International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(6): 2537-2541

Received: 03-10-2020
Accepted: 09-11-2020

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Effect of doses and time of application of Jeevamrit on nutrient uptake and soil health under natural farming system

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DOI: https://doi.org/10.22271/chemi.2020.v8.i6aj.11154

Abstract
Jeevamrit is a fermented liquid manure which contains huge quantity of microbial load that enhances soil bio-mass upon its application to the soil even at very lesser rate as it acts as a tonic to the soil besides improving soil health. Laboratory studies and field experiment was conducted at organic farm of Department of Organic Agriculture, CSK HPKV, Palampur to evaluate the effect of doses and application time of Jeevamrit on nutrient uptake, microbial population, organic carbon and NPK status of soil. Ten treatments comprising of jeevamrit application @ 5 per cent at 2, 3 & 4 weeks interval (T_1, T_2 & T_3), jeevamrit @ 10 per cent at 2, 3 & 4 weeks interval (T_4, T_5 & T_6), jeevamrit @ 20 per cent at 2, 3 & 4 weeks interval (T_7, T_8 & T_9) and vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha (T_{10}) were randomly allocated and replicated thrice. As per findings, application of jeevamrit @ 20 per cent at 2 weeks interval (T_3) recorded higher nitrogen uptake, which was at par with the application of jeevamrit @ 10 per cent at 2 & 3 weeks interval, jeevamrit @ 20 per cent at 3 weeks interval and to the application of vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha (T_{10}). Microbial studies revealed that significantly higher colony forming units (cfu) of bacteria (32.69×10^6), fungi (24.86×10^3) and actinomycetes (6.02×10^2) per gram of soil were recorded in T_3, which was at par with T_2 (30.68×10^6, 23.18×10^3, 5.56×10^2) & T_6 (29.34×10^6, 22.33×10^3, 5.55×10^2) cfu/g soil. Whereas, higher soil organic carbon (0.80%) was recorded in check (T_{10}), which was at par with T_3 (0.79%), T_2 (0.77%) & T_6 (0.76%) and higher available NPK (220.8, 36.6 and 200.6 kg/ha, respectively) were recorded in check (T_{10}) after the harvest of crop.

Keywords: Jeevamrit, *vermiwash*, nitrogen uptake, microbial studies, colony forming units

Introduction

Agricultural production more than tripled between 1960 and 2015, owing in part to productivity-enhancing green revolution technologies and a significant expansion in the use of land, water and other natural resources for agricultural purposes. Indiscriminate use of agro-chemicals during the last 5-6 decades has adversely affected the soil fertility, crop productivity, produce quality and particularly the environment. Maintaining favourable soil physical, chemical and biological condition is the need of the hour. It has been estimated that the soil organic carbon content in India has drastically reduced from 1.2% to 0.6% in 2000 and is declining further (Devasenapathy *et al.*, 2008) [4]. The unscientific use of agrochemicals has affected the soil health adversely and brought down the productivity of the soil by destroying natural soil microorganisms like *Rhizobium* and Phosphorus Solublizing Bacteria (PSB) resulting in stagnation of crop productivity (Dademal and Dongale, 2004) [3]. Many experts in the field of agriculture have said that any more efforts to persist with the model of chemical agriculture will only prove counterproductive in the long run and cause irreparable damage to soil health and environment.

Natural farming uses a variety of methods to improve soil fertility including application of Jeevamrit (a liquid organic manure) which is one of the most important component for nutrient management. The philosophy of the natural farming is to nurture the growth of beneficial microorganisms without using external manure and chemical pesticides. Jeevamrit is a fermented liquid product prepared by mixing up cow dung with cow urine, jaggery, legume flour and handful of live soil (Palekar, 2006) [11]. It contains enormous amount of microbial load which multiply and act as soil tonic.

