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Effect of *Panchgavya* and *jivamrut* on yield, chemical and biological properties of soil and nutrients uptake by *kharif* groundnut (*Arachis hypogaea* L.)

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Abstract
A field experiment was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar-385506, District Banaskantha (North Gujarat) during *kharif* 2011 to 2016 to study the effect of *panchgavya* and *jivamrut* on yield, chemical and biological properties of soil and nutrient uptake by *kharif* groundnut (*Arachis hypogaea* L). The soil of experimental plot was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorous and high in available potash. The 27 treatment combinations in the experiment comprised of 9 levels of *panchgavya* and *jivamrut* including RDF and control and three stages of application (branching, flowering and branching + flowering stages) were tried in randomized block designed with factorial concept. The results revealed that foliar spray of *panchgavya* @ 4 % + soil application of *jivamrut* @ 500 lit./ha recorded significantly higher pod yield (1563 kg/ha) than rest of the treatments but remained at par with treatments foliar spray of *panchgavya* @ 2 % + *jivamrut* @ 500 l/ha as soil application (Bn_5) and (application of 100% RDN through FYM (Bn_0). Application of bionutrients (*panchgavya* and *jivamrut*) at both the stages i.e. at branching and flowering stages recorded significantly the highest pod yield (1482 kg/ha) as compared to single application either at branching or flowering stage. Significantly the highest uptake of N, P and K by kernel and haulm was recorded by application of *Panchgavya* (6 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha). Application of bionutrients at both the stages, i. e. at branching + flowering stage (S_3) registered significantly higher uptake of N, P and K by kernel and haulm. The soil quality parameters such as the microbial count of bacteria and the chemical properties of the soil viz; available P, K and OC (organic carbon) in the soils are remarkably enhanced. Among various stages of application, population of *rhizobium*, *azospirillum* and *azotobacter* was noted the highest when *panchgavya* was applied both at branching and flowering stages to *kharif* groundnut as compared to application at individual stage only

Keywords: Groundnut, *Panchgavya*, *Jivamrut*, Branching, Flowering, Foliar spray, pod yield, haulm yield

Introduction
Continuous use of inorganic fertilizers hazards the soil health in respect of physical, chemical and biological properties of soil. Therefore, it is necessary to minimize the application of inorganic fertilizers by substituting with organics. It is well established that the improvement of quality and productivity of the crops either food grain, oilseed or fruit crop could be made possible with combined application of organic manure and balanced chemical fertilizers. The contribution of organic manure is to be judged not only in terms of nutrient contribution, but also by their role in building up nutrient reserves in soil and increasing organic matter level of soil which ultimately improves physical, chemical and biological properties of soil and it is more critical in the context of sustainable agriculture.

Conventional agriculture has made an adverse impact on soil and plant health. This eventually, leads to high demand for organic farming to protect soil and plant health. Organic farming in recent years is gaining impetus due to realization of inherent advantages as it confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment (Lokanath and Parameshwarappa, 2006) [7]. In India, organic farming was well developed during the past such as 'Vedas' which has specified use of '*panchgavya*' in agriculture. In Sanskrit, *panchgavya* means the blend of five products obtained from cow

namely dung, urine, milk, curd and ghee. Presence of naturally occurring, beneficial, effective microorganisms (EMO's) in *panchgavya* predominantly and lactic acid bacteria, yeast, actinomycetes photosynthetic bacteria and certain fungi besides beneficial and proven fertilizers such as *Acetobacter*, *Azospirillum* and *Phosphobacterium* were detected which have the beneficial effect especially in improving soil quality, growth and yield of crops (Xu and Xu., 2000 and Selvaraj *et al.*, 2007) [12, 9]. *Panchagavya*, an organic product is a potential source to play great role for promoting growth and providing immunity in plant system. Bio- chemical properties of *panchagavya* revealed that it possesses almost all the major nutrients like N, P, K and micro nutrients essential for plant and growth hormones like IAA and GA required for crop growth (Selvaraj *et al.*, 2007) [9]. The use of organic liquid such as *panchgavya* and *jivamrut* results in higher growth, yield, and quality of crops. Very little research work has been reported on combined effect of *panchagavya* and *jivamrut* on growth and yield of crops especially on groundnut under North Gujarat condition. Considering the above facts in view, an experiment was planned to study the effect of *Panchagavya* with *jivamrut* on growth and yield of *kharif* groundnut (*Arachis hypogaea* L).

