RESPONSE OF DIFFERENT LEVELS OF JEEVAMRUTHA AND GHANAJEEVAMRUTHA ON POD YIELD AND YIELD COMPONENTS OF RAINFED GROUNDNUT (*ARACHIS HYPOGAEA* L.)

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Abstract. The aim of the study was to assess the effects of different levels of jeevamrutha and ghanajeevamrutha on yield parameters of rainfed groundnut (*Arachis hypogaea* L.). Randomized complete block design was used with two levels of sole ghanajeevamrutha and jeevamrutha and four levels of combined application of ghanajeevamrutha and jeevamrutha. The results indicated that integrated use of organic manure (FYM @ 7.5 t ha^{-1}) and inorganic fertilizers have registered significant improvement in pod yield (1715 kg ha^{-1}), haulm yield (2703 kg ha^{-1}) and nutrient uptake (N-82.72, P-16.08 and K-67.84 kg ha^{-1}). Combined application of ghanajeevamrutha @ 1250 kg ha^{-1} and jeevamrutha @ 3000 l ha^{-1} through four equal splits was equally effective as inorganic fertilizers with FYM by recording statistically on par results concerning pod yield (1669 kg ha^{-1}) and haulm yield (2596 kg ha^{-1}).
Keywords: *organic manure, enzyme, haulm yield, nutrient uptake, package of practice*

Introduction

Groundnut (*Arachis hypogaea* L.) is a leguminous crop. Among the different oilseeds grown, groundnut is the second most important annual oilseed crop. It is an important crop around the globe for its nutritional and trade values. The monocropping system, as well as the increased and frequent use of fertilizers and pesticides, caused significant damage to the soil's biological operation, crop diversity, increased cultivation costs, deterioration of groundwater, loss of flora-fauna, increased human diseases, malnutrition, and decreased soil fertility, almost leaving it barren in large areas. As a result, small-scale farmers invest in these costly inputs, which expose them to high monetary risks and push them into the debt cycle (Nelson et al., 2019). Though conventional farming helps in getting substantial yields, indiscriminate use of inorganic fertilizers and continuous farming has resulted in various soil hazards, ultimately leading to lower productivity. Additionally, overemphasis on conventional farming has resulted in the deterioration of soil and plant health (Pandey et al., 2008). Restoring soil health by reverting to nonchemical agriculture has assumed great importance to attain sustainability in production. In this search for eco-friendly alternate systems of farming, natural farming is increasingly becoming popular among the farming community with

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limited use of cow dung and cow urine. All the inputs (insecticides, fungicides, and pesticides) are made of natural herbs and locally available inputs, which reduces the usage of synthetic fertilizers and industrial pesticides. As a result, it is a low input, climate resilient, and low-cost agricultural method (Laishram et al., 2022).

Trials conducted in farmer's field indicated jeevamrutha and ghanajeevamrutha are the two major inputs used in natural farming which supply both micro and macro nutrients but most importantly enhances soil biological activity and microbial population in soil (Palekar, 2006; Duraivadivel et al., 2022). Ghanajeevamrutha is organic manure that enriches the soil and plant health and provides all the nutrients required for the growth of the plant. Despite having positive effects of jeevamrutha and ghanajeevamrutha on plants and soil health, detailed information on the quantity of ghanajeevamrutha and jeevamrutha to be used in field crops has not yet been standardized in field crops, especially in groundnut. Therefore, our study aimed to assess the response of different levels of jeevamrutha and ghanajeevamrutha on yield and yield components of rainfed groundnut.

Materials and Methods

Place and time of study

A field experiment was conducted during *Kharif* 2019 and 2020 at the College of Agriculture, KSNUAHS Shivamogga situated in the Southern Transition Zone (Zone-7) of Karnataka. India. The experimental site was located at 14°0'N to 14º1' N latitude and 75°40' E to 75º42’ E longitudes with an altitude of 650 meters above mean sea level. The soil of the experimental site was sandy loam which falls under *Alfisols* order. The soil was neutral in reaction (pH 6.76), low in available nitrogen (230.71 kg ha^{-1}), high in available phosphorous (92.00 kg ha^{-1}) and medium in available potassium (310.31 kg ha^{-1}). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications and ten treatments. The test variety used was TMV-2 was sown at 30 cm x 10 cm. The plot size was 6 m x 3 m, the date of sowing being 15/07/2019 and 25/07/2020 and the date of harvest were 20/10/2019 and 01/11/2020. No major pest or disease incidences were noticed during crop growth (*Table 1*, *Fig. 1*).

