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Response of Soybean to P & K with and without *Rhizobium japonicum* and Phosphorous Solubilizing Bacteria on Nutrients, Protein and Yield Sustainability of Soybean in Black Soil

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ABSTRACT

An experiment was conducted to during kharif season of 2016 and 2017 at Sehore (M.P). The experiment was laid out in Randomized block design with three replication having Ten treatments viz. Control (T1), Bradyrhizobium japonicum alone(T_2), Local check (KRIBHICO–rhizobium culture(T3), T_2+ P $_{60}$ kg/ha through SSP(T4), T_2 + K $_{30}$ kg through MOP(T5), T_2 + PSB 10 g/kg seed treatment(T6), T_2 + P $_{30}$ kg/ ha + PSB 10 g/kg seed treatment(T7), T_2 + K 15kg /ha + PSB 10 g/kg seed treatment(T8), T_2 + T_8 (T9) and P $_{60}$ kg/ ha+ K $_{30}$ kg/ha (T_{10}). The soil at the experimental field was medium black (vertisol) having clay loam texture and 40cms depth. The experimental soil was low in available nitrogen, medium in available phosphorus and medium in available potassium low in available Boron, Molybdenum and Zinc with pH Different growth and yield attributing character of grain and straw yields were studied. On the basis of results obtained on various parameters following summary and conclusions have been drawnout: It was found significantly higher yield and N, P, K, Zn, B & Mo in straw and seed as well as protein content in seed compared to other treatments and control. Application of P $_{60}$ kg/ ha+ K $_{30}$ kg/ha (T_{10}) as compared to other treatments followed by (T_5 and T_6).also improved the content of N, P, K , Zn, B and Mo in soil at harvest of soybean.

Key words: *Soybean, Kharif, Boron, Molybdenum and Zinc*

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is one of the important grain legume crop of India, which not only helps in maintaining soil fertility but it is also a rich source of protein (38 to 42%) and oil (18-20%). Its cultivation has become popular in Madhya Pradesh due to the establishment of processing units and high remunerative prices.

Bhaskar has reported the significant response of FYM @ 2.5 t ha^{-1} along with RDF, Zinc, Molybdenum and biofertilizers on NPK uptake protein in seed and yield of soybean in clay loam soil.

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The productivity of this crop is affected by many factors viz crop genetics, nutrient management and climatic factors. For sustaining the crop productivity under the modern intensive agriculture system, It is imperative to adopt integrated, nutrient management approach. Some of the micronutrient such as Zn, Mo, B and biofertilizers *viz, rhizobium* inoculation in Soybean have improved the productivity in many pockets of the country[5,2].

Seeds of legumes when inoculated with manganese and molybdenum mixed with rhizobium culture increased the yield and protein content[5].

The application of Zinc and molybdenum in Soybean increased the grain yield and seed index . They have also started that the nodule rhizoid can fix nitrogen only of the plant is adequately supplied with all the minerals elements essential for active growth. In this context, zinc molybdenum, boron and biofertilizers play an important role enhancing biological inoculation in Soybean. Gharpinde *et al.*, reported that 100% RFR + 25 kg K/ha + biofertilizers gave the highest grain and straw yields (14.26 and 30.68 quintal/ha, respectively), grain and straw N contents (74.77 and 57.47 kg/ha), grain P content (9.36 kg/ha), and grain and straw K contents (10.17 and 37.33 kg/ha).Konthoujam *et al.*, reported that the application of 75% RDF + vermicompost a @ 1 t ha-1 + PSB recoded highest protein percent in soybean seed.

RESULTS AND DISCUSSIONS

Nutrient content in soybean (plant and seed) as affected by different treatments

The critical examination reveals that the maximum significantly higher N content. P content and K content were recorded under T_{10} followed by $T_{6,}$ respectively in plant and seed and T_5 & P content and K content,respectively in plant and seed. The lowest N,P and K content in plant & seed were noticed under control.

The increase N, P and K content in soybean straw and seed could be visualized because of the fair availability of nitrogen, phosphorus and potassium in the soil due to enhanced nitrogen fixation owing to incorporation of B. japonicum inoculation alongwith zinc, molybdenum and boron. It also revealed the synergistic effect of zinc, molybdenum and boron with nitrogen , phosphorus and potassium utilization by plants. Similar findings have also been observed with the results of Anonymous[1]. and[5].

