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# Evaluation of Inhana Rational Farming (IRF) technology as an effective organic package of practice – a case study from state horticultural research & development station, Krishnagar, Nadia, West Bengal

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**ABSTRACT**

*Application of synthetic fertilizers and toxic agro-chemicals with sole objectivity of higher productivity has led to nature's disequilibrium as reflected in the ineffective soil-plant relationship. This resultant uncertainty of crop due to increased incidence of pest/ disease vis-à-vis higher risk of pesticide contamination in food chain has compelled the scientists to revisit the sustainable farming approach. Present study was conducted in State Horticultural Research and Development Station, Krishnagar, Nadia, West Bengal; to evaluate Inhana Rational Farming (IRF) Technology (Developed by Dr. P. Das Biswas) as a comprehensive organic package of practice towards crop sustenance and soil quality development in comparison to conventional farming practice. Novcom compost was prepared from farm waste and cow dung (at 80 : 20 ratio) within 21 days and quality evaluation of end product indicated mature compost with no phytotoxic effect. Total NPK content of compost was found to be 5.12 percent on dry matter basis and huge population of self generated microbes was also noted in the order of $10^{16}$ c.f.u per gm moist compost. Presence of high microbial population can positively impact speedy soil rejuvenation leading to efficient soil-plant-nutrient relationships. Tomato (Solanum lycopersicum) and cabbage (Brassica oleracea Linn) representing vegetable and gladiolus (Gladiolus X hortulanus) representing flower were taken as test crops for the comparative study. In case of tomato and cabbage crop productivity was 29% and 19% higher under organic treatment as compared to chemically treated plots, similarly higher (8%) stick initiation was also documented in organic gladiolus plots. The findings indicated towards better soil-plant nutrient dynamics in plots receiving organic treatment under IRF Package of Practice. Study of growth performance of the different trial crops in terms of flower initiation, fruit setting, leaf size and yield/ plant etc., confirmed not only crop sustenance but also better effectivity of organic package (IRF) as compared to conventional practice in terms of soil quality development.*

**Key Words :** Organic package of practice, Novcom compost, organic vegetable, energization of plant system

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## INTRODUCTION

Organic farming has been deemed as the only pathway to root out the severe negativities unleashed by chemical farming practices on soil, plant and surrounding ecology. However, another belief that organic farming is better and perhaps necessary, but is a weaker option and becomes sustainable after long time lag is also slowly creeping in. This is due to continuous failure of input substitution theory i.e. replacing the chemical inputs by organic ones as

followed under the present organic practices, which results in both delayed or lesser effectivity and simultaneously huge hike in cultivation cost. To achieve sustainability, a comprehensive organic method is necessary, which will take into account the intertwined and interrelated relationships of the ecology [1]. In this scenario, Inhana Rational Farming (IRF) Technology has successfully demonstrated its potential as an economically sustainable organic package of practice in largest certified organic tea estate in Assam [2]. IRF was developed by Dr. P. Das Biswas, Founder Director of Inhana Biosciences and a noted scientist who was pioneering in introduction of Scientific Organic Farming in India from the last decade; is an unique Organic Package of Practice which blends ancient wisdom with scientific knowledge, ensuring an effective road map for successful and large scale organic agriculture [3]. IRF is an organic package of practice, which works towards (i) energization of soil system i.e., enabling the soil to function naturally and in the most effective way as an effective growth medium for plants and (ii) energization of plant system i.e., activation of plant physiology enabling better uptake, utilization and assimilation of nutrients as well as enhancement of structural and biochemical defenses or plants host defense mechanism against pests/diseases [4]. The present study aims to evaluate Inhana Rational Farming (IRF) Technology as an effective organic package of practice for agricultural crop production at State Horticultural Research & Development Station, Krishnagar, Nadia, West Bengal.

## MATERIALS AND METHODS

Evaluation of Inhana Rational Farming (IRF) Technology was done at State Horticultural Research & Development Station, Krishnagar, Nadia, West Bengal during the crop year 2007-08. As part of the project, Novcom compost was prepared with farm waste using Novcom Composting Method of Inhana Biosciences. Crop trial using tomato (*Solanum lycopersicum*, variety : Pusa Ruby), cabbage (*Brassica oleracea* Linn; variety : Hybrid Sanjiboni) and gladiolus (*Gladiolus X hortulanus*) was conducted at the government farm to evaluate the effectivity of IRF technology as an Organic Package of Practice. The experiment was laid down as per randomized block design (RBD) with 2 treatments replicated 4 times. In the chemical farming plots N, $P_2O_5$ and $K_2O$ were applied during final land preparation as per recommended dose in the form of urea, single super phosphate and muriate of potash,. In IRF treatments plots, suggestive soil and plant management protocol under IRF were followed. All the experimental plots received standard cultural practices. Treatment wise crop yield data of various experimental plots were analyzed.

