



UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE

Research Institute on Organic Farming, GKV

ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾಲಯ ಬೆಂಗಳೂರು

ಸಾವಯವ ಕೃಷಿ ಸಂಶೋಧನಾ ಸಂಸ್ಥೆ, ಬೆಂಗಳೂರು



**TESTING REPORT
ON
FIBSOL FCM & GEL PRODUCTS
IN GROUNDNUT & TOMATO**



Submitted to

**Director of Research
UAS, GKV, Bengaluru**

Submitted by

Coordinator, RIOF, GKV

**RESEARCH INSTITUTE ON ORGANIC FARMING
UAS, GKV, BENGALURU -560065**



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FIBSOL FCM & GEL TESTING IN GROUNDNUT CROP



Introduction

Groundnut (*Arachis hypogaea* L.) belongs to family *Leguminosae* is an important oilseed crop of India, popularly known as peanut, monkey-nut and locally called as nelagadale/shenga. Their ability to use atmospheric nitrogen through biological nitrogen fixation (BNF) is economically sound and environmentally acceptable. Ground nut is the 4th most important edible oil source crop in world and ranks 13th among the food crops (Ramanathan, 2001). It is mainly grown in *kharif* season as rainfed crop. Also summer crop can be taken under protective irrigation, where irrigation source/facility is available. Globally, 50 per cent of groundnut produce is used for oil extraction, 38 per cent for confectionary use and 12 per cent for seed purpose. In India, 80 per cent of the total produce is used for oil extraction, 11 percent as seed, 8 per cent as direct food and only 1 per cent produce is exported.

There are many factors which influence the growth and yield of crops. Among them, Nutrient is important factor decide the quantity and quality of vegetable crops (Chang *et al.*, 2010). Nutrient can be meet out from both inorganic and organic sources for the crop requirement. At present instance, Frequent and huge usage of inorganic fertilizer have been associated with some environmental pollution, alteration in soil textures and physical property of the soil. Moreover, the nutritional value of the crops will be affected seriously by the continuous use of synthetic fertilizer and also increases in the cost of crop production (Shimbo *et al.*, 2000). Hence, current globe demands eco-friendly and cost-effective agricultural practices for sustainable food production. This sustainable agricultural practices are coincides with organic farming which is invariably ancient agricultural practices and gives major emphasis on maintenance of soil fertility for sustainable yield. Organic farming helps to improve the physical, chemical and biological properties of soil as well as maintain the balance in environment through holistic approach and supports living system for future generation. This sustainable practice gaining importance across the world because of its socio-economical viability and preservation of natural resources and biodiversity. Application of organic manure

Among the various factors affecting the growth and yield of crops, nutrient management plays a vital role. In crop production, chemical fertilizers are the major source of nutrients, but escalating cost, coupled with increasing demand of chemical fertilizers and depleting soil health necessitates the safe and efficient use of organics in crop production. It helps to enhance and maintain soil organic carbon status for sustained crop yield. India is endowed with enormous potential of biological resources and industrial byproducts.

Organic matter has an overwhelming effect on almost all soil properties. Organic matter, a most precious component, is also considered as storehouse of many nutrients. For mineralization of organic matter, soil fauna and microorganisms are indispensable. Soil harbors a dynamic microbial population, arthropods and others (soil biota). The living phase of soil is greatly stimulated by organic manure addition which serves as a food (carbon) and energy source for soil life. Both soil and enzyme systems are associated with organic manure management which carries out a wide range of processes that are important for soil health and fertility. (Ramesh, 2007).

Biofertilizers hold promise in improving the productivity of groundnut in a sustainable way. To improve the soil health, and for better transformation and mobilization of nutrients in soil, application of highly competitive strains of groundnut rhizobia, plant growth promoting rhizobacteria and other beneficial microbes is very crucial to enhance groundnut productivity. Thus, application of highly competitive and efficiently nitrogen fixing strains of groundnut rhizobia would help in enhancing the biological nitrogen fixation vis-à-vis groundnut yield. The soils of groundnut growing areas are very often affected by acidity or alkalinity coupled with deficiency in available P, Fe, Zn, Mo, and other micronutrients. Therefore, with the application of phosphate solubilizing microorganisms, plant growth promoting rhizobacteria and other beneficial bacteria having multiple plant growth promoting traits, transformation and availability of P, Fe, Zn, Mo and other micronutrients can be improved substantially. (Annon, 2014)

In the view of above importance of the biofertilizers in crop production and as a low cost input are being extensively used by the organic farmers. Apart from these many commercial biofertilizers are also available in the market. FIB-SOL life technologies products viz Fibsol FCM & Fibsol gel biofertilizers is used for better growth and yield of crops. The product is used as pre planting seed treatment, seedling treatment, soil drenching and foliar spray product. In order to test the efficacy of FIBSOL products with other popular

bio-fertilizers and as well as chemical and organic fertilizers wanted to test their product with the following objectives;

Objectives:

1. To evaluate the effect of **FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo** and **FIB-SOL GEL NPK combo** growth parameters of Groundnut crop
2. To evaluate the effect of **FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo** and **FIB-SOL GEL NPK combo** on yield of Groundnut crop under field condition

Review of literature

The studies on organic cultivation of groundnut showed that groundnut can be organically produced, provided adequate phosphorus is applied as phosphocompost. The highest yield of groundnut obtained with combination of phosphocompost, poultry manure, neem cake and vermicompost. 100% RDF were at par with all the treatments receiving 2 or more than 2 sources of organic manure in respect of pod yield and produced significantly more pods than control. (Parthasarathi patra and Ashim Chandra sinha, 2012)

Anon, 2014 reported that Inoculation with NC92 rhizobium strain increased yield of the cultivar 'JL 24' at Junagadh in Gujarat. Two identified strains of *Bradyrhizobium*, IGR 6 and IGR 40 increased the groundnut yield by 11%. In Tamil Nadu, a strain of *Rhizobium* (TNAU 14) and another of *Bradyrhizobium* (T19) are used for commercial manufacture of inoculants. Inoculating the soil with a suspension of peat containing rhizobia in water has been found successful.

In so far as the quantum of fertilizer savings due to inoculation is concerned, a field trial by All India Co-ordinated Research Project on Biological Nitrogen Fixation (AICRP-BNF) at Coimbatore showed that inoculation of rhizobia along with *Pseudomonas* PS 2 at 100% N and P gave maximum pod yield and substituted for 25% N and P. (Anon, 2014)

The highest number of pods, number of seeds, weight of pods, weight of the seeds, and weight of 100 seeds were recorded in the combined application of Biofertilizer T4-(*Rhizobium leguminosarum* and *Bacillus megaterium*) than in single application i.e., only (*Rhizobium leguminosarum*). (Mahakavi et. al. 2014)

Devakumar *et al.* (2016) reported that application of N equivalent compost with beejamruta and jeevamruta resulted in increasing the yield of organic field bean compared to individual application of different N equivalent compost and beejamruta.

The results of experiment revealed that various growth characters like, plant height, number of functional leaves etc., yield and yield attributing characters viz., dry pod weight per plant etc. and quality attributes like oil content, oil yield etc. was recorded significantly highest with application of 37.5:75:0 kg NPK ha⁻¹ over other levels of inorganic fertilizers. Regarding all economic parameters of groundnut; application of 37.5:75:0 kg NPK ha⁻¹ was recorded highest, exceptionally the maximum benefit: cost ratio was obtained with 25:50:0 kg NPK ha⁻¹ compared to other levels of fertilizers. Dual seed inoculation of *Rhizobium* spp. + PSB gave significantly maximum growth, yield and yield attributes, quality and economic values of groundnut over individual inoculation of *Rhizobium* spp. and PSB treatments. (Patil, S.R.,2012).

Sheela Sharma, (2012) reported that application *Rhizobium*, PSB, and VAM biofertilizers significantly increased the growth and yield parameters in groundnut crop.

Zalate and Padmani, (2009) reported that Seed inoculation with biofertilizers (*Rhizobium*+PSM) significantly increased the plant height, nodules per plant, yield attributing characters and yield of groundnut. Manuring the crop with FYM 6 t/ha+*Rhizobium*+PSM gave significantly 40.19 and 35.96 per cent higher pod and haulm yields of groundnut, respectively over no manuring. Fertilizing the crop with vermicompost 2.0 t/ha+*Rhizobium*+PSM and FYM 3.0 t/ ha+*Rhizobium*+PSM found equally effective and significantly superior to control in respect to growth parameters, yield attributes and yield of groundnut.

Bekele *et al.* (2009) reported higher pod yield obtained from combined application of 46:46 kg N: P₂O₅ ha⁻¹ and 2.5 t vermicompost ha⁻¹ exceeded the pod yield produced from nil application of fertilizers by about 100%.

The application of 25 kg N+ 50 kg P-2O₅ + 40 kg K₂O ha⁻¹ along with *Rhizobium*, VAM and PSB recorded significantly higher available nitrogen 164.1 kg ha⁻¹ and available phosphorus 26.6 kg ha⁻¹ whereas minimum were noted with the application of RDF- NPK alone. However, this treatment also provided significantly higher NPK uptake by the crop and crop yields (pod, kernel and haulm) over rest of the treatments. The minimum yields

were noted with the application of alone RDF, poultry manure, vermicompost and their mixture (Choudhary, et al., 2011)

MATERIAL AND METHODS:

A field experiment entitled **“Effect of FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo and FIB-SOL GEL NPK combo on growth and yield of Groundnut(*Arachis hypogaea* L.)”** was conducted at organic farming block of Research Institute on Organic Farming (RIOF), University of Agricultural Sciences, GKVK, Bengaluru-65 during *kharif* 2019 and summer 2020.

General description

Location of the experimental site

The experiment was conducted at organic farming block of Research Institute on organic farming, GKVK, University of Agricultural Sciences, Bengaluru which is situated at eastern dry zone of Karnataka at a latitude of 12° 58" North, longitude of 75° 35" East and at an altitude of 930 m above the mean sea level.

Soil Characteristics of experimental site

Before layout of the experiment, composite soil samples were drawn from the experimental plot by core sampler method from upper 0-15 cm soil layer and soil was analyzed for chemical properties viz., pH, EC, Organic carbon, Available nitrogen, phosphorus and potassium. Biological properties viz., general soil bacteria, fungi, actinomycetes, P-solubilizer, N-fixing bacteria,

Soil of experimental plot was red sandy loam, grouped under the class of *alfisols*. Soil pH was near to neutral (6.7) with an electrical conductivity of 0.22 dS m⁻¹, soil organic carbon content was medium (0.45 %) and medium in available nitrogen (340 kg ha⁻¹) phosphorus (40.5 kg ha⁻¹) and potassium (239 kg ha⁻¹). The soil biological properties has bacteria 11 (No.10⁵ x CFU/g soil), fungi 6.6 (No.10⁴ x CFU/g soil), actinomycetes 7.0 (No.10³ x CFU/g soil), N-fixers 3.0(No.10⁵ x CFU/g soil), P-solubilizers 4.5 (No.10⁵ x CFU/g soil) in organic block.

Experimental details

Location: Research institute on organic farming (RIOF) field, UAS, GKVK, Bengaluru

Season: Kharif 2019 (under protective irrigation through drip)

Crop: Groundnut

Variety: GKVK-5

Spacing: 30 cm x 10 cm

Gross plot size: 4.5 m × 3.5 m

Net plot size: 3.9 m x 3.3 m

No. of Treatments- 09

Replications-3

Design: Randomized complete block design

Source of Nutrients

FIBSOL PRODUCTS TESTED

1. FIBSOL FCM (Fertilizer carrying membrane)- N-FIB, P-FIB, K-FIB
2. FIB-SOL GEL : N-GEL, P-GEL AND K-GEL
Both the above mentioned products are given in split dosage: one as seed treatment and 2nd dosage at pod formation.
3. Organic manures viz., FYM on N equivalent basis and Vermicompost, biodigester liquid manure and Panchagavya as liquid organic manures in organic production of groundnut
4. Integrated organic pest management was followed to control pests and diseases.

