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Effect of panchagavya, Jivamruta and fertility levels on soil health of greengram in Varanasi region

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Abstract
A biannual trial on greengram was carried out in agriculture research farm of Banaras Hindu University, Varanasi during cropping year 2020-21 and 2021-22 to assess the consequences of Panchagavya, Jivamruta and fertility levels on health of soil. HUM 16 variety of moong bean was cultivated in sandy clay loam soil. Greengram improves soil fertility through biological nitrogen fixation and addition of root material. The research was carried out in split plot design with 3 main plot treatments (3 levels of RDF) and 4 subplot treatments (fertilizer control, Panchagavya, Panchagavya+ Jivamruta and Jivamruta). At the end of trial, Lowest pH (7.69), highest EC (0.285 dSm^{-1}), highest SOC (0.503%), highest available N (195.53 kg ha^{-1}), P (22.67 kg ha^{-1}), K (207.74 kg ha^{-1}), DHA (27.96 µg TPF g^{-1} soil day^{-1}), APA (64.97 µg P-NP soil h^{-1}) was found with Panchagavya treatment (in subplot). And Jivamruta recorded highest SMBC (348.8 µg g^{-1} soil). Liquid organic manures like PG and JM can reduce the use of agro-chemicals in greengram and maintain soil health.

Keywords: Greengram, panchagavya, Jivamruta, soil

Introduction
Greengram is botanically named as *Vigna radiata* L. and commonly called as "mung/moong bean". It is one of the dominant pulse crop and cultivated extensively in South-Asian countries. Pulses are important food source of protein for nutritional security. Greengram has unique quality of being adopted in almost all farming systems due to its diverse qualities. It can be cultivated either as main crop or catch crop, cover crop or inter/ mix crop, green manure or short duration crop. India produces above 70% of world's moong bean. 2.60 M tonnes of moong bean was harvested in an area of 3.58 M ha during 2020-21 (Anonymous, 2021) [4]. It is the 3rd highest cultivated pulse crop after chickpea and pigeon pea in India (Tamang *et al*., 2015) [39]. The pulse is rich in protein (24.5%), carbohydrates, minerals (calcium -75 mg g^{-1}, phosphorus -4.5 mg g^{-1}) & vitamins. It provides 348 K calories energy (Meena *et al*., 2013) [19]. It adds organic matter and nitrogen through biological fixation.

Pulses are generally cultivated in poor soil without proper care and fertilization. Proper fertilization holds key in improving yield of greengram. Liquid organic manures and along with fertilizers has great potential in greengram production. Microbial diversity holds significant importance in spurring plant growth and development along with management of soil & plant health. Panchagavya-PG and Jivamruta-JM are remarkably good in rejuvenation of degraded soil. Moreover, India has traditional knowledge of preparation and use of organic liquid manures since ages (Ram *et al*., 2019) [27]. PG is combination of native cow dung, cow urine, milk, curd and ghee. It is blended with herbal produce such as cane juice, tender coconut water, jaggery, ripe banana to enhance its agricultural efficacy. Sangeetha and Thevanatham, 2010 [29] reported its bio-enhancing ability on crops. The diverse microorganisms present in PG revamp soil fertility, sustain crop production by changing the rhizospheric environment that support proper plant growth and yield (Beaulah, 2001) [5]. It contains N, P, K and micro nutrients like Iron, Copper, Zinc, Manganese along with indole acetic acid and Gibberellic acid (Natarajan, 2002 and Selvaraj *et al*., 2007) [21, 32]. The other liquid manure is Jivamrit (JM). It is part of Zero Budget Natural Farming prepared by admixing native cow dung and their urine, any legume flour, jaggery & handful of live soil (Palekar, 2006) [24]. Native cow dung is rich in *Azotobacter*, nitrogen fixers, *Azospirillum* and PSB (*Pseudomonas*) and potash solubilizers (*Bacillus silicus*) which is used in preparation of JM (Ramprasad *et al*., 2009 and Devakumar *et al*., 2008) [28, 9]. It is one of the cheapest liquid manures prepared in shortest time with locally available inputs. And enriches soil through indigenous beneficial microorganisms (Gore and Sreenivasa, 2011) [11].

