The Pharma Innovation Journal 2023; SP-12(8): 1584-1588

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(8): 1584-1588
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www.thepharmajournal.com
Received: 09-05-2023
Accepted: 14-07-2023

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Impact of nutrient management through organic sources on productivity and economics of soybean under middle Gujarat condition

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Abstract
A field experiment was conducted at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India during *kharif* season of the years 2022-23 to study the impact of different organic sources on productivity and economics of soybean under middle Gujarat condition. The experiment was comprised of twelve treatments of different organic sources supplying 100%, 75% and 50% N through different combinations of farm yard manure (FYM), vermicompost (VC) and poultry manure (PM), seed treatment and soil application of Bio NP consortium, *Jeevamrut* (soil and foliar application) and *ghan Jeevamrut* compared with control treatment. The experiment was laid in the loamy sand textured soil found medium in organic carbon, available nitrogen and phosphorus and high in available potash.

Application of 50% N through FYM + 50% N through VC + *Jeevamrut* soil and foliar application registered significantly higher plant height and number of branches/plant at 60 DAS and at harvest, dry matter accumulation and number of pods/plant at harvest. The same treatment produced significantly higher seed yield (1518 kg/ha) and haulm yield (2454 kg/ha) of soybean. Maximum net realization of ₹ 74353/ha was recorded under application of 50% N through FYM + 50% N through VC + *Jeevamrut* soil and foliar application with BCR of 3.02, followed by treatment with 250 kg/ha FYM + 250 kg/ha *ghanjivamrut* + 500 L/ha *Jeevamrut* (soil and foliar application) with net realization of ₹70157/ha and BCR of 3.40.

Keywords: Organic sources, FYM, vermicompost, poultry manure, *Jeevamrut*, soybean

Introduction
Soybean [*Glycine max* (L.) Merr.], due to its multiple uses, is considered a wonder crop, and none of the soybean byproducts remains unused. Globally India stands fourth in the soybean cultivation area with a share of 8.6% and in term of production, India occupies the sixth position with a 3.8% share. In India, Madhya Pradesh (50.53%) and Maharashtra (34.86%) are the leading states which are contributing >80% of the production (Kolar *et al.*, 2021) [7]. The highest annual growth rate (AGR) for production was observed in the case of soybean (4.5%) and it has emerged as the golden bean of the 21st century (Nigam *et al.*, 2021) [10]. Due to its nutritional value and favorable agro-climatic conditions, there are ample scopes to increase the production of soybean through use of integration of different organic sources in middle Gujarat condition.

One of the biggest challenges in the tropics is to develop organic farming technologies which could be adopted by the farmers. Technologies must be effective within farmer resource constraints, increase food production, reduce risk and enhance the soil fertility (Snapp *et al.*, 1998) [16]. Farmers uses inorganic fertilizers excessively might cause soil health problem (Saini *et al.*, 2019) [14]. Hence, to solve such problem one should start integrating or solely using organic manure instead of inorganic fertilizers. Substituting chemical fertilizer with organics is an important agricultural practice that improves crop yields but also affects soil biogeochemical cycling (Li *et al.*, 2022) [8]. Application of organic manure can pave the way to replenishing the essential nutrients and improving soil health and crop productivity (Berner *et al.*, 2008; Bajeli *et al.*, 2016) [3, 2]. Application of different organics *viz.*, FYM, poultry manure, vermicompost and goat manure significantly improved organic carbon and other soil properties. (Diwale *et al.*, 2020) [5]. Application of consortium bio-inoculants of rhizobia with PGPR improved nodulation and biological nitrogen fixation ability through the production of flavonoids, phytohormones, and Nod factor or soil enzyme activities in legumes (Medeot *et al.*, 2010) [9].

The *Jeevamrut* is cheaper eco-friendly liquid organic concoction which is an excellent source of organic carbon, nitrogen, phosphorous, potassium and lot of other micro nutrients required by crops (Palekar, 2006; Vasanthkumar, 2006) [11, 17]. It was also reported (Bhawariya *et al.*, 2022) [4] that it contains macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms.
In light of this context, a field experiment was conducted to study the impact of different nutrient sources on productivity and economics on soybean under middle Gujarat conditions.