Table 1. *Treatment details*

Treatments	Particulars
T1	Ghanajeevamrutha (GJ) @ 1000 kg/ha
T2	Ghanajeevamrutha @ 1250 kg/ha
T3	Jeevamrutha (J) @ 2000 l ha^{-1} through four equal splits at sowing, 30, 60 and 90 DAS.
T4	Jeevamrutha @ 3000 l ha^{-1} through four equal splits at sowing, 30, 60 and 90 DAS.
T5	Ghanajeevamrutha @ 1000 kg/ha + Jeevamrutha @ 2000 l ha^{-1} through four equal splits at sowing, 30, 60 and 90 DAS
T6	Ghanajeevamrutha @ 1250 kg/ha + Jeevamrutha @ 2000 l ha^{-1} through four equal splits at sowing, 30, 60 and 90 DAS.
T7	Ghanajeevamrutha @ 1000 kg/ha + Jeevamrutha @ 3000 l ha^{-1} through four equal splits at sowing, 30, 60 and 90 DAS
T8	Ghanajeevamrutha @ 1250 kg/ha + Jeevamrutha @ 3000 l ha^{-1} through four equal splits at sowing, 30, 60 and 90 DAS.
T9	Package of Practice FYM 7.5 t ha^{-1}+Fertilizers 25:50:25 NPK kg ha^{-1}+ $ZnSO_4$10 kg ha^{-1}+ Borax 10 kg ha^{-1}+ Gypsum 500 kg ha^{-1}
T10	Control (Treatment which did not receive any nutrients)

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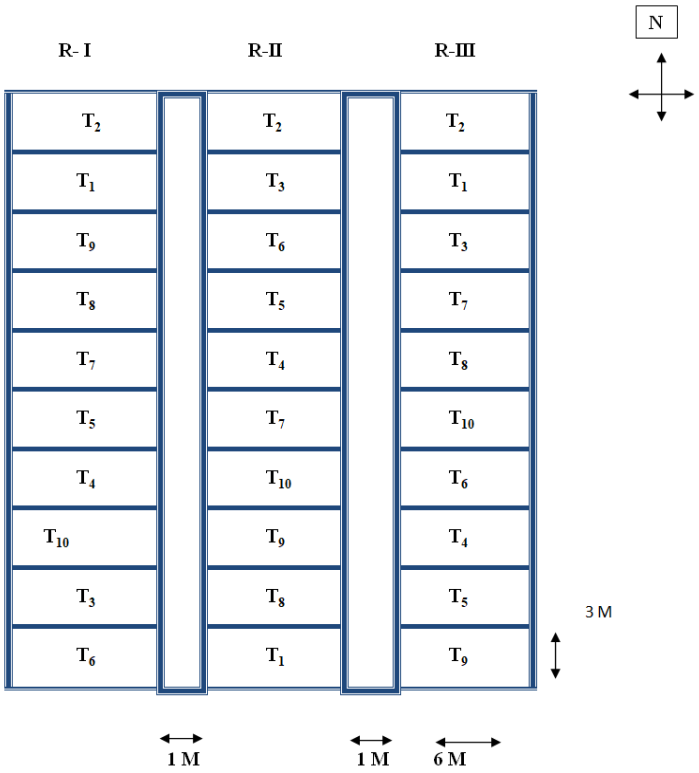

Figure 1. *Plan and layout of groundnut experimental plot*

Ghanajeevamrutha and jeevamrutha - preparation and application

Ghanajeevamrutha

Initially 100 kg of dried desi cow dung was spread on the polythene sheet; 10 liters of desi cow urine, 2 kg of powdered jaggery, and two kg pulse flour were added to the desi cow dung. All the materials were thoroughly mixed with desi cow dung and the mixture was kept under shade by covering it with a wet gunny bag to maintain 60 per cent moisture. Turning of the mixture was done twice a day for up to seven days to improve the aeration and microbial population. After seven days of turning, ghanajeevamrutha was ready for its application in the field. Ghanajeevamrutha was applied to the soil as a one-time application at the time of sowing as per the treatments.

Jeevamrutha

Jeevamrutha was prepared by mixing 10 kg desi cow dung, 10 liters of cow urine, 2 kg jaggery, 2 kg pulse flour, and a hand full of soil collected from the field near the bund. All these were put in a 200 liters plastic or cement drum and mixed thoroughly by adding water until the volume was made up to 200 liters. The mixture was stirred well in a clockwise direction thrice a day using a wooden stick until the mixture becomes homogeneous. The plastic drum was kept under shade and covered with a wet gunny bag. Well-fermented jeevamrutha was applied uniformly to the soil through manual sprinkling at the time of sowing and 30, 60 and 90 days after sowing as per the treatments.