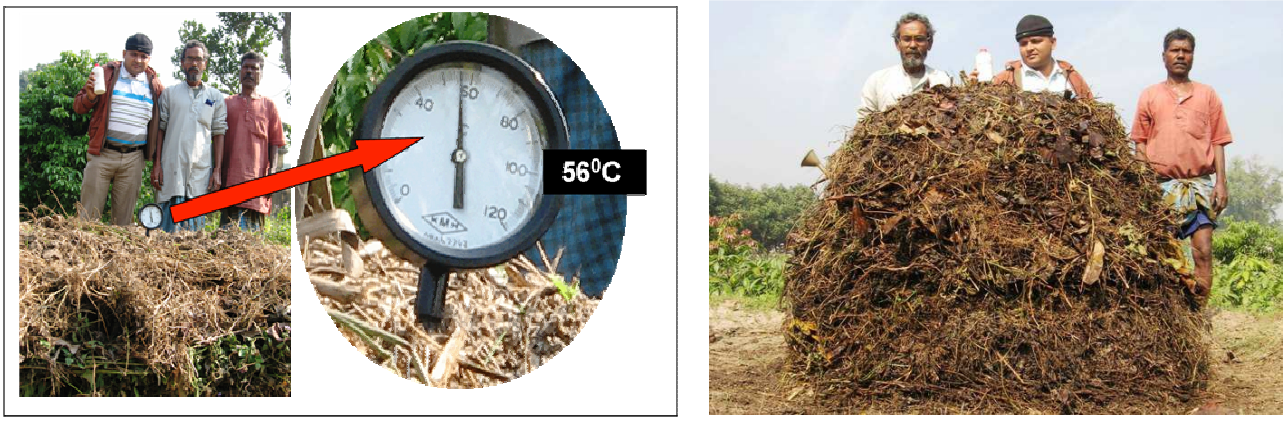
**Novcom composting programme at Horticultural Research & Development Station, Krishnagar:** Novcom compost was produced following Novcom composting method of Inhana Biosciences. Th end product Novcom compost forms the primary component of soil management IRF Technology. Novcom solution [5, 6] was used during composting process. Compost under this process is process is produced within 21 days time using green matter and cow dung as a raw materials.

***Raw materials used:*** Common farm weeds and cow dung at 80:20 ratio was used for making Novcom compost.

***Novcom solution:*** Biologically activated and potentized extract of Doob grass (*Cynodon dactylon*), Bel (*Sida cordifolia L*) and common Basil (*Ocimum bascilicum*). Details regarding Novcom solution is well documented by [7].

***Total requirement of Novcom solution:*** Total 250 ml Novcom solution is required for 1 ton of raw materials (100 ml on day 1 followed by 75 ml each, on day 7 and day 14).

**Preparation of Novcom compost:**
**Day 1 :** At a selected upland and flat area chopped green matter was spread to make a base layer measuring 10 ft. in length, 5 ft. in breadth and 1 ft. in thickness. This layer was sprinkled thoroughly with diluted Novcom solution (5 ml/ ltr. of water) and over this layer, a layer of cow dung (3 inches in thickness) was made followed by a second layer of chopped green material, once again 1 ft. in thickness. The green matter layer was once again sprinkled with diluted Novcom solution (5 ml/ ltr. of water) and the process was continued till the total height reached to about 6 ft. After construction of each layer of green matter it was compressed downward from the top and inward from the sides for compactness.




**Pic. 1 : Temperature hike of 56$^0$C within Novcom composting heap, at State Hort. Res. & Dev. Station, Krishnagar, Nadia, West Bengal**

**Day 7 :** On the 7th day compost heap was demolished and churned properly. The material was next laid layer wise and after making each layer diluted Novcom solution (5 ml/ ltr.) was sprinkled thoroughly as done on 1st day. After seven days the volume of the composting material decreased due to progress in decomposition process. Hence, to once again maintain heap height to about 6 ft.; length and breadth of heap were altered to 6 ft. x 6 ft. respectively. The heap was once again made compact as described earlier.

**Day 14 :** The same process was repeated as on day 7 and to maintain heap height to about 6 ft., the length and breadth of the heap was further altered to 6 ft. x 4 ft. respectively.

**Day 21 :** The composting process was complete and compost was ready for use.

**Analysis of compost samples:**
Physicochemical properties of compost *viz.* moisture content, pH, electrical conductivity and organic carbon were analyzed according to the procedure of [8]. The total N, P and K in compost were determined using the acid digestion method [9]. Estimation of bacteria, fungi and actinomycetes was performed using Thornton's media, Martin's media and Jensen's media respectively, according to standard procedure [10]. Stability tests for the compost ($CO_2$ evolution rate, phytotoxicity bioassay test/germination index) were performed according to the procedure suggested by [8]. Cress (Lepidiun sativum L.) seeds were used for the phytotoxicity bioassay test.

**Inhana Rational Farming (IRF) Technology**
Inhana Rational Farming (IRF) Technology has been developed by an eminent Indian Scientist, Dr. P. Das Biswas, associated with organic research for the last 15 years and pioneer of comprehensive organic technology for sustainable organic crop production. The technology provides a nature receptive pathway for crop production taking into account the interrelated and integrated relationships of all the components of the ecosystem, which ultimately leads to ecological improvement thereby ensuring economic sustainability. IRF is probably the only package of practice which provides complete solutions for organic farming from seed showing to harvesting in an effective and economic manner [11]. The technology offers:

**A. Complete scientific guidelines for successful organic farming.**
- Recycling of on-farm/ locally available resources through production of high quality compost within the shortest period of 21 days and at the lowest cost.
- Organic seed treatment and healthy nursery development- potential for better crop and quality
- Customized package for individual crop/ group of crops.
- Activation of plant physiology to support higher crop
- Effective pest and disease management by attaining ecological balance and activating plants Host- Defense mechanism against pest.

