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RESEARCH PAPER

Influence of ghanajeevamrutha and liquid organic manures on soil fertility and productivity of chickpea in vertisol

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Abstract: A field investigation was undertaken to assess "Influence of ghanajeevamrutha and liquid organic manures on soil fertility and productivity of chickpea in vertisol" in medium deep black soils at College of Agriculture, Vijayapura. The experiment was laid out under Randomized Complete Block design (RCBD) with 3 replications, 13 treatments which include different levels of ghanjeevarmrutha application equivalent to recommended dose of phosphorus alone and in combination with cow urine, jeevamrutha and vermiwash. The results showed that application of ghanajeevamrutha @ 100 % of P nutrient requirement (10 t ha^{-1}) + jeevamrutha @ 10 % twice foliar sprays first at flowering stage and second after 15 days, recorded significantly higher organic carbon content (5.27 g kg^{-1}), available N (307.33 kg ha^{-1}), P (29.62 kg ha^{-1}), K (446.33 kg ha^{-1}) and S (22.93 kg ha^{-1}) at harvest stage, higher grain yield (1576 kg ha^{-1}), haulm yield (1852 kg ha^{-1}) and also substantially higher dehydrogenase activity (7.20 and 6.64 µg TPF g^{-1} soil day^{-1} , pod filling stage and harvesting stage, respectively) and phosphatase activity (14.56 and 13.78 µg PNP g^{-1} soil hr^{-1}, at pod filling stage and harvesting stage, respectively), gross returns (₹ 95466 ha^{-1}), net returns (₹ 63291 ha^{-1}) and BC ratio (2.97).

Key words: Chickpea , Cow urine, Ghanajeevamrutha, Jeevamrutha

Introduction

Chickpea (*Cicer arietinum* L.) is the third most vital food legume belongs to family Fabaceae. This has been the most important ancient pulse crop historically grown in India during *rabi* and is popularly known as gram or bengal gram, most frequently grown in the world's semi-arid regions and has a well-branched tap root that grows deep in the soil profile with moisture retained to support growth. Next to groundnut and soybean, it is the highest protein yielding grain legume with 21.1 per cent protein, 61.5 per cent carbohydrates and 4.5 per cent fat and is also rich in calcium, iron and niacin. The green leaves contain the malic and oxalic acid which are really effective for alleviating bowel disorder.

Chickpea globally, grown over an area of about 14.56 m ha and a production of 14.78 mt. It accounts for greater than 20 percent of world pulse production and most of the world chickpea supply (72 %) is from India and ranks first in area and production in the world, with an area of 10.56 m ha, production of 11.17 mt and productivity 1077 kg ha^{-1} (Kumar *et al.,* 2019). In Karnataka, it is grown over an area of 1128.60 thousand ha with an annual production of 574.46 thousand tonnes, having an average productivity of 509 kg ha^{-1} (Anon., 2019). Chickpea is widely cultivated in northern Karnataka, particularly in the districts of Vijayapura, Dharwad, Belagavi, Gadag, Bagalkot, Bidar, Gulbarga, Raichur and Yadagir.

The indiscriminate use of fertilizers, lack of organic manures and recycling of crop residues which adversely affected the soil health (physical, chemical and biological properties of the soil) affect the sustainable crop production systems (Virmani, 1994). In addition, Indian soils are deficient in organic matter, and plant nutrients.Conventional farming with monocropping, such as rice, wheat and cotton on the same piece of land with intensive use of chemical fertilizers and pesticides resulted in the degradation of soil, contamination of surface and ground water with harmful chemicals and heavy metals like Cd, Cu, Mn and Zn which has lead to risk of adverse health of human. Hence, there is need for alternative systems to chemical farming which are economically viable and ecologically sound.

Organic matter improves the soil physical condition and chemical properties and encourages the biological activities. The beneficial impact of organic matter on the physical, chemical and biological properties of the soil is well identified. The suitability of organic materials as fertilizer depends to a large extent on their mineralization intensity and release of the nutrients present in them. The research was carried out to observe changes in soil chemical properties when soil is amended with graded levels of ghanajeevamrtha along with liquid organic manures (Jeevamrutha, Vermiwash and Cow urine). The nutrient composition of ghanajeevamrutha was 1.0, 0.5 and 0.2 per cent of N, P and K respectively. Similarly the nutrient composition of Jeevamrutha was 1.35, 0.16 and 0.31 per cent of N, P and K, respectively, cow urine consisted 1.62, 0.10 and 2.46 per cent of N, P and K respectively and vermiwash 0.18, 0.15 and 1.25 per cent of N, P and K respectively. The main four priorities namely, beejamrutha, jeevamrutha, mulching and vapsa were adopted in holistic way to revital soil quality, improve productivity and quality of produce. However, there is a need to standardize these practices in different crops and agro-ecological situations.

