International Journal of Environment and Climate Change

Volume 13, Issue 4, Page 23-30, 2023; Article no.IJECC.97398
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effect of Vermicompost and Organic Formulations on Growth and Yield of Soybean Grown on Vertisol

P. B. Lokhande [a*], A. L. Dhamak [a], N. M. Patil [a], A. J. Ingole [a] and P. P. Satwadhar [a]

[a] Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i41708

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/97398

Original Research Article

Received: 02/01/2023
Accepted: 04/03/2023
Published: 09/03/2023

ABSTRACT

Soybean called as golden beans belongs to *leguminosae* family. It is native of East Asia. It is rich source of protein and also an excellent source of fiber. Balanced fertilization is necessary to increase the productivity of pulses. Organic manures and formulations favor plant growth and regulation and adaptability to the surrounding environments in terms of improvement in yields and quality parameters in addition to enhanced tolerance to biotic and abiotic stresses. Unlike, chemical fertilizer, these organic products are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animal and birds. Thus, integrations of organic manure and formulations with chemical fertilizer seems to be an alternative supply for plant nutrition. Keeping the above points in view the present experiment were conducted during *kharif*-2020 and *kharif*-2021 at Research Farm, Department of Soil Science and Agricultural Chemistry, College of Agriculture, VNMKV Parbhani, to study the effect of vermicompost and organic formulations on growth and yield of soybean grown on Vertisol. The experiment was laid in factorial randomized block design with twelve treatments

**Corresponding author: E-mail: priyankalokhande0704@gmail.com;*

and three replications. Experimental treatments consist of two factors in which one factor consist of vermicompost consist of three levels C_1-RDF, C_2- Vermicompost eq. to RDN, C_3- Vermicompost eq. to RDN + RD of vermicompost @ 5 t ha^{-1}, another factor organic formulations consist of four levels OF_0- control, OF_1- Panchagavya, OF_2- Beejamruth + Jeevamruth, OF_3-Beejamruth + Jeevamruth + Panchagavya. The growth parameters like leaf area, no. of pods and chlorophyll a, chlorophyll b and total chlorophyll showed significant increased with the application of RDF as compared to other treatments. Among organic formulations treatments highest value recorded in combined application of Beejamruth + Jeevamruth + Pancahgavya (OF_3) as compared to alone application. The significant increase in seed and straw yield was recorded in treatment receiving in treatment combination of RDF (C_1) along with combined application of Beejamruth + Jeevamruth + Panchagavya (OF_3). The result of the experiment revealed that application of RDF along with combined application of Beejamruth + Jeevamruth + Panchagavya was found beneficial for increase in growth and yield of soybean in Vertisol.

Keywords: Vermicompost; organic formulations; inorganic fertilizer; growth attributes; yield; soybean.

1. INTRODUCTION

Soybean is a leguminous oil seed crop that is primarily grown as a rainfed crop in central India's Vertisol [1]. It was dubbed the "Golden Bean" miracle crop of the twentieth century. To address the country's edible oil shortage, the soybean crop was introduced in the 1960s as a supplementary oil seed crop. It is an important pulse as well as oilseed crop, used to prepare different byproducts viz. soya milk, soya flakes, soybean oil, soy beverages, soya biscuits, fortified bakery products and generate rural employment for improving the economy of the farming community, hence called 'Golden bean'. Soybean was the third most important oilseed crop in India's edible oil scene. Soybean is a good source of protein (43.2%), oil (19.5 %), carbohydrates (26 %), phospholipids (2 %) and minerals (4 %). In India, to get the more food the farmers are using the chemical fertilizers continuously without knowing the actual dose and their residual effects on soil properties. The cost of chemical fertilizer is also increasing enormously to an extent that they are out of reach of small and marginal farmers. Use of chemical fertilizers and insecticides, the population of beneficial organisms decrease and natural generation of nutrition in the soil cease. Soil becomes barren and decreases fertility of soil.