Materials and Methods

A field experiment was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District Banaskantha (North Gujarat) during *kharif* seasons of 2011, 2012, 2014, 2015 and 2016 to study the effect of foliar application of *panchgavya* and *soil application of jivamrut* on growth and yield of *kharif* groundnut (*Arachis hypogaea* L) under North Gujarat condition. During crop growth period 1211, 1084, 915, 1084, 652 and 931 mm rainfall was received during 2011, 2012, 2014, 2015 and 2016, respectively. The experiment was vitiated during 2013 due to heavy infestation of white grub during initial growth period. The soil of experimental plot was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorous and high in available potash. The experiment was laid out in factorial randomized block design with three replications. The treatments comprised of Bn_1: *Panchgavya* (2 % foliar spray), Bn_2: *Panchgavya* (4 % foliar spray), Bn_3: *Panchgavya* (6 % foliar spray), Bn_4: *Jivamrut* (soil application @ 500 l/ha), Bn_5: *Panchgavya* (2 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha), Bn_6: *Panchgavya* (4 % foliar spray) + *Jivamrut* (soil application @ 500 l/ah), Bn_7: *Panchgavya* (6 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha), Bn_8: RDF (12.5-25-00 kg N-P-K/ha) and Bn_9: Control (application of 100% RDN through FYM). Bionutrients sources were applied S_1: at branching (25 DAS), S_2: at flowering (40-45 DAS) and S_3: both at branching + flowering stages. Hence, total 27 treatment combinations were tested in this experiment.

*Panchagavya s*olution was prepared by thorough mixing of fresh cow dung (7 kg), cow-ghee (1.0 kg), fresh cow urine (10 lit), cow milk (3 lit), cow curd (2 lit), jaggery (3.0 kg) and tender coconut water (3 lit). On the first day, 7 kg cow dung was thoroughly mixed with 1 kg cow ghee and kept for 72 hours followed by addition of 10 lit cow urine and 10 lit water. The mixture was stirred twice a day and allowed to ferment for 15 days. On the 19th day, 3 lit cow milk, 2 lit cow curd, 3 kg jaggery, 2 kg banana and 3 lit tender coconut water are added in the mixture and allowed to ferment for 7 days while stirring twice a day. The stock solution of *panchgavya* is ready for use after a period of 25 days. *Jivamrut* solution was prepared by thorough mixing of 100 lit water, 10 kg fresh cow dung, 10 lit cow urine, 2 kg jaggery, 2 kg pulse flour (cowpea) and 1 kg soil from rhizosphere area of banyan tree in barrel with the help of a wooden stick. The mixture was stirred twice (morning and evening) in a day in clock wise direction and allowed to ferment for 7 days. The *jivamrut* was ready for use after a period of 7 days.