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Uptake of nutrients

Total nitrogen, total phosphorus and total potassium uptake (kg N, kg P_2O_5 and kg K_2O/ha) by different parts of plants was worked out by multiplying the nutrient content and yield of the plant part as given in the following formulae;

$$\text{Nutrient uptake (kg/ha)} = \frac{\%\ \text{nutrient content} \times \text{dry matter yield /grain yield (kg/ha)}}{100} \quad \text{(Eq.1)}$$

Nutrient uptake studies in groundnut

Total nitrogen (N) content (%) on the dry weight basis at harvest of groundnut plant (above ground portion) by micro Kjeldahl's method. Total phosphorus (P_2O_5) content (%) on the dry weight basis at harvest of groundnut plant (above ground portion) by Vanadomolybdo phosphoric acid yellow color method. Total potassium (K_2O) content (%) on the dry weight basis at harvest of groundnut plant (above ground portion) by Flame photometer method (Jackson, 1967). Total nitrogen, total phosphorus, and total potassium uptake (N, P_2O_5 and K_2O kg/ha), the concentration (%) of N, P_2O_5 and K_2O were multiplied with the respective above-ground portion biomass yield (on oven dry basis) at harvest of groundnut and soybean to obtain/ha uptake of N, P_2O_5, and K_2O in a plant (*Table 2*).

Table 2. *Nutrient and microbial composition of ghanajeevamrutha and jeevamrutha*

Particulars	Ghanajeevamrutha	Jeevamrutha
Nitrogen	0.80 %	0.52 %
Phosphorus	0.34 %	0.21 %
Potassium	0.73 %	0.35 %
Calcium	1.72 %	0.13 %
Magnesium	1.28 %	0.05 %
Zinc	81.46 mg kg^{-1}	10.30mg kg^{-1}
Manganese	63.60 mg kg^{-1}	12.47mg kg^{-1}
Copper	38.20 mg kg^{-1}	1.40mg kg^{-1}
Iron	1708.00 mg kg^{-1}	241.64mg kg^{-1}
Bacteria	215.00 (cfu×10^6 g^{-1})	290.00(cfu×10^6 ml^{-1})
Fungi	29.50 (cfu×10^4 g^{-1})	29.00(cfu×10^4 ml^{-1})
Actinomycetes	1.80 (cfu×10^3 g^{-1})	4.00(cfu×10^3 ml^{-1})
N-fixers	18.00 (cfu×10^4 g^{-1})	15.00(cfu×10^4 ml^{-1})
Phosphorous solubilizing microorganisms	20.00 (cfu×10^4 g^{-1})	23.00(cfu×10^4 ml^{-1})
Potassium solubilizing microorganisms	5.00 (cfu×10^4 ml^{-1})	5.00(cfu×10^4 ml^{-1})
Pseudomonas fluorescence	6.50 (cfu×10^4 ml^{-1})	5.50(cfu×10^4 ml^{-1})
Trichoderma	8.50 (cfu×10^4 ml^{-1})	7.00(cfu×10^4 ml^{-1})

Estimation of dehydrogenase, phosphatase, and urease enzymes activities in soil

Rhizosphere soil samples were collected randomly selected from each plot and analyzed for dehydrogenase activity (DHA) following the procedure described by Casida et al. (1964). Ten grams of soil and 0.2 g $CaCO_3$ were thoroughly mixed and dispensed in test tubes. One ml of aqueous solution of 2, 3, 5-Triphenyl tetrazolium chloride (TTC) (3%), one ml of glucose solution (1%) and eight ml of distilled water were added. The tubes were stoppered with rubber cork and incubated at 30 ºC for 24 h. At the end of incubation, 10 ml methanol was added to the contents of the tube. The

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slurry was filtered through Whatman No. 50 filter paper. Rinsing of soil with one ml methanol was continued till the filtrate ran free of red colour. The filtrate was pooled and made up to 50 ml with methanol in a volumetric flask. The intensity of red colour was measured at 485 nm against methanol as blank using UV- VIS spectrophotometer. The concentration of TPF in soil samples was determined by referring to a standard curve prepared using graded concentration of TPF. The results were expressed as µg of triphenyl formazan (TPF) formed per g of soil per day.