"Panchagavya, Beejamruth and Jeevamruth are cheaper ecofriendly organic preparations made by cow products namely dung, urine, pulse flour, jaggery, live soil and local vegetation extracts etc" [2]. Panchagavya means a combination of five products obtained from cow i.e. dung, urine, milk, ghee and curd. Panchagavya is rich in essential nutrients, microorganisms, growth regulatory substances and insecticidal/ pesticidal properties which would enhances the productivity through the increase in growth of roots, stems, branches and leaves and plays a very important role in the growth and development of plants and contributes to better yield and yield attributes. Jeevamruth is a rich bio-formulation contains consortia of beneficial microbes like *Azospirillium*, *PSM*, *pseudomonas*, *Trichoderma*, yeast and mould which promotes immense biological activity in soil and makes the nutrients available to crop. It promotes immense biological activity in soil and makes the nutrients available to crop. Jeevamruth constitutes a rich source of nutrients like carbon, phosphorus, potassium along with rich soil microorganisms that helps in fixing the nitrogen, solubilize phosphorus. "Beejamruth is rich in beneficial micro flora like *Azospirillium, Azotobacter, Phosphobacteria, Psudomonas, Lactic acid bacteria and Methylotrophs* and is known to protect the seed from harmful soil and seed- borne pathogens. Thus it helps in the better germination, seedling growth, plant root and shoot growth, seedling vigour and yield. Beejamruth protect the crop from soil borne and seed borne pathogens and it improves seed germination also" [3]. Use of liquid manures results in increase in soil microbial activity and microbial biomass. The application of liquid organic inputs like panchagavya and Jeevamruth results in increase in number of beneficial microbes and also shows profound effect on soil enzymatic activity. Thus, they influence the growth of crop and can help in sustaining of safe environment and productivity. Balanced fertilization is necessary to increase the productivity of pulses. Regular and judicious use of fertilizers not only helps in raising good crop yield, but also can help farmers to gain consistently higher profit. Organic manures and

formulations favor plant growth and regulation and adaptability to the surrounding environments in terms of improvement in yields and quality parameters in addition to enhanced tolerance to biotic and abiotic stresses. “Unlike, chemical fertilizer, these organic products are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animal and birds Thus, integrations of organic manure and formulations with chemical fertilizer seems to be an alternative supply for plant nutrition. For sustainable agriculture, emphasis should be given on the use of organic sources of nutrients for growing crops” [4]. Integrated nutrient management hold not only the great promise in crop production but also control the emergence of multiple nutrient deficiencies and maintain good soil health.

To achieve sustainable soil fertility and crop productivity, the role of organic manures and other nutrient management practices like use of fermented organic nutrients *viz*. Jeevamruth, Beejamruth and Panchagavya etc. are becoming popular among farmers. These fermented liquid organic fertilizers contain in addition to nutrients, numerically microorganisms and growth promoting substances which help in improving plant growth, metabolic activity and resistance to pest and diseases.

2. MATERIALS AND METHODS

The field experiments were conducted to study the effect of vermicompost and organic formulations on growth and yield of soybean grown on Vertisol during *Kharif*-2020 and *Kharif*-2021 at Research Farm, Department of Soil Science and Agril. Chemistry, College of Agriculture, VNMKV Parbhani, The experiment was laid out in factorial randomized block design with twelve treatments and three replications. Experimental treatments consist of two factors in which one factor consist of vermicompost consist of three levels viz., C_1-RDF, C_2- Vermicompost eq. to RDN, C_3- Vermicompost eq. to RDN + RD of vermicompost @ 5 t ha^{-1}, another factor organic formulations consist of four levels OF_0-control, OF_1- Panchagavya, OF_2- Beejamruth + Jeevamruth, OF_3-Beejamruth + Jeevamruth + Panchagavya. The soybean variety ‘MAUS-162’ was sown at spacing 45 cm row to row and 5 cm plant to plant. Seeds were treated with beejamruth just before sowing. The vermicompost was incorporated about 8 days before sowing respectively and RDF was applied at the time of sowing as per treatments. All other operations were performed as per recommendations of the crop. The soil of the experimental site was dominant in montmorillonite mineral followed by moderate amount of kaolinite type of mineral and traces of Illite mineral. The data on various growth and yield attributes and seed and straw yields were recorded under various treatments.

3. RESULTS AND DISCUSSION

3.1 Effect of Vermicompost and Organic Formulations on Growth Attributes of Soybean

3.1.1 Leaf area

The integrated use of inorganic and organic liquid manure as a source of nutrients significantly influenced the leaf area of soybean. Results indicated in Table 1 revealed that, increase in leaf area with the increase in age of crop. Significantly increase in leaf area (36.38, 63.67 and 64.54 Sq cm.) was found in the treatment receiving only RDF (C_1) at flowering, pod development and at harvest stage respectively. However, lowest value of leaf area was found in the treatment Vermicompost eq. to RDN (C_2). Similarly, application of different organic formulations also increased leaf area with the increasing age of the crop. Highest value of leaf area (39.72, 64.11 and 68.50 Sq cm.) was found in the treatment Beejamruth + Jeevamruth + Panchagavya (OF_3) at flowering, pod development and and at harvest stage, respectively as compared to control treatment (OF_0).