Materials and Methods

The Moong bean (Var. Malaviya Jankalyani/HUM 16) trial was run in agriculture research farm of Institute of agricultural sciences (Banaras Hindu University, Varanasi) during 2020-21 and 2021-22. The farm is situated at 75.70 m above mean sea level coming under Northern Gangetic Alluvial Plains of U. P. The soil was sandy clay loam and the crop was sown post-harvest of zero tillage wheat (wheat was 1st crop in the experiment). The post-harvest value of soil pH, organic carbon, nitrogen, phosphorous, potassium, soil microbial biomass carbon, dehydrogenase activity and alkaline phosphatase activity was considered as initial value of plot for greengram crop. The crop research trial was led out in same plot which was previously sown with zero tillage wheat in split plot design (three main plots and four sub-plots). The main plot treatments were different fertility levels *i.e.* $RDF_{100\%}$- (15 kg N + 30 kg P_2O_5 + 30 kg K_2O ha^{-1}), $RDF_{75\%}$ - (11.25 kg N +22.5 kg P_2O_5 + 22.5 kg K_2O ha^{-1}), $RDF_{50\%}$ -50% RDF (7.5 kg N + 15 kg P_2O_5 + 15 kg K_2O ha^{-1}) and for sub plot; O_0 - Control (without organic liquid formulations), O_{PG} - PG @ 50 L/ha at 30 DAS + 3% foliar spray of PG at 30 and 45 DAS, O_{JM} - JM @ 500 L/ha 30 DAS + 3% foliar spray of PG at 30 and 45 DAS, O_{PG+JM} - PG @ 25 L/ha + JMS @ 250 L/ha at 30 DAS + 3% foliar spray of PG at 30 and 45 DAS. There were 12 (3 main plots × 4 sub-plots) treatment combinations replicated thrice that created 36 plots (experimental units) in the experiment. Randomization principles were adopted for assignment of treatments in each experimental unit. PG was prepared by the procedures recommended by Selvaraj *et al.*, 2007 [32] whereas JM by Palekar, 2006 [24]. The biochemical parameters of these liquid manures presented in Table 1 was analysed in laboratory of institute. The cow dung, urine, was collected from Desi cow Gaushala in Ramana, Varanasi. Cow milk, yoghurt was sourced from Gir cow entrepreneur in Ramana, Varanasi. Patanjali ghee was used in preparation while remaining ingredients were gathered from market near to university. Microbial population *viz.* bacteria, actinomycetes, fungi, phosphorous solubilising bacteria (PSB) and zinc solubilising bacteria (ZSB) were identified and counted using growth media recommended by different researchers. Microbial population (cfu/ml) were counted by serial dilution technique along with petri-plate.

Table 1: Bio-chemical properties of Panchagavya and Jivamruta applied in soil and as foliar application.

Biochemical Properties	Jivamrutam		Panchagavya		References
	2020	2021	2020	2021	
pH	4.9	4.53	6.28	6.15	Digital pH meter
EC	3.86	3.93	6.86	7.56	Systronics EC meter
Total N (ppm)	545.0	603.5	248.00	301	Subbiah and Asija, 1956 [36]
Total P (ppm)	352.2	323.4	215.00	232	Jackson, 1973
Total K (ppm)	280.4	312.6	256.00	279	Jackson, 1973
Total Mn (ppm)	0.12	0.10	0.13	0.17	AAS
Total Cu (ppm)	0.04	0.043	0.03	0.28	AAS
Total Zn (ppm)	0.17	0.185	0.18	0.23	AAS
Total Fe (ppm)	8.67	9.42	17.50	16.2	AAS
Bacteria (cfu/ml)	3.4×10^6	9.2×10^6	55×10^6	38×10^7	Nutrient Agar media
Fungi (cfu/ml)	1.9×10^5	4.3×10^4	23×10^3	64×10^2	Agar media
Actinomycetes (cfu/ml)	2.7×10^4	7.6×10^4	41×10^2	73×10^2	Subba Rao, 1977 [35]
PSB (cfu/ml)	4.1×10^5	4.7×10^6	66×10^5	15×10^6	Nautiyal *et al.*, 1999 [22]
ZnSB (cfu/ml)	3.3×10^5	9.8×10^4	37×10^5	84×10^5	Saravanan *et al.*, 2004 [30]