**B. Regeneration of Soil Quality within Shortest Time Frame for Meeting Desired Crop Yield.**
**C. Guideline for Sustainable Crop Production under Reduced Chemical Application.**

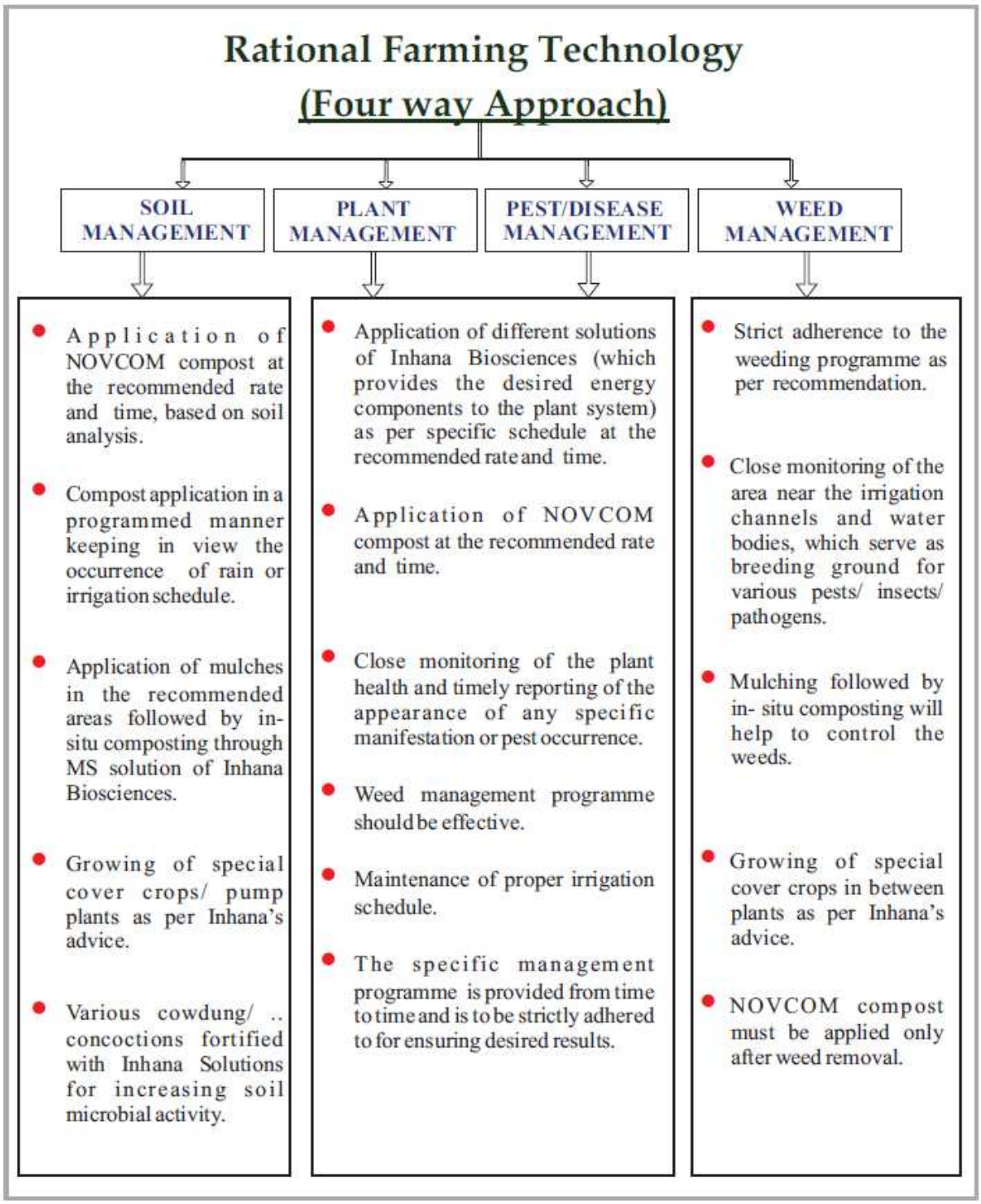



**Fig. 1 : Flow diagram showing working mechanism of IRF Technology**

**Element- Energy Activation (E.E.A.)® Principle**
**Brief details :** All living bodies are like machines and the vital driving force or energy behind them is "Chaitanya Shakti" or Basic Life Force. Solar energy is the manifestation of "Chaitanya Shakti". Except at birth and at death, two major processes (Nourishment & Self protection) are going on in every living body.

**Self-Nourishment** – Five basic elements (Panchamahabhutas) Soil, Air, Water, Fire and Space take care of nourishment till time we Humans do not interfere with these qualities, it performs without any problem. The individual element responsible or role of Panchamahabhutas for specific mechanism of nourishment are as follows.

**Earth :** Nutrition and structure formation.
**Water :** Transportation of nutrients for transpiration.
**Fire :** Metabolism, Ripening of fruits, Photosynthesis.
**Air :** Respiration

**Space :** Making space available for any bio-chemical reaction .
The self-defense mechanism is said to be controlled by five different Life Forces or Prana-Shaktis. These are originated from the basic life-force i.e., Solar energy. The life forces or Prana-Shaktis are actually vehicles of these basic elements and movement of nutrients is impossible without them. Their role within the plant system are as follow.

**Apana Prana :** Controls the function of roots extraction of nutrients.
**Samana Prana :** Controls transpiration.
**Udana Prana :** Controls Photosynthesis and secretion of enzymes, hormones.
**Prana Prana :** Controls respiration and eases movement of respiratory products.
**Vyana Prana :** Makes space available for all functions.