Ghanajeevamrutha is organic manure redeveloped for critical crop requirements by using old methods. This is prepared for supplying major and minor supplements to plants and supply

food to earth worms and other useful micro flora and fauna in soil. By improving aeration in root zone enhancing mineralization process in soil helps in sustained release of nutrients in the soil, which in turns make available useful elements to plants. In addition, liquid organic manures also fulfill the crop nutrient requirements with higher nutrient availability during peak growing periods and their application correct their deficiencies under organic production systems (Shwetha *et al.*, 2009). The liquid organic solutions like beejamrutha, jeevamrutha and panchagavya are prepared from cow dung, urine, milk, curd, ghee and jaggary. Also vermiwash and cow urine are the source of macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms. There is an opportunity for increasing pulse yield and quality by raising soil fertility and productivity by increased ability of conservation of soil organic carbon and soil moisture (Palekar, 2006).

Material and methods

The experiment was conducted during the *rabi* season-2019 at Instructional farm, College of Agriculture, Vijayapura, situated in the Northern Dry Zone of Karnataka (Zone 3), it is situated at 16^0 49' North latitude, 75^0 43' East longitude and at an altitude of 593.8 m above the mean sea level. The experiment was carried out by adopting Randomized Complete Block Design (RCBD) with three replication and 13 treatments viz.,T_1-RDF+FYM, T_2- Ghanajeevamrutha @ 50% of P nutrient requirement, T_3-Ghanajeevamrutha @ 75% of P nutrient requirement, T_4-Ghanajeevamrutha @ 100% of P nutrient requirement, T_5-T_2+foliar spray of Jeevamrutha @ 10%, T_6-T_2+foliar spray of Cow urine @ 10%, T_7-T_2+foliar spray of Vermiwash @ 10%, T_8-T_3+foliar spray of Jeevamrutha @ 10%, T_9-T_3+foliar spray of Cow urine @ 10% , T_{10}-T_3+foliar spray of Vermiwash @ 10%, T_{11}-T_4+foliar spray of Jeevamrutha @ 10%,T_{12}-T_4+foliar spray of Cow urine @ 10%, T_{13}-T_4+foliar spray of Vermiwash @ 10%. Foliar sprays of all the liquid manures were taken at flowering stage and 15 days after the first spray.

The gross plot size was 5.4 m × 4.0 m. The soil type of the experiment is medium deep black soils. Initial composite soil sample was collected at a depth of 0 to 15 cm before sowing from the experimental area and analyzed for physical and chemical properties mainly organic carbon (3.62g kg^{-1}), available nitrogen (236.32 kg ha^{-1}), available phosphorus (22.6 kg ha^{-1}), available potassium (388.40 kg ha^{-1}). Organic manure ghanajeevamrutha (@ 5, 7.5 and 10 t ha^{-1}) was incorporated to the soil before sowing as per the treatments and were applied equivalent to recommended dose of phosphorus (50 kg P_2O_5 ha^{-1}) except for the treatment receiving RPP where DAP is used as a source of nutrient, so that the recommended nutrients for chickpea (25:50, N:P_2O_5 kg ha^{-1}) were met. Small furrows opened manually adjacent to the seed line as per the treatment and covered with soil to avoid the nutrient losses. The seeds were treated with *Rhizobium* and PSB each at the rate 500 g per ha before sowing.

Composite soil samples were collected randomly from 0-15 cm depth from each plot after harvest. For the analysis of organic carbon, available nitrogen, phosphorus, potassium and sulphur, the soil samples were collected with the help of auger and for the analysis of dehydrogenase and phosphatase activity soil sample were taken from the root region with the help of sickle at flowering, pod filling and harvesting stages of chickpea.