A recommended dose of FYM @ 5 t/ha was applied uniformly in all the treatments before sowing of the crop. The experiment was conducted on fixed site. The groundnut, variety GG 2 was sown in rows at 45 cm apart using 120 kg seed/ha for 5 successive years. It was sown on 12th July, 4th July, 8th July, 26th June and 30th June and harvested on 11th November, 3rd November, 4th November, 25th October and 18th October during 2011, 2012, 2014, 2015 and 2016, respectively. The initially prepared and filtered solution of *panchgavya* was sprayed on the crop foliage as per treatments. Similarly, *jivamrut* was applied on the soil @ 500 lit/ha as per treatments. The *jivamrut* was sprinkled on the soil using bundle of neem branches during evening hours and optimum soil moisture was maintained at the time of its application. Biological and pod yield was computed from the plants harvested from net plot in each treatment. For uptake of nutrients, plant samples were collected after harvest of the crop and oven dried separately as kernals and haulm. After oven drying, these were grinded with the help of stainless steel blade mixture. The plant samples were analyzed for N, P and K content as per the standard methods. The concentration of element in kernel and haulm were used to calculate the uptake of nutrients by groundnut crop. The initial composite representative soil sample of surface layer from experimental field and treatment wise soil samples after harvest of the crop were collected by using the standard soil sampling procedure. These were air dried in shade and ground by using wooden mortar-pestle and sieved through 0.5 and 2 mm plastic sieve for further soil analysis. The 0.5 mm sieved soil for organic carbon analysis, 2 mm sieved soil samples were subjected to chemical analysis like, available, P_2O_5 and K_2O using standard methods. The population of *Rhizobium, Azospirillum* and *Azotobacter* (CFU x 10^4/g of soil) were calculated after harvest of the crop using standard procedure. Post sowing cultural operations and plant protection measures were taken as per recommendations. The test of significance of variation due to treatments of *panchgavya* and *jivamrut* and their stages of application were done using experimental data obtained for various treatment effects by SPSS software. The data of individual year's were subjected for pool analysis to obtain a trend among results over the years.

Results and Discussion

Effect on pod and haulm yield

The pooled data presented in Table 2 revealed that application of bionutrients (*panchgavya* and *jivamrut*) and time of application had significant effect on pod and haulm yield of groundnut. Foliar spray of *panchgavya* @ 4 % + soil application of *jivamrut* @ 500 l/ha (Bn_6) recorded significantly higher pod yield (1563 kg/ha) than rest of the treatments being at par with treatments Bn_0 (application of 100% RDN through FYM i.e. control) and Bn_5 (*Panchgavya* @ 2 % foliar spray + *jivamrut* @ 500 l/ha as soil application). Application of *panchgavya* and *jivamrut* at both the stages i.e. at branching + flowering (S_3) recorded significantly higher pod yield (1482 kg/ha) over single application either at branching stage or at flowering stage. However, latter two

treatments remained at par with each other. Similar results were also reported by Chaudhary *et al*. (2014) [2] in greengram at Sardarkrushinagar.

Similarly, foliar application of different concentrations of *panchgavya* along with *jivamrut* had recorded significantly higher haulm yield (3086 kg/ha) of groundnut with application of *panchgavya* @ 4 % as foliar spray + *jivamrut* @ 500 lit/ha as soil application (Bn_6) but was found at par with treatments Bn_0 (application of 100% RDN through FYM i.e. control), Bn_5 (*Panchgavya* @ 2 % foliar spray + *jivamrut* @ 500 lit/ha as soil application) and Bn_8 (RDF). However, time of application of bionutrient sources (*panchgavya* and *jivamrut*) did not exert significant effect on haulm yield.

Smaller quantities of IAA and GA present in *panchagavya* when foliar sprayed could have created stimuli in the plant system which in turn increased the production of growth regulator in cell system and the action of growth regulators in plant system stimulated the necessary growth and development, leading to better yield. Yadav and Lourduraj (2006) reported that higher yield of crops with *panchagavya* application due to enhancement in the biological efficiency of crop plants. Effects are more pronounced when combined application of *panchgavya* and *jivamrut* are done. The maximum improvement in pod and biological yield with bionutrient sources might be associated with increased yield attributes due to concomitant increase in dry matter accumulation and supply of all the plant nutrients (Kumawat *et al*., 2009) [6]. Shwetha (2008) [10] in soybean and Kumar *et al.* (2011) [5] in black gram who reported higher pods per plant, number of seed per pod and test weight with the use of *beejamrut*, *jivamrut* and *panchgavya* as organic source of nutrient.

Effect on N, P_2O_5 and K_2O uptake

N uptake by kernel and haulm

The nitrogen uptake by kernel and haulm of groundnut was influenced significantly due to bionutrients and stages of application (Table 2). However, N uptake by haulm due to application of bionutrients at different stages was non-significant. The maximum uptake of N by kernel (55.74 kg/ha) was recorded due to application of *Panchgavya* @ 6 % foliar spray + *Jivamrut* as soil application @ 500 l/ha. It also recorded significantly higher uptake of N by haulm (49.65 kg/ha) as compared to rest of the treatments except Bn_8, Bn_0, and Bn_1. Among the different stages of bionutrients application, use of bionutrients at different stages had significant effect on N uptake by kernel (Table 2). use of bionutrients at both the stages, i. e. at branching + flowering stage (S_3) registered significantly higher uptake of N by kernel as compared to single application either at branching or at flowering stage only.