**Self protection –** If there is any imbalance in sub functions like structure, formation, circulation, metabolism etc. as well as nourishment then the whole system tries to protect itself. This self-defense mechanism is controlled by five different Life Forces or Prana Shaktis. All these process, functions and sub-functions are interdependent and operate in an orchestral manner, in nature. Any imbalance leads to the disease or pest manifestation or lack of nourishment. According to EEA® Principle to overcome the disease or pest infestation, life forces are to be stimulated instead of encountering from outside leading to unfavourable repercussions. Similarly, deactivated plant system can't uptake, assimilate or utilize the stored and applied nutrients in an effective manner. Addition of nutrients can't change the phenomenon for which life forces are to be added.

**Objectivities of Inhana Rational Farming (IRF) Technology**
A. **Energization of Soil System i.e., enabling the soil to function naturally and in the most effective way as an effective growth medium for plants :** Soil is not an inert matter but is enlivened by millions of microorganisms that inhabit the soil. These numerous (both macro and micro) tiny organisms work towards the conversion, utilization and assimilation of stored and applied nutrients in soil, which are the life ingredients for plant system. Energization of soil system mainly aims for restoration, proliferation and reactivation of these living components of soil primarily through the application of Novcom compost.

**Novcom compost produced under Novcom composting method is**
- The fastest composting method which completes in just 21 days.
- Any type of biodegradable matter can be used as raw material.
- Most economic production cost i.e., less than Rs. 1.00 per kg compost.
- Novcom compost possesses huge population of naturally generated microbes.
- Better quality hence, requirement is less as compared to any other organic manure.

**Novcom compost has three way action :**
- It improves the physical properties of soil *viz*. soil aggregates, porosity, bulk density, water holding capacity as well as gradually restricts soil erosion.
- Enables proper growth by ensuring balanced supply of nutrients to plant at the desired time and in required quantity, through activation of soil nutrient dynamics.

➢ Eradicates soil pathogens and encourages enhancement of beneficial soil microflora to increase inherent soil productivity.

B. **Energization of Plant System towards optimum extraction, utilization and assimilation of nutrients as well as enhancement of biochemical and structural defenses of the plants for activated host- defense mechanism against pest/ disease :** A healthy soil will always ensure healthy plants but in the present scenario where plants have lost their inherent capacities of drawing nutrients from soil due to long term exposure to synthetic chemicals, along with predominance of designed varieties that are totally dependant on fertilizers, this theory fails to be functional. Hence, IRF recommends energization of plant system to regenerate the two lost qualities of plant system, i.e. (i) Sense of Self- Nourishment & (ii) Sense of Self – Protection.

To energize, stimulate and activate the plant system IRF recommends various potentized and energized botanical solutions developed by Inhana Biosciences, which work under Element - Energy - Activation (E.E.E.) principle.

➢ The potentized and energized solutions of Inhana Biosciences add up energy components to energize, stimulate and activate physiological and biochemical functions of plant system.
➢ Enhancement of plant physiological functions enables better uptake, assimilation, and translocation of macro and micro nutrients during different developmental stages of the plant.
➢ Activation of physiological and biochemical functions also stimulates the secretion of different growth hormones within plant system in required quantity at specific growth stages, supporting natural development and activating Host Defense mechanism of the plants against pest.
➢ Stimulation of the bio-chemical functions also leads to release of specific enzymes within plant system that not only provides relief form biotic and abiotic stress but also relieves from injury due to natural calamity.

Most interestingly these solutions do not add up any element from outside but only provides the desired energy to bring back normalcy from the deactivated stage. Hence, these solutions are very different from any other available organic/ biological/ herbal products.

**Solutions Developed Under Rational Farming Technology**
'Inhana solutions' are developed on 'Energy Element Activation (E.E.A.)' Principle. These solutions are vastly different from any other herbal formulation considering that they contain Energy Components in Activated Forms. Radiant solar energy is stored in plants and this binding stored energy components are extracted from energy rich plant parts by a specific extraction procedure and subsequently potentized in the order of $10^3$ to $10^4$, so that the Activated Energy Forms release the Energy Components when sprayed on the Plant System. Hence, these potentized and energized botanical extracts do not add any element from outside but only provide the necessary energies for activation of plant physiology, towards better nutrient uptake/ utilization and better Host- Defense mechanism of the plant system.

**Seed and Nursery Management Solution**

| Plant management (for plant physiological development) | | | |
|---|---|---|---|
| **Sl.No** | **Solution Name** | **Biologically activated & potentised extract of** | **Role in Plant Physiological Development** |
| 1. | Seed Solution I | Hyoscyamus niger & Embellia ribs | Cell expansion and hydrolysis of food reserve in the endosperm. |
| 2. | Seed Solution II | Calotropic procera R. & Tinospora crispa | Photosynthesis enhancement and increased uptake of organic and inorganic solutes through roots. |
| 3. | IB (Ag)-1 | Ficus hispida Linn. | Initiation of metabolic resources during germination. |
| 4. | IB (Ag)-2 | Erythrina Variegate Linn. | Faster independence of seedling from the seed reserve. |
| 5. | IB (Ag)-3 | Alstonia schlaris R. | Leaf photosynthesis and uptake of inorganic solutes. |