Note: PG values are average of two preparations (30 days after preparation) and JM values are average of 3 preparations (5 days after preparation) in both the years.

Results and discussions

Effect of panchagavya, Jivamruta and fertility levels on pH, salt concentration (EC) and soil organic carbon in GREENGRAM in Varanasi region

The treatments didn't show severe effects on soil pH, salt concentration (electrical conductivity) and organic carbon content. This was a short-term trial meant only for two years but these soil properties (pH, EC and SOC) require long term practices to show any visible responses to treatments.

The perusal of data in table 2 shows non-significant reduction in soil pH as consequence of Panchagavya (PG) and Jivamruta (JM) application in sub plots. The treatments O_{PG}, (7.69), O_{PG+JM} (7.70) & O_{JM} (7.71) recorded low pH in comparison to fertilizer control (7.80) in second year of trial. The result was almost similar in 1st year of trial. Moreover, there was not significant pH changes as compared to initial values. This is because soil pH is representation of parent material and affected by climatic conditions and texture of the soil. Devakumar *et al.* (2014) [9] and Palekar, (2006) [24] observed presence of phosphorous solubilizing bacteria (PSB), nitrogen fixers and *Azotobacter* in JM while Nileema and Sreenivasa, (2011) [23] observed them in PG solution. These microorganisms have been found to decline pH of the soil by production of organic acids (Khan *et al.*, 2017) [16].

Likewise, a non-significant increment in salt concentration (EC) was observed in $RDF_{100\%}$ which recorded highest salt concentration (0.284 dSm^{-1}) and was followed by $RDF_{75\%}$ and $RDF_{50\%}$ i.e., 0.273 dSm^{-1} and 0.263 dSm^{-1}, respectively. In subplots with organic liquid treatments, O_{PG} was observed with elevated EC succeeded by O_{PG+JM}, O_{JM} and O_0 i.e., 0.285 dSm^{-1}, 0.277 dSm^{-1}, 0.274 $dSm^{-1}$and 0.258 dSm^{-1}, respectively. These liquid organic manures also contain some amount of salt (Natarajan, 2002) [21] and their application would have sown the effect. Furthermore, the activity of beneficial microbes in soil through mineralization could have contributed in small changes in salt concentration. The table 2 vividly reflects no significant changes in initial and final value of salt concentration in both the years.

The other stable parameter of soil is organic carbon which has reflected highest value with $RDF_{100\%}$ (0.507%) and, $RDF_{75\%}$ (0.495%) and $RDF_{50\%}$ (0.489%) followed it in descending order in second year. In subplots, O_{PG} treatment responded more (0.503%) as compared too other treatments and lowest response was observed in O_0 (0.485%) in second year. These values were similar in 1st year too without any noticeable value. There were neither significant increment over their initial values. It is evident from the fact that organic matter addition plays great role in enhancement of organic carbon in the soil. The minute increment in OC value with $RDF_{100\%}$ in main plot and OPG in sub plot would probably be due to rapid mineralization of soil and residual wheat anchorage post-harvest. Furthermore, the addition and mineralization of voluminous root of greengram in 1st year would have slightly increased the value in 2nd year in respective treatments.

There were no interaction effects of treatments.