The cow urine rich in uric acid, a source of nitrogen was readily soluble and liquid form, one of the important compounds in *panchagavya* and *jivamrut* which was readily available to the plants directly influencing the nitrogen content of leaves. *Panchagavya* eliminates the imbalances in physical, chemical and biological processes due to the cosmic energy produced by stirring of the stock solution

P_2O_5 uptake by kernel and haulm

The uptake of phosphorus by kernel and haulm was influenced significantly due to bionutrients and time of application except by haulm due to time of appliaction (Table 2). Significantly the highest uptake of P_2O_5 by kernel (5.29 kg/ha) as well as haulm (5.84 kg/ha) was recorded by foliar application of *panchgavya* @ 6 % + soil application of *jivamrut* @ 500 lit/ha, but both were at par with application of 100 % RDN through FYM (Bn_0). Similarly, application of bionutrients at both the stages i.e. at branching + flowering stage (S_3) noticed significantly the highest P_2O_5 uptake in kernel over application at single stage only.

K_2O uptake by kernel and haulm

The variation in K_2O uptake by kernel and haulm was significantly influenced due to application of bionutrients (Table 2). While K_2O uptake by haulm was found non significant due to stages of application. The maximum removal of K_2O by kernel (6.23 kg/ha) was noted under foliar spray of *panchgavya* @ 6 % + soil application of *jivamrut* @ 500 lit/ha but it was at par with foliar spray of *panchgavya* @ 2 %. However, application of 100 % RDN through FYM recorded significantly higher uptake of K_2O by haulm (21.68 kg/ha) over rest of the treatments except use of *panchgavya* @ 6 % as foliar spray + soil application of *jivamrut* @ 500 l/ha. An application of bionutrients at both the stages i. e. at branching + flowering stage (S_3) registered significantly the highest removal of K by kernel (21.68 kg/ha).

Nutrient accumulation in plants is a function of nutrient content and dry matter accumulation. The increase supply of plant nutrients with source of foliar application in plant available form might have increased the accumulation of dry matter concomitantly by affecting the ramification of roots favourably. The increase dry matter in above ground parts favours translocation of more carbohydrates towards developing roots. Increase allocation of food materials to roots in turn enhanced the root volume and there by concomitantly increase uptake of more plant nutrients (Poorter and Nagel 2000) [8]. Such remarkable effect on content and uptake of some nutrients was also observed by Sanjutha *et al.* (2008), Gore and Shreenivasa (2011) [3] and Tharmaraj *et al.* (2011) [5].

Effect on post-harvest soil chemical and biological properties

The data on impact of bio inoculants on the soil quality are presented in Table 3, 4 and 5.

Organic carbon content

The data presented in Table 3 indicated that organic carbon content in soil at harvest was significantly affected due to application of bionutrients. An application of 100 % RDN through FYM (Bn_0) recorded significantly the highest organic carbon content (0.29%) in soil at harvest. Organic carbon content ranged from 0.29 % in Bn_0 (100 % RDN through FYM) to 0.26 % in Bn_1 (*Panchgavya* @ 2 % foliar spray). Application of bionutrients at different stages did not exert any significant effect on organic carbon content in soil at harvest (Table 3). Bindumathi (2008) [1] reported small increase in O.C. content in soil after intervention due to soil application of organic growth promoters *viz. panchagavya*, *amritpani* and *baggasis.*

The interaction effect between Bn x S was found significant (Table 4). The treatment combination Bn_0S_2 (application of 100 % RDN through FYM at flowering stage) registered significantly the higher organic carbon content (0.34 %) in soil as compared to other treatment combinations.

Available P_2O_5

Significant effect of bionutrients on available P_2O_5 content in soil at harvest was recorded in pooled results (Table 3).