**Plant Management Solutions**

| Plant management (for plant physiological development) | | | |
|---|---|---|---|
| **Sl No** | **Solution Name** | **Biologically activated & potentised extract of** | **Role in Plant Physiological Development** |
| 1. | IB 1 (Samridhi) | *Hyoscyamus niger, Ficus benghalensis &* *Dendrocalamus strictus Nees.* | Organic growth promoter, activator and regulator<br>1. Energizes and stimulates the plants system for the best use of nutrients both applied and stored in the soil.<br>2. Regulates every stage of the Grand Growth Period influencing growth correlation. |
| 2. | IB 2 (Immunosil) | *Ocimum sanctum, Calotropic procera R. & Cynodon dactylon* | Silica induced immunity against fungal attack<br>1. Activates plants' host defense mechanism through silica management providing structural defense against fungal pathogens.<br>2. It also stimulates plants immune system by activating the biosynthesis of different phenolic compounds having fungi-toxic property. |
| 3. | IB 3 (OrganiK) | *Adhatoda vasica Nees, Zingiber officinale Roscoe & Embellia ribs.* | Organic solution for potash absorption and utilization<br>1. Increases the efficiency of potash uptake through energized root capacity, so that gradual reduction in application is ensured.<br>2. It activates suction pressure by influencing diffusion pressure deficit. |
| 4. | IB 4 (OrganiN) | *Calotropis Procera R., Dendrocalamus strictus Nees & Bombax malabaricum D. C.* | Ensures biological absorption of atmospheric-N directly by plant.<br>1. Helps the plant to utilize the atmospheric nitrogen. It also balances the quantity of nitrogen in the plant system at the right time, thereby preventing deleterious effect on quality of the produce.<br>2. Ensures gradual reduction of chemical nitrogen application. |
| 5. | IB 5 (Solution I) | *Cynodon dactylon & Calotropic gigantean.* | Energizes the various biochemical process of plant resulting in harmonious grand growth period.<br>1. Regulates and stimulates the cellular oxidation process.<br>2. Energizes the phloemic function resulting in encouraged translocation of organic solutes. Stimulates the hydrolysis of starch to D-Glucose units by enhancing the enzymatic activity. |
| 6. | IB 6 (Solution II) | *Hyoscyamus niger & Solanum Verbascifolium* | Energizes and activates respiration and photosynthesis activity and plays complementary role of solution-I<br>1. Energizes respiration by activating the protoplasmic factors and the concentration of respiratory substrate.<br>2. Stimulates the rate of photosynthesis by quick translocation of carbohydrates. |
| 7. | IB 7 (Solution PP5) | *Ocimum sanctum* | Stimulates the root function, activates root growth/ penetration and energizes soil in the root zone thus improves soil-plant relationship.<br>1. Develops the CEC of soil.<br>2. Energizes the production of micro-flora and bio-flora around the root zone.<br>3. Improves the degree of base saturation to the desired level.<br>4. Enhances the Root Cation Exchange Capacity.<br>5. Stimulates the root growth and penetration by activating the Contact Exchange Capacity of the Root. |
| 8. | IB 8 (Atermit) | *Solanum verbascifolium, Prosopis spicigera & Ocimum bascilicum.* | Organic solution for termite management.<br>1. It has both controlled and contained action. It restricts the movement of termites.<br>2. Repels termite activity by influencing thermostatic environment of the soil. |
| 9. | IB 9 (ZXN) | *Albizzia maranguihses, Biscifia javanica &* *Erythrina Variegate Linn.* | Ensures enhanced photosynthesis and balances respiration<br>1. It influences the action spectrum and absorption spectrum of plants.<br>2. It enhances or activates Xanthophills. |
| 10. | IB 10 (Special Solution I) | *Costus specicus sm. & Typhora indica mer.* | Improves plant transport by deliberating essential substances to the various internal mechanism. |
| 11. | IB 11 (Special Solution II) | *Solanum xanthocarpum schard & Aristolochia indica Linn.* | Improves the movement of solutions by providing systemic presence to give structural integrity. |
| 12. | IB 12 (Special Solution III) | *Sida Cordifolia Linn. & Barberis asiatica Roxb. Ex. De.* | Improves the plant's capacity for starch synthesis. |