Zn, B & Mo content (ppm) as affected by different treatments

The maximum and significantly higher Zn content was noticed under T_{10} ($T_2 + T_7 + T_8 + T_9$) i.e. followed by $T_{5,}$ and T_8 . In case of Boron content , it was recorded significantly higher in T_{10} followed by T_4 and T_6 , while Mo content was also noticed significantly higher under T_{10} followed by T_6 and T_9 . The minimum Zn, B & Mo content in plant and seed were noticed under control.

Nutrient content in soybean (plant and seed) as affected by different treatments (mean values of two years)

Treatment		N content (%)		P content (%)		K content (%)		Zn content (ppm)		B content (ppm)		Mo content (ppm)		Protein content (%)
		Plant	Seed	Plant	Seed	Plant	Seed	Plant	Seed	Plant	Seed	Plant	Seed	
T_1	Control	0.91	6.09	0.20	0.40	1.01	2.42	22.22	30.21	38.85	63.65	0.74	1.01	37.41
T_2	*Bradyrhizobium japonicum* alone	1.03	6.51	0.21	0.43	1.14	3.44	20.25	32.23	47.55	71.51	1.08	1.33	40.33
T_3	Local check (KRIBHICO– *rhizobium* culture)	1.06	6.35	0.20	0.42	1.03	3.41	22.74	32.74	40.81	65.87	0.75	1.02	39.46
T_4	T_2+ P 60 kg/ha(SSP)	1.15	6.60	0.33	0.44	1.21	3.48	25.11	35.11	59.25	81.64	1.49	1.65	40.94
T_5	T_2 + K 30 kg (MOP)	1.31	6.77	0.33	0.52	1.35	3.64	32.46	42.46	54.36	77.93	1.40	1.64	41.91
T_6	T_2 + PSB 10 g/kg seed treatment	1.35	7.03	0.38	0.50	1.40	4.61	26.79	36.85	55.22	79.97	1.60	2.09	43.41
T_7	T_2 + P 30 kg/ ha + PSB 10 g/kg seed treatment	1.16	6.45	0.26	0.44	1.18	3.42	24.74	34.82	49.90	70.45	1.07	1.32	40.43
T_8	T_2 + K 15kg /ha + PSB 10 g/kg seed treatment	1.20	6.55	0.22	0.46	1.21	3.54	30.25	40.11	52.29	76.90	1.02	1.33	40.51
T_9	T_2 + T_8	1.22	6.71	0.32	0.45	1.31	3.58	24.46	34.75	53.64	77.48	1.46	1.94	41.74
T_{10}	P 60 kg/ ha+ K 30 kg/ha	1.41	7.15	0.41	0.75	1.56	4.79	33.14	43.26	63.33	91.72	1.77	2.10	44.41
	S.E(m) ±	0.01	0.03	0.005	0.008	0.006	0.33	0.53	0.52	4.78	1.36	0.25	0.25	0.19
	CD at 5%	0.03	0.08	0.014	0.024	0.016	0.95	1.51	1.50	13.84	3.96	0.75	0.75	0.50

Zn, B & Mo contents (ppm) as affected by different treatments under the investigation:

The critical evaluation and interpretation of results indicate that the maximum and significantly higher Zn content was noticed under T_{10} i.e. followed by T_5 and T_8. In case of Boron content, it was recorded significantly higher in T_{10} followed by T_4 and T_6 , while Mo content was also noticed significantly higher under followed by T_6 and T_9 .The minimum Zn, B & Mo content in plant and seed were noticed under control.

The significant increase response of Zn, B and Mo content in soybean plant and seed could be ascribed due to the enhanced physiological process within the plant soybean which could be attributed because of fair availability of Zn, B and Mo in the soil due to their application along with B. japonicum for plant absorption . Further the enhanced Zn, B and Mo content in soybean seed compared to plant indicated that translocation of these nutrients from plant to seeds might have taken place at maturity and hence such more accumulation of these nutrients in seeds. Though these findings are in close conformity of the results reported by Jain and Thakur [5].

Protein content (%)

The critical examination of perusal of data on protein reveled that it was noticed significantly superior under T_{10} followed by T_6 and T_5. The minimum protein content was noticed under control.

The increase in protein content in seeds at maturity in soybean could be ascribed due to the enhanced nitrogen content in plant and then in seeds due to enhanced nitrogen fixation by *B. japonicum* and Mo application similar findings have also reported by Jain and Thakur[5].

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