Materials and Methods

The present investigation was carried out during *kharif* season of the year 2022on organic certified plot at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand in loamy sand soil found low in available nitrogen (210 kg N/ha) while medium in organic carbon (0.83%), available phosphorus (31 kg P_2O_5/ha) and available potash (280 kg K_2O/ha) with Soil pH (1:2.5) of 7.79. The experiment, conducted to determine the impact of different organic sources on productivity and economics of soybean (Var. NRC 37), was comprised of twelve treatments of different organic sources *viz*., Control (T_1), 100% N through farm yard manure (FYM) (T_2), 100% N through vermicompost (VC) (T_3), 100% N through poultry manure (PM) (T_4), 75% N through FYM + Seed treatment and soil application of Bio NP consortium (T_5), 75% RDN through VC + Seed treatment and soil application of Bio NP consortium (T_6), 75% N through PM+ Seed treatment and soil application of Bio NP consortium (T_7), 50% N through FYM + 50% N through VC (T_8), 50% N through FYM + 50% N through VC + *Jeevamrut* (soil and foliar application) (T_9), 50% N through FYM + 50% N through PM + *Jeevamrut* (soil and foliar application) (T_{10}), 25% N through FYM + 25% N through VC + 25% PM + Bio NP consortium + *Jeevamrut* (soil and foliar application) (T_{11}) and 250 kg/ha FYM + 250 kg/ha *ghan Jeevamrut* + 500 L/ha *Jeevamrut* (soil and foliar application) (T_{12}) laid out in Randomized Block Design. The nitrogen content of FYM, VC and PM were 0.56, 1.58 and 3.01 percent, respectively. All the organic manures were incorporated 15 days before sowing in the respective treatment, while Bio NP consortium was applied as a seed treatment (5 mL/kg) seed and also as soil application (1 L/ha) at the time of sowing and *Jeevamrut* was applied as a soil application (500 L/ha) at the time of sowing and at 30 DAS and as a foliar spray (5%) at 30 and 45 DAS.
Jeevamrut and *Ghanjivamrut* were prepared adopting following procedure.

Preparation of *Jeevamrut*

Ingredients *viz*; 10 kg of Fresh *desi* cow dung, 10 L *desi* Cow urine, 2 kg Jaggery, 2 kg pulse flour and 1 kg virgin soil (take from below side of banyan tree) were taken incorporated in to 180 L water in a plastic drum. Kept the plastic container in the shade for one week for proper fermentation and then stirred the mixture in the morning and evening for five minutes in the clockwise direction. The concoction was ready for use after a week.

Preparation of *Ghanjivamrut*

Ingredients *viz*; 100 kg cow dung (air-dried for 4-5 days), 1 kg jiggery,1 kg pulse flour, 3 L of cow urine and 250 g soil from undisturbed bunds/forest were mixed well and it was prepared like cakes, which could be ready to use in fields after 10 days of preparation. Generally, 250 kg *ghan Jeevamrut* / ha was applied before sowing of the crop.
Economics was calculated on the basis of cost of cultivation, gross and net realization and cost benefit ratio (BCR). The BCR was calculated on the basis of formula given below

$$BCR = \frac{\text{Gross returns (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

Results and Discussion

Results presented in Table 1 shown that though different treatments could not exhibit significant effect on plant height and number of branches per plant at 30 DAS, they manifested significant impact at 60 and at harvest. Treatment T_9 (50% N through FYM + 50% N through VC + *Jeevamrut* soil & foliar application), being at par with all the treatments barring T_1(Control) and T_{12} (250 kg/ha FYM + 250 kg/ha *Ghanjivamrut*+ 500 L/ha *Jeevamrut* soil & foliar application) at 60 DAS and baring T_1 (Control), T_2 (100% N through farm yard manure), T_8 (50% N through FYM + 50% N through VC) at harvest recorded significantly higher plant height of 53.10 cm and 68.10 cm, respectively. Similarly, the same treatment registered significantly higher number of branches/plant (3.80) over T_1, T_2, T_3 & T_4, and (4.55) over T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9 at 60 DAS and at harvest, respectively, while other treatments remained at par. Though dry weight of root nodules could not be affected due to different treatments appreciably, treatment T_9 (50% N through FYM + 50% N through VC + *Jeevamrut* soil & foliar application) recorded significantly higher dry matter accumulation per plant of soybean (14.73 g) at 45 DAS. The combined impact of *Jeevamrut*, FYM and VC on growth parameters of soybean might be the result of synergistic effect on soil microbial activities due to *Jeevamrut*, which enhance the availability of the nutrient to the plant and resulted into practice source to sink ratio. Moreover, the amount of nutrients and microbes in rhizosphere enhanced with application of *Jeevamrut* combine effect with growth promoting hormones from vermicompost influence the cell division and cell elongation in soybean. These results are in conformity with the findings of Sharma and Thakur (2022) [15].
Results presented in Table 2 revealed that though different treatments did not influence pod length, seed index and harvest index of soybean, they had significant impact on number of pods/plant, seed and haulm yield. Among various treatments, T_9 (50% N through FYM + 50% N through VC + *Jeevamrut* soil & foliar application) recorded significantly the highest number of pods per plant (115.08). However, it remained at par with T_{10}, T_{11} and T_{12}. It produces 20.78% higher number of pods/plant compared to T_1. Similar trend was observed for seed yield and treatment T_9, being at par with T_{10}, T_{11} and T_{12} produced significantly higher seed yield (1518 kg/ha). Increase in seed yield recorded to the tune of 31.94, 25.41, 23.65 and 23.93 percentage forT_9, T_{10}, T_{11}& T_{12} treatment respectively over T_1 (control). It is obvious from the results that the treatments included *Jeevamrut* had significantly higher seed yield over rest of the treatments. The same treatment T_9 (50% N through FYM + 50% N through VC + *Jeevamrut* soil & foliar application) registered significantly higher haulm yield (2454 kg/ha) which was statistically at par withT_{10} and T_{11}. The increase was to the tune of 29.09, 24.54 and 21.97 for T_9, T_{10} and T_{11} respectively