Date of Planting: July 2019 – Kharif season

Treatment details

Treatments		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

Agronomy Practices

- Land was tilled with hand operated power tiller followed by harrowing to remove weeds and to crush the clods and brought to fine tilth.
- Basal Farm yard manure was applied @7.5 t ha⁻¹ to plots three weeks before sowing and incorporated into the soil. It is common for all the treatments except control.
- The entire quantity of recommended dose of nitrogen (25 kg N ha⁻¹) was applied through FYM on N equivalent basis according to the treatments in organic production of groundnut followed by application of liquid organic manures. Viz., jeevamrutha and panchagayva. Gypsum was applied in both organic production and inorganic production.
- FIB-SOL FCM (Fertilizer carrying Membrane) & FIB-SOL Gel NPK combo at sowing and flowering stage in two dosages were applied according to the treatments. FCM was dissolved in water of required quantity and then the seeds are soaked for few minutes and sown in treatments which received FCM, Whereas Gel was first dissolved in water and then this solution is added to fine compost & mixed. Later added to the furrows and the seeds were sown.
- Recommended dose of fertilizers (25:50: 25 kg/ha NPK) were applied for groundnut, apart use of FIBSOL products in POP treatment.
- Seed treatment according to the treatments were done and the seeds were line sown at a row spacing of 30 cm, later thinning is carried out at distance of 10 cm between plant to plant. Seed treatment for FIBSOL products were carried out as per the protocol of FIBSOL.
- Gap filling was carried out at 12 to 15 days after sowing and optimum plant population was maintained.
- Earthing up : Important inter-cultivation i.e., Earthing up operation was carried out at flower formation or before the peg formation (@ 30 days) after sowing to sustain the pegs for easy penetration into soil, provide the aeration and control weeds during later stage of crop growth.

- Water management - Since the crop is raised during Kharif season under rainfed situation, protective irrigation is provided by drip irrigation during critical stages.
- Weeding- Weeds are removed at 20 and 40 days after sowing by hand weeding & by passing cycle weeder.

Plant protection

Time to time spraying of botanical extracts, neem oil, trichoderma at regular intervals were carried out and no major outbreak of any pest and diseases incidence was noticed during the experimentation

Harvesting

The pods at maturity were harvested by digging the plots, first border row plants are harvested and later net plot rows are harvested separately. The weight of harvested fruits is recorded separately as net and gross plot yield in kg and then converted into ton ha⁻¹

Results: GROUND NUT -2019 (Kharif)

Growth parameters:

Growth parameters viz; germination percentage, plant height, number of branches, no of leaves (paripinnate leaves per plant) and days to 50 % flowering were recorded and presented in the Table 1 & 2.: Fig 1 & 2

- It was recorded that germination percent, plant height, no of branches per plant, no of leaves per plant has increased were package of practice with FIBSOL Gel formulation T₆ was used and was on par with POP + FIBSOL FCM T₅ as compared to control (T₁).
- Among different combinations of Fibsol FCM & GEL under organic production of groundnut during Kharif season 2019, Higher growth parameters were observed in the treatments of Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (Fibsol FCM) & T₃ (Fibsol Gel).

- Significantly Higher number of nodules were recorded in Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control).
- The treatments T₂ & T₃ i.e., were FIBSOL FCM & FIBSOL GEL only are used also recorded higher number of nodules.
- Significantly Higher number of nodules were recorded in Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control).
- It was recorded that number of pods per plant has increased significantly were package of practice with FIBSOL Gel formulation T₆ was followed and was on par with POP + FIBSOL FCM T₅ as compared to control (T₁).
- Higher number of pods per plant were observed in the treatments of Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (Fibsol FCM) & T₃ (Fibsol Gel).

Yield parameters:

Yield parameters viz: pod, kernel yield per ha and test weight (100 no. kernel) were recorded and presented in the Table 3 & Fig 3.

- Higher pod yield was obtained in the treatment were package of practice with FIBSOL Gel formulation T₆(25.80 q/ha) was used and was on par with POP + FIBSOL FCM T₅ (25.26 q/ha) as compared to control (T₁) (10.24 q/ha).
- Among different combinations of Fibsol FCM & GEL under organic production of groundnut during Kharif season 2019, Organic production systems, T₈(24.16 q/ha) & T₉(24.68) were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL recorded higher pod yield over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (only Fibsol FCM) & T₃ (only Fibsol Gel). However, T₈ & T₉ were found to be on par.
- Similarly, Significant Higher kernel yield/ha and kernel test weight (g) were recorded in Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control).

Soil chemical proprieties after harvest

Chemical properties of soil viz., soil pH, electrical conductivity and organic carbon of soil & soil available nutrients (NPK kg/ha) at harvest of the groundnut as influenced by FIBSOL products tested in organic as well as inorganic production system is presented in (Table 4). However no significant difference in these proprieties is noticed, but wherever FIBSOL products are used, higher values were observed.

Biological parameters:

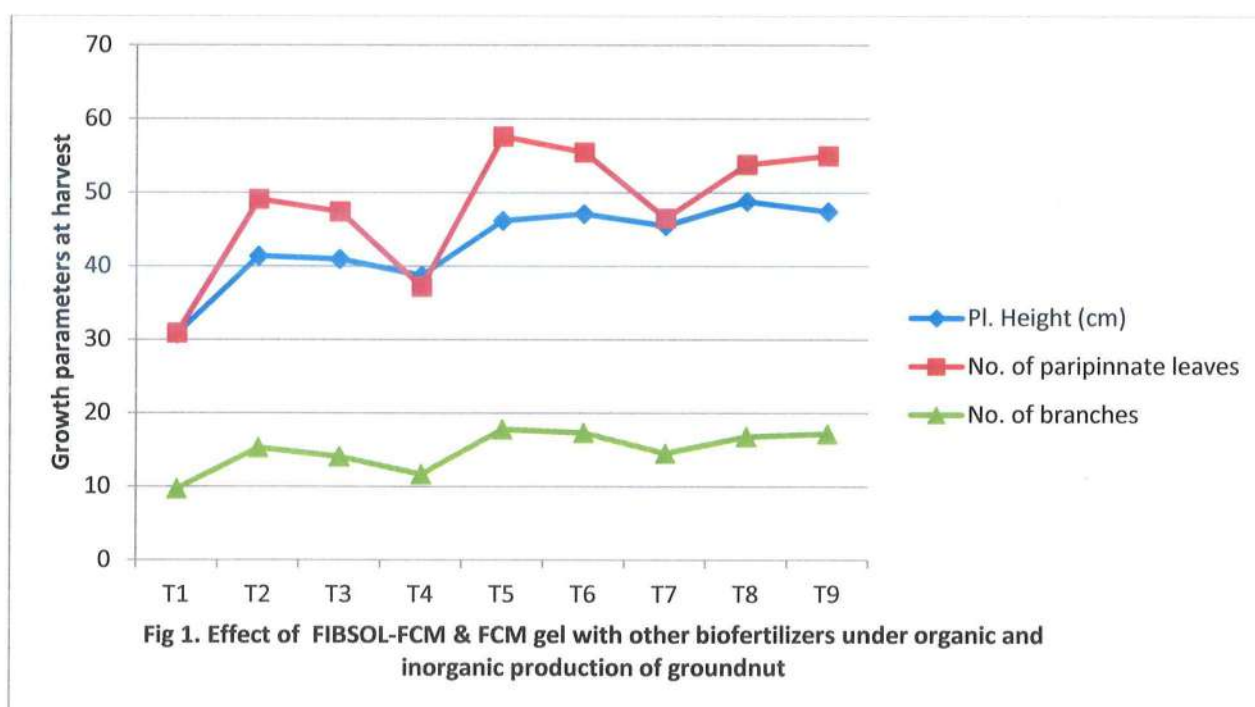
Microbial population of soil after harvest of groundnut crop, higher population were observed in FIBSOL products used treatments as compared to T₁- control, T₅ – POP + FCM, T₆- POP + Gel.(Table 5). This clearly shows that in organic production system along with use of FIBSOL FCM and FIBSOL gel, favorable microbial population development can be observed due to available of more carbon source in form of organic manures, liquid organic manures, mulching etc., Organic carbon from manures provides the energy source for the active, healthy soil microbial environment that both stabilizes nutrient sources and make those nutrients available to crops. (Gangadhar, 2019).

Economics of groundnut *Kharif*-2019

The per hectare cost of cultivation, gross returns, net returns and benefit: cost ratio was worked for groundnut cultivation (*Kharif*-2019) under different production methods is represented in Table 6. The cost of cultivation was highest under organic practice with FIBSOL FCM (Rs. 33320) followed by package of practices in combination with FIBSOL FCM(Rs. 33150), organic practice with FIBSOL Gel (Rs.31820) and package of practices in combination with FIBSOL Gel(Rs. 31650).The highest net returns was recorded in package of practices in combination with FIBSOL Gel (Rs. 97350) followed by package of practices in combination with FIBSOL FCM (Rs. 93150), organic practice with FIBSOL Gel(Rs. 81580) and organic practice with FIBSOL FCM(Rs. 77630) with high benefit: cost ratios of 4.08, 3.81, 3.56 and 3.33, respectively. Similar trend was also observed in the case of lowest cost per quintal of groundnut production.

Table 1: Growth parameters as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Plant Height (cm)			No. of Leaves (paripinnate)/plant			No. of Branches		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T ₁	9.98	25.70	30.77	13.80	25.70	30.9	4.32	7.40	9.67
T ₂	12.10	33.23	41.37	25.00	33.23	49.10	7.80	13.20	15.33
T ₃	12.15	33.26	40.96	26.20	33.26	47.40	7.80	12.15	14.12
T ₄	11.91	32.30	38.70	21.20	32.30	37.20	6.67	10.50	11.68
T ₅	14.00	36.23	47.20	32.10	36.23	55.60	9.91	16.10	17.34
T ₆	14.25	36.54	48.11	32.60	36.54	57.50	10.17	16.70	17.80
T ₇	13.74	35.27	45.50	27.50	35.27	52.50	8.60	14.30	14.53
T ₈	14.19	36.33	48.80	28.50	36.33	53.80	8.91	15.90	16.80
T ₉	14.08	36.27	47.40	28.30	36.27	55.00	8.75	16.30	17.20
SE.m+	0.56	1.23	1.61	1.37	1.23	2.37	0.55	0.89	0.93
C.D @ 5 %	1.67	3.70	4.84	4.11	3.70	7.11	1.64	2.67	2.78

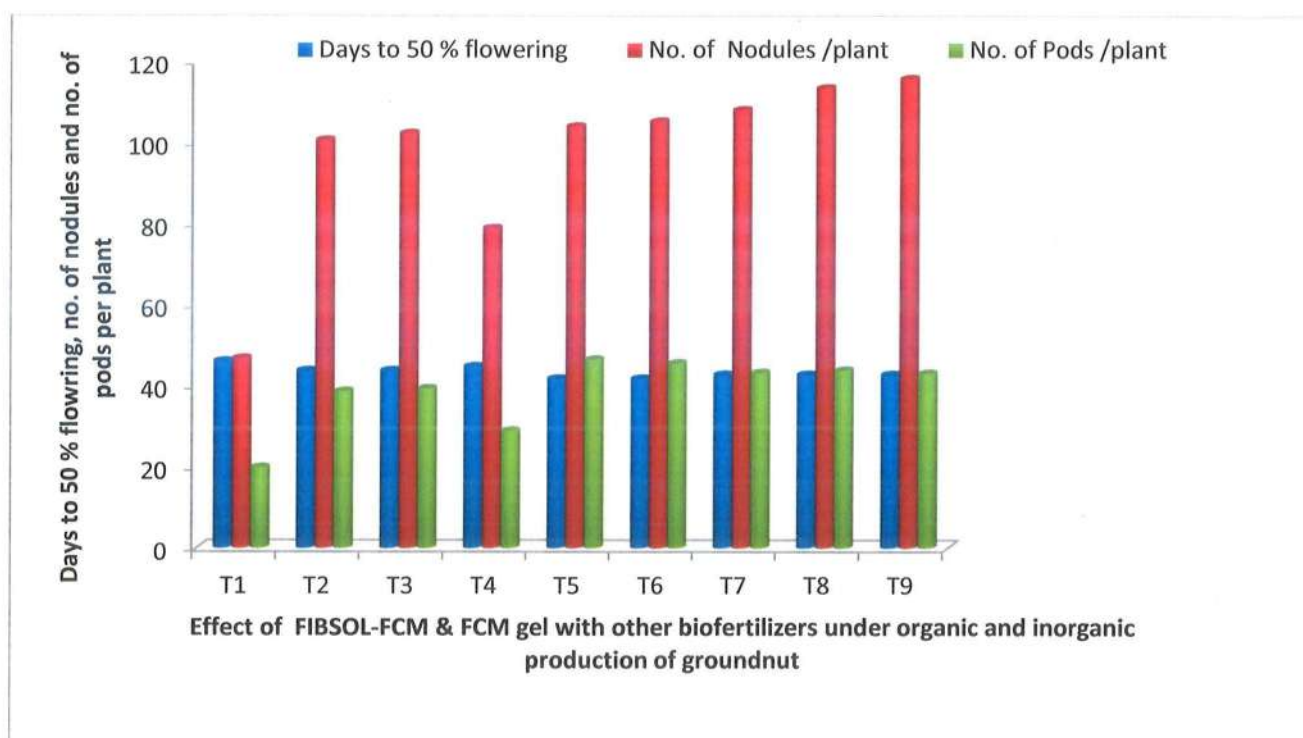


Legend		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP* + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

