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RESEARCH ARTICLE

Performance of soybean [*Glycine max* (L.) Merrill] varieties to levels of fertility and vermicompost under agro-climatic conditions of vindhyan plateau

■ **Raju Jatav and Hansraj Jatav**

SUMMARY

The present experiment was laid out in the field number 31 of the Research Farm, R.A.K. College of Agriculture, Sehore. The experiment was laid out in split plot design with 18 treatments and each treatment was replicated three times. The observations on plant population per square meter were recorded at 30 days after sowing and at maturity. The effect of varieties was found significant and levels of fertility and vermicompost was found non-significant. Plant population per square meter at 30 DAS was ranged from 45.18 to 59.60 plants, but at maturity it was ranged from 45.12 to 58.13 plants due to effect of varieties. Plant population per square meter at 30 DAS was ranged from 54.33 to 54.64 plants, but at maturity it was ranged from 53.41 to 53.91 plants due to effect of fertility levels although it was found non-significant. The effect of vermicompost on plant population per square meter was also found non-significant, but vermicompost @ 5t/ha was given maximum plants per square meter at both 30 DAS (54.49 plants/sq. meter) and at maturity stages (53.70 plants/sq meter). Varieties had given significant effect on height of plant. Among varieties, JS 93-05 had given significantly tallest plant (46.11 cm) than JS 335 (43.71 cm) and JS 95-60 (41.05 cm). Levels of fertility had given non-significant effect on plants height. Although, higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) had given tallest plants (43.87 cm) than rest of the levels. Levels of vermicompost had also given significant effect on height of plants. Although, Vermicompost @ 5t/ha had given tallest plants (44.25 cm) than control.

Key Words : Soybean, Vermicompost, Variety, Fertility level, Plant population

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Soybean plays a vital role in the agricultural economy of the state Soybean is extensively grown all over Madhya Pradesh because of its wide adaptability to agro-climatic conditions and high market value of the produce; hence, the state is designated as "Soya state" of India. Among the major soybean growing states, about 80 per cent of the area and production is from Vertisols

in the semi-arid regions of Central India. It had been grown under energy starvation conditions which resulted in poor yield performance.

Varieties play an important role in the production of seed yield. Selection of a proper variety for a set of agro-climatic conditions is very important to achieve maximum potential, because due to their different habit of growth and development behaviour, it is only due to their genetic characters. In recent years the developments of early maturing varieties of soybean have enabled its successful cultivation.

Variety performance on an average cultivator's field is the important factor, which are generally associated with low productivity of this crop in the state. The local soybean cultivars apart from undesirable characters like late maturity, shattering habit have low seed yield. Early maturity varieties would play an important role in increasing soybean production.

Continuous use of chemical fertilizers is leading reduction in the crop yield and resulted in imbalance of nutrients in the soil, which has adverse effects on soil health. Use of organic manure alone or in combination with chemical fertilizer will help to improve physic-chemical properties of the soils, efficient utilization of applied fertilizers for improving seed yield and quality. Organic manures provide good substrates for the growth of micro-organisms and maintain a favorable nutritional balance and soil physical properties. It is recognized that combined source of organic matter and chemical fertilizers play a key role in increasing the productivity of soil (Maheshbabu *et al.*, 2008). Singh *et al.* (1994) reported significant increase in protein content with 120 kg N per hectare but they noticed no significant change in the oil content. However, Pradhan *et al.* (1995) reported increased oil content with 80 kg N per hectare. Tiwari *et al.* (1994) observed that application of 120 kg P_2O_5 per hectare recorded higher protein and oil contents. The protein and oil content of seeds were significantly increased with increase in levels of K upto 40 kg per hectare (Nayak, 1989). Seed yield, crude protein and oil content were increased by the addition of organic manures with increasing P level. Thus, though many reports are available on the effect of individual nutrients on the seed protein and oil content of soybean, there is only meagre information on the effect of combined application of inorganic and organic sources on yield attributes and yield of soybean.

Vermicompost is rich organic manure and vermiwash (a liquid nutrient) consists of macro and micronutrients, plant growth promoting substances, beneficial micro-organisms that are necessary for plant growth. Higher growth, nodulation and yield values were recorded when vermicompost were applied at 12.5 tones/ha. and 750kg/ha in enriched from (Thanunathan *et al.*, 2002).