**Pest and Disease Management Solutions**

| Plant management (for pest/ disease management) | | | |
|---|---|---|---|
| **Sl No** | **Solution Name** | **Biologically activated & potentised extract of** | **Role in Plant Physiological Development** |
| 1. | IB 13 (Sp. Immunosil1) | *Ficus racemosa Linn. & Calotropuc procera R.* | **A**ctivates necrosis or hypersensitive defense system by disintegrating the hypha. |
| 2. | IB 14 (Sp. PP5) | *Ocimum sanctum & Costus specicus sm.* | **I**mprove root health and activates apoplastic and symplastic mechanism. |
| 3. | IB 15 (CDS – F) | *Veronica cineria Less. & Solanum verbascifolium (Root &stem)* | **I**mproves and fortifies the cow dung and cow urine concoction towards better toxicity removal and plant sanitization effect. |
| 4. | IB 16 (CDS – G) | *Veronica cineria Less. & Solanum verbascifolium (Root)* | **I**mproves and fortifies cow dung and cow urine concoction for faster organic activity in the surface soil. |
| 5. | IB 17 (KPS) | *Prosopis spicigera & Costus specisus sm.* | **A**ctivates karanj seed and cow urine concoction for anti-ovulatory effect on Helopeltis Theivora. |
| 6. | IB 18 (Sp. Immunosil 2) | *Barberis asiatica Roxb. Ex. De., Ficus racemosa Linn., Ocimum sanctum & Cynodon dactylon* | **I**nfluences the cell wall swelling, thereby inhibits host penetration and infection by pathogens. |
| 7. | IB 19 (Jay Vijay) | *Bombax malabaricum D.C., Calotropic procera R & Ocimum bascilicum.* | **O**rganic pest management<br>1. An organic pest repellant with anti-feedant action.<br>2. It activates the Plants Host Defense Mechanism.<br>3. It enhances Environmental Resistance and reduces the Biotic Potential. |
| 8. | IB 20 (Sp. Jay Vijay) | *Bombax malabaricum D.C., Calotropic procera R, Ocimum bascilicum. & Biscifia javanica* | **A**ctivates plant system for enhanced secretion of phytoalexins particularly pisatin and orchinol. |
| **Other concoction recommended for organic pest management** | | | |
| 9. | Micronized sulphur (MS) and Jay Vijay (JV) concoction | | For mite control |
| 10. | Lime sulphur and Jay Vijay (JV) concoction | | For mite control |
| 11. | Neem oil (NO), Karanj oil (KO) and Jay Vijay (JV) concoction | | For control of different types of leaf sucking and chewing pests |
| 12. | Neem oil (NO), cow urine and Jay Vijay (JV) concoction | | For control of different types of leaf sucking and chewing pests |

**Analysis of soil samples :**

Surface soil samples from 0 to 25 cm soil depth were collected from all the experimental plots, air dried, ground in a wooden mortar and pestle and passed through 2 mm sieve. The sieved samples were stored separately in clean plastic containers. Soil physicochemical and fertility status were analyzed as per standard methodology (Black, 1965).

## RESULTS AND DISCUSSION

Novcom compost sampled from Krishnagar farm, was analyzed for physical, chemical, microbiological, stability and maturity parameters as per standard protocol of U.S. Composting Council, 2002 [12]. All the compost samples appeared dark brown in colour with an earthy smell, deemed necessary for mature compost [13]. The data revealed that moisture percent and bulk density were higher than the standard whereas the water holding capacity was within limits. The higher value of porosity was indicative of good quality compost (Table 1).

**Table 1 : Physical parameters of Novcom compost.**

| Sl. No | Parameter | Analytical value | Reference range |
|---|---|---|---|
| 1. | Moisture percent (%) | 65.0 | 35 - 55 |
| 2. | Bulk density (g/cc) | 0.81 | 0.40 – 0.70 |
| 3. | Porosity (%) | 41.86 | - |
| 4. | Water holding capacity ( | 69.71 | 75 - 200 |

The alkaline pH (8.1) of compost facilitated an effective fermentation process whereas high EC value (i.e. 2.873) indicated its high nutrient status which was further substantiated through fertilizer analysis. The total volatile solids as well as organic carbon content of compost were within the stipulated range considered for compost maturity whereas the high value of CEC indicated higher conversion potential. The mineralization index value showed a value greater than 1.0 (i.e., 1.67), indicating compost stability as also suggested by [14]. High sorption capacity index (i.e., 11.18), substantiated greater ion exchange capacity of compost thereby indicating higher post application effectivity (Table 2).

**Table 2 : Chemical parameter of Novcom compost**

| Sl. No | Parameter | Analytical value | Reference range |
|---|---|---|---|
| | **Chemical parameters** | | |
| 1. | $pH_{water}$ (1 : 5) | 8.10 | 5.0 – 8.5 |
| 2. | EC (1 :5) dS/m | 2.873 | < 4.0 |
| 3. | Total volatile solids (%) | 51.84 | 30 - 70 |
| 4. | Organic carbon (%) | 28.80 | 16 - 38 |
| 5. | CEC ($cmol(p^+)kg^{-1}$) | 321.9 | 36.9– 228.6 |
| 6. | Buffering capacity ($meqH^+L^{-1}$) | 98.0 | - |
| 7. | Compost mineralization index | 1.67 | 4.38 – 0.80 |
| 8. | Sorption capacity index | 11.18 | - |

Nitrogen content in normally available green plants i.e., farm weeds etc. varies from about 1.1 to 1.5 percent while in cow dung it is present in much lower concentration (~0.8%). But Novcom compost produced using commonly available weeds contained higher total nitrogen percent (i.e., 2.1%) indicating fixation of atmospheric nitrogen by naturally generated autotrophic microorganisms. This is once again confirmed by high population (in the range of $10^{16}$ c.f.u.) of microbes in Novcom compost as also confirmed by several other workers [15, 16, 17, 7, 18, 19 & 20]. Analysis also revealed that total phosphate and potash content of compost were much higher than the reference range [21, 22]. Hence compared with the standard range of N, P & K as suggested for quality compost, the values obtained for Novcom compost indicated its rich nutritional quality. The C/N ratio of compost also substantiated the finding (Table 3).