*Package of practices for groundnut

Table 2: Days to 50 % flowering, no o nodules/plant and no. of pods/plant as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Days to 50 % flowering	No. of Nodules /plant	No. of Pods /plant
T ₁	46.3	47.00	20.13
T ₂	44.00	100.67	34.93
T ₃	44.00	102.33	35.60
T ₄	45.00	79.00	29.20
T ₅	42.00	104.00	46.73
T ₆	42.00	105.23	45.80
T ₇	43.00	108.00	40.47
T ₈	43.00	113.40	43.33
T ₉	43.00	115.70	44.07
SE.m±	0.41	2.06	2.08
C.D @ 5 %	1.20	6.17	6.25



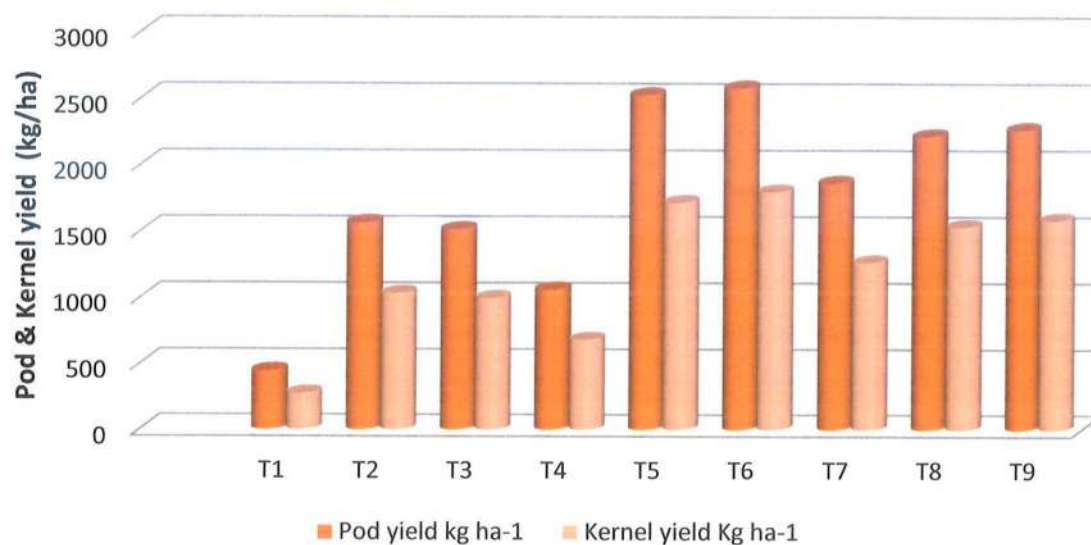
Legend		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP* + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

*Package of practices for groundnut

Table 3: Pod yield/ha, kernel yield/ha and 100 kernel test weight (g) as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Pod yield kg ha ⁻¹	Kernel yield Kg ha ⁻¹	Test weight 100 Kernel (g)
T ₁	448.00	277.00	31.60
T ₂	1567.00	1034.00	40.00
T ₃	1515.00	1000.00	39.70
T ₄	1063.00	686.40	35.00
T ₅	2526.67	1718.07	43.73
T ₆	2580.00	1801.33	45.00
T ₇	1867.00	1269.10	42.00
T ₈	2218.67	1536.50	43.70
T ₉	2268.00	1587.00	45.00
SE.m _±	109.00	100.10	1.08
C.D @ 5 %	326.79	300.11	3.25

Fig. 3. Effect of FIBSOL-FCM & FCM gel with other biofertilizers under organic and inorganic production of groundnut



Legend		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP* + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

*Package of practices for groundnut

Table 4: Soil chemical properties & Soil available nutrients as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	pH	Ec (ds/m ²)	OC (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T ₁	4.88	0.20	0.40	202.50	11.90	101.00
T ₂	5.00	0.30	0.43	238.4	13.52	135.70
T ₃	5.00	0.30	0.43	239.3	13.60	138.20
T ₄	4.80	0.26	0.41	220.4	12.30	128.00
T ₅	4.90	0.26	0.40	250.5	14.20	151.50
T ₆	4.80	0.26	0.40	260.9	15.30	152.30
T ₇	5.10	0.30	0.44	242.0	17.30	140.20
T ₈	5.00	0.30	0.43	242.0	18.10	143.30
T ₉	5.00	0.30	0.44	243.0	18.60	145.30
SE.m±	0.131	0.003	0.005	13.14	0.83	2.20
C.D @ 5 %	NS	NS	NS	39.05	NS	NS

Table 5: Soil Microbial population as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	Bacteria (No. x 10 ⁵ CFU/g of soil)	Fungi (No. x 10 ⁴ CFU/g of soil)	Actinomycetes (No. x 10 ³ CFU/g of soil)
T ₁	24.70	10.55	14.90
T ₂	30.00	12.60	17.00
T ₃	30.00	13.20	17.93
T ₄	29.80	11.93	16.15
T ₅	26.17	10.70	14.30
T ₆	27.70	10.50	14.90
T ₇	33.00	16.25	18.20
T ₈	35.67	18.25	18.90
T ₉	38.30	19.33	20.60
F-test	*	*	*
SE.m±	2.41	0.836	1.145
C.D @ 5 %	7.85	2.48	3.40

Legend		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP* + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

Economics

Table 6. Economics of Groundnut Kharif 2019

Sl. No.	Particulars	T1	T2	T3	T4	T5	T6	T7	T8	T9
I	Variable cost (Rs.)	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost
1	Land preparation	2400	2400	2400	2400	2400	2400	2400	2400	2400
2	Seeds and sowing	2500	2500	2500	2500	2500	2500	2500	2500	2500
3	FYM	0	8000	8000	8000	8000	8000	11670	11670	11670
4	Weeding and irrigation	3000	3000	3000	3000	3000	3000	3000	3000	3000
5	Plant protection	750	750	750	750	1250	1250	750	750	750
6	Earthing up	1500	1500	1500	1500	1500	1500	1500	1500	1500
7	Fertilizer	0	7500	6000	600	10500	9000	1500	7500	6000
8	Gypsum	0	1500	1500	1500	1500	1500	1500	1500	1500
9	Harvesting and threshing	2500	2500	2500	2500	2500	2500	2500	2500	2500
	Total cost	12650	29650	28150	22750	33150	31650	28820	33320	31820
II	Returns									
1	Main product quantity (qtl)	4.48	15.67	15.15	10.63	25.26	25.8	18.67	22.19	22.68
2	Gross returns (Rs.)	22400	78350	75750	53150	126300	129000	93350	110950	113400
3	Net returns (Rs.)	9750	48700	47600	30400	93150	97350	64530	77630	81580
4	Cost of production (Rs./qtl)	2824	1892	1858	2140	1312	1227	1544	1502	1403
5	BCR	1.77	2.64	2.69	2.34	3.81	4.08	3.24	3.33	3.56

Legend	
T ₁	: Control
T ₂	: FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	: FIB-SOL GEL NPK combo
T ₄	: Commercial bio-fertilizer (reputed company) NPK combo
T ₅	: POP* + FIBSOL FCM
T ₆	: POP + FIBSOL GEL
T ₇	: GKVK Organic practice
T ₈	: GKVK Organic practice + FIBSOL FCM
T ₉	: GKVK Organic practice + FIBSOL GEL

INFERENCE

- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers can be used for improving growth & yield in organic groundnut production as well as in conventional farming.
- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers performs better when application of FYM/Vermicompost/Compost on N equivalent basis is applied along with the above products. This can be observed where only FIBSOL FCM & FIBSOL gel is applied in void of organic manures to the crop where 30 per cent yield is reduced as compared to supplementation of organic manures along with fib sol products.
- For sustenance of NPK microbial population in the soil and support the crop growth, organic manures play a key role.
- Plant remains more greener even during later stages *ie.*, harvesting compared to control.
- Soil Microbial load has been improved in organic production system and where FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers was used.
- FCM & GEL bio-fertilizers are more effective in combination of organic manures
- By utility, GEL formulation is easy to use in crop production.
- B:C ratio worked is found better in GEL bio-fertilizers.

Groundnut -2020 (summer)

Experimental details

Location: Research institute on organic farming (RIOF) field, UAS, GKVK, Bengaluru

Season: Summer 2020 (under drip irrigation)

Crop: Groundnut

Variety: GKVK-5

Spacing: 30 cm x 10 cm

Gross plot size: 4.5 m × 3.5 m

Net plot size: 3.9 m x 3.3 m

No. of Treatments- 09

Replications-3

Design: Randomized complete block design

Source of Nutrients

FIBSOL PRODUCTS TESTED

1. FIBSOL FCM (Fertilizer carrying membrane)- N-FIB, P-FIB, K-FIB
2. FIB-SOL GEL : N-GEL, P-GEL AND K-GEL
Both the above mentioned products are given in split dosage: one as seed treatment and 2nd dosage at pod formation.
3. Organic manures viz., FYM on N equivalent basis and Vermicompost, biodigester liquid manure and Panchagavya as liquid organic manures in organic production of groundnut
4. Integrated organic pest management was followed to control pests and diseases.

Treatment details

Treatments		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

Agronomy Practices

- Land was dugged manually followed by harrowing to remove weeds and to crush the clods and brought to fine tilth.
- Basal Farm yard manure was applied @ 7.5 t ha⁻¹ to plots three weeks before sowing and incorporated into the soil. It is common for all the treatments except control.
- The entire quantity of recommended dose of nitrogen (25 kg N ha⁻¹) was applied through FYM on N equivalent basis according to the treatments in organic production of groundnut followed by application of liquid organic manures. Viz., jeevamrutha and panchagayva. Gypsum was applied in both organic production and inorganic production.
- FIB-SOL FCM (Fertilizer carrying Membrane) & FIB-SOL Gel NPKcombo at sowing and flowering stage in two dosages were applied according to the treatments. FCM was dissolved in water of required quantity and then the seeds are soaked for few minutes and sown in treatments which received FCM, Whereas Gel was mixed with fine compost and then added to the furrows and the seeds were sown in treatments which received GEL
- Recommended dose of fertilizers (25:50: 25 kg/ha NPK) were applied for groundnut, apart use of FIBSOL products.
- Seed treatment according to the treatments were made and the seeds were line sown at a row spacing of 30 cm, later thinning is carried out at distance of 10 cm between plant to plant. Seed treatment for FIBSOL products were carried out as per the protocol of FIBSOL.
- Gap filling was carried out at 12 to 15 days after sowing and optimum plant population was maintained.
- Earthing up : Important inter-cultivation i.e., Earthing up operation was carried out at flower formation or before the peg formation (@ 30 days) after sowing to sustain the pegs for easy penetration into soil, provide the aeration and control weeds during later stage of crop growth.

- Water management - Since the crop is raised during Summer season situation, irrigation is provided by drip irrigation throughout the crop growth.
- Weeding- Weeds are removed at 20 and 40 days after transplanting manually & by passing cycle weeder.

Plant protection

Time to time spraying of botanical extracts, neem oil, trichoderma at regular intervals were carried out and no major outbreak of any pest and diseases incidence was noticed during the experimentation

Harvesting

The pods at maturity were harvested by digging the plots, first border row plants are harvested and later net plot rows are harvested separately. The weight of harvested fruits is recorded separately as net and gross plot yield in kg and then converted into ton ha⁻¹

Results: GROUND NUT -2020 (Summer season)

Growth parameters:

Growth parameters viz; germination percentage, plant height, number of branches, no of leaves (paripinnate leaves per plant) and days to 50 % flowering were recorded and presented in the Table 7 & 8.:

It was recorded that germination percent, plant height, no of branches per plant, no of leaves per plant has increased were package of practice with FIBSOL Gel formulation T₆ was used and was on par with POP + FIBSOL FCM T₅ as compared to control (T₁).

