Effect of Organics on Yield, Quality, Nutrient Content and Uptake of Soybean [glycine Max (L.)] Under Rainfed Condition

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Abstract**:** A field experiment was conducted during 2021 to study the effect of organics as foliar soil application on yield, quality, nutrient content and uptake of soybean [*Glycine max* (L.)] under rainfed condition. The results revealed that foliar application of 4% seaweed extract at 30 and 45 DAS recorded significantly higher seed yield (1595 kg ha^{-1}), stover yield (3062 kg ha^{-1}), crude protein yield (634 kg ha^{-1}), oil yield (312 kg ha^{-1}), nutrient content and uptake by seed and stover of soybean. Soybean sown with application of jeevamrut @ 500 l ha^{-1} produced significantly the highest seed yield (1644 kg ha^{-1}), stover yield (3072 kg ha^{-1}), crude protein yield (653 kg ha^{-1}), oil yield (319 kg ha^{-1}), nutrient content and uptake by seed and stover of soybean. The inteication effect of 4% seaweed extract at 30 and 45 DAS and jeevamrut @ 500 l ha^{-1} was recorded significantly higher seed yield of soybean.

Key words: Soybean, organic spray, jeevamrut, yield, quality, nutrient, content and uptake)

Received: August 29, 2022. Revised: June 2, 2023. Accepted: June 16, 2023. Published: July 4, 2023.

1. Introduction

Soybean [*Glycine max* (L.)] is an important oil yielding crop having worldwide adaptation. It belongs to the legume family and native to East Asia. It belongs to the family Fabaceae and sub family Papilionaceae. Soybean is known as the "Golden Bean" of the twentieth century. The leading soybean growing countries are USA, Brazil, China, Argentina, and India. In India, soybean occupies an area of about 10.38 million hectares producing 10.94 million tonnes with the productivity of 1050 kg ha^{-1}, whereas in Gujarat it is grown in 0.15 million hectares with the production of 0.12 million tonnes and productivity of 788 kg ha^{-1} (Anonymous, 2020). Panchgavya is an organic product blended with five different cow products, commonly applied to crop plant in organic farming. It acts as growth promoter and immunity booster and also restricts the incidence of common disease. Vermiwash is watery extract of vermicompost, extracted in the presence of rich population of earthworm and contains several enzymes, plant growth hormone, vitamins along with micro and micro and macronutrients which increase the resistance power of crops against various diseases and enhance the growth and productivity of crops (Zambare *et al*. 2008).

The extract of marine macro algae *viz*., brown, red and green algae is known to have positive effect on growth and yield of crops. The brown algae are the most commonly used seaweeds in agriculture. Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite and sulphate. It contains 95% water, 2.5% urea, 2.5% others (mineral salts, hormones and enzyme). Novel organic liquid nutrient is a product of Navsari Agricultural University which was patented in the year of 2012. It is prepared from banana pseudostem sap. Jeevamrut also contains enormous amount of microbial load which multiply and enhance N fixation and nutrient mobilization and utilization increase the soil fertility (Palekar, 2006). Jeevamrut contains small amount of macro and micronutrient as well as growth hormone which is helpful to enhancing the growth and yield of crops. Looking into importance

of organics as foliar spray and soil application of jeevamrut, a field experiment was conducted to see that effects on growth, yield and economics of soybean under rainfed condition.

2. Materials and Methods

The field experiment was conducted at the College Farm, Navsari Agricultural University, campus Bharuch (South Gujarat Agro Climatic Zone - II) in the Plot No. 12 during the *Kharif* season of 2021. The soil of experimental field was clayey in texture and slightly alkaline in reaction. The soil was low in available N (244 kg ha^{-1}), low in available P_2O_5 (26.2 kg ha^{-1}) and high in available K_2O (330.21 kg ha^{-1}). The experiment was laid out in FRBD with 12 treatment combinations consisting of two factors *i.e.,* foliar nutrition application (F_1- control, F_2- 4% panchgavya at 30 and 45 DAS, F_3- 2% novel organic liquid at 30 and 45 DAS, F_4-4% seaweed extract at 30 and 45 DAS, F_5- 4% cow urine at 30 and 45 DAS and F_6-2% vermiwash at 30 and 45 DAS) and soil application (S_1- control, S_2- jeevamrut @ 500 l ha^{-1}) were tested in factorial randomized block design with three replication. The entire dose of fertilizer was 30-60-00 N: P_2O_5: K_2O kg ha^{-1}. Soybean variety KDS-344 was sown by the opening of furrow at distance of 45 x 10 cm. Specially prepared jeevamrut solution was applied at the rate of 500 l ha^{-1} along with the application of FYM in treated plots. Applications of different foliar spray as per treatments were applied at 30 and 45 DAS, using 500-liter water $hectare^{-1}$.