**Table 3 : Nutritional parameters of Novcom compost**

| Sl. No. | Parameter | Analytical value | Reference range |
|---|---|---|---|
| **Nutritional parameters** | | | |
| 1. | Total nitrogen (%) | 2.10 | 1.0 – 2.0 |
| 2. | Total phosphate (%) | 1.12 | 0.6 – 0.9 |
| 3. | Total potash (%) | 1.90 | 0.2 – 0.5 |
| 4. | C/N ratio | 14 : 1 | 10.0 – 20.0 |
| **Water extract components** | | | |
| 5. | Water soluble carbon (%) | 6.88 | - |
| 6. | Water soluble inorganic nitrogen (%) | 0.13 | 0.011– 0.021 |
| 7. | Water soluble organic nitrogen (%) | 1.22 | - |
| 8. | Organic C/N ratio | 5.1 | 5 - 6 |

Microbial status of compost is one of the most important parameter for judging compost quality because microbes are the driving force behind soil rejuvenation as well as crop sustenance through maintenance of soil – plant – nutrient dynamics [1]. The microbial population (in the order of $10^{16}$ c.f.u to $10^{14}$ c.f.u in case of total bacteria, total fungi and total actinomycetes count) in Novcom compost (Table 4) was significantly higher (at least $10^3$ to $10^6$ c.f.u times) than the population obtained in case of other compost samples. This status forms the most important criteria of Novcom compost since the uniqueness in terms of fastest conversion, high and balanced nutrients dynamics, desirable EC etc. are the benefits which can be contributed only by the presence of such huge microbial population. The microbial biomass content was much below the critical level for compost maturity. This was also supported by the C/N ratio of compost water extract (5.1) which was within the range of standard value (i.e., 5—6).

**Table 4 : Microbial potential & biomass carbon**

| Sl. No. | Parameter | Analytical value | Reference range |
|---|---|---|---|
| 1. | Total bacteria (per gram moist compost) | $92 \times 10^{16}$ | - |
| 2. | Total fungi (per gram moist compost) | $18 \times 10^{16}$ | - |
| 3. | Total actinomycetes (per gram moist compost) | $12 \times 10^{16}$ | - |
| 4. | Microbial biomass carbon (%) | 1.36 | < 1.7 % (mature) |

$CO_2$ evolution rate of compost (3.8) indicated its stability. Compost maturity and phytotoxicity rating were also assessed considering that they are one of the most important criteria for ensuring soil safety post compost application [23]. Analytical interpretation of Novcom compost revealed that it satisfied the critical limit for $NH_4^+$- N (i.e.,<0.04) and $NO_3^-$- N (i.e.,>300). Test results of Novcom compost revealed that percent seed germination and

root elongation over control were 98.3 and 99.7 respectively (Table 5), indicating that the compost was very mature with no phototoxic effect. The germination index value (i.e., 0.83) also confirmed that Novcom compost enhanced rather than impaired germination and radical growth [8].

**Pic. 2 : Dr. Ranajoy Dutta, Assistant Horticulturist and Sajal Shit, Fruit Biochemist of State Horticulture and Development Station inspecting the experiment for evaluation of IRF Package of Practice at Krishnagar Farm**

**Table 5 : Stability, maturity & phytotoxicity rating**

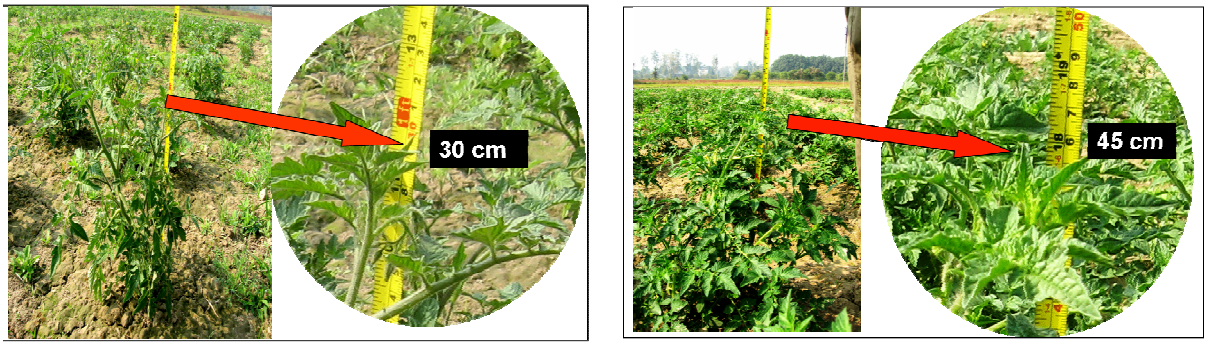
| Sl. No. | Parameter | Analytical value | Reference range |
|---|---|---|---|
| **Stability** | | | |
| 1. | $CO_2$ evolution rate ($mgCO_2$ – C/g OM/day) | 3.8 | Stable (2 – 5) |
| **Maturity** | | | |
| 2. | $NH_4^+$ - Nitrogen (%) | 0.03 | < 0.04 % (stable) |
| 3. | $NO_3^-$ - Nitrogen ($mgkg^{-1}$) | 413 | > 300 (mature) |
| 4. | Nitrification index ($NH_4^+$ - N : $NO_3^-$ - N) | 12.9 : 1 | 0.03 to 18.9 (mature)<br>< 7.14 (mature) |
| **Phytotoxicity (germination test)** | | | |
| 5. | Seedling emergence (% of control)<br>Original [10x dilution] | 98.3 | > 90<br>(no phytotoxic effect) |
| 6. | Root elongation (% of control)<br>Original [10x dilution] | 99.7 | > 90<br>(no phytotoxic effect) |
| 7. | Germination index (phytotoxicity bioassay)<br>Original [10x dilution] | 0.83 | 1.0 – 0.8<br>(No inhibition of plant growth) |