Keeping in this view, the present investigation was under taken to evaluate "Performance of soybean [*Glycine max* (L.) Merrill] varieties to levels of fertility and vermicompost under agro-climatic conditions of Vindhyan plateau'' following objectives:

– To find out the suitable varieties of soybean.

– To study the effect of different fertility levels and vermicompost on growth, yield attributes and yields of soybean.

– To study the interaction effect of varieties, fertility levels and vermicompost on productivity of soybean.

MATERIAL AND METHODS

The present experiment was laid out in the field number 31 of the Research Farm, R.A.K. College of Agriculture, Sehore. The experimental site had fairly uniform topography, normal fertility status and soil heterogeneity. The experiment was laid out in split plot design with 18 treatments and each treatment was replicated three times. Main plot treatment (Varieties) V_1-JS-335, V_2- JS-9305 and V_3-JS-9560 sub plot treatment (Fertilizer levels) fertility levels (kg/ha) F_1-10N + 30 P_2O_5 + 10K_2O kg/ha, F_2-15N + 40P_2O_5 + 15K_2O kg/ha and F_3-20N + 60P_2O_5 + 20K_2O kg/ha sub sub plot treatment (VERMI) VERMI-0 @ 0 t/ha vermicompost and VERMI-1 @5 t/ha vermicompost. The effect of vermicompost on plant population per square meter was also found non-significant, but vermicompost @ 5t/ha was given maximum plants per square meter at both 30 DAS (54.49 plants/sq. meter) and at maturity stages (53.70 plants/sq meter). Varieties had given significant effect on height of plant. Among varieties, JS 93-05 had given significantly tallest plant (46.11 cm) than JS 335 (43.71 cm) and JS 95-60 (41.05 cm). Levels of fertility had given non-significant effect on plants height. Although, higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) had given tallest plants (43.87 cm) than rest of the levels. Levels of vermicompost had also given significant effect on height of plants. Although, vermicompost @ 5t/ha had given tallest plants (44.25 cm) than control.

RESULTS AND DISCUSSION

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

Growth parameters:

Plant population per square meter:

The observations on plant population per square meter were recorded at 30 days after sowing and at maturity (Table 1). The effect of varieties was found significant and levels of fertility and vermicompost was found non-significant. Plant population per square meter at 30 DAS was ranged from 45.18 to 59.60 plants, but at maturity it was ranged from 45.12 to 58.13 plants due to effect of varieties.

Plant population per square meter at 30 DAS was ranged from 54.33 to 54.64 plants, but at maturity it was ranged from 53.41 to 53.91 plants due to effect of fertility levels although it was found non-significant.

The effect of vermicompost on plant population per square meter was also found non-significant, but vermicompost @ 5t/ha was given maximum plants per square meter at both 30 DAS (54.49 plants/sq.meter) and at maturity stages (53.70 plants/sq meter).

Plant height (*cm*):

The observations on plant height were recorded at 30 DAS and there after with the intervals of 20 days upto maturity. The data are presented in Table 2.

Varieties had given significant effect on height of plant. Among varieties, JS 93-05 had given significantly tallest plant (46.11 cm) than JS 335 (43.71 cm) and JS 95-60 (41.05 cm).

Levels of fertility had given non-significant effect on plants height. Although, higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) had given tallest plants (43.87 cm) than rest of the levels.

Levels of vermicompost had also given significant effect on height of plants. Although, Vermicompost @ 5t/ha had given tallest plants (44.25 cm) than control.

The interaction between varieties, levels fertility and vermicompost were found non-significant.

Branches per plant:

Branching is one of the important characters, which have direct effect on seed yield (Table 3). The observation on number of branches per plant were recorded starting from 30 DAS and there after at an intervals of 20 days upto maturity.