Its application enhances microbial activity in the soil and ultimately ensuring the availability and uptake of nutrients by the crops. Microorganisms are well activated in the soil by the addition of jeevamrit. The microorganisms such as nitrogen fixer- *Azotobacter*, *Azospirillum* and phosphorus solubilizing bacteria *Pseudomonas fluorescence* and potash solubilizing bacteria like *Bacillus silicus* are present in the cow dung that is used to prepare jeevamrit (Ramprasad *et al.*, 2009) [12]. Manjunatha *et al.* (2009) [9] reported that the application of jeevamrit increased the activity of microbes by solubilization and also enhanced nutrient uptake. Since, there is no scientific information available on the effect of doses and application time of 'Jeevamrit' on the nutrient uptake, microbial population and available NPK of soil under 'natural farming system', therefore laboratory studies and field experiment was conducted to know the microbial composition and other soil parameters.

Materials and Methods

The experiment was carried out in randomized block design comprising of ten treatments; application of jeevamrit @ 5 per cent at 2, 3 & 4 weeks interval (T_1, T_2 & T_3), jeevamrit @ 10 per cent at 2, 3 & 4 weeks interval (T_4, T_5 & T_6), jeevamrit @ 20 per cent at 2, 3 & 4 weeks interval (T_7, T_8 & T_9) and vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha (T_{10}). Each treatment was allocated randomly and replicated three times. The experiment site is located at an elevation of 1224 metre above mean sea level. The experiment was conducted at organic farm, Department of Organic Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The soil of experiment site was silty clay loam in texture and acidic in reaction (pH 5.20), medium in organic carbon (0.72%), low in available nitrogen (208.05 kg/ha), high in available phosphorus (31.50 kg/ha) and medium in available potassium (185.33 kg/ha). Prior to sowing, *Ghan*jeevamrit @ 250 kg/ha + sieved FYM @ 250 kg/ha was applied and incorporated in plots of treatments except organic check where vermicompost @ 10 t/ha was applied and incorporated, respectively.

Organically produced seeds of 'HPW-368' variety of wheat were used for sowing. It was sown at a spacing of 20 cm with the seed rate of 100 kg/ha. Seeds of wheat were treated with *beejamrit* @ 10 litres/100 kg of seeds. In organic check, seeds of wheat were treated with *beejamrit* @ 10 litres/100 kg of seeds and *Azotobacter* + PSB culture @ 50 g/3 kg of seeds each. In order to check the weeds, hand weeding was done with khurpi or handhoe. For nutrient management, soil was drenched with jeevamrit at regular intervals, as per the treatments till the initiation of grain filling. In organic check, 3 sprays of vermiwash @ 750 l/ha was done, respectively at 10, 25 and 45 days after sowing.

For soil analysis, the soil samples were collected from 0-15 cm depth from each net plot after harvesting of crop. These samples were dried, processed and analyzed for organic carbon using Wet digestion method (Walkley and Black, 1934) [16], available nitrogen using Alkaline permanganate method (Subbiah and Asija, 1956) [15], phosphorous using Olsen's method (Olsen *et al.*, 1954) [10] and potassium using Ammonium acetate extraction method (AOAC, 1970) [1].

For microbial analysis, soil samples were collected from the rhizosphere of the soil profile at harvest. Population of soil bacteria, fungi and actinomycetes were determined by the standard serial dilution plate count method using nutrient agar for bacteria, krustose agar for actinomycetes and Rose Bengal agar for fungi. Plates were incubated at 28 ± 2^0C in an incubator and colony counts were recorded after six days of incubation. The population was expressed as number of colony forming units per gram (cfu/g) dry weight of soil.

For plant analysis, representative grain and straw samples were collected from each treatment at harvest. Samples were oven dried and grinded into fine powder by using mixer grinder. Nitrogen content in plant samples was determined by digesting the sample in concentrated sulphuric acid with K_2SO_4 + $CuSO_4$ + Se mixture and distilling in alkaline medium (Jackson, 1973) [6]. Phosphorus content in grain and straw samples was determined by digesting the sample in triacid mixture and then using Vanado-molybdo-phosphoric acid method (Jackson, 1973) [6]. Potassium content in grain and straw samples was determined by digesting the sample in triacid mixture and then using wet digestion method (Black, 1965) [2].

Protein content of grains was determined by using formula –

Crude protein (%) = Nitrogen content of grains (%) x 6.25

The nutrient uptake was calculated by multiplying per cent concentration of a particular nutrient with grain and straw yields. The uptake of the nutrients obtained in respect of grain and straw was summed up to compute the amount of total nutrient removed by crop.