The phosphatase activity of the rhizosphere soil samples was determined by following the procedure of Evazi and Tabatabai (1979). One gram of soil sample was placed in a 50 ml Erlenmeyer flask and 0.2 ml toluene was added followed by four ml of modified universal buffer (pH 7.5). One ml of para-nitrophenol phosphate solution made in modified universal buffer was added to the flasks and the contents of the flasks were mixed by swirling for 2 minutes. The flasks were stoppered and incubated at 37 °C for one hour. After incubation, one ml of 0.5 M $CaCl_2$ and four ml of 0.5 M NaOH were added to the flask, swirled, and filtered through Whatman No. 42 filter paper. The intensity of the yellow colour developed was measured at 420 nm against the reagent blank using a spectrophotometer. Controls were maintained for each soil sample. The phosphatase activity in the soil samples was expressed as µg para nitrophenol formed per gram of soil per hour with reference to the standard curve prepared by using graded concentrations of p-nitrophenol phosphate.

Urease activity in the rhizosphere soil samples was determined by following the procedure of Tabatabai and Bremner (1972). Ten grams of soil samples were mixed with 1 ml toluene and 10 ml phosphate buffer and incubated at 30 °C for 24 h. After incubation, 15 ml 1N KCl was added, and the contents were filtered through Whatman No. 42. The filtrate volume was made up to 100 ml with distilled water. One ml of the extractant was taken and 2 ml of 10 per cent sodium tartarate, 0.5 ml Nesseler's reagent were added and incubated for 30 min and the volume was made up to 25 ml with distilled water. The colour (yellow) developed was read at 610 nm against a blank (without urea solution) using a UV- VIS spectrophotometer. The results were expressed as µg NH_4-N per g soil per day (*Table 3*).

Climatic conditions prevailed during the crop growth

During the crop growth period (July to November of 2019 and 2020), total of 1094.9 mm of rainfall was received. Actual rainfall was higher than normal in August (+446.8 mm), September (+140.8 mm) and October (+196.7 mm). The actual mean maximum and minimum temperature, relative humidity and bright sunshine hours were slightly less than normal.

Data analysis

To record various biometric parameters in the experiment, a sample consisting of five plants was selected at random from each net plot and tagged. Observations on different growth, yield, and quality parameters were recorded in all samples at various crop growth stages (30, 60, and 90 days after sowing and at harvest). The data were analyzed statistically for the test of significance following the procedure described by Gomez and Gomez (1984). Data were subjected to ANOVA. Duncan multiple range test was used to evaluate the significant differences between the treatments. The 'F' test was used to test statistical significance at a 5% level of probability, and the treatment means were compared with a critical difference.

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Table 3. *Procedure for recording observations on yield parameters in groundnut*

Sl. No	Parameter	Procedure
1	Total number of pods /plant	The total number of pods produced /plant was counted in all five plants and the average /plant was worked out.
2	Dry pod weight (g /plant)	The average weight of developed pods /plants was recorded. These pods were air-dried before weighing.
3	100 pod weight (g)	Samples of 100 pods were taken from the produce of each net plot and their weight was recorded.
4	Dry pod yield (kg/ha)	Pods from the net plot area were washed and cleaned to remove the soil adhering to the pods, impurities, and immature pods. The developed pods were dried completely (up to 8 % moisture level) and weighed. Based on the pod yield net/plot, the pod yield/ha was calculated.
5	Kernel yield (kg/ha)	Kernel yield (kg/ha) = $\frac{\text{Dry pod yield (kg/ha)} \times \text{Shelling percent}}{100}$
6	Dry haulm yield (kg/ha)	After plucking the pods from harvested groundnut plants, the remaining produce was sun dried to constant weight and haulm yield/plot was recorded and dry haulm yield (kg/ha) was calculated.
7	Shelling per cent	From each net plot produced, 200 g of clean pods were weighed and kernels were obtained after shelling. Shelling per cent was worked out by dividing kernel weight by pod weight and expressing in percentage.
8	100 Kernel weight (g)	After shelling the groundnut pods, 100 kernels were randomly counted and weighed.

Results and Discussion

In general, the productivity of groundnut was more in the second year (2020) than in the first year (2019) but the response to different treatments was similar in both years of experimentation and hence, pooled data is discussed here**.** Application of nutrients through recommended dose of FYM and fertilizers showed significant improvement in various yield attributing characters like the number of pods plant^{-1}, pod weight plant^{-1}, kernel weight plant^{-1}, shelling percentage (27.39, 21.28 g, 14.53 g, and 68.73%, respectively) pod yield, and haulm yield of groundnut (1715 and 2703 kg ha^{-1}) (*Fig. 2*) over control (20.23, 15.35 g, 9.00 g, 57.85%, respectively) (*Table 4*). The increase in yield with the application of nutrients through FYM and fertilizers was to an extent of 71.84 per cent with respect to pod yield and 35.39 per cent, 38.63 per cent, 61.44 per cent and 18.8 per cent with respect to a number of pods, pod weight, kernel weight and shelling percentage, respectively, over control. The improvement in yield attributes and pod yield of groundnut with FYM + RDF during the progressive years might be due to the buildup of organic matter and subsequent optimization of nutrient supply to the crop. The added FYM acts as a storehouse of several macro and micronutrients which are released during the process of mineralization through the stimulated activity of microorganisms which helps to release plant nutrients present in the soil, it increases the fertilizer use efficiency (Sherchan et al., 1999; Kharub and Chander, 2008; Ramesh et al., 2008; Aulakh et al., 2018). The treatment which did not receive any nutrients either through FYM and fertilizers or through natural farming inputs recorded significantly lowest pod and haulm yield levels of 998 and 2030 kg ha^{-1} compared to all other treatments.