The data on seed and stover yield was recorded from the net plot and converted on a hectare basis. The nitrogen content in soybean seed was estimated by micro alkaline permanganate oxidation method as described by Subbiah and Asija (1956). The crude protein content of the seed was computed by multiplying the nitrogen percentage with 6.25 for each treatment. The oil content was determined by Soxhlet extraction method as per procedure given by Soxhlet (1879). Chemical studies about nitrogen, phosphorus, potassium content and their uptake by seed and stover and available nitrogen, phosphorus, potassium status in the soil after harvest of the crop were determined as per

different methods *viz.,* Modified alkaline permanganate oxidation method (for N), Spectro photometric (for P) and Flame photometric method (for K). The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1967). The purpose of the analysis of variance was to determine the significant effect of treatments on soybean. Uptake of nutrients by seed and plant was calculated by using following formula:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) x seed / stover yield (kg ha}^{-1}\text{)}}{100}$$

3. Results and Discussion

3.1 Effect of foliar nutrition

Yield

The data given in Table 1 indicated that significantly higher seed yield (1595 kg ha^{-1}) and stover yield (3062 kg ha^{-1}) was registered under foliar application of 4% seaweed extract at 30 and 45 DAS (F_4), however it was statistically at par with treatment of 4% panchgavya at 30 and 45 DAS (F_2), 2% novel organic liquid at 30 and 45 DAS (F_3) and 2% vermiwash at 30 and 45 DAS (F_6). Higher seed yield might be due to IAA and GA present in seaweed extract when spray could have created stimuli in the plant system which in turn increased the production of growth regulators in cell system and the action of growth regulators in plant system stimulated the necessary growth and development coupled with better translocation and accumulation of photosynthates from source to sink and ultimately increased the seed yield. These findings were in accordance with the results of Akhila *et al*. (2017), in their studies foliar application of 2% *Kappaphycus alvarezii* seaweed sap gave significantly the highest seed (26.65 q ha^{-1}) and stover yield (12.21 q ha^{-1}) over 6% *Kappaphycus alvarezii*,1% enriched banana pseudostem sap and 2% enriched banana pseudostem sap.

3.2 Quality parameters

The data of Table 1 indicated that protein content and oil content were not differed

significantly due to different foliar nutrition practices. Numerically higher crude protein content (39.77 per cent) and oil content (19.61 per cent) were recorded by the application of 4% seaweed extract at 30 and 45 DAS (F_4). However, protein yield and oil yield were significantly influenced due to different foliar nutrition practices. Application of 4% seaweed extract at 30 and 45 DAS (F_4) recorded significantly higher protein yield (634 kg ha^{-1}) and oil yield (312 kg ha^{-1}) which was statistically at par with treatment of 4% panchgavya at 30 and 45 DAS (F_2), 2% novel organic liquid at 30 and 45 DAS (F_3) and 2% vermiwash at 30 and 45 DAS (F_6).This might be due to increase in seed yield when applied with seaweed extract. Similar reasons have also been reported by Zodape *et al*. (2010). They reported that protein content had increased by 7.07% with the foliar application of 10% *Kappaphycus alvarezii* seaweed sap as compared to 5% and 15%.

3.3 Nutrient content and uptake

An appraisal of data given in Table 3 revealed that no significant difference was observed in nitrogen, phosphorus and potassium content in seed and stover due to different foliar nutrition practices. However, significantly higher nitrogen, phosphorus and potassium uptake by seed and stover was recorded by application of 4% seaweed extract at 30 and 45 DAS (F_4) which was remained statistically at par with treatment of 4% panchgavya at 30 and 45 DAS (F_2), 2% novel organic liquid at 30 and 45 DAS (F_3) and 2% vermiwash at 30 and 45 DAS (F_6) and lowest nitrogen, phosphorus and potassium uptake by seed and stover was recorded in control (F_1). This increased might be due to foliar application of seaweed extract. The presence of marine bioactive substance in seaweed extract improves stomata uptake efficiency in treated plants as compared to non-treated plants. Similar finding by Pramanick *et al*. (2013) recorded highest N (57.67 kg ha^{-1}), P (5.85 kg ha^{-1}) and K (22.97 kg ha^{-1}) uptake by seed and highest N (143.33 kg ha^{-1}), P (7.83 kg ha^{-1}) and K (80.95 kg ha^{-1}) uptake by stover by the application of 15% *Kappaphycus*-sap + RDF as compared to different

concentration of *Kappaphycus*-sap and *Gracilaria*-sap.