Amongst different treatments tested, an application of 100 % RDN through FYM (Bn_0) recorded significantly the highest available P_2O_5 (45.24 kg/ha) in soil over rest of the treatments. However, it remained on same bar with treatments Bn_6 and Bn_7. Application of bionutrients at different stages of crop growth had non-significant effect on available P_2O_5 content of soil in pooled data (Table 3).

The interaction between Bn x S was found non-significant on available P_2O_5 content in soil at harvest

Available K_2O

Application of bionutrients had significant effect on available K_2O content in soil at harvest in pooled result (Table 4). Amongst different treatments tested, an application of 100 % RDN through FYM (Bn_0) being at par with treatment receiving foliar spray of *Panchgavya* (6%) + soil application of *Jivamrut* @ 500 lit./ha (Bn_7) and foliar spray of *Panchgavya* (4%) + soil application of *Jivamrut* @ 500 lit./ha (Bn_6) gave significantly higher available K_2O content in soil over rest of the treatments (Table 3).

Available K_2O content in soil at harvest was significantly changed due to application of bionutrients at different stages of crop growth in pooled results. An application of bionutrients at both the stages (branching + flowering) being at par with application at flowering stage recorded significantly higher available K_2O content in soil as compared to application at branching stage only.

The interaction between Bn and S was also found significant in pooled results (Table 4). Treatment combination Bn_0S_1 (application of 100 % RDN through FYM at branching stage) recorded significantly the highest K_2O content in soil (249.68 kg/ha) over rest of the treatment combinations.

Table 1: Pod and haulm yields of groundnut as influenced by applicationof *panchagavya* and *jivamrut* at different growth stages (Pooled over 5 years)

Treatments	Yield (kg/ha)	
	Pod	Haulm
Panchgavya and *jivamrut* application (Bn)		
Bn_0: Control (application of 100% RDN through FYM)	1468	3006
Bn_1: *Panchgavya* (2 % foliar spray)	1282	2665
Bn_2: *Panchgavya* (4 % foliar spray)	1331	2721
Bn_3: *Panchgavya* (6 % foliar spray)	1275	2545
Bn_4: *Jivamrut* (soil application @ 500 l/ha)	1340	2709
Bn_5: *Panchgavya* (2 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	1468	2820
Bn_6: *Panchgavya* (4 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	1563	3086
Bn_7: *Panchgavya* (6 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	1342	2705
Bn_8: RDF (12.5-25-00 kg N-P-K/ha)	1414	2822
S.Em. ±	41.7	93.5
C.D. (P=0.05)	120.4	269.4
Stages of application (S)		
S_1: Branching	1356	2767
S_2: Flowering	1322	2702
S_3: Branching + Flowering	1482	2891
S.Em. ±	33.3	50.0
C.D. (P=0.05)	107.4	NS
Bn x S		
C.D. (P=0.05)	NS	NS
C.V.%	12.47	13.20

Table 2: Effect of bionutrients and stages of application on N, P_2O_5 and K_2O uptake by kernel and haulm of *kharif* groundnut (Pooled over 5 years)