Interaction effect of vermicompost (C) and organic formulations (OF) on leaf area of soybean leaves was found non- at flowering, pod development and at harvest stage, respectively. The cause for increase in leaf area was due to enhanced levels of cytokinin which is present in panchagavya, thereby causing manifold increase in cell division and also panchagavya, a potential source to play great role for promoting growth and providing immunity in plant system besides, a source of nutrients and microorganisms as well as easy availability of nutrients through chemical fertilizer resulting in enhancement of leaf area. Similar results was also reported by Gowthamchand et al. [5]. Jagdale et al. [6] revealed that the application of RDF +beejamruth + jeevamruth + panchagavya significantly improved leaf area of soybean.

3.1.2 Chlorophyll content

The significant effect of vermicompost and organic formulations on chlorophyll "a", "b" and total chlorophyll in soybean leaves is presented in Table 2. The highest chlorophyll "a", "b" and total chlorophyll (2.457, 0.800 and 3.066 mg g^{-1}) was recorded in the treatment receiving only RDF (C_1) at flowering stage, respectively. However, the effect of organic formulations was found significant on chlorophyll "a", "b" and total chlorophyll in soybean leaves and highest (2.602, 0.890 and 3.270 mg g^{-1}) was observed in treatment with application of Beejamruth + Jeevamruth + Panchagavya (OF_3) and it was followed by the treatment with application of Beejamruth + Jeevamruth (OF_2). The interaction effect of vermicompost (C) and organic formulations (OF) on the chlorophyll "a", "b" and total chlorophyll in soybean leaves was non-significant. The increase in chlorophyll content might be due to presence of increased population of photosynthetic bacteria in the liquid organic formulations. The use of liquid formulation with RDF have increased nitrogen content in leaves and might have enhanced the Mg absorption form the soil. Martincz et al. [7] also reported that increased chlorophyll may be attributed to the increased biological nitrogen fixation, better organic nitrogen utilization, better development of root system and the possible synthesis of plant growth regulators like IAA, GA_3 and cytokinins present in panchagavya. Sanjutha et al. [8] observed that highest chlorophyll content was observed with application of FYM @ 15 t ha^{-1} + NPK @ 75:75:50 ha^{-1} + Panchagavya @ 3 % foliar spray.

3.2 Effect of Vermicompost and Organic Formulations on Yield Attributes and Yield of Soybean

3.2.1 Number of pods per plant

The number of pods at harvest of soybean was significantly influenced by different vermicompost and organic formulation treatments presented in Table 3. The significantly highest number of pods (88.41) was recorded in the treatments with RDF (C_1) and it was statistically at par with number of pods (83.04) was reported with Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3). Application of different organic formulations increased number of pods. Among, organic formulation treatments the significantly highest number of pods (92.06) was observed in combined application of Beejamruth+ Jeevamruth + Panchagavya (OF_3) and it was statistically at par with the number of pods (87.89) was observed in treatment with Beejamruth + Jeevamruth (OF_2). The interaction effect of vermicompost (C) and organic formulations (OF_3) regarding number of pods at harvest was found non-significant. Increase in number of pods per plant might be due to the significant increase in growth parameters and efficient nutrient utilization. It may also be due to adequate availability of major nutrients which are required in larger quantity thus directly helps the plants to increase crop yield. Similar results was also reported by Patel and Thanki [9] and Gowthamch and et al. [5]. Somasundaram and Amanullah et al. [10] reported that significantly higher number of seeds per pod recorded with panchagavya 3% as compared to other treatments.

3.2.2 Seed yield

The data related to seed yield as influenced by vermicompost and different organic formulation treatments presented in Table 4. Significantly highest seed yield (2284.00 kg ha^{-1}) was found in the treatment with RDF (C_1) and it was statistically at par with seed yield (2198.00 kg ha^{-1}) was recorded in the treatment with Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3). Similarly, organic formulations alone or in combinations also significantly influenced the seed yield of soybean. The significantly highest seed yield (2335.00 kg ha^{-1}) was recorded in the treatment with Beejamruth+ Jeevamruth + Panchagavya (OF_3) over rest of the treatments. The interaction effect of vermicompost (C) and organic formulations (OF) was found statistically significant and recorded highest seed yield (2600.00 kg ha^{-1}) in the treatment RDF (C_1) along with application of Beejamruth+ Jeevamruth + Panchagavya (OF_3).