Results and discussion

Influence of different levels of ghanajeevamrutha and liquid organic manures on soil fertility and enzymatic activities

Organic carbon content of soil at harvest of chickpea

There was no significant influence of ghanajeeevamrutha on pH and EC at harvest of chickpea, although there was some effect on organic carbon content of soil treated with ghanajeevamrutha. Higher organic carbon was found with the inclusion of ghanajeevamrutha @ 100 % of P nutrient requirement + twice jeevamrutha @ 10 % foliar sprays which was superior by 45.98 % as contrast to control (Table 1). This higher organic carbon content was mainly due to inclusion of ghanajeevamrutha which upon its slow decomposition lead to production of organic acids which in turn was main reason for higher accumulation of organic carbon and also due to leaves fall off from chickpea crop which was followed by their decomposition again leads to production of organic acids which lead to increment in organic carbon content of soil. The work of Reshma *et al.*(2018) in cowpea cultivation where application of jeevamrutha at 1000 l ha^{-1} was done and recorded significant organic carbon content at harvesting stage of crop compared to control. Meena and Ram (2016) concluded that INM (integrated nutrient management) had a major impact on black gram productivity and plant essential nutrient status in the soil. The application of RDF + Rhizobium for seed treatment + PSB along with FYM @ 5 t ha^{-1} have remarkably documented superior organic carbon, available nitrogen (N), phosphorus (P_2O_5), potassium (K_2O), sulphur (S) and zinc (Zn) contents in the soil over regulation.

Available nutrient content of soil at harvest of chickpea

The results pertaining to available nitrogen, phosphorus and potassium were superior with infusion of ghanajeevamrutha @ 100 % of P nutrient requirement + jeevamrutha @ 10 % foliar spray which were superior by (74.66, 7.82 and 62.33 kg ha^{-1}, N, P_2O_5, K_2O, respectively) over control (Table 1). These superior results were majorly due to incorporation of ghanajeevamrutha which acts as a source of energy for some of the beneficial microbes and enzymes which helps in nitrogen mineralization (*Nitrobacter, nitrosomonas* and *nitrogenase*) and phosphorus solubalizers (*Bacillus, Pseudomonas* etc.) and mobilizers (*Mychorrhiza*) and so on which converts unavailable form of nutrients to available form there by increase their availability. Chickpea being a leguminous crop fixes the atmospheric nitrogen by biological nitrogen fixation with the help of nitrogenase enzyme and also due to chelating action of ghanajeevamrutha helps in reducing the P-fixation hence increased phosphorus availability and due to increased CEC of the soil due to infusion of ghanajeevamrutha improved ion exchange resulted in higher available K. Organic acids released during decomposition helps in solubalization of phosphorus there by increased P availability. Halemani *et al.* (2004) revealed

Table 1. Influence of ghanajeevamrutha and foliar sprays of liquid organic manures on soil physico - chemical properties of soil after harvest of chickpea

Treatments	pH (1:2.5)	EC (dS m^{-1})	OC (g kg^{-1})	Available nutrients (kg ha^{-1})			Available S (kg ha^{-1})
				N	P_2O_5	K_2O	
T_1 - RPP	8.14	0.22	3.61	232.67	21.80	384.00	18.69
T_2 - Ghanajeevamrutha @ 50 % of P nutrient requirement	7.87	0.22	3.64	239.10	21.22	350.67	18.21
T_3 - Ghanajeevamrutha @ 75 % of P nutrient requirement.	7.85	0.24	3.77	246.90	24.21	365.67	17.97
T_4 - Ghanajeevamrutha @ 100 % of P nutrient requirement.	7.82	0.21	4.73	278.67	25.22	384.00	19.10
T_5 - T_2 + foliar spray of Jeevamrutha @ 10 %	7.74	0.24	4.21	257.43	24.63	377.33	18.37
T_6 - T_2 + foliar spray of Cowurine @ 10 %	7.66	0.23	3.91	260.67	24.29	363.41	18.12
T_7 - T_2 + foliar spray of Vermiwash @ 10 %	7.82	0.22	4.18	262.00	24.32	373.00	18.28
T_8 - T_3 + foliar spray of Jeevamrutha @ 10 %	7.99	0.21	4.69	284.67	27.69	416.33	20.97
T_9 - T_3 + foliar spray of Cowurine @ 10 %	7.94	0.23	3.93	270.33	25.52	398.67	18.44
T_{10} - T_3 + foliar spray of Vermiwash @ 10 %	7.81	0.24	4.40	272.33	25.98	402.67	18.50
T_{11} - T_4 + foliar spray of Jeevamrutha @ 10 %	7.84	0.22	5.27	307.33	29.62	446.33	22.93
T_{12} - T_4 + foliar spray of Cowurine @ 10 %	7.78	0.22	4.52	273.33	25.69	404.00	19.62
T_{13} - T_4 + foliar spray of Vermiwash @ 10 %	7.69	0.23	4.62	280.33	26.06	409.10	20.29
S.Em. ±	0.33	0.02	0.22	8.90	1.19	12.20	0.79
C.D. (P = 0.05)	NS	NS	0.65	25.99	3.46	35.60	2.34