- Among different combinations of Fibsol FCM & GEL under organic production of groundnut during Summer season 2020, Higher growth parameters were observed in the treatments of Organic production systems, T₈& T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (Fibsol FCM) & T₃ (Fibsol Gel).

- Significantly Higher number of nodules were recorded in Organic production systems, T₈& T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control).
- The treatments T₂ & T₃ i.e., were FIBSOL FCM & FIBSOL GEL only are used also recorded higher number of nodules.
- Significantly Higher number of nodules were recorded in Organic production systems, T₈& T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control).
- It was recorded that number of pods per plant has increased significantly were package of practice with FIBSOL Gel formulation T₆ was followed and was on par with POP + FIBSOL FCM T₅ as compared to control (T₁).
- Higher number of pods per plant were observed in the treatments of Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (Fibsol FCM) & T₃ (Fibsol Gel).

Yield parameters:

Yield parameters *viz*; pod, kernel yield per ha and test weight (100 no. kernel) were recorded and presented in the Table 9 & Fig 4.

- Higher pod yield was obtained in the treatment were package of practice with FIBSOL Gel formulation T₆ (27.36 q/ha) was used and was on par with POP + FIBSOL FCM T₅ (27.68 q/ha) as compared to control (T₁) (5.26 q/ha).
- Among different combinations of Fibsol FCM & GEL under organic production of groundnut during summer season 2020, Organic production systems, T₈ (22.85 q/ha) & T₉ (23.05) were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL recorded higher pod yield over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (only Fibsol FCM) & T₃ (only Fibsol Gel). However, T₈ & T₉ were found to be on par.
- Similarly Significantly Higher kernel yield/ha and kernel test weight (g) were recorded in Organic production systems, T₈& T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control).

Soil chemical proprieties after harvest

Chemical properties of soil viz., soil pH, electrical conductivity and organic carbon of soil & soil available nutrients (NPK kg/ha) at harvest of the groundnut as influenced by FIBSOL products tested in organic as well as inorganic production system is presented in (Table 10). However no significant difference in these proprieties is noticed, but wherever FIBSOL products are used, higher values were observed.

Biological parameters:

Microbial population of soil after harvest of groundnut crop, higher population were observed in FIBSOL products used treatments as compared to T₁- control, T₅ – POP + FCM, T₆- POP + Gel.(Table 11). This clearly shows that in organic production system along with use of FIBSOL FCM and FIBSOL gel, favorable microbial population development can be observed due to available of more carbon source in form of organic manures, liquid organic manures, mulching etc.,

Economics

Economics of groundnut Summer-2020

The per hectare cost of cultivation, gross returns, net returns and benefit: cost ratio was worked for groundnut cultivation (Summer-2020) under different production methods is represented in Table 12. The cost of cultivation was highest under GKVK organic practice with FIBSOL FCM (Rs. 34600) followed by UASB package of practices in combination with FIBSOL FCM (Rs. 34430), GKVK organic practice with FIBSOL Gel (Rs.33100) and UASB package of practices in combination with FIBSOL Gel (Rs.32930).The highest net returns was recorded in UASB package of practices in combination with FIBSOL Gel (Rs. 112390) followed by UASB package of practices in combination with FIBSOL FCM (Rs. 109210), GKVK organic practice with FIBSOL GEL (Rs. 87913) and GKVK organic practice with FIBSOL FCM (Rs. 85363) with high benefit: cost ratios of 4.41, 4.17, 3.66 and 3.47, respectively. Similar trend was also observed in the case of lowest cost per quintal of groundnut production.

INFERENCE

- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers can be used for improving growth & yield in organic groundnut production as well as in conventional farming.
- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers performs better when application of FYM/Vermicompost/Compost on N equivalent basis is applied along with the above products. This can be observed where only FIBSOL FCM & FIBSOL gel is applied in void of organic manures to the crop where 30 per cent yield is reduced as compared to supplementation of organic manures along with fib sol products.
- For sustenance of NPK microbial population in the soil and support the crop growth, organic manures play a key role.
- Plant remains greener even during later stages *ie.* Harvesting compared to control.
- Higher yield is obtained in summer groundnut as it is irrigated crop and also groundnut crops respond to favorable sunlight hours.
- FCM & GEL bio-fertilizers are more effective in combination of organic manures
- By utility, GEL formulation is easy to use in crop production.
- B:C ratio worked is found better in GEL bio-fertilizers.

Table 7: Growth parameters as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Plant Height (cm)			No. of Leaves (paripinnate)/plant			No. of Branches		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T ₁	11.26	25.70	30.77	14.33	26.33	32.00	4.77	8.50	11.00
T ₂	13.66	35.42	42.22	25.97	34.21	50.57	8.61	15.00	17.44
T ₃	13.71	35.24	40.96	27.21	34.24	48.81	8.79	13.81	16.06
T ₄	13.44	34.22	39.61	21.99	33.25	38.31	7.52	11.93	13.23
T ₅	15.45	37.33	47.28	33.30	36.26	59.32	11.17	18.30	20.16
T ₆	16.08	37.65	47.11	33.79	36.81	57.16	11.65	18.98	19.64
T ₇	15.51	37.37	45.50	28.67	36.57	47.89	9.79	16.26	16.51
T ₈	16.01	38.50	48.80	29.67	37.67	55.42	10.15	18.05	19.09
T ₉	15.89	38.43	48.66	29.46	37.61	56.66	9.96	18.50	19.54
SE.m ₊	0.96	1.53	2.150	1.15	1.43	2.30	0.36	0.89	0.66
C.D @ 5 %	2.87	4.59	6.45	3.45	4.29	6.88	1.07	2.66	1.98

Table 8. Days to 50 % flowering, no o nodules/plant and no. of pods/plant as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Days to 50 % flowering	Nodules/Plant	Pods/Plant
T ₁	47.00	55.00	21.67
T ₂	43.88	104.95	40.49
T ₃	43.88	98.46	41.00
T ₄	44.87	93.02	30.33
T ₅	41.88	110.73	50.58
T ₆	41.88	111.90	49.67
T ₇	42.88	113.83	45.55
T ₈	42.88	117.73	49.33
T ₉	42.88	120.42	47.80
SE.m ₊	1.30	3.58	2.26
C.D @ 5 %	3.91	10.73	6.79

Table 9: Pod yield/ha, kernel yield/ha and 100 kernel test weight (g) as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Pod yield kg ha ⁻¹	Kernel yield Kg ha ⁻¹	Test weight 100 Kernel (g)
T ₁	525.8	324.6	41.70
T ₂	1750	1155	46.60
T ₃	1770	1168	47.80
T ₄	1107	714.8	42.10
T ₅	2736	1860.8	49.00
T ₆	2768	1932.2	49.33
T ₇	2041.9	1472.9	49.30
T ₈	2285	1582.2	45.90
T ₉	2304.8	1612.7	46.00
SE.m±	133.98	98.47	1.43
C.D @ 5 %	401.67	295.23	4.28

Fig. 4. Effect of FIBSOL-FCM & FCM gel with other biofertilizers under organic and inorganic production of groundnut

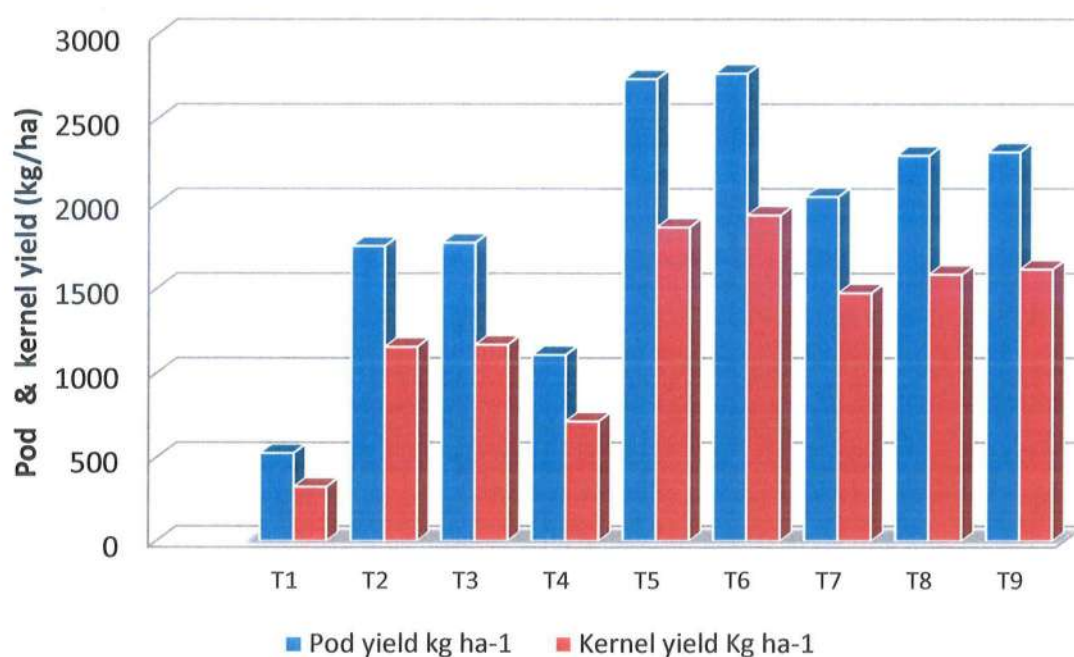


Table 10: Soil chemical properties & Soil available nutrients as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	pH	Ec (ds/m ²)	OC (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T ₁	4.40	0.23	0.40	257.50	26.31	183.95
T ₂	5.23	0.30	0.45	312.95	28.79	219.17
T ₃	5.26	0.30	0.45	325.22	30.97	228.57
T ₄	4.40	0.23	0.40	304.94	30.66	223.72
T ₅	4.41	0.23	0.40	359.93	36.35	254.14
T ₆	4.43	0.23	0.40	375.54	35.35	258.13
T ₇	5.30	0.30	0.45	325.6	32.43	236.70
T ₈	5.34	0.30	0.45	337.5	35.55	236.09
T ₉	5.36	0.30	0.45	344.30	36.35	240.16
SE.m+	0.13	0.01	0.10	24.21	2.38	22.32
C.D @ 5 %	NS	NS	NS	NS	NS	NS

Table11: Soil Microbial population as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	Bacteria (No. x 10 ⁵ CFU/g of soil)	Fungi (No. x 10 ⁴ CFU/g of soil)	Actinomycetes (No. x 10 ³ CFU/g of soil)
T ₁	25.89	15.28	12.75
T ₂	33.91	20.22	14.05
T ₃	34.13	21.80	14.43
T ₄	33.10	20.15	14.58
T ₅	30.53	18.63	14.58
T ₆	31.55	18.02	15.38
T ₇	34.33	21.80	15.96
T ₈	36.93	22.01	17.35
T ₉	37.29	23.45	18.95
SE.m+	2.46	1.39	1.07
C.D @ 5 %	NS	NS	NS

Economics

Table 12: Economics of Groundnut Summer 2020

Sl. No.	Particulars	T1	T2	T3	T4	T5	T6	T7	T8	T9
I	Variable cost (Rs.)	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost
1	Land preparation	2400	2400	2400	2400	2400	2400	2400	2400	2400
2	Seeds and sowing	2500	2500	2500	2500	2500	2500	2500	2500	2500
3	FYM	0	8000	8000	8000	8000	8000	11670	11670	11670
4	Weeding and irrigation	4280	4280	4280	4280	4280	4280	4280	4280	4280
5	Plant protection	750	750	750	750	1250	1250	750	750	750
6	Earthing up	1500	1500	1500	1500	1500	1500	1500	1500	1500
7	Fertilizer	0	7500	6000	600	10500	9000	1500	7500	6000
8	Gypsum	0	1500	1500	1500	1500	1500	1500	1500	1500
9	Harvesting and threshing	2500	2500	2500	2500	2500	2500	2500	2500	2500
	Total cost	13930	30930	29430	24030	34430	32930	30100	34600	33100
II	Returns									
1	Main product quantity (qtl)	5.26	17.5	17.7	11.07	27.36	27.68	20.42	22.85	23.05
2	Gross returns (Rs.)	27615	91875	92925	58117.5	143640	145320	107205	119962.5	121012.5
3	Net returns (Rs.)	13685	60945	63495	34088	109210	112390	77105	85363	87913
4	Cost of production (Rs./qtl)	2648	1767	1663	2171	1258	1190	1474	1514	1436
5	BCR	1.98	2.97	3.16	2.42	4.17	4.41	3.56	3.47	3.66