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Table 4. *Growth and yield parameters of groundnut as influenced by different levels of jeevamrutha and ghanajeevamrutha*

Treatments	At harvest																	
	No. of pods/plant			Pod weight (g/plant)			Kernel weight (g)			Shelling percentage (%)			Pod yield (kg/ha)			Haulm yield (kg/ha)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1– G j @ 1000 kg ha-1	20.30	21.32	20.81^{fg}	15.21	16.36	15.79^{ef}	9.20	12.96	11.08^{d}	59.00	60.26	59.63^{bc}	1224	1326	1275^{d}	2531	2582	2556^{ab}
T_2– G j @ 1250 kg ha^{-1}	21.20	22.45	21.83^{ef}	15.87	16.56	16.22^{ef}	9.89	13.12	11.51^{cd}	60.00	61.37	60.69^{bc}	1269	1346	1307^{d}	2539	2641	2590^{ab}
T_3– J @ 2000 l ha^{-1}	21.00	23.56	22.28^{e}	15.72	17.68	16.70^{de}	9.56	13.24	11.40^{cd}	59.50	61.33	60.42^{bc}	1223	1386	1305^{d}	2536	2637	2587^{ab}
T_4– J @ 3000 l ha^{-1}	23.40	23.95	23.68^{d}	17.51	17.54	17.53^{cd}	10.75	13.57	12.16^{bc}	60.50	62.01	61.26^{bc}	1299	1389	1344^{d}	2541	2490	2516^{b}
T_5– G j @ 1000 kg ha^{-1} + j @ 2000 l ha^{-1}	23.40	24.15	23.78^{d}	17.51	17.25	17.38^{cd}	11.03	13.24	12.14^{bc}	61.20	63.15	62.18^{b}	1475	1623	1549^{c}	2543	2416	2479^{b}
T_6– G j @ 1250 kg ha^{-1} + j @ 2000 l ha^{-1}	23.90	25.36	24.63^{cd}	17.90	17.95	17.93^{c}	11.10	12.56	11.83^{c}	61.30	63.22	62.26^{b}	1512	1686	1599^{bc}	2544	2569	2557^{ab}
T_7– G j @ 1000 kg ha^{-1} + j @ 3000 l ha^{-1}	25.20	26.35	25.78^{bc}	18.91	19.65	19.28^{b}	12.01	13.58	12.80^{b}	61.40	63.51	62.45^{b}	1554	1695	1625^{abc}	2536	2561	2549^{ab}
T_8– G j @ 1250 kg ha^{-1} + j @ 3000 l ha^{-1}	26.20	26.85	26.53^{ab}	19.67	18.59	19.13^{b}	12.03	13.65	12.84^{b}	61.80	64.29	63.04^{b}	1625	1712	1669^{ab}	2545	2647	2596^{ab}
T_9 – Package of Practice	27.20	27.58	27.39^{a}	20.42	22.14	21.28^{a}	13.82	15.24	14.53^{a}	65.60	71.87	68.73^{a}	1635	1795	1715^{a}	2650	2756	2703^{a}
T_{10}–Control	19.30	21.15	20.23^{g}	14.45	16.24	15.35^{f}	8.75	9.24	9.00^{e}	58.80	56.90	57.85^{c}	960	1036	998^{e}	1923	2136	2030^{c}
S. Em±	0.45	0.47	0.46	0.34	0.35	0.34	0.21	0.25	0.23	1.17	5.74	3.25	27.66	30	29	48.45	59	50
C.D @ 5%	1.34	1.40	1.35	1.01	1.06	1.04	0.63	0.81	0.78	3.46	17.04	9.67	82.17	91	88	143.95	177	154