Table 2. Influence of ghanajeevamrutha and foliar sprays of liquid organic manures on grain & haulm yield and harvest index of chickpea

Treatments	Grain yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
T_1 – RPP	1145	1516	0.43
T_2 - Ghanajeevamrutha @ 50 % of P nutrient requirement	1249	1587	0.44
T_3 - Ghanajeevamrutha @ 75 % of P nutrient requirement.	1331	1627	0.45
T_4 - Ghanajeevamrutha @ 100 % of P nutrient requirement.	1420	1681	0.46
T_5 - T_2 + foliar spray of Jeevamrutha @ 10 %	1291	1617	0.44
T_6 - T_2 + foliar spray of Cowurine @ 10 %	1284	1610	0.44
T_7 - T_2 + foliar spray of Vermiwash @ 10 %	1309	1615	0.38
T_8 - T_3 + foliar spray of Jeevamrutha @ 10 %	1442	1748	0.45
T_9 - T_3 + foliar spray of Cowurine @ 10 %	1380	1686	0.45
T_{10} - T_3 + foliar spray of Vermiwash @ 10 %	1418	1695	0.46
T_{11} - T_4 + foliar spray of Jeevamrutha @ 10 %	1576	1852	0.46
T_{12} - T_4 + foliar spray of Cowurine @ 10 %	1393	1670	0.45
T_{13} - T_4 + foliar spray of Vermiwash @ 10 %	1424	1696	0.46
S.Em.±	46	52	0.03
C.D. (P = 0.05)	137	153	NS

Note:
RPP - Recommended package of practices.
Ghanajeevamrutha applied equivalent to 50, 75 and 100 % recommended doses of P_2O_5 (5, 7.5 and 10 t ha^{-1} respectively)
Foliar sprays of the liquid manures: First spray at flowering stage and second spray after 15 days.

that the application of FYM @ 10 t ha^{-1} retained higher available soil N, P_2O_5 and K_2O than the rest of the inorganic treatments in *Vertisol* of Dharwad. Investigations of Ramesh *et al.* (2012) also reported that, application of organic manures increased soil available N, P and K compared to chemical farming.

Available sulphur content of soil at harvest of chickpea

The status of available sulphur in soil was considerably maximum with supply of ghanajeevamrutha @ 100 % of P nutrient requirement + jeevamrutha @ 10 % foliar spray over control (Table 1). This higher availability of sulphur in soil might be attributed to the incorporation of ghanajeevamrutha which helps in dissolution of native sulphur from soil with improvement in biological property of soil which increases the activity of sulphur solubilizers such as *Thiobacillus* strains in soil by acting as a food source to them. Yadav *et al.* (2017) opined that inclusion of vermicompost (VC) @ 2 t ha^{-1} recorded higher available sulphur after harvest of chickpea

Grain yield and haulm yield of chickpea

Outstanding increase in grain yield and haulm yield (1576 and 1852 kg ha^{-1}, respectively) was noticed with infusion of ghanajeevamrutha @ 100 % of P nutrient requirement + jeevamrutha @ 10 % foliar spray which were greater by 37.57 and 22.13 per cent, respectively over control (Table 2) as ghanajeevamrutha applied was 10 t ha^{-1}. This increment in grain and haulm yield is majorly due to inclusion of ghanajeevamrutha at higher dose as well as jeevamrutha into the soil which improved the soil nutrient status (Table 1). Also improved vegetative and reproductive growth of chickpea helps in realizing potential yield of plant, higher photosynthetic rate and accumulation of photosynthates to sink also leads to higher

yield. Anusha *et al.* (2018) reported that application of 100 per cent N through FYM (60 %) + Neem cake (40 %) + Seed treatment with ghanajeevamrutha + Foliar spray of panchagavya @ 3 % at every 10 days interval up to 15 days before harvest recorded higher plant growth and yield parameters compared to other treatments. Kumbar and Devakumar (2016) reported that the use of higher levels of jeevamrutha (2000 l ha^{-1}) and panchagavya (6 %) had significantly higher plant heights (27.26 and 26.74 cm, respectively), branch numbers per plant (6.64 and 6.13, respectively) and pods per plant (15.36 and 14.69, respectively) in french beans leading to higher pod yield (134.3 and 124.4 q ha^{-1}, respectively) accompanied by jeevamrutha @ 1500 l ha^{-1} and 1000 l ha^{-1} (115.0 and 106.7 q ha^{-1}, respectively) and confirmed that the use of higher levels of jeevamrutha (2000 l ha^{-1}) and panchagavya (6 %) can increase the yield.