Legend	
T ₁	: Control
T ₂	: FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	: FIB-SOL GEL NPK combo
T ₄	: Commercial bio-fertilizer (reputed company) NPK combo
T ₅	: POP* + FIBSOL FCM
T ₆	: POP + FIBSOL GEL
T ₇	: GKVK Organic practice
T ₈	: GKVK Organic practice + FIBSOL FCM
T ₉	: GKVK Organic practice + FIBSOL GEL

REFERENCES

- ANONYMOUS, 2014., Groundnut, Directorate of Groundnut Research, ICAR, Junagadh
- G. BEKELEI, DECHASSA, N, TANA.T AND SHARMA, J, 2019, Effects of nitrogen, phosphorus and vermicompost fertilizers on productivity of groundnut (*Arachis hypogaea* L.) in Babile, Eastern Ethiopia, *Agronomy Research* 17(4), 1532–1546.
- CHANG, K.H., WU, R.Y., CHUANG, K.C., HSIEH, T.F. AND CHUNG, R.S., 2010, Effects of chemical and organic fertilizers on the growth, flower quality and nutrient uptake of *Anthurium andreanum*, cultivated for cut flower production. *Scientia Horti.*, **125**:434–441.
- CHOUDHARY, S.K., JAT, M.K, M SHARMA, S.R. AND SINGH, P, 2011. Effect of inm on soil nutrient and yield in groundnut field of semi-arid area of Rajasthan., *Legume Res.*, **34** (4) : 283 - 287, 2011
- DEVAKUMAR N., RAO, G.G.E., AND SHUBA, S., 2011, Evaluation of locally available media for the growth and development of nitrogen fixing microorganisms. *Proc. Of the third scientific conference of ISOFAR "Organic is like knowledge for tomorrow"*- Korea. pp. 504-509
- NEELAM SINGH, EKTA JOSHI, SASODE, D.S, SIKARWAR, R.S. AND RAWAT, G.S., 2018, Liquid Biofertilizer and Inorganic Nutrients Effect on Physiological, Quality Parameters and Productivity of Kharif Groundnut (*Arachis hypogaea* L.), *Int.J.Curr.Microbiol.App.Sci* (2018) 7(9): 729-735.
- MAHAKAVI.T , L.BASKARAN , M.RAJESH AND K.SANKAR GANESH, 2014, Efficiency of biofertilizers on growth and yield characteristics of groundnut *Arachis hypogaea* L. J. *Environmental Treatment Techniques*, **2**(4), 158-161.
- PARTHASARATHI PATRA AND ASHIM CHANDRA SINHA, 2012, Cultivation of groundnut in Cooch Behar, *Indian J. Agronomy.*, **57** (4), 386-389.
- PATIL, S.R., 2012, Effect of inorganic and bio-fertilizers on growth, yield and quality of summer groundnut, *M.Sc.(Agri.)* , sub to Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.
- RAMNATHAN, T. 2001. Genetic improvement of groundnut, Associated Publishing Company. New Delhi, pp: 9.
- SHEELA SHARMA, 2012, Effect of fertility levels and biofertilizers on growth, yield and quality of groundnut, *M.Sc.(Agri.)* sub to Swami Keshvanand Rajasthan Agricultural University, Bikaner,
- SHIMBO, S., ZHANG, Z.W., WATANABE, T., NAKATSUKA, H., MATSUDA-INOGUCHI, N., HIGASHIKAWA, K. AND IKEDA, M., 2001, Cadmium and lead contents in rice and other cereal products in Japan in 1998-2000. *Sci. Envir.*, **281**: 165-175.
- ZELATE, P.Y. AND PADMANI, D.R. 2009. Effect of organic manure and biofertilizers on yield, harvest index, shelling percentage and quality of kharif groundnut (*Arachis hypogaea* L.). *International Journal of Agricultural Sciences*, **5** : 343-345.



PLATE 1: OPENING OF FURROWS FOR GROUND NUT CROP SOWING



PLATE 2: FIELD VIEW OF TOMATO CROP PLANTING

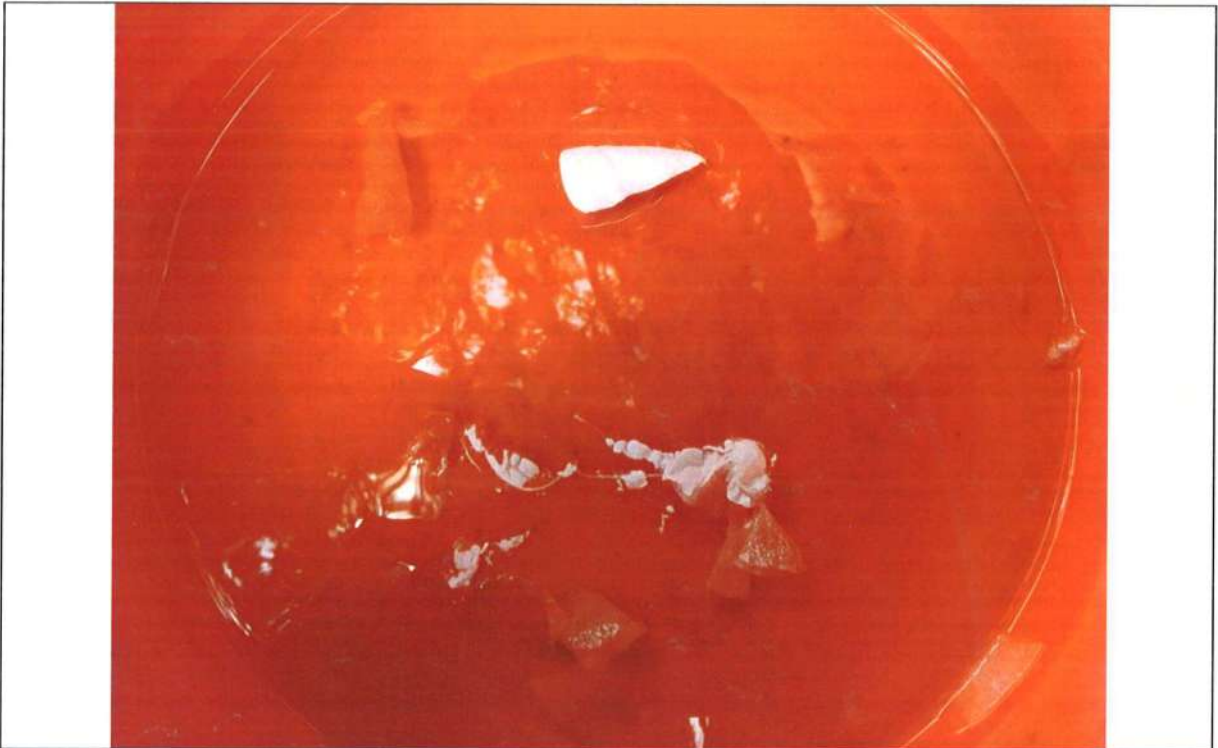


PLATE 3: FCM NPK BIOFERTILIZER BEING DISSOLVED IN WATER



PLATE 4: GEL FORM NPK BIOFERTILIZERS BEING DISSOLVED IN WATER



PLATE 5: GEL NPK BIOFERTILIZER MIXING WITH FINE COMPOST AND APPLIED TO FURROWS



PLATE 6: FIBSOL PRODUCTS LTD. REPRESENTATIVE ALONG WITH RIOF STAFF



PLATE 7: GENERAL VIEW OF FIBSOL PRODUCTS TESTING TRAIL IN GROUNDNUT – Kharif 2019



PLATE 8: GENERAL VIEW OF FIBSOL PRODUCTS TESTING TRAIL IN GROUNDNUT – Summer 2020



PLATE 11: T1 – CONTROL-GROUNDNUT



PLATE 12: T9- ORGANIC PRODUCTION SYSTEM + FIBSOL NPK GEL-GROUNDNUT

FIBSOL FCM & GEL TESTING IN TOMATO CROP



Introduction

Tomato (*Lycopersicon esculentum* Mill.) is important vegetable crop mostly grown under irrigated condition in kitchen garden, commercial field in green house or poly house and soilless culture (hydroponic). It is native of tropical America cultivated both in tropical and sub-tropical condition. Tomato is perishable fruit which is rich source of Vitamin A and C, also contain significant amount of dietary fiber, beta-carotene, mineral nutrients like Fe, Mg, K, P and organic acids such as citric, malic and acetic acid. It has health benefits of gastric secretion, acts as blood purifier and intestinal antiseptic.

There are many factors which influence the growth and yield of crops. Among them, Nutrient is important factor decide the quantity and quality of vegetable crops (Chang *et al.*, 2010). Nutrient can be meet out from both inorganic and organic sources for the crop requirement. At present instance, Frequent and huge usage of inorganic fertilizer have been associated with some environmental pollution, alteration in soil textures and physical property of the soil. Moreover, the nutritional value of the crops will be affected seriously by the continuous use of synthetic fertilizer and also increases in the cost of crop production (Shimbo *et al.*, 2000). Hence, current globe demands eco-friendly and cost-effective agricultural practices for sustainable food production. This sustainable agricultural practices are coincides with organic farming which is invariably ancient agricultural practices and gives major emphasis on maintenance of soil fertility for sustainable yield. Organic farming helps to improve the physical, chemical and biological properties of soil as well as maintain the balance in environment through holistic approach and supports living system for future generation. This sustainable practice gaining importance across the world because of its socio-economical viability and preservation of natural resources and biodiversity. Application of organic manure

Objectives:

1. To evaluate the effect of **FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo** and **FIB-SOL GEL NPK combo** growth parameters of Tomato crop
2. To evaluate the effect of **FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo** and **FIB-SOL GEL NPK combo** on yield of Tomato crop under field condition

Review of literature

Vamadeva angadi et. al. (2017) that tomato crop receiving the recommended dose of fertilizers along with the bio fertilizers recorded superior plant growth, yield parameters which was followed by combination of FYM @ 6t/ha + poultry manure @ 3.5 t/ha. The treatments with bio fertilizers recorded higher values compare to without bio fertilizers. Chinnaswami and Marakulandai, (1967) reported that combination of FYM and inorganic manure (12:106:84 NPK Kg ha⁻¹) significantly enhanced the keeping quality of tomato.

Ranganathan and Rani Perumal (1995) reported that integration of composted coir pith + *Azospirillum* with micro food registered a significant increase in the haulm dry matter of tomato over the other treatments. The increase in the haulm yield of tomato at harvest ranged from 11.50 to 29.00 per cent over NPK in *Inceptisols* and 11.00 to 26.00 per cent in *Alfisols*.

Reddy (1999) reported that application of 20 t compost ha⁻¹ was sufficient to realize the high TSS (4.6^o Brix), acidity (0.84 %) and ascorbic acid (14.30 mg 100 g⁻¹ juice). Highest plant height (43.30 cm) was recorded with application of 20 t compost ha⁻¹ highest fruit yield (15 t ha⁻¹) was recorded in the 30 t compost ha⁻¹ but it was on par with 20 t of compost ha⁻¹ (14 t ha⁻¹).

Renuka and Ravishankar (2001) observed earlier flowering (21.50 days), higher fruit set (57.76 %), number of primary branches per plant (6.00), dry matter (113.34 g plant⁻¹), fruit volume (30.33 cc), fruits per plant (17.81) and fruit yield (47.66 t ha⁻¹) with application of FYM and biogas slurry in tomato. The fruit yield was two and half times more over N, P and K inorganic fertilizer application (18.44 t ha⁻¹).

Nileema and Sreenivasa (2011) opined that combined application of recommended dose of fertilizer (150:100:60 N: P₂O₅: K₂O kg and FYM 25 t ha⁻¹) + Beejamrutha + Jeevamrutha (500 l ha⁻¹) + Panchagayya (3%) recorded statically higher plant height (143.2 cm), dry matter accumulation (7.94 g plant⁻¹) number of fruits plant⁻¹ (23.3) and fruit weight plant⁻¹ (316.6 g plant⁻¹) as compared to alone application of RDF (124.8 cm, 5.43 g plant⁻¹, 11.1 and 167.2 g plant⁻¹).

Geetharani and Parthiban (2014) revealed that application of poultry manures @ 7 t ha⁻¹ recorded significantly higher plant height (58.3 cm), number of fruits plant⁻¹ (30.7), fruit yield (1.1 kg plant⁻¹) and seed yield (0.68 g plant⁻¹) as compared to application of vermicompost @ 6 t ha⁻¹ (49.3 cm, 21.83, 0.9 kg ha⁻¹ and 0.55 g plant⁻¹, respectively) .