The increase in seed yield in the treatment receiving only RDF along with combined application of Beejamruth + Jeevemruth + Panchagavya may be due to adequate supply of essential major nutrient in addition to this more phosphorus supplied through RDF as compared to other treatment. Phosphorus is essential constituent of enzymes in carbohydrate and fat metabolism and respiration in plant also it regulate the photosynthesis govern physio-biochemical processes and also helps in development of roots and nodulation ultimately it helps in increase in yield of crop. While, increase

in seed yield could be attributed due to the beneficial effect of jeevamruth cause more vigorous and extensive root system of crop leading to increased vegetative growth means for more efficient sink formation and greater sink size. It also increases biological efficiency of crop plants enhanced the level of soil microorganisms and enzyme activities and promoted the recycling of nutrients that may be released slowly during crop growth which ultimately led to increase in seed yield Moreover, IAA and GA present in panchagavya when applied as foliar spray could have treated as stimuli in plant system and increase the production of growth regulators in the cell system and the action of growth regulators in plant system ultimately stimulated growth and development. These results are in agreement with the findings of Kachave et al. [11] reported that significantly highest fruit yield of tomato was obtained with treatment RDF + Beejamruth + Jeevamruth + Panchagavya. This might be due to adequate supply of required nutrients through chemical fertilizers and also overall improvement in soil physico-chemical and biological properties due to combined application of organic formulations. However, Gore and Shreenivasa [12], they reported that "fruit yield per plant was highest in treatment receiving RDF + Beejamruth + Jeevamruth + Panchagavya followed by RDF + Beejamruth + Panchagavya over RDF and alone application of liquid organic manures".

3.2.3 Straw yield

Data presented in Table 4 related to straw yield of soybean was increased significantly due to vermicompost and organic formulations treatments. The significantly maximum straw yield (3860.00 kg ha^{-1}) was recorded in the treatment with RDF (C_1) over rest of the treatments. It was followed by the treatment with Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3). Minimum straw yield (3519.00 kg ha^{-1}) was found in treatment with Vermicompost eq. to RDN (C_2). Further, application of different organic formulations significantly influenced straw yield of soybean and highest straw yield (3947.00 kg ha^{-1}) was noted in treatment with Beejamruth+ Jeevamruth + Panchagavya (OF_3) over rest of the treatments. The interaction effect of vermicompost (C) and organic formulations (OF) was found statistically significant and recorded straw yield (4299.00 kg ha^{-1}) in the treatment RDF (C_1) along with application of Beejamruth+ Jeevamruth + Panchagavya (OF_3). The interaction effect of vermicompost (C) and organic formulations (OF) was found statistically significant and recorded straw yield (42.99 kg ha^{-1}) in the treatment RDF (C_1) along with application of Beejamruth+ Jeevamruth + Panchagavya (OF_3). The results of present investigation revealed that combined application of Beejamruth + Jeevamruth + Panchagavya along with RDF improved straw

Table 1. Effect of vermicompost and organic formulations on leaf area (Sq cm) at critical growth stages of soybean (Pooled data of two year)

Treatments	Leaf area (Sq cm)		
	At flowering	Pod development	At harvest
Factor I - Vermicompost			
C_1- RDF	36.38	63.67	64.54
C_2-Vermicompost eq. to RDN	33.46	58.00	58.29
C_3-Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1}	34.46	60.17	62.71
S.Em.±	0.33	0.40	0.42
C.D. at 5 %	0.96	1.16	1.24
Factor II - Organic Formulations			
OF_0- Control	32.11	57.72	57.78
OF_1- Panchagavya	33.06	59.22	59.50
OF_2- Beejamruth + Jeevamruth	34.17	61.39	61.61
OF_3- Beejamruth+ Jeevamruth + Panchagavya	39.72	64.11	68.50
S.Em.±	0.38	0.46	0.49
C.D. at 5 %	1.11	1.37	1.43
Interaction (I X II)			
S.Em.±	0.66	0.79	0.84
C.D. at 5 %	NS	NS	NS