Soil enzyme activities (dehydrogenase and phosphatase) at different stages of chickpea production

Soil enzymatic activities (dehydrogenase and phosphatase activity) are the indication of the improved biological property of a soil, increase in biological activities helps in better mineralization and solubilisation of nutrients in soil. In the present investigation dehydrogenase and phosphatase activities were significantly more at pod filling stage followed by harvesting stage of chickpea. The greatest dehydrogenase and phosphatase activity were found with treatment receiving ghanajeevamrutha @ 100 % of P nutrient requirement + jeevamrutha @ 10 % foliar spray at pod filling and harvesting as against to control (Table 3). This higher activity of both dehydrogenase and phosphatase enzymes at pod filling stage and harvesting stage was mainly due to application of ghanajeevamrutha which helps in higher availability of organic matter which is being source of energy for microbes and enzymes. Also due to its narrow C:N ratio increased microbial biomass in turn triggered enzyme activities. Since dehydrogenase which occurs only within the bacterial cells like *Pseudomonas*, they never function on their own without host, hence this also indicate higher activities of such beneficial bacteria. Dehydrogenase enzymes mainly involved in oxido-reduction of soil organic matter. Similarly phosphatase enzymes secreted by some microbes, which catalyses hydrolysis and releases the free phosphate, helps in inositol P release from soil, hence due to increased activities of these enzymes increased nutrient availability as well as uptake by the chickpea. Patil *et al.* (2012) reported that infusion of enriched compost ($1/3^{rd}$) + vermicompost ($1/3^{rd}$) + glyricidia leaf manure ($1/3^{rd}$) equal to 100 % RDN along with 3 % of panchagavya foliar spray firstly at flowering stage and another at 15 days later reorded higher activity of both dehydrogenase and phosphatase enzymes.

Influence of ghanajeevamrutha and liquid organic manures on economics of chickpea production

Economic gain is one of the main factors in any technology's success and will not be embraced by the farming community unless it is economically viable. Highest gross returns (₹ 95466 ha^{-1}) were obtained with incorporation of ghanajeevamrutha @ 100 % of P nutrient requirement + jeevamrutha @ 10 % foliar spay over control (₹ 95466 ha^{-1}, Table 4). This was attributed to higher grain yield and haulm yield of chickpea due to addition of ghanajeevamrutha.

Table 3. Influence of ghanajeevamrutha and foliar sprays of liquid organic manures on soil biological parameters at different stages of chickpea

Treatments	Dehydrogenase activity (µg TPF/g soil/day)			Phosphatase activity (µg PNP/g soil/hr)		
	At flowering stage	At pod filling stage	At harvesting stage	At flowering stage	At pod filling stage	At harvesting stage
T_1 - RPP	3.51	3.40	3.27	11.49	11.26	10.72
T_2 - Ghanajeevamrutha @ 50 % of P nutrient requirement	4.79	4.91	4.62	12.18	12.58	11.79
T_3 - Ghanajeevamrutha @ 75 % of P nutrient requirement.	4.89	5.43	4.72	12.42	12.63	11.87
T_4 - Ghanajeevamrutha @ 100 % of P nutrient requirement.	5.48	6.10	5.17	12.67	12.68	11.93
T_5 - T_2 + foliar spray of Jeevamrutha @ 10 %	5.19	5.92	4.86	12.55	12.86	12.08
T_6 - T_2 + foliar spray of Cowurine @ 10 %	5.02	5.76	5.35	12.45	12.61	12.01
T_7 - T_2 + foliar spray of Vermiwash @ 10 %	5.14	5.64	5.52	12.49	12.72	12.20
T_8 - T_3 + foliar spray of Jeevamrutha @ 10 %	5.91	6.47	5.88	13.39	13.52	12.72
T_9 - T_3 + foliar spray of Cowurine @ 10 %	5.70	6.21	5.48	12.43	12.75	12.20
T_{10} - T_3 + foliar spray of Vermiwash @ 10 %	5.73	6.28	5.59	12.65	13.29	12.42
T_{11} - T_4 + foliar spray of Jeevamrutha @ 10 %	6.06	7.20	6.64	13.51	14.56	13.78
T_{12} - T_4 + foliar spray of Cowurine @ 10 %	5.76	6.18	5.56	13.32	13.13	12.52
T_{13} - T_4 + foliar spray of Vermiwash @ 10 %	5.87	6.29	5.62	13.35	13.25	12.62
S.Em.±	1.38	0.25	0.29	0.49	0.39	0.37
C.D. (P = 0.05)	NS	0.72	0.86	NS	1.13	1.08