Nutrient uptake (kg/ha) was worked out by using formula –

$$\text{Nutrient uptake} = \frac{\text{Percent nutrient concentration}}{100} \text{ x Yield (kg/ha)}$$

Total uptake was calculated as follows –

Total uptake = uptake by straw + uptake by grain

Results and Discussion

Nutrient uptake

Nitrogen content in grain and straw, protein content and total nitrogen uptake

Treatments did not have any significant effect on the nitrogen content in grain and straw, and also on the grain protein content. Application of jeevamrit @ 20 per cent at 2 weeks interval (T_3) recorded higher nitrogen uptake (80.75 kg/ha), which was at par with the application of jeevamrit @ 10 per cent at 2 & 3 weeks interval, jeevamrit @ 20 per cent at 3 weeks interval and check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha). Though the N content of grain and straw did not differ significantly, the significant variation in N uptake might be attributed to the significant variation of grain and straw yields as influenced by different treatments.

The uptake of nitrogen was higher in treatments receiving more number of soil drenchings of jeevamrit which might be ascribed to the rapid mineralization of native and applied nutrients due to build-up of microflora, as the microbial inoculum i.e. jeevamrit when soil drenched at different intervals, resulted in increased availability of nutrients and consequently increased the enzymatic activity and helped in increased uptake of nutrients. Gore and Sreenivasa (2011) [5] reported that jeevamrit promotes immense biological activity in soil and enhance nutrient availability to crop.

Table 1: Effect of treatments on nitrogen content in grain and straw, protein content of grains and total nitrogen uptake by wheat crop

Treatment	Grain N content (%)	Straw N content (%)	Grain protein content (%)	Total N uptake (kg/ha)
T_1-Jeev. @ 5% (2 weeks interval)	1.39	0.55	8.67	65.83
T_2-Jeev. @ 10% (2 weeks interval)	1.40	0.57	8.75	75.15
T_3-Jeev. @ 20% (2 weeks interval)	1.42	0.59	8.90	80.75
T_4-Jeev. @ 5% (3 weeks interval)	1.38	0.54	8.63	63.20
T_5-Jeev. @ 10% (3 weeks interval)	1.39	0.56	8.67	71.40
T_6-Jeev. @ 20% (3 weeks interval)	1.41	0.57	8.81	75.34
T_7-Jeev. @ 5% (4 weeks interval)	1.33	0.53	8.31	59.53
T_8-Jeev. @ 10% (4 weeks interval)	1.35	0.54	8.44	63.65
T_9-Jeev. @ 20% (4 weeks interval)	1.36	0.56	8.50	67.43
T_{10}-VC @ 10 t/ha at sowing + 3 sprays of vermiwash (Check)	1.44	0.58	9.02	76.30
SEm±	0.06	0.02	0.64	3.26
CD at 5%	NS	NS	NS	9.70

Jeev. – Jeevamrit, VC – Vermicompost.

Phosphorus content in grain & straw and total P uptake

Application of vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha (check) recorded higher phosphorus content (0.22%) in grain, which behaved statistically similar with the application of jeevamrit @ 20 per cent at 2 weeks interval (0.21%), jeevamrit @ 10 per cent at 2 weeks interval (0.20%) and jeevamrit @ 20 per cent at 3 weeks interval (0.20%). Application of jeevamrit @ 20 per cent at 2 weeks interval being at par with vermicompost @ 10 t/ha + 3 sprays of vermiwash @750 l/ha (check) recorded higher phosphorus content (0.11%) in straw. The application of jeevamrit @ 10 per cent at 2 weeks interval (0.10%) was also at par to these treatments.

Significantly higher phosphorus uptake (17.31 kg/ha) was recorded with application of jeevamrit @ 20 per cent at 2 weeks interval (T_3). It behaved statistically similar to the check i.e. application of vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha (16.55 kg/ha). The significant variation in phosphorus uptake might be attributed to the significant variation of grain and straw yields as influenced by different treatments. Treatments which received more drenchings of Jeevamrit recorded relatively higher phosphorus uptake because of increased microbial activity which might have helped in solubilization of native & applied phosphorus and provided greater quantity of available phosphorus for plant uptake.