Table 2: Effect of Panchagavya, Jivamruta and Fertility levels on soil pH, salt concentration (EC), Soil Organic Carbon in greengram in Varanasi region.

	pH				Electrical Conductivity (dSm^{-1})				Soil Organic Carbon (%)			
Treatments	**2020-21**		**2021-22**		**2020-21**		**2021-22**		**2020-21**		**2021-22**	
Main Plot	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
$RDF_{100\%}$	7.71	7.71	7.70	7.70	0.282	0.283	0.284	0.284	0.501	0.503	0.505	0.507
$RDF_{75\%}$	7.72	7.71	7.71	7.71	0.270	0.271	0.272	0.273	0.490	0.492	0.493	0.495
$RDF_{50\%}$	7.78	7.78	7.78	7.77	0.260	0.261	0.262	0.263	0.483	0.485	0.487	0.489
S.Em	0.16	0.16	0.16	0.16	0.006	0.006	0.006	0.006	0.010	0.010	0.010	0.010
LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Subplot												
O_0	7.81	7.81	7.80	7.80	0.255	0.256	0.257	0.258	0.482	0.483	0.484	0.485
O_{PG}	7.70	7.70	7.70	7.69	0.282	0.283	0.284	0.285	0.497	0.499	0.501	0.503
O_{JM}	7.73	7.72	7.72	7.71	0.271	0.272	0.273	0.274	0.491	0.493	0.495	0.497
O_{PG+JM}	7.72	7.71	7.71	7.70	0.275	0.276	0.277	0.277	0.495	0.497	0.499	0.501
S.Em	0.16	0.16	0.16	0.16	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Initial values are after harvest of zero tillage wheat and final values after harvest of greengram

Soil available nitrogen (kg ha^{-1}) in greengram in Varanasi region

As presented in table 3, the discernible response of treatments on the soil available nitrogen (N) was visible post-harvest of greengram crop. In main plots with different fertility level treatments, the response of $RDF_{100\%}$ was 196.84 kg N ha^{-1} which was equivalent to 191.10 kg N ha^{-1} with $RDF_{75\%}$ and 187.33 kg N ha^{-1} with $RDF_{50\%}$. The non-significant response between treatments might be due to very less variation in N application and almost similar N-fixation by root nodules. While in sub-plots with liquid fertilizer application, the response was pronounced. The available N in the plot treated with O_{PG} was 195.53 kg ha^{-1} which was significantly enhanced as compared to O_0 (185.09 kg ha^{-1}) but equivalent to O_{PG+JM} (193.86 kg ha^{-1}) & O_{JM} (192.56 kg ha^{-1}) in second year crop. The second-year response received minute increment in all plots over previous year probably due to improvement in soil health. Greengram being a nitrogen rich crop, the application of N fertilizer is very less whereas it exploits more N from the soil, furthermore, the post-harvest extreme temperature and dryness would have reduced the soil available N content as compared to initial value in both the year. PG is rich in N-fixing bacteria, fungi (Selvaraj *et al.*, 2007; Somasundaram and Singaram, 2006 & Amalraj *et al.*, 2013) [32, 34, 2], actinomycetes (Somasundaram and Singaram, 2006 & Amalraj *et al.*, 2013) [34, 2], *Azotobacter*, *Azospirillum* (Natarajan, 2002 and Somasundaram and Singaram, 2006) [21, 32], acid formers (Selvaraj *et al.*, 2007) [32], methanogens (Maheshwari *et al.*, 2007; Natarajan, 2002; Somasundaram and Singaram, 2006 and Selvaraj *et al.*, 2007) [18, 21, 34, 32]. Jivamrutam is rich in bacteria, fungi, actinomycetes and N-fixers (Devakumar *et al.*, 2014 and Palekar, 2006) [9, 24]. These microorganisms act as catalyst to transform chemical form of nitrogen and its oxidation form too (Hayatsu *et al.*, 2008) [13]. Furthermore, these beneficial microbes would have performed biological N fixation into soil, as these microbes play crucial role in soil mineralization and enzymatic processes (Schimel and Schaeffer, 2012) [31]. Symbiotic N fixation in root nodules of legumes help bacteria with an absolute niche and reciprocate the plants with personalized N sources (Andrew *et al.*, 2007) [3]. Furthermore, there is small amount of nitrogen present in both the liquid manures (see Table 1). Several other authors like Shwetha, 2008 [33] and Aher *et al.*, 2022 [1] have reported positive impact on soil N content due to combined application of these liquid manures along with fertilizer sources.