Means followed by common letters are not significantly different by Tukey test

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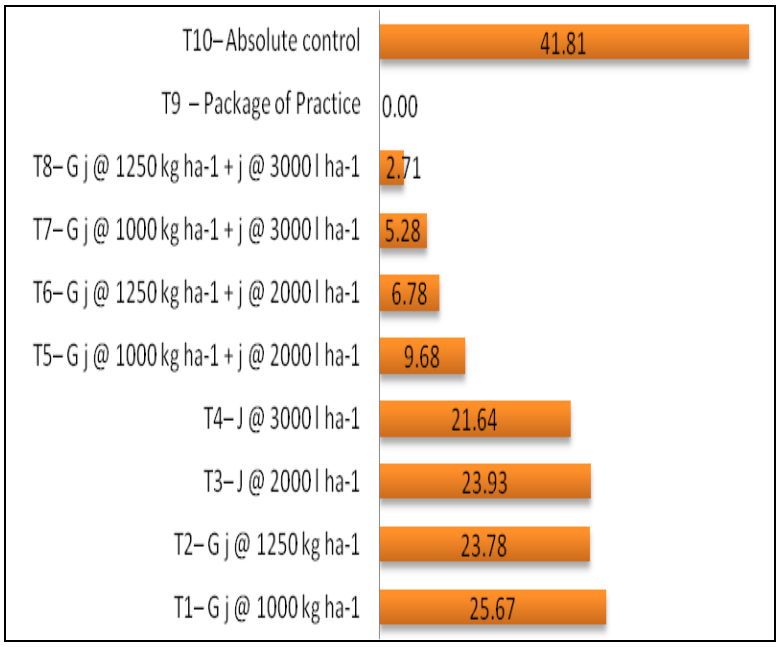

Figure 2. *per cent decrease in pod yield as compared to Package of Practice*

Among combined applications of ghanajeevamrutha and jeevamrutha, application of ghanajeevamrutha @ 1250 kg ha^{-1} along with jeevamrutha @ 3000 l ha^{-1} through four equal splits recorded higher pod yield (1669 kg ha^{-1}) over alone application of jeevamrutha @ 2000 l ha^{-1} or 3000 l ha^{-1} through four equal splits (1305 and 1344 kg ha^{-1}), or alone application of ghanajeevamrutha either @ 1000 kg ha^{-1} or 1250 kg ha^{-1} (1275 and 1307 kg ha^{-1}), respectively. Combined application of ghanajeevamrutha and jeevamrutha at their varied rates showed improvement in yield and yield parameters as compared to the isolated application of either ghanajeevamrutha or jeevamrutha at different quantities. The increase in pod yield with the combined application of ghanajeevamrutha @ 1250 kg ha^{-1} and jeevamrutha @ 3000 l ha^{-1} through four equal splits was to an extent of 67.23 per cent, with the application of ghanajeevamrutha alone @ 1000 kg ha^{-1} 27.76 per cent, with the application of ghanajeevamrutha alone @ 1250 kg ha^{-1} 30.96 per cent with the application of jeevamrutha alone @ 2000 l ha^{-1} through four equal splits 30.76 per cent, with the application of jeevamrutha alone @ 3000 l ha^{-1} through four equal splits 34.67 percent (*Fig. 3*). Improvement in yield and yield attributes with the combined soil application of ghanajeevamrutha and jeevamrutha was due to higher microbial load, which might have enhanced the mobilization of nutrients and facilitated for release of adsorbed nutrients in the soil, resulted in higher yield due to higher nutrient uptake by the plants when compared to the alone application of ghanajeevamrutha and jeevamrutha (*Fig. 4*) as reported by Yogananda et al. (2015), Jidhu Vaishnavi and Jayakumar (2016) and Siddappa et al. (2016). The inorganic nutrient stimulation of root development as well as increased water and nutrient absorption also supported a complimentary effect after fermentation, favoring better yield. These findings are in line with those reported by Avudaithai et al. (2010), Kumar et al. (2011) and Reshma et al. (2019).

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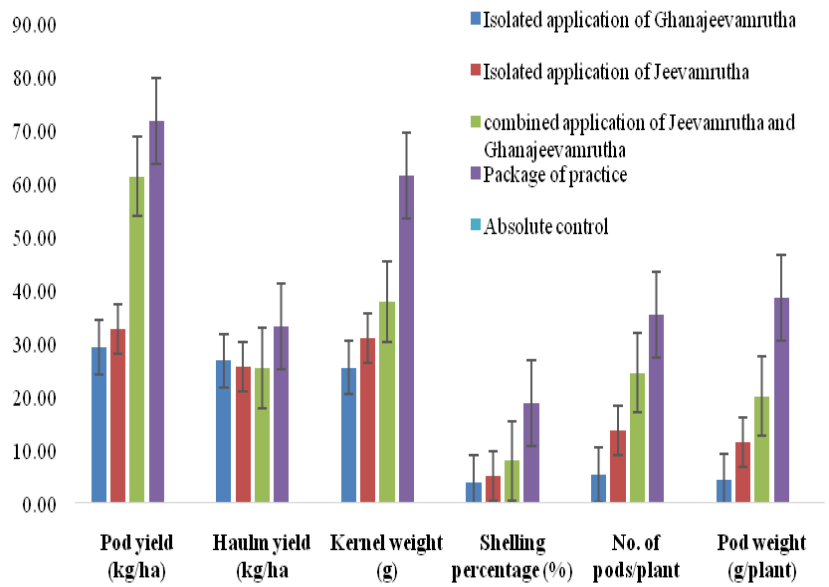