Rajya laxmi (2015) *et al.*, observed that application of 50 per cent RDF + 50 per cent FYM recorded maximum plant height (133.53 cm), minimum days to first flowering (29.47), maximum number of fruits per cluster (5.67), maximum number of fruits per plant (36.72), maximum fruit yield per plant (849 g), maximum fruit yield per ha (33.77 t) net returns (Rs.2, 14,925 ha⁻¹) and B:C ratio (2.75:1) compared to application of 100 per cent RDF.

MATERIAL AND METHODS:

A field experiment entitled “Effect of FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo and FIB-SOL GEL NPK combo on growth and yield of tomato (*Lycopersicon esculentum* Mill.)” was conducted at organic farming block of Research Institute on Organic Farming (RIOF), University of Agricultural Sciences, GKVK, Bengaluru-65 during *kharif* 2019.

General description

Location of the experimental site

The experiment was conducted at organic farming block of Research Institute on organic farming, GKVK, University of Agricultural Sciences, Bengaluru which is situated at eastern dry zone of Karnataka at a latitude of 12° 58" North, longitude of 75° 35" East and at an altitude of 930 m above the mean sea level.

Soil Characteristics of experimental site

Before layout of the experiment, composite soil samples were drawn from the experimental plot by core sampler method from upper 0-15 cm soil layer and soil was analyzed for chemical properties *viz.*, pH, EC, Organic carbon, Available nitrogen, phosphorus and potassium. Biological properties *viz.*, general soil bacteria, fungi, actinomycetes, P-solubilizer, N- fixing bacteria,

Soil of experimental plot was red sandy loam, grouped under the class of *alfisols*. Soil pH was near to neutral (6.5) with an electrical conductivity of 0.21 dS m⁻¹ soil organic carbon content was medium (0.44 %) and medium in available nitrogen (320 kg ha⁻¹) phosphorus (39.8 kg ha⁻¹) and potassium (225 kg ha⁻¹).

Experimental details

Location: Research institute on organic farming (RIOF) field, UAS, GKVK, Bengaluru

Season: Kharif 2019 (under protective irrigation through drip)

Crop: Tomato

Variety: NAS 501(Namdhari seeds)

Spacing: 90 × 45 cm

Gross plot size: 4.5 m × 3.5 m

Net plot size: 2.7 m x 2.6 m

No. of Treatments- 09

Replications-3

Sources of nutrients: FIBSOL- FCM, FIBSOL- GEL,

Treatment details

Treatments		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

Agronomy Practices

- Land was tilled with hand operated power tiller followed by harrowing to remove weeds and to crush the clods and brought to fine tilth.
- Basal Farm yard manure was applied @ 25 t ha⁻¹ to plots three weeks before sowing and incorporated into the soil. It is common for all the treatments except control.
- The entire quantity of recommended dose of nitrogen (100 kg N ha⁻¹) was applied through FYM on N equivalent basis according to the treatments in organic production of groundnut followed by application of liquid organic manures. Viz., jeevamrutha and panchagayva.
- FIB-SOL FCM (Fertilizer carrying Membrane) & FIB-SOL Gel NPK combo at sowing and flowering stage in two dosages were applied according to the treatments. FCM was dissolved in water of required quantity and then the seeds are soaked for few minutes and sown in treatments which received FCM, Whereas Gel was mixed with fine compost and then added to the furrows and the seeds were sown in treatments which received GEL
- Recommended dose of fertilizers (100:100:100 kg/ha NPK) were applied for tomato, apart use of FIBSOL products.
- Seedlings of 21 days old were treated with FIBSOL products as per the protocol of FIBSOL and with common bio fertilizers according to the treatments. The seedlings are transplanted at a row spacing of 90 cm, 45 cm between plant to plant. Gap filling is carried out at 12 to 15 days after transplanting where the transplanted seedlings were failed to establish and optimum plant population is maintained.
- Earthing up: Important inter-cultivation i.e., Earthing up operation was carried out at flower formation after transplanting and staking were provided for tomato plant & were tied with jute thread and wire so as to prevent the tomato plant from lodging to ground at fruit bearing stage.
- Water management - Since the crop is raised during Kharif season under rainfed situation, protective irrigation is provided by drip irrigation during critical stages.
- Weeding- Weeds are removed at 20 and 30 days after transplanting manually & by passing cycle weeder. After earthing up mulching with finger millet straw were provided

Plant protection

Time to time spraying of botanical extracts, neem oil, trichoderma, bordeaux mixture, gypsum (for controlling black heart disease) at regular intervals were carried out and incidence of fruit borer was taken care by Funnel trap with *Helilure*. No major outbreak of any pest and diseases incidence was noticed during the experimentation

Harvesting

Ripen fruits are harvested by picking at different intervals, first border row plants are harvested and later net plot rows are harvested separately. The weight of harvested fruits is recorded separately as net and gross plot yield in kg and then converted into tone ha⁻¹

Results: Tomato -2019 (Kharif)

Growth parameters:

Growth parameters *viz*; plant height, number of branches, no of leaves per plant and days to 50 % flowering were recorded and presented in the Table 13 & 14

- It was recorded that plant height, no of branches per plant, no of leaves per plant has increased were package of practice with FIBSOL Gel formulation T₆ was used and was on par with POP + FIBSOL FCM T₅ as compared to control (T₁).
- Among different combinations of Fibsol FCM & GEL under organic production of tomato during Kharif season 2019, Higher growth parameters were observed in the treatments of Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (Fibsol FCM) & T₃ (Fibsol Gel).

Yield parameters:

Yield parameters *viz*; no. of flower clusters /plant, fruit weight (kg for 10 no. fruit), fruit yield (t/ha) were recorded and presented in the Table 15 & Fig 5.

- Higher fruit yield (t/ha) was obtained in the treatment were package of practice with FIBSOL Gel formulation T₆ (39.4 t/ha) was used and was on par with POP + FIBSOL FCM T₅ (37.6 t/ha) as compared to control (T₁) (9.00 q/ha).
- Among different combinations of Fibsol FCM & GEL under organic production of tomato during Kharif season 2019, Organic production systems, T₈ (32.40 t/ha) & T₉ (33.90 t/ha) were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL recorded higher fruit yield over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (only Fibsol FCM) & T₃ (only Fibsol Gel). However, T₈ & T₉ were found to be on par.
- Similarly Significantly Higher number of flower clusters and ten no. fruit weight (kg) were recorded in package of practice with FIBSOL Gel formulation T₆ (6.80 flower clusters and 1.280 kg per 10 fruit) and was on par with POP + FIBSOL FCM T₅ (6.0 flower clusters and 1.20 kg per 10 fruit) as compared to control (T₁) (3.4 flower clusters and 0.620 kg per 10 fruit).
- Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL recorded higher no. of flower clusters and 10. No. fruit weight (kg) over T₁ (Control) and other organic production systems were only bio fertilizers and basal FYM is used.

Soil chemical proprieties after harvest

Chemical properties of soil viz., soil pH, electrical conductivity and organic carbon of soil & soil available nutrients (NPK kg/ha) at harvest of the groundnut as influenced by FIBSOL products tested in organic as well as inorganic production system is presented in (Table 16). However no significant difference in these proprieties is noticed, but wherever FIBSOL products are used, higher values were observed.

Biological parameters:

Microbial population of soil after harvest of groundnut crop, higher population were observed in FIBSOL products used treatments as compared to T₁- control, T₅ – POP + FCM, T₆- POP + Gel.(Table 17). This clearly shows that in organic production system along

with use of FIBSOL FCM and FIBSOL gel, favorable microbial population development can be observed due to available of more carbon source in form of organic manures, liquid organic manures, mulching etc., Organic carbon from manures provides the energy source for the active, healthy soil microbial environment that both stabilizes nutrient sources and make those nutrients available to crops.(Gangadhar,2019).

Economics of Tomato *Kharif*-2019

The per hectare cost of cultivation, gross returns, net returns and benefit: cost ratio was worked for tomato cultivation (*Kharif*-2019) under different production methods is represented in Table 17. The cost of cultivation was highest under package of practices in combination with FIBSOL FCM(Rs. 70950) followed by package of practices in combination with FIBSOL Gel (Rs. 69450) and Organic practice with FIBSOL FCM(Rs. 66350). The highest net returns was recorded in package of practices in combination with FIBSOL Gel (Rs. 295000) followed by package of practices in combination with FIBSOL FCM (Rs. 276850), organic practice with FIBSOL Gel (Rs. 248725) and organic practice with FIBSOL FCM (Rs. 233350) with high benefit: cost ratios of 5.25, 4.90, 4.84 and 4.52, respectively.

INFERENCE

- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers can be used for improving growth & yield in organic groundnut production as well as in conventional farming.
- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers performs better when application of FYM/Vermicompost/Compost on N equivalent basis is applied along with the above products. This can be observed were only FIBSOL FCM & FIBSOL gel is applied in void of organic manures to the crop were 30 per cent yield is reduced as compared to supplementation of organic manures along with fib sol products.
- For sustenance of NPK microbial population in the soil and support the crop growth, organic manures play a key role.
- FCM & GEL bio-fertilizers are more effective in combination of organic manures
- GEL formulation bio-fertilizers application have increased the yield of the respective crops from 2-6 %.
- By utility, GEL formulation is easy to use in crop production.
- B:C ratio worked is found better in GEL bio-fertilizers

Table 13 Growth parameters as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Plant Height (cm)			No. of Leaves /plant		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T ₁	30.70	66.82	90.33	40.20	60.10	56.00
T ₂	38.80	72.35	104.50	48.30	75.40	70.20
T ₃	40.20	73.10	105.20	50.50	77.20	72.00
T ₄	35.60	70.50	96.33	44.20	68.00	66.80
T ₅	53.00	90.45	126.30	75.00	125.00	120.30
T ₆	54.70	92.17	127.30	83.00	129.00	122.67
T ₇	47.10	84.25	116.80	65.80	119.00	115.53
T ₈	49.60	86.20	121.50	70.20	120.00	118.00
T ₉	50.30	88.30	123.47	73.40	123.23	120.17
SE.m±	2.58	3.83	5.91	3.69	6.86	6.17
C.D @ 5 %	7.73	11.49	17.72	11.07	20.55	18.79

Table 14. Days to 50 % flowering, No. of branches/plant at 90 DAT, No. of flower clusters/plant, fruit yield (t/ha) as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Days to 50 % flowering	No. of branches /plant at 90DAT	No. of flower clusters /plant	Fruit weight kg/ (10 no. fruits)	Fruit yield (t/ha)
T ₁	43.70	4.17	2.40	0.620	9.00
T ₂	41.70	5.80	5.00	0.885	23.90
T ₃	37.05	5.88	5.10	0.956	24.30
T ₄	40.00	5.66	3.80	0.809	18.00
T ₅	38.00	7.22	6.00	1.200	37.60
T ₆	37.42	7.15	6.80	1.280	39.40
T ₇	34.07	6.36	5.30	1.000	29.00
T ₈	35.33	6.75	5.60	1.151	32.40
T ₉	32.29	6.85	5.80	1.169	33.90
SE.m ₊	1.87	0.34	0.43	0.020	1.64
C.D @ 5 %	5.61	1.02	1.30	0.04	4.92

Fig 5. No. of flower clusters/plant & fruit yield (t/ha) as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production



Legend		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP* + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

Table 15: Soil chemical properties & Soil available nutrients as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	pH	Ec (ds/m ²)	OC (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T ₁	6.52	0.190	0.42	247.40	21.77	193.34
T ₂	6.62	0.215	0.46	271.40	23.54	207.00
T ₃	6.60	0.213	0.47	272.63	23.78	210.34
T ₄	6.63	0.206	0.46	266.20	22.79	203.40
T ₅	6.57	0.217	0.43	300.43	26.84	229.41
T ₆	6.59	0.217	0.44	308.00	27.61	235.00
T ₇	6.65	0.221	0.48	276.30	24.23	214.30
T ₈	6.67	0.224	0.50	281.20	25.62	214.37
T ₉	6.68	0.228	0.51	286.30	26.84	218.16
SE.m ₊	0.01	0.01	0.02	10.32	1.45	8.60
C.D @ 5 %	NS	NS	NS	NS	NS	NS