There were no interaction effects of treatments.

Soil available phosphorous (kg ha^{-1}) in greengram in Varanasi region

In main plots with varied levels of fertility, highest soil available phosphorous (22.18 kg ha^{-1}) was observed in $RDF_{100\%}$ which was significantly high as compared to both the treatments ($RDF_{75\%}$ - 21.11 kg P ha^{-1} and $RDF_{50\%}$ - 17.94 kg P ha^{-1}) in second year. There were variable dosages of P applied in different plots, this could have caused significant differences among the treatments in main plots. While the observation table clearly showed pronounced response of Panchagavya and Jivamruta as compared to fertilizer control. 22.67 kg P ha^{-1} reported from plot O_{PG} was significantly high as compared to 16.18 kg P ha^{-1} by O_0 but at par with O_{PG+JM} (21.71 kg P ha^{-1}) & O_{JM} (21.06 kg P ha^{-1}) in second year trial. In first year of trial, there were less available P reported as compared to 2nd year in each plot and the differences among treatments were in similar pattern as in 2nd year. Panchagavya contains fungi, bacteria (Maheshwari *et al.*, 2007; Ram *et al.*, 2019 and Rakesh *et al.*, 2017) [18, 27, 26], actinomycetes (Ram *et al.*, 2019; Rakesh *et al.*, 2017; Maheshwari *et al.*, 2007) [27, 26, 18], P-Solubilizers and *Pseudomonas* (Somasundaram and Singaram, 2006; Amalraj *et al.*, 2013 & Ram *et al.*, 2019) [34, 2, 27] (see table 1 too). Jivamruta too contains actinomycetes, bacteria fungi and PSB (see table 1; Palekar, 2006 [24];

Devakumar *et al*., 2014) [9]. These diverse P-solubilizers play crucial role in mineralization process of organic phosphorous and solubilization process of inorganic phosphorous in the soil there by storing huge amount of P in biomass (Liang *et al*., 2020 & Gross *et al*., 2020) [17, 12]. This activity of microbial population could have enhanced the available P in the soil treated with organic liquid manures. Furthermore, there is small amount of phosphorous in these liquid manures (see table 1) which would have made slight difference due to their addition in the soil. These observations are similar to the observations made by Jain *et al*., 2014 [15] and Swami *et al*., 2021 [38]. There were no interaction effects of treatments.

Table 3: Effect of Panchagavya, Jivamruta and Fertility levels on soil Available nitrogen (N), phosphorous (P), and potassium (K) in greengram in Varanasi region.

	Available N (kg ha^{-1})				Available P (kg ha^{-1})				Available K (kg ha^{-1})			
Treatments	**2020-21**		**2021-22**		**2020-21**		**2021-22**		**2020-21**		**2021-22**	
Main Plot	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
$RDF_{100\%}$	221.16	192.98	225.10	196.84	22.17	20.23	23.33	22.18	210.24	202.86	215.38	207.44
$RDF_{75\%}$	206.71	187.08	213.20	191.10	20.37	19.23	22.24	21.11	201.62	194.26	206.65	198.50
$RDF_{50\%}$	186.35	183.31	199.01	187.33	17.58	16.38	19.16	17.94	188.91	184.65	196.99	188.76
S.Em	4.78	2.08	4.28	2.05	0.44	0.43	0.50	0.47	4.74	4.73	4.55	5.02
LSD	18.76	NS	16.81	NS	1.74	1.67	1.98	1.85	NS	NS	NS	NS
Subplot												
O_0	187.63	180.64	192.69	185.09	17.22	14.81	17.61	16.18	187.43	179.90	191.64	183.33
O_{PG}	218.05	191.70	225.38	195.53	21.79	20.68	23.76	22.67	208.99	203.23	215.63	207.74
O_{JM}	204.83	188.78	212.03	192.56	20.29	19.11	22.15	21.06	200.52	194.34	207.05	199.42
O_{PG+JM}	208.45	190.06	219.64	193.86	20.87	19.84	22.80	21.71	204.09	198.22	211.03	202.44
S.Em	4.75	1.15	6.25	1.00	0.48	0.45	0.53	0.48	4.15	4.29	4.54	4.52
LSD	16.42	3.97	21.61	3.46	1.66	1.55	1.83	1.67	14.35	14.84	15.72	15.63
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Initial values are after harvest of zero tillage wheat and final values after harvest of greengram