Figure 3. *Percent increase in yield parameters of groundnut as influenced by different levels of jeevamrutha and ghanajeevamrutha*

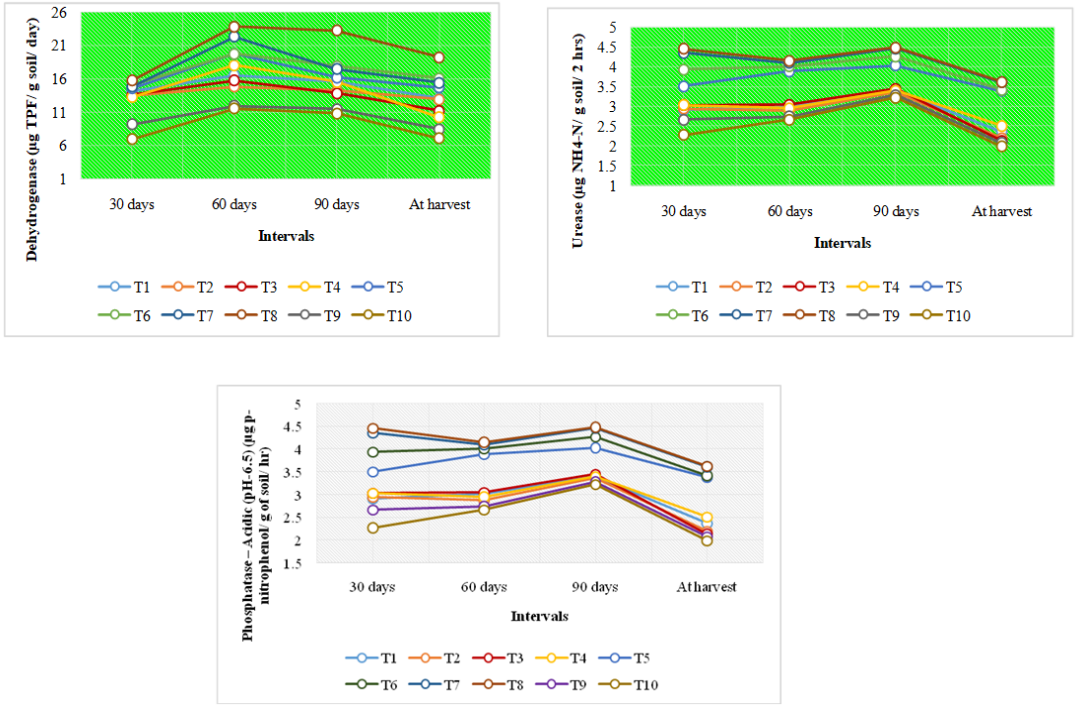

Figure 4. *Effect of different levels of jeevamrutha and ghanajeevamrutha on soil enzyme activity*

Nutrient uptake was statistically higher (NPK – 82.72, 16.08 and 67.84 kg ha^{-1}, respectively) with the application of nutrients through recommended dose of FYM and fertilizers which was closely followed by the combined application of ghanajeevamrutha @ 1250 kg ha^{-1} along with jeevamrutha @ 3000 l ha^{-1} through four

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equal splits (NPK – 75.61, 13.81 and 58.26 kg ha^{-1}, respectively) (*Table 5*). These findings are in accordance with Palekar (2006); Vasanthkumar (2006), Devakumar et al. (2008), Manjunatha et al., (2009) and Reshma et al. (2019) reported the beneficial effects of jeevamrutha attributed to incremental yield, microbial load and growth hormones which might have enhanced the soil biomass, thereby sustaining the availability and uptake of applied nutrients as well as native soil nutrients which ultimately resulted in higher growth and yield of crops.