Treatments	Uptake of nutrients (kg/ha)					
	N		P_2O_5		K_2O	
	Kernel	Haulm	Kernel	Haulm	Kernel	Haulm
Panchgavya and *jivamrut* application (Bn)						
Bn_0: Control (application of 100% RDN through FYM)	49.68	48.75	4.92	5.70	5.49	18.25
Bn_1: *Panchgavya* (2 % foliar spray)	50.16	45.92	4.14	4.78	5.86	21.05
Bn_2: *Panchgavya* (4 % foliar spray)	42.56	34.59	3.31	4.01	4.46	14.77
Bn_3: *Panchgavya* (6 % foliar spray)	44.71	37.90	3.84	4.50	4.81	16.27
Bn_4: *Jivamrut* (soil application @ 500 l/ha)	43.40	35.74	3.88	4.37	4.74	15.51
Bn_5: *Panchgavya* (2 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	45.67	37.10	4.29	4.93	4.81	16.02
Bn_6: *Panchgavya* (4 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	50.46	41.65	4.58	4.97	5.57	17.69
Bn_7: *Panchgavya* (6 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	55.74	49.65	5.29	5.84	6.23	21.68
Bn_8: RDF (12.5-25-00 kg N-P-K/ha)	46.39	45.33	4.47	5.20	5.28	19.01
S. Em. ±	1.68	1.69	0.17	0.18	0.21	0.88
C.D. (P=0.05)	4.83	4.87	0.50	0.52	0.60	2.52
Stages of application (S)						
S_1: Branching	46.43	41.55	4.21	4.90	5.07	17.56
S_2: Flowering	44.78	40.45	4.06	4.76	4.96	17.28
S_3: Branching + Flowering	51.71	43.54	4.64	5.11	5.72	18.57
S. Em. ±	1.22	0.80	0.11	0.09	0.14	0.33
C.D. (P=0.05)	3.98	NS	0.36	NS	0.45	NS
Bn x S						
S. Em. ±	2.26	2.21	0.20	0.27	0.25	0.93
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
C.V.%	14.60	13.94	18.32	15.16	15.86	14.19

Table 3: Effect of bio nutrients and stages of application on organic carbon content, available P_2O_5 and K_2O in soil after harvest of groundnut (Pooled over 5 years)

Treatments	Organic carbon (%)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Panchgavya and *jivamrut* application (Bn)			
Bn_0: Control (application of 100% RDN through FYM)	0.293	45.2	232.0
Bn_1: *Panchgavya* (2 % foliar spray)	0.256	42.5	224.7
Bn_2: *Panchgavya* (4 % foliar spray)	0.258	42.9	227.7
Bn_3: *Panchgavya* (6 % foliar spray)	0.259	42.8	228.5
Bn_4: *Jivamrut* (soil application @ 500 l/ha)	0.257	42.6	225.9
Bn_5: *Panchgavya* (2 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	0.261	42.1	227.3
Bn_6: *Panchgavya* (4 % foliar spray) + *Jivamrut* (soil application @ 500 l/ah)	0.278	43.5	229.5
Bn_7: *Panchgavya* (6 % foliar spray) + *Jivamrut* (soil application @ 500 l/ha)	0.268	43.9	231.3
Bn_8: RDF (12.5-25-00 kg N-P-K/ha)	0.269	42.8	227.3
S. Em. ±	0.004	0.65	0.98
C.D. (P=0.05)	0.011	1.81	2.72
Stages of application (S)			
S_1: Branching	0.264	43.5	226.6
S_2: Flowering	0.266	43.7	228.9
S_3: Branching + Flowering	0.270	44.0	229.3
S. Em. ±	0.003	0.38	0.57
C.D. (P=0.05)	NS	NS	1.57
Bn x S			
S. Em. ±	0.004	1.83	2.70
C.D. (P=0.05)	0.010	NS	7.62
C.V.%	5.46	9.99	2.87
Initial soil status (kg/ha)	0.221	39.6	221.1

Table 4: Effect of Bn x S interaction on organic carbon content (%) and available K_2O in soil after harvest of groundnut (Pooled over 5 years)

Treatments	Organic carbon content (%)			Available K_2O (kg/ha)		
	S_1	S_2	S_3	S_1	S_2	S_3
Bn_0	0.265	0.336	0.277	249.7	230.8	215.5
Bn_1	0.251	0.236	0.281	233.1	207.8	233.2
Bn_2	0.265	0.249	0.262	218.9	224.1	239.9
Bn_3	0.239	0.266	0.271	230.0	232.3	223.2
Bn_4	0.263	0.242	0.267	226.1	229.3	222.2
Bn_5	0.275	0.258	0.250	227.5	232.3	222.0
Bn_6	0.303	0.240	0.290	210.2	239.7	238.6
Bn_7	0.261	0.286	0.256	220.9	237.3	235.8
Bn_8	0.252	0.277	0.277	222.7	226.1	233.1
CD (P=0.05)	0.010			7.62		
CV (%)	5.46			2.87		