Soil available Potassium (kg ha^{-1}) in Greengram in Varanasi Region

The careful scrutiny of table 2 withholds highest soil available K content of 207.44 kg ha^{-1} by $RDF_{100\%}$ that was equivalent to $RDF_{50\%}$ (188.76 kg ha^{-1}) and $RDF_{75\%}$ (198.50 kg ha^{-1}) in second year of trial and this was non-significant difference due to different fertility levels. While the scenario in subplots was different. Panchagavya and Jivamrutam treated plots outperformed fertilizer control. 207.74 kg ha^{-1} was highest available K observed with O_{PG} which was significantly high as compared to O_0 (183.33 kg ha^{-1}) but at par with O_{PG+JM} (202.44 kg ha^{-1}) & O_{JM} (199.42 kg ha^{-1}) in 2nd year trial. Alike differences were seen in 1st year but the K content increased slightly in 2nd year of trial. Potassium addition through organic liquid application have contributed slight differences in availability of available K (see table 1; Nileema and Sreenivasa, 2011) [23] and the presence of multiple microbes in Panchagavya (see table 1; Selvaraj *et al*., 2007 [32]; Natarajan 2002 [21] & Nileema and Sreenivasa, 2011) [] and Jivamrutam (Palekar, 2006 and Nileema and Sreenivasa, 2011) [24, 23] and mineralization by the action of these microbes in soil would have contributed in enhanced available K sources. Biradar *et al*., 2017 [6] and Chaudhari *et al*., 2018 [8] made similar observations. There were no interaction effects of treatments.

Biochemical activity (Soil microbial biomass carbon, dehydrogenase activity and alkaline phosphatase activity)

The meticulous observation of data in table 3 withholds clear picture of enzymatic activity *wrt* different treatments. Soil microbial biomass carbon and enzymatic activity like DHA (Dehydrogenase activity) and APA (alkaline phosphatase activity) did not show significant differences among treatments during both year of trial in main plots with different fertility levels. However, highest SMBC (365.81 µg g^{-1} soil), DHA (25.22 µg TPF g^{-1} soil day^{-1}) and APA (65.0 µg P-NP soil h^{-1}) was observed with $RDF_{100\%}$ in second year trial. So, this implies that these biochemical parameters are influenced by difference in presence of diverse floral and faunal population in soil, soil moisture level and organic matter content. There is restricted role of improving these biochemical parameters through agro-chemicals.