Table 16: Soil Microbial population as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	Bacteria (No. x 10 ⁵ CFU/g of soil)	Fungi (No. x 10 ⁴ CFU/g of soil)	Actinomycetes (No. x 10 ³ CFU/g of soil)	N-fixer (No. x 10 ⁵ CFU/g of soil)	PSB (No. x 10 ⁵ CFU/g of soil)
T ₁	27.94	16.01	12.22	7.11	12.44
T ₂	31.51	17.74	14.39	8.11	13.37
T ₃	32.37	17.19	14.91	8.00	13.87
T ₄	30.97	16.8	14.20	7.47	13.25
T ₅	29.11	16.01	13.57	7.22	12.97
T ₆	30.01	16.80	13.15	7.38	13.00
T ₇	36.77	21.07	16.16	8.69	16.44
T ₈	38.58	22.96	17.07	9.17	17.35
T ₉	41.90	24.46	18.64	9.87	18.84
SE.m ₊	1.60	0.94	0.72	0.40	0.73
C.D @ 5 %	4.80	2.76	2.11	1.16	2.14

Economics

Table 17. Economics of Tomato Kharif 2019

Sl. No.	Particulars	T1	T2	T3	T4	T5	T6	T7	T8	T9
I	Variable cost (Rs.)	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost
1	Land preparation	6000	6000	6000	6000	6000	6000	6000	6000	6000
2	Seeds and sowing	7000	7000	7000	7000	7000	7000	7000	7000	7000
3	FYM	0	10000	10000	10000	10000	10000	16350	16350	16350
4	Weeding and irrigation	6000	6000	6000	6000	6000	6000	6000	6000	6000
5	Plant protection	3500	3500	3500	3500	4250	4250	3500	3500	3500
6	Earthing up	5000	5000	5000	5000	5000	5000	5000	5000	5000
7	Fertilizer	0	7500	6000	600	17700	16200	6000	7500	6000
8	Gypsum	5000	5000	5000	5000	5000	5000	5000	5000	5000
9	Harvesting and threshing	10000	10000	10000	10000	10000	10000	10000	10000	10000
	Total cost	42500	60000	58500	53100	70950	69450	64850	66350	64850
II	Returns									
1	Main product quantity (qtl)	9.00	23.90	24.30	18.00	37.60	39.40	29.00	32.40	33.90
2	Gross returns (Rs.)	83250	221075	224775	166500	347800	364450	268250	299700	313575
3	Net returns (Rs.)	40750	161075	166275	113400	276850	295000	203400	233350	248725
4	Cost of production (Rs./qtl)	4722	2510	2407	2950	1887	1763	2236	2048	1913
5	BCR	1.96	3.68	3.84	3.14	4.90	5.25	4.14	4.52	4.84

Legend

T ₁	:	Control
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T ₈	:	GKVK Organic practice + FIBSOL FCM
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SUMMER 2020- Tomato crop

Experimental details

Location: Research institute on organic farming (RIOF) field, UAS, GKVK, Bengaluru

Season: Summer 2020 (through drip irrigation)

Crop: Tomato

Variety: NAS 501(Namdhari seeds)

Spacing: 90 × 45 cm

Gross plot size: 4.5 m × 3.5 m

Net plot size: 2.7 m x 2.6 m

No. of Treatments- 09

Replications-3

Sources of nutrients: FIBSOL- FCM, FIBSOL- GEL,

Treatment details

Treatments		
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Agronomy Practices

- Land was tilled with hand operated power tiller followed by harrowing to remove weeds and to crush the clods and brought to fine tilth.
- Basal Farm yard manure was applied @ 25 t ha⁻¹ to plots three weeks before sowing and incorporated into the soil. It is common for all the treatments except control.
- The entire quantity of recommended dose of nitrogen (100 kg N ha⁻¹) was applied through FYM on N equivalent basis according to the treatments in organic production of groundnut followed by application of liquid organic manures. Viz., jeevamrutha and panchagayva.
- FIB-SOL FCM (Fertilizer carrying Membrane) & FIB-SOL Gel NPK combo at sowing and flowering stage in two dosages were applied according to the treatments. FCM was dissolved in water of required quantity and then the seeds are soaked for few minutes and sown in treatments which received FCM, Whereas Gel was mixed with fine compost and then added to the furrows and the seeds were sown in treatments which received GEL
- Recommended dose of fertilizers (100:100:100 kg/ha NPK) were applied for tomato, apart use of FIBSOL products.
- Seedlings of 21 days old were treated with FIBSOL products as per the protocol of FIBSOL and with common bio fertilizers according to the treatments. The seedlings are transplanted at a row spacing of 90 cm, 45 cm between plant to plant. Gap filling is carried out at 12 to 15 days after transplanting where the transplanted seedlings were failed to establish and optimum plant population is maintained.
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- Water management - Since the crop is raised during Kharif season under rainfed situation, protective irrigation is provided by drip irrigation during critical stages.
- Weeding- Weeds are removed at 20 and 30 days after transplanting manually & by passing cycle weeder.

Plant protection

Time to time spraying of botanical extracts, neem oil, trichoderma, bordeaux mixture, gypsum (for controlling black heart disease) at regular intervals were carried out and incidence of fruit borer was taken care by Funnel trap with *Helilure*. No major outbreak of any pest and diseases incidence was noticed during the experimentation

Harvesting

Ripen fruits are harvested by picking at different intervals, first border row plants are harvested and later net plot rows are harvested separately. The weight of harvested fruits is recorded separately as net and gross plot yield in kg and then converted into ton ha⁻¹

Results: Tomato -2020 (Summer)

Growth parameters:

Growth parameters viz; plant height, number of branches, no of leaves per plant and days to 50 % flowering were recorded and presented in the Table 18 & 19

- It was recorded that plant height, no of branches per plant, no of leaves per plant has increased were package of practice with FIBSOL Gel formulation T₆ was used and was on par with POP + FIBSOL FCM T₅ as compared to control (T₁).
- Among different combinations of Fibsol FCM & GEL under organic production of tomato during summer season 2020, Higher growth parameters were observed in the treatments of Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (Fibsol FCM) & T₃ (Fibsol Gel).

Yield parameters:

Yield parameters viz; no. of flower clusters /plant, fruit weight (kg for 10 no. fruit), fruit yield (t/ha) were recorded and presented in the Table 19 & Fig 6.

- Higher fruit yield (t/ha) was obtained in the treatment were package of practice with FIBSOL Gel formulation T₆ (41.50 t/ha) was used and was on par with POP + FIBSOL FCM T₅ (40.49 t/ha) as compared to control (T₁) (10.20 q/ha).
- Among different combinations of Fibsol FCM & GEL under organic production of tomato during summer season 2020, Organic production systems, T₈ (34.20 t/ha) & T₉ (36.60 t/ha) were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL recorded higher fruit yield over T₁ (Control), T₄ (Commercial biofertilizer), T₂ (only Fibsol FCM) & T₃ (only Fibsol Gel). However, T₈ & T₉ were found to be on par.
- Similarly Significantly Higher number of flower clusters and ten no. fruit weight (kg) were recorded in package of practice with FIBSOL Gel formulation T₆ (7.60 flower clusters and 1.460 kg per 10 fruit) and was on par with POP + FIBSOL FCM T₅ (7.30 flower clusters and 1.430 kg per 10 fruit) as compared to control (T₁) (3.00 flower clusters and 0.729 kg per 10 fruit).
- Organic production systems, T₈ & T₉ were application of organic manures @ N equivalent basis along with use of FIBSOL FCM & GEL recorded higher no. of flower clusters and 10. No. fruit weight (kg) over T₁ (Control) and other organic production systems were only bio fertilizers and basal FYM is used.

Soil chemical proprieties after harvest

Chemical properties of soil viz., soil pH, electrical conductivity and organic carbon of soil & soil available nutrients (NPK kg/ha) at harvest of the groundnut as influenced by FIBSOL products tested in organic as well as inorganic production system is presented in (Table 20). However no significant difference in these proprieties is noticed, but wherever FIBSOL products are used, higher values were observed.

Biological parameters:

Microbial population of soil after harvest of groundnut crop, higher population were observed in FIBSOL products used treatments as compared to T₁- control, T₅ – POP + FCM, T₆- POP + Gel.(Table 21). This clearly shows that in organic production system along

with use of FIBSOL FCM and FIBSOL gel, favorable microbial population development can be observed due to available of more carbon source in form of organic manures, liquid organic manures, mulching etc., Organic carbon from manures provides the energy source for the active, healthy soil microbial environment that both stabilizes nutrient sources and make those nutrients available to crops.(Gangadhar,2019).

Economics of Tomato Summer 2020

The per hectare cost of cultivation, gross returns, net returns and benefit: cost ratio was worked for tomato cultivation (Summer-2020) under different production methods is represented in Table 22. The cost of cultivation was highest under package of practices in combination with FIBSOL FCM(Rs. 72150) followed by package of practices in combination with FIBSOL Gel(Rs. 70650) and organic practice with FIBSOL FCM (Rs. 67550). The highest net returns was recorded in package of practices in combination with FIBSOL Gel (Rs. 349538) followed by package of practices in combination with FIBSOL FCM (Rs. 337811), organic practice with FIBSOL Gel (Rs. 304525) and organic practice with FIBSOL FCM (Rs. 278725) with high benefit: cost ratios of 5.95, 5.68, 5.61 and 5.13, respectively.

INFERENCE

- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers can be used for improving growth & yield in organic Tomato production as well as in conventional farming.
- FIBSOL FCM & FIBSOL GEL form of NPK bio fertilizers performs better when application of FYM/Vermicompost/Compost on N equivalent basis is applied along with the above products. This can be observed were only FIBSOL FCM & FIBSOL gel is applied in void of organic manures to the crop were 30 per cent yield is reduced as compared to supplementation of organic manures along with fib sol products.
- For sustenance of NPK microbial population in the soil and support the crop growth, organic manures play a key role.
- FCM & GEL bio-fertilizers are more effective in combination of organic manures
- GEL formulation bio-fertilizers application have increased the yield of the respective crops from 2-6 %.
- By utility, GEL formulation is easy to use in crop production.
- B:C ratio worked is found better in GEL bio-fertilizers.

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Director of Research
University Of Agricultural Sciences
G.K.V.K Bengaluru-560 065


Co-ordinator
Research Institute on
Organic Farming
UAS, GKVK, Bangalore-560 065

Table 18: Growth parameters as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Plant Height (cm)			No. of Leaves /plant		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T ₁	33.30	69.20	92.10	45.10	74.20	70.30
T ₂	43.40	75.90	106.90	56.20	88.30	80.40
T ₃	45.10	78.20	108.20	62.30	92.10	87.20
T ₄	42.70	74.30	101.10	50.00	80.00	72.10
T ₅	59.40	95.40	133.30	83.25	139.33	127.00
T ₆	60.67	98.30	136.50	89.10	144.47	133.40
T ₇	52.47	87.20	122.40	78.40	126.20	120.40
T ₈	53.13	91.10	124.80	80.60	130.10	122.30
T ₉	55.20	92.40	126.90	84.60	135.40	126.40
SE.m±	2.87	3.94	5.99	4.72	6.52	6.03
C.D @ 5 %	8.59	11.81	17.96	14.15	19.55	18.08
C.V	10.03	8.06	8.88	11.68	10.07	10.00

Legend		
T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP* + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

Table 19. Days to 50 % flowering, No. of branches/plant at 90 DAT, No. of flower clusters/plant, fruit yield (t/ha) as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production.