yield. The organic formulations improve the microbial and enzymatic activity in soil and it provides adequate supply of nutrients at critical growth stages of soybean as well as presence of growth regulators contributing to higher straw yield. Jeevamrutha contains enormous amount of microbial load which enhances the microbial activity in soil upon its application, while panchagavya act as a source of nutrients besides producing hormonal effect. These results are also in conformity with the findings of Shwetha and Babalad [13], who found that "higher straw yield of soybean in combined application of organic manure along with fermented organics viz., beejamruth, jeevamrutha soil application and panchagavya foliar spray". These results are in conformity with the findings of Kachave et al. [11] found that significantly higher dry matter yield with treatment RDF + Beejamruth+ Jeevamruth + Panchagavya. Further, Kasbe et al. [14] who reported that "better nutrient status of jeevamruth formulation (2500 litre ha^{-1}) resulted in profused growth in the form of higher dry matter accumulation and yield parameters".

Table 2. Effect of vermicompost and organic formulations on chlorophyll content in leaves at flowering stage of soybean (Pooled data of two year)

Treatments	Chlorophyll content		
	Chlorophyll "a" (mg g^{-1})	Chlorophyll "b" (mg g^{-1})	Total chlorophyll (mg g^{-1})
Factor I - Vermicompost			
C_1- RDF	2.457	0.800	3.066
C_2-Vermicompost eq. to RDN	2.124	0.621	2.792
C_3-Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1}	2.372	0.767	3.053
S.Em.±	0.040	0.037	0.08
C.D. at 5 %	0.116	0.108	0.23
Factor II - Organic Formulations			
OF_0- Control	2.090	0.665	2.781
OF_1- Panchagavya	2.238	0.664	2.849
OF_2- Beejamruth + Jeevamruth	2.368	0.698	2.981
OF_3- Beejamruth+ Jeevamruth + Panchagavya	2.602	0.890	3.270
S.Em.±	0.068	0.043	0.09
C.D. at 5 %	0.199	0.125	0.27
Interaction (I X II)			
S.Em.±	0.118	0.075	0.16
C.D. at 5 %	NS	NS	NS

Table 3. Effect of vermicompost and organic formulations on number of pods at harvest of soybean (Pooled data of two year)

Treatments	No. of pods at harvest
Factor I - Vermicompost	
C_1- RDF	88.41
C_2-Vermicompost eq. to RDN	78.65
C_3-Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1}	83.04
S.Em.±	1.80
C.D. at 5 %	5.27
Factor II - Organic Formulations	
OF_0- Control	75.92
OF_1- Panchagavya	77.60
OF_2- Beejamruth + Jeevamruth	87.89
OF_3- Beejamruth+ Jeevamruth + Panchagavya	92.06
S.Em.±	2.08
C.D. at 5 %	6.09
Interaction (I X II)	
S.Em.±	3.59
C.D. at 5 %	NS

Table 4. Seed and straw yield of soybean as influenced by vermicompost and organic formulations (Pooled data of two year)

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Factor I - Vermicompost		
C_1- RDF	2284.00	3860.00
C_2-Vermicompost eq. to RDN	1727.00	3131.00
C_3-Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1}	2198.00	3519.00
S.Em.±	25.00	34.00
C.D. at 5 %	72.00	101.00
Factor II - Organic Formulations		
OF_0- Control	1860.00	3225.00
OF_1- Panchagavya	1962.00	3345.00
OF_2- Beejamruth + Jeevamruth	2122.00	3497.00
OF_3- Beejamruth+ Jeevamruth + Panchagavya	2335.00	3947.00
S.Em.±	28.00	40.00
C.D. at 5 %	83.00	117.00
Interaction (I X II)		
S.Em.±	49.00	69.00
C.D. at 5 %	144.00	202.00

Table 4a. Interaction effect of vermicompost and organic formulations on seed yield of soybean

Treatment	OF_0	OF_1	OF_2	OF_3	Mean
C_1	1944.00	2151.00	2441.00	2600.00	**2284.00**
C_2	1538.00	1615.00	1715.00	2040.00	**1727.00**
C_3	2097.00	2120.00	2210.00	2366.00	**2198.00**
Mean	**1860.00**	**1962.00**	**2122.00**	**2335.00**	
Interaction	**C (A)**	**OF (B)**	**AXB**		
SE±	25.00	28.00	49.00		
CD at 5 %	72.00	83.00	144.00		