over T_1(control). This might be due to plant growth promoting substance *viz*; IAA, GA, cytokinin etc. presented in *Jeevamrut* might had double impact when applied in the soil and as foliar spray. Application of *Jeevamrut* in the soil might stimulate the microbial activities which in turn make all the essential nutrients available to the plant persistently throughout its growth period. The spray of *Jeevamrut* might stimulate growth regulators in cell system, which in turn resulted into better translocation and increase in the photosynthetic activity, resulted into accumulation of photosynthates to sink which might be resulted into higher growth, higher dry matter production and yield attributes, which ultimately produced higher seed and haulm yield. Similar finding was reported by Bag *et al*., (2015) [1], Patil and Udmale (2016) [13], Patel *et al*., (2018) [12] and Jegoda *et al*. (2019) [6].

Data presented in Table 3 indicated that treatment T_9 (50% N through FYM + 50% N through VC + *Jeevamrut* soil & foliar application) fetched the highest net realization of ₹.74353/ha with followed by T_{12} (250 kg/ha FYM + 250 kg/ha *Ghanjivamrut*+ 500 L/ha *Jeevamrut* soil & foliar application) with net realization of ₹.70157/ha. The additional income gained under T_9 over control was ` 22897/ha which was 30.79% higher over control. However, the highest BCR (3.57) was recorded with T_7 (75% N through PM + Seed treatment and soil application of Bio NP consortium), followed by T_{12} (3.40) and T_9 (3.02).

Table 1: Plant height, Number of branches/plants, Dry weight of nodules and Dry matter accumulation as influenced by different treatments

	Treatments	plant height (cm)			Number of branches/plants			Dry weight of nodules (mg/plant)	Dry matter accumulation (g/plant)
		At 30 DAS	At 60 DAS	At Harvest	At 30 DAS	At 60 DAS	At Harvest	At 45 DAS	At 45 DAS
T_1	Control (no manure)	23.55	46.80	60.55	2.35	2.70	3.70	28.50	11.73
T_2	100% N through farm yard manure (FYM)	24.35	51.25	64.50	2.4	2.95	3.80	29.08	11.89
T_3	100% N through vermicompost (VC)	24.95	50.00	65.50	2.45	3.20	3.95	29.67	12.46
T_4	100% N through poultry manure (PM)	25.10	51.00	65.55	2.45	3.30	4.00	31.08	12.48
T_5	75% N through FYM + Seed treatment and soil application of Bio NP consortium	25.15	51.15	65.65	2.5	3.35	4.05	31.33	12.69
T_6	75% N through VC + Seed treatment and soil application of Bio NP consortium	25.85	52.05	65.70	2.45	3.35	4.10	31.33	12.94
T_7	75% N through PM+ Seed treatment and soil application of Bio NP consortium	25.95	51.53	65.85	2.55	3.40	4.15	31.42	12.98
T_8	50% N through FYM + 50% N through VC	24.55	51.60	64.50	2.4	3.05	3.90	29.58	12.36
T_9	50% N through FYM + 50% N through VC + *Jeevamrut* (soil & foliar application)	26.25	53.10	68.10	2.7	3.80	4.55	32.50	14.73
T_{10}	50% N through FYM + 50% N through PM + *Jeevamrut* (soil & foliar application)	26.20	51.05	66.55	2.65	3.70	4.45	32.42	14.34
T_{11}	25% N through FYM + 25% N through VC + 25% PM + Bio NP consortium + *Jeevamrut* (soil & foliar application)	26.10	51.60	66.85	2.55	3.40	4.20	31.58	13.27
T_{12}	250 kg/ha FYM + 250 kg/ha *Ghanjivamrut*+ 500 L/ha *Jeevamrut* (soil & foliar application)	26.10	51.35	66.10	2.55	3.45	4.30	32.08	13.54
S.Em ±		0.80	1.61	1.19	0.10	0.21	0.15	1.23	0.48
CD (P=0.05)		NS	4.64	3.42	NS	0.59	0.44	NS	1.38
CV %		6.33	6.31	3.63	8.71	12.47	7.46	7.98	7.41