Treatments	Days to 50 % flowering	No. of branches /plant at 90DAT	No. of flower clusters /plant	Fruit weight kg/ (10 no. fruits)	Fruit yield (t/ha)
T ₁	45.20	4.00	3.00	0.729	10.20
T ₂	43.10	5.30	5.78	1.023	25.90
T ₃	43.88	5.50	6.00	1.247	26.40
T ₄	44.20	5.00	4.48	0.910	21.10
T ₅	39.60	6.50	7.30	1.430	40.49
T ₆	38.20	6.70	7.60	1.460	41.50
T ₇	42.50	5.60	6.80	1.280	32.10
T ₈	41.70	6.20	7.00	1.340	34.20
T ₉	41.00	6.30	7.10	1.380	36.60
SE.m±	0.77	0.32	0.38	0.020	6.04
C.D @ 5 %	2.30	0.96	1.15	0.04	18.12

Fig. 6. No. of flower clusters/plant & fruit yield (t/ha) as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production

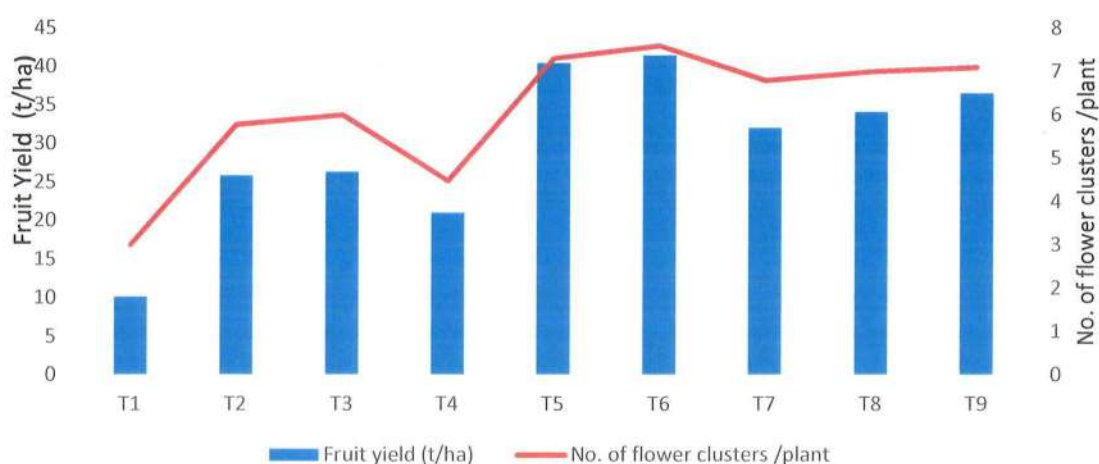


Table 20: Soil chemical properties & Soil available nutrients as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	pH	Ec (ds/m ²)	OC (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T ₁	6.52	0.190	0.42	249.12	22.10	188.61
T ₂	6.62	0.215	0.46	284.60	25.15	218.30
T ₃	6.60	0.213	0.47	286.30	25.90	218.56
T ₄	6.63	0.206	0.46	281.20	24.35	205.78
T ₅	6.57	0.217	0.43	309.23	26.35	234.36
T ₆	6.59	0.217	0.44	316.00	27.80	241.00
T ₇	6.65	0.221	0.48	287.10	25.99	219.10
T ₈	6.67	0.224	0.50	291.35	26.10	227.20
T ₉	6.68	0.228	0.51	296.42	26.80	229.10
SE.m _±	0.01	0.01	0.02	11.20	1.05	8.53
C.D @ 5 %	NS	NS	NS	NS	NS	NS

Table 21: Soil Microbial population as influenced by FIBSOL FCM & FIBSOL GEL with other commercial bio-fertilizers in organic and inorganic production after harvest.

Treatments	Bacteria (No. x 10 ⁵ CFU/g of soil)	Fungi (No. x 10 ⁴ CFU/g of soil)	Actinomycetes (No. x 10 ³ CFU/g of soil)	N-fixer (No. x 10 ⁵ CFU/g of soil)	PSB (No. x 10 ⁵ CFU/g of soil)
T ₁	24.24	13.00	10.00	5.45	10.40
T ₂	29.51	16.55	13.30	6.23	12.17
T ₃	30.17	16.30	13.70	7.00	12.35
T ₄	30.00	15.80	13.10	7.20	11.86
T ₅	28.60	15.00	12.40	6.30	11.00
T ₆	30.20	15.40	12.25	6.75	11.26
T ₇	35.12	20.20	16.56	8.25	15.04
T ₈	37.62	21.66	17.50	9.33	16.50
T ₉	41.90	23.30	18.70	9.67	17.24
SE.m _±	1.20	1.10	0.80	0.30	0.60
C.D @ 5 %	3.80	3.00	2.20	1.00	1.94

Economics

Table 21. Economics of Tomato Summer 2020

Sl. No.	Particulars	T1	T2	T3	T4	T5	T6	T7	T8	T9
I	Variable cost (Rs.)	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost
1	Land preparation	6000	6000	6000	6000	6000	6000	6000	6000	6000
2	Seeds and sowing	7000	7000	7000	7000	7000	7000	7000	7000	7000
3	FYM	0	10000	10000	10000	10000	10000	16350	16350	16350
4	Weeding and irrigation	6000	6000	6000	6000	6000	6000	6000	6000	6000
5	Plant protection	3500	3500	3500	3500	4250	4250	3500	3500	3500
6	Earthing up	5000	5000	5000	5000	5000	5000	5000	5000	5000
7	Fertilizer	0	7500	6000	600	17700	16200	6000	7500	6000
8	Gypsum	6200	6200	6200	6200	6200	6200	6200	6200	6200
9	Harvesting and threshing	10000	10000	10000	10000	10000	10000	10000	10000	10000
	Total cost	43700	61200	59700	54300	72150	70650	60050	67550	66050
II	Returns									
1	Main product quantity (qtl)	10.2	25.9	26.4	21.1	40.49	41.5	32.1	34.2	36.6
2	Gross returns (Rs.)	103275	262237.5	267300	213637.5	409961.25	420187.5	325012.5	346275	370575
3	Net returns (Rs.)	59575	201038	207600	159338	337811	349538	258963	278725	304525
4	Cost of production (Rs./qtl)	4284	2363	2261	2573	1782	1702	2058	1975	1805
5	BCR	2.36	4.28	4.48	3.93	5.68	5.95	4.92	5.13	5.61

Legend

T ₁	:	Control
T ₂	:	FIB-SOL FCM (Fertilizer carrying Membrane) NPK combo
T ₃	:	FIB-SOL GEL NPK combo
T ₄	:	Commercial bio-fertilizer (reputed company) NPK combo
T ₅	:	POP* + FIBSOL FCM
T ₆	:	POP + FIBSOL GEL
T ₇	:	GKVK Organic practice
T ₈	:	GKVK Organic practice + FIBSOL FCM
T ₉	:	GKVK Organic practice + FIBSOL GEL

References

- CHANG, K.H., WU, R.Y., CHUANG, K.C., HSIEH, T.F. AND CHUNG, R.S., 2010, Effects of chemical and organic fertilizers on the growth, flower quality and nutrient uptake of *Anthurium andraeanum*, cultivated for cut flower production. *Scientia Hort.*, **125**:434-441.
- CHINNASWAMI, K. N. AND MARAKULANDAI, K. A., 1967, Influence of organic and inorganic manures on the firmness and storage life of tomatoes. *South Indian Hort.* **15**: 36-42.
- GANGADHAR KARALE., 2019, Effect of different sources of organic manures, decomposers on nutrient release, growth and yield of Chilli. *Ph.D Thesis sub.to UAS, GKVK, Bangalore.*
- GEETHARANI, P. AND PARTHIBAN, S., 2014, Effect of organic manures on growth and seed yield of tomato. *The Asian J. Hort.*, **4** (1): 281-282.
- NILEEMA, S. G AND SREENIVASA, M. N., 2011, Influence of liquid organic manures on growth, nutrient content and yield of tomato (*Lycopersicon esculentum* Mill.) in the sterilized soil. *Karnataka J. Agric. Sci.*, **24** (2) : 153-157.
- RAGNGANATHAN, D.S. and RANIPERUMAL, 1995, Effect of micronutrients with/without organic and bio- fertilizers on growth and development of tomato in Inceptisol and Alfisol. *South Indian Hort.*, **43**(3&4): 89-92.
- REDDY, V. C., 1999, Effect of urban garbage compost on growth and yield of tomato. *Current Research*, **28**: 43-44.
- RENUKA, B. AND RAVISHANKAR, C., 2001, Effect of organic manures on growth and yield of Tomato. *South Indian Hort.*, **49**: 216-219.
- SHIMBO, S., ZHANG, Z.W., WATANABE, T., NAKATSUKA, H., MATSUDA-INOGUCHI, N., HIGASHIKAWA, K. AND IKEDA, M., 2001, Cadmium and lead contents in rice and other cereal products in Japan in 1998-2000. *Sci . Envir.*, **281**: 165-175.
- RAJYA LAXMI P, SARAVANAN, S. AND LAKSHMAN NAIK, M., 2015, Effect of organic manures and inorganic fertilizers on plant growth, yield, fruit quality and shelf life of tomato (*Solanum lycopersicon* L.) C.V. PKM-1. *International J. Agril. Sci. Res.*, **5**(2): 7-15.
- VAMADEVA ANGADI, PRASHANT KUMAR RAI AND BINEETA M BARA., 2017, Effect of organic manures and biofertilizers on plant growth, seed yield and seedling characteristics in tomato (*Lycopersicon esculentum* Mill.), *J. Pharmacogn. Phytochem.* **6**(3): 807-810



PLATE 9: GENERAL VIEW OF FIBSOL PRODUCTS TESTING TRAIL IN Tomato – Kharif 2019



PLATE 10: GENERAL VIEW OF FIBSOL PRODUCTS TESTING TRAIL IN Tomato – Summer 2020



PLATE 13: T1 – CONTROL - TOMATO



PLATE 14: T9- ORGANIC PRODUCTION SYSTEM + FIBSOL NPK GEL- TOMATO

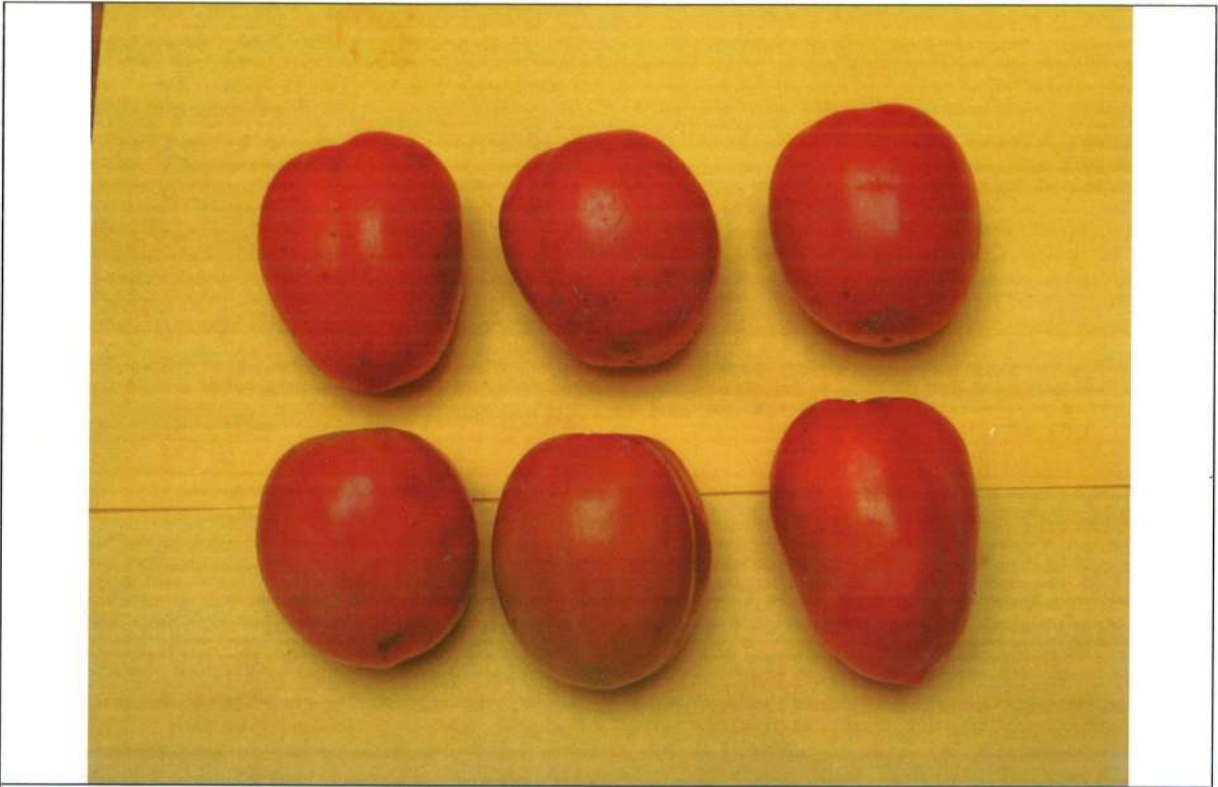


PLATE 15: T1 – CONTROL – FRUIT YIELD



PLATE 16: T9- ORGANIC PRODUCTION SYSTEM + FIBSOL NPK GEL- FRUIT YIELD