Note:
RPP - Recommended package of practices.
Ghanajeevamrutha applied equivalent to 50, 75 and 100 % recommended doses of P_2O_5 (5, 7.5 and 10 t ha^{-1} respectively)
Foliar sprays of the liquid manures: First spray at flowering stage and second spray after 15 days.

Table 4. Influence of ghanajeevamrutha and foliar sprays of liquid organic manures on economics of chickpea cultivation

Treatments	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	B:C ratio
T_1 - RPP	69478	41470	31633	2.18
T_2 - Ghanajeevamrutha @ 50 % of P nutrient requirement	75753	49078	26675	2.84
T_3 - Ghanajeevamrutha @ 75 % of P nutrient requirement	80644	51469	29175	2.76
T_4 - Ghanajeevamrutha @ 100 % of P nutrient requirement	86020	54345	31675	2.72
T_5 - T_2 + foliar spray of Jeevamrutha @ 10 %	78269	51094	27175	2.88
T_6 - T_2 + foliar spray of Cowurine @ 10 %	77825	50900	26925	2.89
T_7 - T_2 + foliar spray of Vermiwash @ 10 %	79348	51673	27675	2.87
T_8 - T_3 + foliar spray of Jeevamrutha @ 10 %	87374	57699	29675	2.90
T_9 - T_3 + foliar spray of Cowurine @ 10 %	83623	54198	29425	2.84
T_{10} - T_3 + foliar spray of Vermiwash @ 10 %	85927	55752	30175	2.85
T_{11} - T_4 + foliar spray of Jeevamrutha @ 10 %	95466	63291	32175	2.97
T_{12} - T_4 + foliar spray of Cowurine @ 10 %	84395	51970	32425	2.60
T_{13} - T_4 + foliar spray of Vermiwash @ 10 %	86268	53593	32675	2.64
S.Em.±	2786	2786	-	0.08
C.D. (P = 0.05)	8131	8132	-	0.26

Note:
RPP - Recommended package of practices.
Ghanajeevamrutha applied equivalent to 50, 75 and 100 % recommended doses of P_2O_5 (5, 7.5 and 10 t ha^{-1} respectively)
Foliar sprays of the liquid manures: First spray at flowering stage and second spray after 15 days.

Application of jeevamrutha found to be most effective when we used it with the ghanajeevamrutha than used in alone. Alternatively maximum net returns (₹ 63291 ha^{-1}) and benefit cost ratio (2.97) were possible with the incorporation of ghanajeevamrutha @ 100 % of nutrient requirement + jeevamrutha @ 10 % foliar spray as contrast to control (₹ 41470 ha^{-1} and 2.18, respectively, Table 4). Higher net returns and B:C ratio was mainly due to higher gross returns and lower cost of ghanajeevamrutha which inturn decreased cost of cultivation of chickpea. Upendranaik *et al.* (2017) studied that jeevamrutha + mulching + IFS compost + vermicompost + panchagavya (IFS Compost (50 %), vermicompost (50 %) equivalent to 100 % RDN and panchagavya (3 %), jeevamrutha (3 %), respectively at 30, 45 DAS) inclusion reported higher net realization and B:C ratio (₹ 39,846 ha^{-1} and 3.48 respectively) and was documented on a par with inclusion of jeevamrutha + mulching + IFS compost + panchagavya (₹ 36,863 ha^{-1} and 3.25 respectively). Channagouda *et al.* (2015) reported that the combined use of crop residue (50 %) + vermicompost (50 %) equal to RDN with jeevamrutha at 500 l ha^{-1} surface application had outstandingly higher net yields (₹ 60,009 ha^{-1}) as contrast to other combinations.

Conclusion

It was concluded that application of ghanajeevamrutha (10 t ha^{-1}) equivalent to 100% of recommended nutrient requirement of chickpea coupled with twice foliar sprays of 10 % organic liquid manure of jeevamrutha, first at flowering stage and second after 15 days found optimum for obtaining higher grain yield, haulm yield and higher net returns; improving soil enzyme activity and soil fertility status.

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