Table 5. *Nutrient uptake as influenced by different levels of ghanajeevamrutha and jeevamrutha on rainfed groundnut*

Treatments	Total uptake (kg/ha)								
	N			P			K		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T1– G j @ 1000 kg ha^{-1}	48.41	57.54	52.97	6.87	8.88	7.87	38.93	47.22	43.07
T2– G j @ 1250 kg ha^{-1}	51.71	61.64	56.67	7.87	9.95	8.92	40.4	50.18	45.28
T3– J @ 2000 l ha^{-1}	48.34	57.53	52.93	7.12	7.56	7.34	39.48	45.91	42.7
T4– J @ 3000 l ha^{-1}	53.51	60.62	57.07	7.96	8.63	8.29	41.76	47.84	44.79
T5– G j @ 1000 kg ha^{-1} + j @ 2000 l ha^{-1}	62.49	68.04	65.26	9.63	10.98	10.3	50.81	51.84	51.32
T6– G j @ 1250 kg ha^{-1} + j @ 2000 l ha^{-1}	66.88	73.59	70.24	10.71	12.5	11.6	51.86	56.39	54.12
T7– G j @ 1000 kg ha^{-1} + j @ 3000 l ha^{-1}	69.21	77.09	73.15	11.38	14.09	12.73	53.5	59.42	56.47
T8– G j @ 1250 kg ha^{-1} + j @ 3000 l ha^{-1}	72.72	78.5	75.61	12.23	15.4	13.81	55.56	60.95	58.26
T9 – Package of Practice	78.02	87.42	82.72	14.56	17.61	16.08	68.23	67.45	67.84
T10– Control	25.58	32.73	29.16	4.13	5.18	4.65	24.63	31.44	28.03
S. Em±	2.4	3.03	2.63	0.39	0.52	0.44	1.93	2.45	2.09
C.D @ 5%	7.12	9.01	7.81	1.16	1.55	1.31	5.71	7.06	6.2

The highest dehydrogenase, urease, acid and alkaline phosphatase activity was observed at all the stages of crop growth, in the treatment receiving ghanajeevamrutha @ 1250 kg ha^{-1} + jeevamrutha @ 3000 l ha^{-1} (15.75, 23.83, 23.26 and 19.22 µg TPF/ g soil/ day; 4.46, 4.16, 4.49, and 3.63 µg NH_4-N/ g soil/ 2 hrs; 10.62, 11.37, 10.49 and 8.79 µg p-nitrophenol/ g of soil/ hr and 3.83, 3.36 3.18 and 2.91 µg p-nitrophenol/ g of soil/ hr at 30, 60, 90 and harvest stages, respectively) (*Fig. 4*) and least was noticed in

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control in two years study. This could be due to the enrichment of soil by natural farming inputs that not only supplied plant nutrients but also facilitated an enormous increase in microorganisms which intensify biological activity in the soil thereby improving soil health and leading to higher crop yields. The growth in microbial population caused by the increased microbial activity as a result of the increased availability of substrate, specifically organic carbon through organic manures, may have released enzymes with extracellular origin. Similar results were recorded by Naveena (2017). Soil enzymatic activity is strongly connected with soil organic source content. The higher organic source level can provide enough substrate to support higher microbial biomass, hence higher enzyme production (Yuan and Yue, 2012). Several authors reported a positive correlation between enzyme and organic source content (Chodak and Niklińska, 2010; Moeskops et al., 2010; Romero et al., 2010; Zhao et al., 2010; Gowthamchand et al., 2020).

Conclusion

Research results indicated that integrated use of organic (FYM @ 7.5 t ha^{-1}) and inorganic fertilizers (25:50:25 NPK kg ha^{-1}+ $ZnSO_4$ 10 kg ha^{-1} + Borax 10 kg ha^{-1}+ Gypsum 500 kg ha^{-1}) have registered significant improvement in pod yield of 1635.23 kg ha^{-1} with good maintenance of soil nutrient status. However, under the situation of scarcity of organic manures and costlier inorganic fertilizers, combined application of ghanajeevamrutha either @ 1000 or @ 1250 kg ha^{-1} with the same level of jeevamrutha @ 3000 l ha^{-1} through four equal splits registered higher pod yield of 1553.65, 1624.62, respectively. Combined application of ghanajeevamrutha @ 1250 kg ha^{-1} along with jeevamrutha @ 3000 l ha^{-1} through four equal splits recorded significantly higher microbial population during all the crop growth stages. Statistically superior nutrient uptake (NPK) was recorded with the application of nutrients through recommended dose of FYM and fertilizers which was closely followed by the combined application of ghanajeevamrutha @ 1250 kg ha^{-1} along with jeevamrutha @ 3000 l ha^{-1} through four equal splits.

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