Table 4b. Interaction effect of vermicompost and organic formulations on straw yield of soybean

Treatment	OF_0	OF_1	OF_2	OF_3	Mean
C_1	3428.00	3696.00	4016.00	4299.00	**3860.00**
C_2	2922.00	3003.00	2929.00	3671.00	**3131.00**
C_3	3324.00	3336.00	3546.00	3870.00	**3519.00**
Mean	**3225.00**	**3345.00**	**3497.00**	**3947.00**	
Interaction	**C (A)**	**OF (B)**	**AXB**		
SE±	34.00	40.00	69.00		
CD at 5 %	101.00	117.00	202.00		

4. CONCLUSION

From the data it is concluded that the application of recommended dose of fertilizers (30:60:30 N:P_2O_5:K_2O kg ha^{-1}) to soybean along with the Beejamruth (seed treatment), Jeevamruth (soil application @ 500 L ha^{-1} at 30 and 45 DAS) and Panchagavya (foliar spray @ 3% at flowering and 15 Days after first spray) recorded significantly highest growth parameters viz., leaf area, chlorophyll a, chlorophyll b, total chlorophyll and yield attributing parameters like number of pods, seed yield and straw yield of soybean.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Damodaran T, Hedge DM. Oil seed situation: A statistical compedium. Directorate of Oil Seed Research, Rajendranagar, Hyderabad, India; 1999.
2. Kulkarni SS, Gargelwar AP. Production and microbial analysis of Jeevamrutham for nitrogen fixers and phosphate solubilizers in the rural area from Maharashtra. Journal of Agriculture Veterinary. 2019;12:85-92.
3. Boraiah B, Devakumar N, Palanna KB, Latha B. Influence of composted coir pith, farmyard manure and panchagavya application to capsicum on soil chemical properties. International Journal of Agriculture Innovations and Research. 2015;3(2):2319-1473.
4. Tejada M, Hernandez MT, Garcia C. Soil restoration using composted plant residue; Effects on soil properties. Soil and Tillage Research. 2009;102:109-117.
5. Gowthamchand NJ, Ganpathi, Soumya TM. Effect of bulky manures and fermented liquid organics on growth, yield, nutrient uptake and economics of French bean (*Phaseolus vulgaris* L.) under rainfed condition. International Journal of Agriculture, Environment and Biotechnology. 2019;12(4):361-368.
6. Jagdale A, Dhamak A, Pagar B, Wagh P. Effect of different organic formulations on growth and yield of soybean. International Journal of Chemical Studies. 2020;8 (4):1634- 1638.
7. Martincz R, Dibut B, Casanova I, Ortega M. Stimulating action of *Azotobacter chrococcoccum* on tomato crop on a red ferrallitic soil. Agrototecnia-de-Cuba. 2001; 27:23-26.
8. Sanjutha S, Subramanian S, Indu Rani C, Maheshwari J. Integrated nutrient management in Andrographis paniculate. Research Journal of Agriculture and Biological Sciences. 2008;4(2):141-145.
9. Patel HR, Thanki JD. Effect of integrated nutrient management on growth, yield, soil nutrient status and economics of chickpea (*Cicer arietinum* L.) under south Gujarat conditions. Journal of Pharmacognosy and Phytochemistry. 2020;9 (6):623-626.
10. Somasundaram E, Amanullah MM. Panchagavya on growth and productivity of crops: A review. Green Farming. 2007;1 22-26.
11. Kachave TR, Dhamak AL, Shinde VN, Gajbhiye BR. Effect of organic formulations and inorganic fertilizer on yield attributes, yield and quality of tomato. International Journal of Current Microbiology and Applied Sciences. 2021;10 (06).
12. Gore N, Shreenivasa MN. Influence of liquid organic manures on growth, nutrient content and yield of tomato. Karnataka Journal of Agricultural Sciences. 2011; 24(2):153-157.
13. Shwetha BN, Babalad. Effect of nutrient management through organics in soybean wheat cropping system. M.Sc. (Agri.) Thesis, University Agricultural Science, Dharwad; 2008.
14. Kasbe SS, Joshi M, Bhaskar S, Gopinath KA, Kumar MK. Evaluation of jeevamruta as a bio-resource for nutrient management in aerobic rice. International Journal of Bio-resource and Stress Management. 2015; 6(1):155-160.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/97398