3.4 Available nutrient in soil after harvest

The different foliar nutrition practices were influenced non-significant effect on available N, available P_2O_5 and K_2O in the soil after harvest of soybean crop. Dwivedi *et al*. (2015) recorded maximum available N (166.2 kg ha^{-1}), P_2O_5 (34.05 kg ha^{-1}) and K_2O (418.9 kg ha^{-1}) in soil after harvest under foliar spray of 15% *Kapphaphycus* spp + RDF on soybean.

3.5 Effect of soil application Yield

The data given in Table 1 indicated that significantly the highest seed yield (1644 kg ha^{-1}) and stover yield (3072 kg ha^{-1}) of soybean was observed under the application of jeevamrut @ 500 l ha^{-1} (S_2) in comparison to control (S_1) (1290 kg ha^{-1}, 2466 kg ha^{-1}). The significant improvement in seed yield $plant^{-1}$ was attributed due to increased supply of plant nutrients, more root nodules and phytohormones supplied through application of jeevamrut. The results were supported by findings of Upperi *et al*. (2009), who recorded application of jeevamrut recorded the highest mean yield and yield attributes of treated field as compared to control.

3.6 Quality parameters

The data of Table 1 indicated that protein content and oil content were not differed significantly due to soil application. Numerically highest crude protein content (39.69 per cent) and oil content (19.39 per cent) were recorded by application of jeevamrut @ 500 l ha^{-1} (S_2) in comparison to control (S_1). However, protein yield and oil yield were significantly influenced due to soil application. Jeevamrut @ 500 l ha^{-1} (S_2) recorded significantly highest protein yield (653 kg ha^{-1}) and oil yield (319 kg ha^{-1}) in comparison to control (S_1). Increase in protein yield might be due to increase in nitrogen content and seed yield by soil application of jeevamrut. Similar finding reported by Patil and Udmale (2016) for the higher protein and oil content in seed of soybean by the application of FYM + vermicompost (50 % each) + jeevamrut (2 times *i.e*., at 30 and 45 DAS).

3.7 Nutrient content and uptake

An appraisal of data given in Table 3 revealed that no significant difference was observed in nitrogen, phosphorus and potassium content in seed and stover due to soil application of jeevamrut @ 500 l ha^{-1}. However, significantly highest nitrogen, phosphorus and potassium uptake by seed and stover was recorded by application of jeevamrut @ 500 l ha^{-1} (S_2) and lowest nitrogen, phosphorus and potassium uptake by seed and stover was recorded in control (S_1). This is might be due to quick build-up of soil micro flora and fauna which has consequently increased the enzymatic activity helped in mineralization, solubilization of native and applied nutrients and making them available for plant uptake. These results are in accordance with the results of Patil and Udmale (2016), who reported that application of FYM + vermicompost (50 % each) + jeevamrut (2 times *i.e*., at 30 and 45 DAS) gave significantly higher uptake of N, P and K by soybean.

3.8 Available nutrient in soil after harvest

The soil application was influenced non-significant effect on available N, available P_2O_5 and K_2O in the soil after harvest of soybean crop. Lahariya *et al*. (2013) recorded the maximum available N, P, K content in soil after harvesting of soybean as compared to control when application of jeevamrut @ 500 l ha^{-1}.

3.9 Interaction effect

The data in Table 3 revealed that the treatment combination of foliar nutrition (F) and soil application (S) significantly influenced seed yield of soybean. The treatments combination of 4% seaweed extract at 30 and 45 DAS with jeevamrut @ 500 l ha^{-1} gave significantly higher seed yield (1745 kg ha^{-1}) and were found statistically at par with application of 2% vermiwash at 30 and 45 DAS with *jeevamrut* @ 500 lit ha^{-1} (1725 kg ha^{-1}), application of 4% *panchgavya* at 30 and 45 DAS with *jeevamrut* @ 500 lit ha^{-1} (1685 kg ha^{-1}) and application of 2% Novel organic liquid at 30 and 45 DAS with *jeevamrut* @ 500 lit ha^{-1} (1619 kg

ha^{-1}) while lowest number seed yield (936 kg ha^{-1}) was registered with treatments combination of control. This might be due to the combine beneficial effect of seaweed extracts and jeevamrut which contain nutrients, plant growth hormones auxins, cytokinin and gibberellins as well as other plant bio stimulant like amino acid and which is increase the photosynthetic activity and further, the translocation and accumulation of photosynthates.

