidity ranged from 58 to 96.7% and total of 1,731.6 mm rainfall were received during the crop season. Experimental site was silty clay loam in texture, acidic in reaction (5.5 *p*H), low in available nitrogen (127 kg/ha), and medium in available phosphorus (13.9 kg/ha) and potassium (155 kg/ha).

The experiment was laid out in split-plot design with 4 main-plots and 4 sub-plots. The main-plots consisted of 4 treatment combinations (2 genotypes and 2 seed rates), while sub-plots consisted of 4 fertility levels [0, 75, 100 and 125% of recommended dose of fertilizer (RDF)]. Each treatment was allocated randomly in each plot using random table. Treated seeds with bavistin were used as per treatment. Recommended dose of nitrogen, phosphorus and potassium was 20, 60 and 40 kg/ha respectively. Pendimethalin (stomp 30 EC) was applied @ 5 litre/ha within 48 h of sowing for the control of weeds. Other package of practices recommended for the region was also followed. Five plants were selected and tagged to record the number of primary branches. The number of primary branches of 5 tagged plants was counted. The total number of branches of 5 randomly tagged plants in each plot was averaged to get the number of primary branches/plant. Pods of 5 random plants at harvesting from each plot were counted and then mean was worked out to get number of pods/plant. The total pods of selected plants were threshed, and their seeds were counted. Total number of seeds was divided by number of pods to obtain the number of seeds/pod. One thousand seeds from each plot were taken and weighed to obtain the test weight. Crop from each net plot was harvested and sun-dried separately for 3 days. After drying, it was weighed and expressed as biological yield. It was further threshed by beating with wooden sticks. After threshing and cleaning the seeds, the produce was sun-dried and its weight was recorded and expressed as seed yield. The straw yield was calculated by subtracting the seed yield from biological yield. The data obtained were subjected to statistical analysis as per the procedures given by Gomez and Gomez (1984).

Number of primary branches/plant was significantly affected by different fertility levels. Significantly higher number of primary branches was noted at 75% RDF, followed by 100 and 125% RDF. The lowest number of branches was recorded in the control. The highest number of pods/plant was recorded in 'HIMSO 1685', and at 100% RDF. Different seed rates resulted in statistically similar number of pods/plant. Number of seeds/pods remained unaffected by different treatments. The maximum number of seeds/pods was recorded in 'Harasoy' at 100 kg/ha seed rate and at 75% RDF. Genotypes and fertility levels significantly affected the test weight. The highest test weight was recorded in 'HIMSO 1685' and at 100% RDF (Table 1). Improvement in the yield-attributing characters might be owing to adequate availability of nutrients and optimum plant stand. Graud *et al.* (2015) also reported higher number of primary branches/plant with better nutrition. Chakma *et al.* (2015) concluded that genotype ('BD 2329') showed considerable better results including higher number of pods with recommended doses of fertilizer. Mehmet (2008) reported that, 1,000-seed weight of the variety was affected by higher nutrient doses and plant density.

Yields and productivity were significantly affected by different genotypes. Significantly higher yields and productivity were recorded in 'HIMSO 1685'. The genotype, 'HIMSO 1685' gave 63.46, 3.62, 18.04 and 216% higher seed, straw and biological yield, and productivity over 'Harasoya', respectively (Table 1). This might be owing to the genetic potential of the genotype. Different seed rates did not significantly influence yields and productivity. However, maximum seed yield (4.14%) and productivity (16%) were recorded when the crop was sown using 75 kg seed/ha. This might be owing to increase in seed rate that led to increased mortality rate which resulted in reduced yield. Werner *et al.* (2016) also observed reduced yield with increasing seed rate. Different fertility levels significantly influenced the yields. The highest yield was recorded with 100% recommended dose of fertilizer while the lowest was in the control treatment. Significantly higher seed yield might be owing to higher number of primary branches, number of pods/plant, seeds/pod and test weight owing to the application of adequate fertilizer nutrients. Graud *et al.* (2015) reported that, application of 125% RDF resulted in significantly higher seed yield over rest of the fertilizer levels, and at par with application of 100% RDF.

Gross and net returns, and benefit: cost (B:C) were significantly affected by genotypes and fertility levels. Significantly higher returns, B:C and profitability were recorded in 'HIMSO 1685'. This might be because of trend of economical parameters with reference to soybean varieties and difference in economical parameters is the function of the yield levels achieved and the respective cost of cultivation incurred. Seed rates remained unaffected in respect of gross returns, net returns and B:C. However, numerically higher returns and profitability were incurred with 75 kg seed/ha. This might be due to lower cost of cultivation. The highest values of gross returns, net returns and B:C were recorded with 100% RDF, while the lowest

Table 1. Effect of genotypes, fertility levels and seed rates on yield attributes, yields, productivity, returns, benefit: cost and profitability of soybean

Treatment	Yield attributes				Yields (t/ha)		Productivity (kg/day/ha)	Returns (×10³ ₹/ha)		Benefit: cost ratio	Profitability (₹/day/ha)
	Primary branches/ plant	Pods/ plant	Seeds/ pod	Test weight (g)	Seed	Straw		Gross	Net		
Genotypes											
'HIMSO 1685'	12	41	3	210	1.60	5.96	13.3	68.8	26.0	0.59	248.8
'Harasoya'	13	37	3	190	0.98	5.42	8.0	48.3	5.5	0.13	78.7
SEm±	0.3	0.5	0.1	2.38	0.07	0.14	0.9	2.0	2.0	0.04	26.5
CD (P=0.05)	NS	1.6	NS	8.24	0.24	0.47	3.0	6.9	6.9	0.15	91.5
Seed rates (kg/ha)											
75	12	39	3	198	1.32	5.59	11.5	5.9	16.6	0.38	196.1
100	13	39	3	203	1.26	5.80	9.9	5.8	14.9	0.34	131.3
SEm±	0.3	0.5	0.1	2.38	0.07	0.14	0.9	2.0	2.0	0.04	26.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fertility levels (% RDF)											
Control	12	39	3	197	0.91	4.46	8.4	43.0	4.1	0.11	140.2
75	13	39	3	196	1.28	5.58	11.1	58.0	15.2	0.35	182.4
100	13	40	3	205	1.46	6.39	11.1	66.3	22.1	0.50	169.2
125	12	37	3	203	1.50	6.33	12.0	67.2	21.7	0.48	163.1
SEm±	0.3	0.6	0.1	1.67	0.06	0.19	0.7	1.7	1.7	0.04	19.3
CD (P=0.05)	0.9	1.8	NS	4.87	0.16	0.55	1.9	5.0	5.0	0.11	NS

RDF, Recommended dose of fertilizer (20, 60 and 40 kg NPK/ha); NS, non-significant

was in the control. Vyas and Khuswah (2015) observed that, soybean varieties 'JS 95-60' and 'JS 97-52' recorded higher net returns with 125% RDF + FYM @ 5 t/ha followed by 'JS 95-60' with 100% RDF + FYM @ 5 t/ha and 'JS 97-52' with 125% RDF. Ram *et al.* (2011) reported that, fertility levels significantly influenced the B:C and the highest was noted in fertilized plots over the control. Interaction effect of genotypes, fertility levels and seed rates was found to be non-significant.

Based on our findings, it was concluded that 'HIMSO 1685' soybean proved superior to 'Harasoya', and 75 kg seed/ha and 100% recommended dose of fertilizer were found to be the best agronomic practices for getting higher productivity and profitability of soybean under mid-hills conditions of Himachal Pradesh.

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