The data on number of branches at various

Table 1: Effect of varieties, levels of fertility and vermicompost on plant population per square meter

Treatments	Plant population per square meter	
	30 DAS	At maturity
Varieties		
JS 335	45.18	45.12
JS 93-05	58.54	57.83
JS 95-60	59.60	58.13
S.E.±	0.16	0.16
C.D. (P=0.05)	0.64	0.64
Fertility levels (kg/ha)		
10 N+30 P_2O_5+10 K_2O	54.33	53.41
15 N+40 P_2O_5+15 K_2O	54.64	53.77
20 N+60 P_2O_5+20 K_2O	54.64	53.91
S.E.±	0.15	0.21
C.D. (P=0.05)	NS	NS
Vermicompost (t/ha)		
VERMI 0	54.39	53.69
VERMI 5	54.49	53.70
S.E.±	0.06	0.05
C.D. (P=0.05)	NS	NS

NS= Non-significant

successive growth stages are presented in Table 4. It is clear from the data that number of branches increased upto 50 days after sowing and thereafter it increased with slow pace and became constant at maturity.

Soybean variety JS 335 recorded significantly higher number of branches per plant (4.80) at maturity than rest of the varieties.

Higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) gave significantly maximum number of branches per plant (4.02) than lower level of fertility at maturity,

Table 2: Effect of varieties, levels of fertility and vermicompost on plant height at successive crop growth stages

Treatments	Plant height (cm)			
	30 DAS	50 DAS	70 DAS	At maturity
Varieties				
JS 335	16.76	36.76	43.29	43.71
JS 93-05	17.34	41.54	46.11	46.11
JS 95-60	17.20	40.89	41.04	41.04
S.E.±	0.09	0.27	0.16	0.18
C.D. (P=0.05)	0.37	1.07	0.64	0.72
Fertility levels (kg/ha)				
10N+30P_2O_5+10K_2O	17.02	39.71	43.10	43.22
15N+40P_2O_5+15K_2O	17.04	40.04	43.64	43.78
20N+60P_2O_5+20K_2O	17.23	40.43	43.70	43.87
S.E.±	0.08	0.28	0.23	0.22
C.D. (P=0.05)	NS	NS	NS	NS
Vermicompost (t/ha)				
VERMI 0	16.93	39.60	42.81	42.99
VERMI 5	17.27	40.33	44.16	44.25
S.E.±	0.03	0.08	0.12	0.12
C.D. (P=0.05)	0.11	0.25	0.36	0.35

NS= Non-significant

Table 3: Effect of varieties, levels of fertility and vermicompost on number of branches plant at successive crop growth stages

Treatments	Number of branches /plant			
	30 DAS	50 DAS	70 DAS	At maturity
Varieties				
JS 335	1.64	4.60	4.80	4.80
JS 93-05	1.57	3.60	3.76	3.76
JS 95-60	1.48	3.00	3.13	3.13
S.E.±	0.03	0.11	0.07	0.07
C.D. (P=0.05)	0.12	0.44	0.27	0.27
Fertility levels (kg/ha)				
10 N+30 P_2O_5+10 K_2O	1.52	3.58	3.79	3.79
15 N+40 P_2O_5+15 K_2O	1.57	3.64	3.88	3.88
20 N+60 P_2O_5+20 K_2O	1.62	3.88	4.02	4.02
S.E.±	0.01	0.08	0.06	0.06
C.D. (P=0.05)	0.05	0.26	0.20	0.20
Vermicompost (t/ha)				
VERMI 0	1.47	3.56	3.81	3.81
VERMI 5	1.67	3.84	3.99	3.99
S.E.±	0.02	0.02	0.02	0.02
C.D. (P=0.05)	0.07	0.08	0.08	0.08

but difference was found non-significant with medium level of fertility (3.88) at maturity.

Levels of vermicompost @ 5 t/ha gave significantly maximum number of branches per plant (3.99) than control (3.81) at maturity.

Number of root nodules per plant:

The data on number of root nodules per plant are presented in Table 4 and 5. The data indicated the higher number of root nodules per plant were recorded at 60 days after sowing than 30 and 45 days after sowing.

Soybean variety JS 335 produced significantly higher number of root nodules per plant at all three stages *i.e*. 30 days after sowing (23.91), 45 days after sowing (39.01) and at 60 days after sowing (42.10) than rest of the varieties.