The liquid organic manure application in subplots had shown noticeable effects on these bio-chemical parameters. Significantly high SMBC was observed with O_{JM} (406.77 µg g^{-1} soil) as compared to O_{PG} (348.84 µg g^{-1} soil), O_{PG+JM} (384.50.11 µg g^{-1} soil) & O_0 (276.70 µg g^{-1} soil). But significantly high DHA with observed with O_{PG} (27.96 µg TPF g^{-1} soil day^{-1}) as compared all remaining treatments, O_{PG+JM} (25.66 µg TPF g^{-1} soil day^{-1}), O_{JM} (24.14 µg TPF g^{-1} soil day^{-1}) and (19.88 µg TPF g^{-1} soil day^{-1}). APA was found significantly high with O_{PG} (64.97 µg P-NP soil h^{-1}) over O_0 (60.53 µg P-NP soil h^{-1}) but was at par with O_{PG+JM} (64.67 µg P-NP soil h^{-1}) and also O_{JM} (63.89 µg P-NP soil h^{-1}) in second year trial. Each treatment recorded small increment in these parameters as compared to previous year due to microbial buildup of soil. And also significant improvement in the soil as compared to initial values are noticeable. Jivamrutam was applied @ 500 L ha^{-1} in treatment O_{JM} while 50 L ha^{-1} panchagavya in O_{PG} plot, this high volume of JM along with rhizospheric activity in legumes would have enhanced the SMBC value in O_{JM} treatment. O_{PG} outperformed O_{JM} due in terms of DHA and APA because of its substantial quantity of element and bio-chemical properties. PG also contains nitrate oxidisers, yeast, Ammonium oxidizers, growth hormones (Indole acetic acid & Gibberellic acid), phenols, reducing sugars and glucose (Patel *et al*., 2014 and Suresh *et al*., 2011) [25, 37], alkanes, fatty acids, alcohols (Selvaraj *et al*., 2007 and K. Natarajan, 2002) [32, 21]. These multiple biochemicals along with growth promoting hormones could have significantly enhanced DHA in soil. Apart from this, the existence of PSB (Ram *et al*., 2019) [27] along with other potential phytochemicals would have accelerated alkaline phosphatase activity. Chandrakala *et al*., 2007 [7]; Naidu *et al*., 2009 [20] and Biradar *et al*., 2017 [6] observed identical effect of these liquid manures *wrt* to these bio-chemical parameters in the soil.

There was no interaction effect on these biochemical parameters (except SMBC in second year).

Table 4: Effect of Panchagavya, Jivamruta and Fertility levels on soil Bio-chemical properties (soil microbial biomass carbon-SMBC, dehydrogenase activity-DHA and alkaline phosphatase activity-APA) in greengram in Varanasi region.

	SMBC (µg g^{-1} soil)				DHA (µg TPF g^{-1} soil day^{-1})				APA (µg P-NP soil h^{-1})			
Treatments	**2020-21**		**2021-22**		**2020-21**		**2021-22**		**2020-21**		**2021-22**	
Main Plot	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
$RDF_{100\%}$	255.1	279.4	334.6	365.8	21.21	21.90	24.11	25.22	63.94	64.68	64.38	65.00
$RDF_{75\%}$	242.0	278.6	321.0	359.4	20.05	21.10	23.33	24.32	62.75	63.24	62.94	63.56
$RDF_{50\%}$	236.0	264.8	303.2	337.4	19.30	20.13	22.85	23.69	61.32	61.66	61.36	61.98
S.Em	5.5	6.3	6.5	7.3	0.39	0.36	0.31	0.37	0.87	0.82	0.82	0.82
LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Subplot												
O_0	192.0	211.9	256.5	276.7	17.38	16.90	19.41	19.88	59.64	60.21	59.91	60.53
O_{PG}	239.8	277.3	317.7	348.8	24.36	24.43	26.50	27.96	64.17	64.65	64.35	64.97
O_{JM}	287.5	315.5	364.9	406.8	18.53	20.24	23.26	24.14	63.06	63.57	63.27	63.89
O_{PG+JM}	258.1	292.2	339.3	384.5	20.48	22.60	24.55	25.66	63.80	64.35	64.05	64.67
S.Em	5.20	6.19	3.32	3.58	0.30	0.33	0.26	0.46	0.59	0.58	0.58	0.58
LSD	18.01	21.43	11.50	12.40	1.03	1.13	0.90	1.58	2.05	1.99	1.99	1.99
Interaction	NS	NS	13.74	14.79	NS	NS	NS	NS	NS	NS	NS	NS

Note: Initial values are after harvest of zero tillage wheat and final values after harvest of greengram

Conclusion

Greengram is an important legume crop with low national productivity requiring less fertilizer dosages. Panchagavya and Jivamruta are two remarkable liquid organic manure with extraordinary potency to be used in greengram production for soil improvement, cost reduction and yield promotion. These liquids can be prepared at home from own domestic resources.

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