Table 2: Effect of treatments on phosphorus content in grain & straw and total P uptake by wheat crop

Treatment	P content (%)		Total P uptake (kg/ha)
	Grain	Straw	
T_1-Jeev. @ 5% (2 weeks interval)	0.15	0.08	12.11
T_2-Jeev. @ 10% (2 weeks interval)	0.20	0.10	15.43
T_3-Jeev. @ 20% (2 weeks interval)	0.21	0.11	17.31
T_4-Jeev. @ 5% (3 weeks interval)	0.13	0.07	10.38
T_5-Jeev. @ 10% (3 weeks interval)	0.18	0.08	13.45
T_6-Jeev. @ 20% (3 weeks interval)	0.20	0.09	14.57
T_7-Jeev. @ 5% (4 weeks interval)	0.11	0.06	9.28
T_8-Jeev. @ 10% (4 weeks interval)	0.13	0.07	10.82
T_9-Jeev. @ 20% (4 weeks interval)	0.15	0.08	12.15
T_{10}-VC @ 10 t/ha at sowing + 3 sprays of vermiwash (Check)	0.22	0.11	16.55
SEm±	0.01	0.004	0.44
CD at 5%	0.02	0.01	1.29

Jeev. – Jeevamrit, VC – Vermicompost

Potassium content in grain & straw and total K uptake

Significantly higher potassium content in grain & straw was recorded with application of vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha (check) and was at par with application of jeevamrit @ 20 per cent at 2 & 3 weeks interval and jeevamrit @ 10 per cent at 2 weeks interval. Application of jeevamrit @ 20 per cent at 2 weeks interval recorded significantly higher potassium uptake (51.59 kg/ha) which behaved statistically similar to application of jeevamrit @ 10 per cent at 2 weeks interval, jeevamrit @ 20 per cent at 3 weeks interval and to the check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha).

Table 3: Effect of treatments on potassium content in grain & straw and total K uptake by wheat crop

Treatment	K content (%)		Total K uptake (kg/ha)
	Grain	Straw	
T_1-Jeev. @ 5% (2 weeks interval)	0.30	0.63	43.42
T_2-Jeev. @ 10% (2 weeks interval)	0.32	0.66	48.80
T_3-Jeev. @ 20% (2 weeks interval)	0.33	0.67	51.59
T_4-Jeev. @ 5% (3 weeks interval)	0.28	0.60	40.15
T_5-Jeev. @ 10% (3 weeks interval)	0.31	0.64	45.53
T_6-Jeev. @ 20% (3 weeks interval)	0.32	0.66	48.44
T_7-Jeev. @ 5% (4 weeks interval)	0.26	0.58	37.83
T_8-Jeev. @ 10% (4 weeks interval)	0.28	0.60	40.39

T_9-Jeev. @ 20% (4 weeks interval)	0.29	0.61	42.27
T_{10}-VC @ 10 t/ha at sowing + 3 sprays of vermiwash (Check)	0.34	0.68	50.09
SEm±	0.01	0.01	1.09
CD at 5%	0.02	0.02	3.25

Jeev. – Jeevamrit, VC – Vermicompost

Soil studies

Organic carbon and available NPK

Significantly higher value of organic carbon (0.80%) was obtained in check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha), which was at par to the application of jeevamrit @ 20 per cent at 2 & 3 weeks interval and jeevamrit @ 10 per cent at 2 weeks interval.

Significantly higher available nitrogen (220.8 kg/ha) was recorded in check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha). This might be due to slow release of nutrients through vermicompost and enriching available pool of nitrogen, due to low soil microbial activity. Remaining treatments behaved statistically at par with each other. This might be due to rapid mineralization of available pool of nitrogen due to higher microbial activity in these treatments with application of jeevamrit. Shwetha (2008) [13] in wheat and Kiran (2014) [8] in chickpea reported higher available nitrogen in soil with application of either organics alone or in combination with liquid organic manures.