Levels of fertility were also found significant at all three stages *i.e.* 30, 45 and 60 days after sowing. Higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) was given higher number of root nodules per plant at 60 days after sowing (40.37) and was found significantly superior than lower level of fertility (10 N+30 P_2O_5+10 K_2O kg/ha).

Although, higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) also gave higher number of root nodules per plant at 60 days after sowing (40.37) and 45 days after sowing (36.62).

Higher levels of vermicompost @ 5t/ha gave significantly higher number of root nodules per plant (40.16) at 60 days after sowing than control. Although, it was also found significantly at 45 days after sowing (36.07) than control.

The interaction of varieties and vermicompost (V x Vermicompost) was found significant. Soybean variety JS 335 along with vermicompost @ 5 t/ha gave

Table 4: Effect of varieties, levels of fertility and vermicompost on number of root nodules per plant at successive crop growth stages

Treatments	No. of root nodules/plant		
	30 DAS	45 DAS	60 DAS
Varieties			
JS 335	23.91	39.01	42.10
JS 93-05	23.59	37.69	39.31
JS 95-60	22.42	30.31	35.67
S.E.±	0.26	0.14	0.21
C.D. (P=0.05)	1.03	0.58	0.83
Fertility levels (kg/ha)			
10 N+30 P_2O_5+10 K_2O	22.88	34.79	37.87
15 N+40 P_2O_5+15 K_2O	23.24	35.60	38.84
20 N+60 P_2O_5+20 K_2O	23.80	36.62	40.37
S.E.±	0.19	0.19	0.28
C.D. (P=0.05)	0.58	0.61	0.86
Vermicompost (t/ha)			
VERMI 0	22.56	35.27	37.89
VERMI 5	24.05	36.07	40.16
S.E.±	0.12	0.08	0.21
C.D. (P=0.05)	0.37	0.23	0.63

NS= Non-significant

Table 5: Interaction effect of V × vermicompost on number of root nodules/plant at 60 days after sowing

Vecompost (t/ha)	Varieties		
	V_1	V_2	V_3
VERMI 0	41.37	38.48	38.80
VERMI 5	42.82	40.13	37.53
		V × Vermicompost	
S.E.±		0.37	
C.D. (P=0.05)		1.10	

significantly higher number of root nodules per plant (42.82) than rest of the combinations at maturity.

Dry weight of root nodules per plant (*mg*):

Dry weight of root nodules per plant was recorded at 30, 45 and 60 days after sowing. Average dry weight of root nodules per plant is presented in Table 6 and 7.

Data showed that the dry weight of root nodules per plant (mg) was found significant at 30, 45 and 60 days after sowing.

Soybean variety JS 335 produced significantly higher value of dry weight of root nodules/plant at 60 days after sowing (198.20mg) and at 45 days after sowing (187.61mg), but it was found at par with JS 93-05 at 30 days after sowing.

Fertility levels were also found significant at 30, 45 and 60 days after sowing. Higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) was given significantly higher value of dry weight of root nodules per plant at 60 days after sowing (174.82 mg), 45 days after sowing (169.46 mg) and 30 days after sowing (89.26 mg) than lower levels of fertility.

Application of vermicompost @ 5 t/ha was found significant. Effect on dry weight of root nodules per plant at 60 days after sowing (174.47mg) was found significantly superior over control. Similar trend was also observed at 30 and 45 DAS.

The interaction effect of varieties and vermicompost was found significant. Interaction between JS 335 along with vermicompost @ 5 t /ha had given significant response on dry weight of root nodules/plant (198.71 mg) than other combinations.

Dry weight of plant (g) :

Dry weight per plant was recorded at 30, 50, 70 DAS and at maturity stage and presented in Table 8, 9

Table 6: Effect of varieties, levels of fertility and vermicompost on dry weight of root nodules per plant at successive crop growth stages