4. Conclusions

On the basis of experiment, it can be concluded that soil application of jeevamrut @ 500 lit ha^{-1} prior to sowing of soybean with foliar application of 4% seaweed extract or 4% panchgavya or 2% novel organic liquid or 2% vermiwash at 30 and 45 DAS found better quality, yield and nutrient uptake of soybean and maintaining soil health.

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Table 1. Effect foliar nutrition and soil application on yield and quality of soybean

Treatments	Yield (kg ha^{-1})		Crude protein content (%)	Crude protein yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
	Seed	Stover				
Foliar nutrition (F)						
F_1	1238	2428	37.63	470	18.20	226
F_2	1562	2873	39.63	618	19.40	303
F_3	1526	2850	39.53	603	18.97	290
F_4	1595	3062	39.77	634	19.61	312
F_5	1374	2602	38.94	538	18.64	257
F_6	1505	2797	39.23	592	19.04	287
S Em ±	44.96	136.30	0.67	20.81	0.48	11.54
C D at 5 %	131.87	399.75	-	61.03	-	33.87
Soil application (S)						
S_1	1290	2466	38.55	499	18.57	240
S_2	1644	3072	39.69	653	19.39	319
S Em ±	25.96	78.69	0.39	12.01	0.27	6.66
C D at 5 %	76.13	230.79	-	35.23	-	19.55
Interaction (F x S)						
S Em ±	63.58	192.75	0.96	29.43	0.68	16.33
C D at 5 %	186.49	-	-	-	-	-

Table 2: Seed yield of soybean as influenced by interaction effect of foliar nutrition and soil application.

Treatments	Soil application (S)	
Foliar nutrition (F)	S_1	S_2
F_1	936	1542
F_2	1440	1685
F_3	1434	1619
F_4	1446	1745
F_5	1199	1551
F_6	1285	1725
S Em ±	63.58	
CD at 5%	186.49	

Table 3.Nutrient content, uptake and available nutrient status of soil by soybean as influenced by foliar nutrition and soil application

——	Nutrient content (%)						Nutrient uptake (kg ha^{-1})						Available Nutrients (kg ha^{-1})		
	Seed			Stover			Seed			Stover					
	N	P	K	N	P	K	N	P	K	N	P	K	N	P_2O_5	K_2O
Foliar nutrition (F)															
F_1	6.021	0.354	1.233	1.245	0.217	0.810	75.23	4.39	15.31	30.30	5.28	19.63	240.61	24.322	291.39
F_2	6.340	0.369	1.271	1.297	0.233	0.852	98.96	5.78	19.87	37.47	6.67	24.62	246.70	26.538	301.41
F_3	6.325	0.361	1.251	1.292	0.228	0.840	96.58	5.52	19.16	36.58	6.51	23.96	246.02	25.893	298.13
F_4	6.362	0.372	1.276	1.311	0.238	0.873	101.54	5.95	20.38	40.32	7.31	26.84	248.69	26.698	304.29
F_5	6.230	0.356	1.241	1.271	0.226	0.828	86.09	4.91	17.12	33.13	5.90	21.57	244.48	25.506	295.51
F_6	6.276	0.360	1.249	1.287	0.227	0.830	94.76	5.44	18.85	36.04	6.37	23.15	245.38	25.727	296.64
S Em. ±	0.109	0.010	0.028	0.031	0.007	0.020	3.32	0.21	0.74	1.86	0.36	1.15	5.481	0.96	6.49
C D at 5 %	-	-	-	-	-	-	9.76	0.63	2.19	5.46	1.06	3.39	-	-	-
Soil application (S)															
S_1	6.168	0.354	1.231	1.258	0.224	0.822	79.90	4.57	15.91	31.03	5.54	20.29	242.40	25.023	292.67
S_2	6.350	0.370	1.275	1.310	0.232	0.855	104.49	6.09	20.99	40.25	7.14	26.30	248.03	26.538	303.12
S Em.	0.063	0.006	0.016	0.018	0.004	0.012	1.92	0.12	0.43	1.07	0.20	0.66	3.164	0.55	3.75

±															
C D at 5 %	-	-	-	-	-	-	5.63	0.36	1.26	3.15	0.61	1.96	-	-	-
Interaction (F x S)															
S Em. ±	0.154	0.014	0.040	0.043	0.010	0.029	4.70	0.30	1.05	2.63	0.51	1.63	7.751	1.35	9.18
C D at 5 %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-