Table 5: Effect of different treatments on population of *Rhizobium*, *Azospirillum* and *Azotobacter* (CFU x 10^4/g of soil) in soil after harvest of groundnut (Mean data of 5 years)

Treatments	*Rhizobium*				*Azospirillum*				*Azotobacter*			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
Bn_0	187.8	197.2	223.2	202.7	126.0	134.4	153.2	137.9	283.2	297.2	346.2	308.9
Bn_1	93.0	104.8	124.2	107.3	82.8	87.2	108.4	92.8	171.6	183.2	231.2	195.3
Bn_2	125.0	133.8	158.6	139.1	101.0	108.6	130.0	113.2	223.2	236.0	268.2	242.5
Bn_3	120.4	132.0	150.8	134.4	94.2	101.4	126.2	107.3	217.2	228.2	262.8	236.1
Bn_4	134.0	144.2	166.8	148.3	109.2	117.6	133.0	119.9	247.6	262.8	314.2	274.9
Bn_5	146.0	162.4	180.4	162.9	116.4	125.0	141.8	127.7	260.4	275.4	324.0	286.6
Bn_6	215.4	234.2	265.4	238.3	135.2	145.6	170.0	150.3	295.6	322.6	365.8	328.0
Bn_7	139.4	146.4	173.4	153.1	108.4	117.0	138.2	121.2	249.6	266.6	320.8	279.0
Bn_8	111.0	117.2	141.4	123.2	88.4	93.2	119.6	100.4	212.6	222.2	255.4	230.1
Mean	141.3	152.5	176.0	156.6	106.8	114.4	135.6	119.0	240.1	254.9	298.7	264.6
Initial population	55				42				68			

Biological fertility of soil

The population of beneficial bacteria (*Rhizobium*, *Azospirillum*, and *Azotobacter*) was increased in all the treatments over its initial population.

The count for *Rhizobium*, *Azospirillum* and *Azotobacter* indicated that foliar spray of *panchagavya* @ 4% + *jivamrut* @500 l/ha as soil application showed maximum number of *Rhizobium*, *Azospirillum* and *Azotobacter* in soil of experimental plot of *kharif* groundnut followed by the treatment Bn_0 (100% RDN through FYM).

Among various stages of application, population of all three microbes was generally the highest when *panchgavya* was applied both at branching and flowering stages to the *kharif* groundnut as compared to application at individual stage only.

Least count of beneficial bacteria (*Rhizobium*, *Azospirillum* and *Azotobacter*) was observed with foliar spray *Panchgavya*

@ 2 % followed by application of 100 % RDF to *kharif* groundnut in mean data of 5 years. Data also showed that the population of *Azotobacter* was found maximum, followed by *Rhizobium* and *Azospirillum.*

Interaction of bionutrients and stages of application showed that the highest count of *Rhizobium*, *Azospirillum* and *Azotobacter* noted with application of *panchgavya* @ 4% as foliar spray + *jivamrut* @ 500 l/ha as soil application at branching and flowering stages (S_3Bn_6).

Effective microorganisms can improve soil quality, growth and yield of crops by synthesizing phytohormones such as auxins and other growth regulators that might have simulated the growth of plants (Xu, 2001) [13]. Presence of naturally occurring beneficial and effective microorganisms predominantly lactic acid bacteria, yeast, Actinomycetes, photosynthetic bacteria and certain fungi were improved with *Panchagavya* treatment. Tharmaraj *et al.* (2011) [5] revealed presence of beneficial micro-organisms from panchagavya spray. Kumar and Singaram (2011) [4] also reported that bacterial, fungal and actinomycetes count in soil were maximum under organic spray treatment in green chillies.

From the results of the experimentation, it is inferred that foliar application of 4% *panchgavya* alongwith soil application of *jivamrut* @ 500 l/ha at branching and flowering stages along with 5 t FYM/ha was found the most effective low cost technology for securing higher pod yield. The soil quality parameters such as the total microbial count and the residual fertility of soil such as available P, K and OC (organic carbon) and total count of viable bacteria in the soils are remarkably enhanced. Therefore, it can be recommended as an alternate source of nutrients under organic farming for cultivation of *kharif* groundnut.

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