Treatments	Dry weight of root nodules/plant (mg)		
	30 DAS	45 DAS	60 DAS
Varieties			
JS 335	89.11	187.61	198.20
JS 93-05	88.86	166.11	169.82
JS 95-60	87.98	145.72	152.87
S.E.±	0.27	0.59	0.16
C.D. (P=0.05)	1.07	2.32	0.65
Fertility levels (kg/ha)			
10 N+30 P_2O_5+10 K_2O	87.93	164.12	172.28
15 N+40 P_2O_5+15 K_2O	88.76	165.87	173.79
20 N+60 P_2O_5+20 K_2O	89.26	169.46	174.82
S.E.±	0.39	0.91	0.19
C.D. (P=0.05)	1.21	2.81	0.61
Vermicompost (t/ha)			
VERMI 0	87.84	164.37	172.79
VERMI 5	89.46	168.59	174.47
S.E.±	0.20	0.40	0.12
C.D. (P=0.05)	0.62	1.19	0.36

Table 7: Interaction effect of V × Vermicompost on dry weight of root nodules/plant at 60 days after sowing

Vecompost (t/ha)	Varieties		
	V_1	V_2	V_3
VERMI 0	197.68	168.82	151.86
VERMI 5	198.71	170.82	153.86
		V × Vermicompost	
S.E.±		0.22	
C.D. (P=0.05)		0.78	

and 10.

It was observed that dry weight increased constantly upto maturity stage in all the treatments.

The effect of variety on dry weight per plant was found significant. The highest dry weight per plant (15.56 g) was found under JS 335. It was found significantly superior than rest of the varieties, while soybean variety JS 93-05 was found significantly superior than JS 95-60.

Higher level of fertility (20 N+60 P_2O_5+20 K_2O kg/ha) gave significantly higher dry weight per plant (12.32g) than lower level of fertility(10N+30P_2O_5+10K_2O kg/ha).

The interaction between varieties and fertility levels was found significant. Maximum dry weight per plant (12.53g) was recorded under interaction between JS 335 and higher level of fertility and it was found significantly

Table 8: Effect of varieties, levels of fertility and vermicompost on dry weight per plant at successive crop growth stages

Treatments	Dry weight/plant (g)			
	30 DAS	50 DAS	70 DAS	At maturity
Varieties				
JS 335	2.33	12.36	15.36	15.56
JS 93-05	2.08	9.06	12.21	12.21
JS 95-60	2.18	8.00	8.76	8.76
S.E.±	0.04	0.07	0.05	0.05
C.D. (P=0.05)	0.16	0.28	0.20	0.20
Fertility levels (kg/ha)				
10 N+30 P_2O_5+10 K_2O	2.10	9.61	11.99	12.06
15 N+40 P_2O_5+15 K_2O	2.21	9.74	12.07	12.14
20 N+60 P_2O_5+20 K_2O	2.28	10.06	12.27	12.32
S.E.±	0.04	0.06	0.07	0.06
C.D. (P=0.05)	0.12	0.20	0.22	0.21
Vermicompost (t/ha)				
VERMI 0	2.00	9.54	11.95	12.00
VERMI 5	2.39	10.07	12.27	13.35
S.E.±	0.03	0.02	0.02	0.02
C.D. (P=0.05)	0.11	0.08	0.05	0.06

Table 9: Interaction effect of V×F on dry weight /plant at 50 days after sowing

Levels of fertility	Varieties		
	V_1	V_2	V_3
F_1	12.16	8.93	7.73
F_2	12.36	9.00	7.86
F_3	12.53	9.23	8.40
		V × F	
S.E.±		0.1	
C.D. (P=0.05)		0.4	

Table 10: Interaction effect of V× Vermicompost dry weight /plant at 50 days after sowing

Vecompost (t/ha)	Varieties		
	V_1	V_2	V_3
VERMI 0	12.17	8.75	7.68
VERMI 5	12.53	9.35	8.31
		V × Vermicompost	
S.E.±		0.14	
C.D. (P=0.05)		0.29	

superior than rest of the combinations.

The interaction between varieties and vermicompost was found significant. The interaction between JS 335 and vermicompost @5 t/ha gave maximum dry weight per plant (12.53 g) and was found significantly superior than rest of combinations.

Conclusion:

The following conclusions can be drawn on the basis of results obtained:

The soybean variety JS 335 was found best among other varieties with respect to grain yield. Soybean variety JS 335 along with vermicompost @ 5t/ha and higher level of fertility ($20N+60P_2O_5+20K_2O$kg/ha) proved better combination for higher production and net profit.

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