Significantly highest available phosphorus (36.6 kg/ha) was recorded in check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha). Significantly lower values were recorded with rest of the treatments, which might be due to lack of addition of external source of phosphorus and there by depletion of native pool of available phosphorus by plants, which was mineralized by build-up of microflora and fauna due to supplementation of jeevamrit. The build-up of available phosphorus was higher in check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha), which might be due to release of organic acid during mineralization of vermicompost that helped in the solubility of native phosphates, thus increased available phosphorus pool in the soil.

Significantly higher available potassium (200.6 kg/ha) was recorded with the application of vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha. Significantly lower values were recorded with rest of the treatments, which might be due to lack of addition of external potassium source and there by depletion of native pool of available potassium by plants, which was mineralized by build-up of microflora and fauna due to supplementation of jeevamrit. There was increment in the available potassium content in check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha) due to the beneficial effect of treatment in releasing K_2O because of the interaction of organic matter with clay and direct addition of K_2O to the available pool of the soil. There was slight reduction in the available potassium content in rest of the treatments except check which might be ascribed to the higher mineralization of K_2O, contributing to its availability due to quick build-up of microflora and fauna by liquid manure (Yadav and Mowade, 2004).

Table 4: Effect of treatments on organic carbon and available primary nutrients in soil after harvest of wheat crop

Treatment	Organic carbon (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
T_1-Jeev. @ 5% (2 weeks interval)	0.75	193.6	27.9	164.8
T_2-Jeev. @ 10% (2 weeks interval)	0.77	190.1	27.7	162.5
T_3-Jeev. @ 20% (2 weeks interval)	0.79	187.6	27.5	160.4
T_4-Jeev. @ 5% (3 weeks interval)	0.73	196.9	28.9	167.9
T_5-Jeev. @ 10% (3 weeks interval)	0.75	194.1	28.4	164.7
T_6-Jeev. @ 20% (3 weeks interval)	0.76	191.2	28.2	161.9
T_7-Jeev. @ 5% (4 weeks interval)	0.72	198.4	29.9	169.2
T_8-Jeev. @ 10% (4 weeks interval)	0.74	197.7	29.4	168.3
T_9-Jeev. @ 20% (4 weeks interval)	0.75	195.6	29.3	163.9
T_{10}-VC @ 10 t/ha at sowing + 3 sprays of vermiwash (Check)	0.80	220.8	36.6	200.6
S.Em±	0.01	5.08	0.82	2.97
CD at 5%	0.04	15.10	2.44	8.83

Jeev. – Jeevamrit, VC – Vermicompost

Microbial population

Significantly higher bacterial, fungal and actinomycetes population were recorded with application of jeevamrit @ 20 per cent at 2 weeks interval and was also at par with application of jeevamrit @ 10 per cent at 2 weeks interval and jeevamrit @ 20 per cent at 3 weeks interval. These treatments were significantly superior to the check (vermicompost @ 10 t/ha + 3 sprays of vermiwash @ 750 l/ha).

The results are in accordance with the findings of Siddappa (2015) in fieldbean, where significantly higher population of bacteria, fungi and actinomycetes was recorded with the application of jeevamrit @ 1500 l/ha followed by jeevamrit @ 1000 l/ha.

Jeevamrit contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil (Palekar, 2006) [11]. Jeevamrit enhances microbial activity in soil and helps in improvement of soil fertility (Joshi, 2012). Organic solutions (jeevamrit), which may not provide enough nutrients in area of application, but they help in the quick build-up of soil fertility through enhanced activity of soil microflora and fauna (Yadav and Mowade, 2004) [17].

Table 5: Effect of treatments on soil microbial flora after harvest of wheat crop