Table 2: Yield attributes and yield of soybean as influenced by different treatments

	Treatment	Number of pods/plants	Pod length (cm)	Seed index (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)	Harvest Index (%)
T_1	Control (no manure)	91.17	3.13	8.32	1033	1740	37.23
T_2	100% N through farm yard manure (FYM)	95.75	3.21	8.39	1108	1993	36.12
T_3	100% N through vermicompost (VC)	97.67	3.23	8.45	1197	1998	37.43
T_4	100% N through poultry manure (PM)	98.25	3.26	8.48	1200	2047	36.90
T_5	75% N through FYM + Seed treatment and soil application of Bio NP consortium	100.00	3.28	8.48	1222	2017	37.66
T_6	75% N through VC + Seed treatment and soil application of Bio NP consortium	100.42	3.33	8.49	1243	2051	37.69
T_7	75% N through PM+ Seed treatment and soil application of Bio NP consortium	101.00	3.43	8.49	1258	2077	37.70
T_8	50% N through FYM + 50% N through VC	96.67	3.21	8.46	1172	2007	36.84
T_9	50% N through FYM + 50% N through VC + *Jeevamrut* (soil & foliar application)	115.08	3.48	9.15	1518	2454	38.17
T_{10}	50% N through FYM + 50% N through PM + *Jeevamrut* (soil & foliar application)	112.00	3.39	8.81	1385	2306	37.54
T_{11}	25% N through FYM + 25% N through VC + 25% PM + Bio NP consortium + *Jeevamrut* (soil & foliar application)	101.58	3.44	8.57	1353	2230	37.73
T_{12}	250 kg/ha FYM + 250 kg/ha *Ghanjivamrut*+ 500 L/ha *Jeevamrut* (soil & foliar application)	108.50	3.45	8.71	1358	2191	38.11
S.Em ±		4.77	0.11	0.22	60	89	0.72
CD (P=0.05)		13.72	NS	NS	174	257	NS
CV %		9.39	6.48	5.18	9.63	8.54	3.85

Table 3: Economics as influenced by application of different organic sources in soybean

Treatment	Yield (kg/ha)		Realization(₹/ha)			Cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
	Seed	Haulm	Seed	Haulm	Gross			
T_1	1033	1740	72310	3480	75790	24334	51456	3.11
T_2	1108	1993	77560	3986	81546	30042	51504	2.71
T_3	1197	1998	83790	3996	87786	36264	51522	2.42
T_4	1200	2047	84000	4094	88094	25867	62227	3.41
T_5	1222	2017	85540	4034	89574	29087	60487	3.08
T_6	1243	2051	87010	4102	91112	33758	57354	2.70
T_7	1258	2077	88060	4154	92214	25852	66362	3.57
T_8	1172	2007	82040	4014	86054	33150	52904	2.60
T_9	1518	2454	106260	4908	111168	36815	74353	3.02
T_{10}	1385	2306	96950	4612	101562	31619	69943	3.21
T_{11}	1353	2230	94710	4460	99170	34558	64612	2.87
T_{12}	1358	2191	95060	4382	99442	29285	70157	3.40

Selling price of soybean: seed: ₹.70/kg, Haulm: ₹.2.00/kg

Conclusion

In light of the above results, it can be concluded that significantly higher seed (1518 kg/ha) and haulm (2454 kg/ha) yield of soybean crop was recorded with 50% N through FYM (2.58 t/ha) + 50% N through VC (0.47 t/ha) along with soil application of *Jeevamrut* (500 lit/ha) at sowing and at 30 DAS followed by foliar spray of *Jeevamrut* (5%) at 30 & 45 DAS (T_9), which was also found statistically at par with the treatments T_{10} (50% N through FYM + 50% N through PM + *Jeevamrut* soil & foliar application), T_{11} (25% N through FYM + 25% N through VC + 25% PM + Bio NP consortium + *Jeevamrut* soil & foliar application) in seed and haulm yield and was also found at par with T_{12} (250 kg/ha FYM + 250 kg / ha *ghanjivamrut* + 500 L/ha *Jeevamrut* soil & foliar application) for seed yield. Treatment T_9 also fetched highest net realization (₹. 74353/ha), followed by T_{12}. However, the highest BCR (3.57) was recorded with T_7 (75% N through PM + Seed treatment and soil application of Bio NP consortium), followed by T_{12} (3.40) and T_9 (3.02).

Acknowledgement

Authors hereby acknowledge the assistance provided by Anand Agricultural University and particularly Principal and Head of Department, Agronomy, B.A. College of Agriculture, Anand for offering facilities for conducting the experiment and facilitating laboratories for soil and plant analysis as well as statistical analysis.

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