Treatment	Bacterial population ($\times 10^6$) cfu/g soil	Fungal population ($\times 10^3$) cfu/g soil	Actinomycetes population ($\times 10^2$) cfu/g soil
T_1-Jeev. @ 5% (2 weeks interval)	27.99	20.82	3.47
T_2-Jeev. @ 10% (2 weeks interval)	30.68	23.18	5.56
T_3-Jeev. @ 20% (2 weeks interval)	32.69	24.86	6.02
T_4-Jeev. @ 5% (3 weeks interval)	25.05	17.93	2.70
T_5-Jeev. @ 10% (3 weeks interval)	28.10	21.38	4.14
T_6-Jeev. @ 20% (3 weeks interval)	29.34	22.33	5.55
T_7-Jeev. @ 5% (4 weeks interval)	23.46	15.61	1.98
T_8-Jeev. @ 10% (4 weeks interval)	25.76	19.70	3.38
T_9-Jeev. @ 20% (4 weeks interval)	27.01	21.52	4.08
T_{10}-VC @ 10 t/ha at sowing + 3 sprays of vermiwash (Check)	28.58	21.93	4.04
SEm±	1.37	0.96	0.19
CD at 5%	4.08	2.85	0.58

Jeev. – Jeevamrit, VC – Vermicompost

Conclusion

Jeevamrit is one of the cheap and efficient organic substitutes for high crop yield and profitability, besides improving the nutrient status of the soil. From experimental findings, it was concluded that addition of jeevamrit enhanced the microbial population of soil and this increase was higher in treatments receiving more number of soil drenchings of jeevamrit which helps in the quick build-up of soil fertility. Jeevamrit when soil drenched at different intervals, resulted in increased availability of nutrients and consequently resulted in increased uptake of nutrients.

References

1. AOAC. Methods of analysis. Association of Official Agricultural Chemists, Washington, 1970.
2. Black CA. Method of soil analysis. Current Science 1965;25:259-260.
3. Dademal AA, Dongale JH. Effect of manures and fertilizers on growth and yield of okra and nutrient availability in lateritic soils of Konkan. Journal of Soils and Crops 2004;14(2):278-283.
4. Devasenapathy P, Ramesh T, Sangeetha SP. Effect of in situ soil moisture conservation and nutrient management practices on performance of rainfed cowpea. Journal of Food Legumes 2008;21(3):169-172.
5. Gore NS, Sreenivasa MN. Influence of liquid organic manures on growth, nutrient content and yield of tomato (*Lycopersion esculentum* Mill.) in the sterilized soil. Karnataka Journal of Agriculture Science 2011;24(2):153-157.
6. Jackson ML. Soil Chemical Analysis. Prentice Hall Inc. Englewood Cliffs, New Jersey, USA, 1973.
7. Joshi M. New Vistas of Organic Farming. Scientific Publishers, New Delhi, India 2012,140.
8. Kiran. Response of chickpea (*Cicer arietinum* L.) to organic sources of nutrition under rainfed condition. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Raichur, India, 2014.
9. Manjunatha GS, Upperi SN, Pujari BT, Yeledahalli NA, Kuligoda VB. Effect of farm yard manure treated with jeevamrutha on yield attributes and economics of sunflower (*Helianthus annuus* L.). Karnataka Journal of Agricultural Sciences 2009;22(1):342-348.
10. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with $NaHCO_3$. United States Department of Agricultural Circular 1954;939:19-33.
11. Palekar Shoonya S, Bandovalada Naisargika Krushi. Published by Swamy Anand, Agri Prakashana, Bengaluru, India, 2006.
12. Ramprasad V, Srikanthamurthy HS, Kakol N, Shivakumar Nagaraju B, Ningaraju Shashidhara *et al*. Sustainable Agricultural Practices. Green Foundation Bangalore, First edition, India, 2009.
13. Shwetha BN. Effect of nutrient management through the organics in soybean-wheat cropping system. M.Sc. Thesis, University of Agricultural Science, Dharwad, India, 2008.
14. Siddappa. Use of jeevamrutha and farm yard manure on growth and yield of fieldbean (*Lablab purpureus* var. *lignosus*). M.Sc. Thesis, University of Agricultural Sciences, Bengaluru, India, 2015.
15. Subbiah BV and Asija CL. A rapid procedure for the estimation of available nitrogen in soil. Current Science 1956;25:258-260.
16. Walkley A, Black CA. An estimation of the method for determination of soil organic matter and a proposed modification of chromic acid titration method. Soil Science 1934;37:29-39.
17. Yadav AK, Mowade SM. Organic manures and compost. In: Organic farming - A ray of hope for Indian farmer. The Organic Farming Association of India, Mapusa, Goa, India 2004,1-104.