**Table 6 : Agronomic Parameters of Tomato under Conventional and Organic (IRF Package of Practice) treatments at State Horticultural Research & Development Station, Krishnagar, Nadia, West Bengal**

| Treatments | Agronomic Parameters | | | |
|---|---|---|---|---|
| | Plant Height (cm) | No. of Branches | Flower Initiation (%) | Fruit Initiation (%) |
| Age of Tomato Plants : 8 weeks | | | | |
| Conventional (Chemical Practice) | 25 cm | 5 -6 | 16.66 % | - |
| Organic (IRF Package of Practice) | 25 cm | 5 - 6 | 13.89 % | - |
| Age of Tomato Plants : 9 weeks | | | | |
| Conventional (Chemical Practice) | 30 cm | 6 - 7 | 58.3 % | - |
| Organic (IRF Package of Practice) | 45 cm | 7 - 8 | 75.0 % | 5.55 % |
| Age of Tomato Plants : 11 weeks | | | | |
| Conventional (Chemical Practice) | 52 cm | 8 - 10 | 86.1 % | 38.9 % |
| Organic (IRF Package of Practice) | 61 cm | 11 - 12 | 97.2 % | 58.3 % |
| Age of Tomato Plants : 12 weeks | | | | |
| Conventional (Chemical Practice) | 56 cm | 9 - 10 | 100.0 % | 66.7 % |
| Organic (IRF Package of Practice) | 64 cm | 12 - 14 | 100.0 % | 94.4 % |

**Agronomic growth performance of Tomato (*Solanum lycopersicum*)**

Comparative growth performance of tomato *viz*. plant height, branches per plant, initiation of flowers and fruits etc. were periodically observed and documented (Table 6). In case of all the treatments plant height steadily increased up to 90 days after which it some what slowed down. Number of branches in each plant also increased with time, where the organically treated plants showed comparatively higher numbers than the chemically treated ones.




**Pic. 3: Growth of tomato plant in conventional and organic treatment plots (after application of Inhana Solutions) in State Hort. Res. & Dev. Station, Krishnagar, Nadia, West Bengal**

But a significant fact noted was early initiation of flowers as well as fruits in organically treated plants as compared to the chemically treated ones. The findings indicated positive influence of organic solutions under IRF towards plant physiology which might have induced favourable crop response. Another major difference observed during the study was longer fruit bearing period under organic treatment as compared to the chemically treated plots. The findings indicated better plant physiological functioning under organic cultivation where solutions under IRF definitely played an important role. Similar effect of IRF plant management package (Inhana solutions) towards plant physiology was noted by other workers [18].

**Pic. 4: Crop load for organically treated tomato plants at Krishnagar Horticultural Farm**

At the same time, average mass of fruits (tomato) at harvestable stage was significantly higher in case of organically treated plants (90 gm/ fruit) as compared to chemically treated plots (80 gm/ fruit). Crop productivity per plant was also 29% higher under organic treatment (3.15 kg/plant) as compared to chemically treated plots (2.24 kg/plants). The finding indicated towards better soil-plant nutrient dynamics in plots receiving organic treatment under IRF Package of Practice. Increase in tomato yield under organic treatment might be due to better nutrient mineralization (in the presence of higher soil microbial population) [2] *vis-à-vis* their efficient uptake and utilization by plants due to activation of plant physiology (as influenced by application of different Inhana Solutions) [3].

**Agronomic growth performance of cabbage (*Brassica oleracea* Linn)**

To evaluate the performance of cabbage under conventional chemical practice *vis-à-vis* organic package of practice (i.e., IRF), agronomic parameters like number of leaves, length of leaves and percent ball formation; was noted. Evaluation of agronomic growth parameters at 8$^{th}$, 9$^{th}$ and 11$^{th}$ week post sowing indicated significant plant growth under organic treatment as compared to chemically treated plots (Table 7).

**Pic. 5 : Spraying of Inhana Plant Management Solutions under organic (IRF) treatment at State Hort. Res. & Dev. Station, Krishnagar, Nadia, West Bengal**

**Table 7 : Agronomic Parameters of cabbage under conventional and organic (IRF Package of Practice) treatment at State Hort. Res. & Dev. Station, Krishnagar, West Bengal**

| Treatments | Agronomic Parameters | | |
|---|---|---|---|
| | Av. No. of leaves | Length of leaves | Ball formation |
| Age of Tomato Plants : 8 weeks | | | |
| Conventional (Chemical Practice) | 9 - 10 | 6 – 7 inch | - |
| Organic (IRF Package of Practice) | 9 - 10 | 6 – 7 inch | - |
| Age of Tomato Plants : 9 weeks | | | |
| Conventional (Chemical Practice) | 14 - 15 | 8 - 9 | - |
| Organic (IRF Package of Practice) | 15 - 16 | 9 - 10 | - |
| Age of Tomato Plants : 11 weeks | | | |
| Conventional (Chemical Practice) | 18 - 20 | 8 - 10 | 50 % |
| Organic (IRF Package of Practice) | 22 - 24 | 11 - 12 | 58.3 % |
| Age of Tomato Plants : 12 weeks | | | |
| Conventional (Chemical Practice) | 28 - 30 | 10 - 12 | 75.0 % |
| Organic (IRF Package of Practice) | 35 - 38 | 12 - 14 | 85.4 % |


**Pic. 6 : On-field soil quality measurement in cabbage experimental plots at State Hort. Res. & Dev. Station, Krishnagar, Nadia, West Bengal**

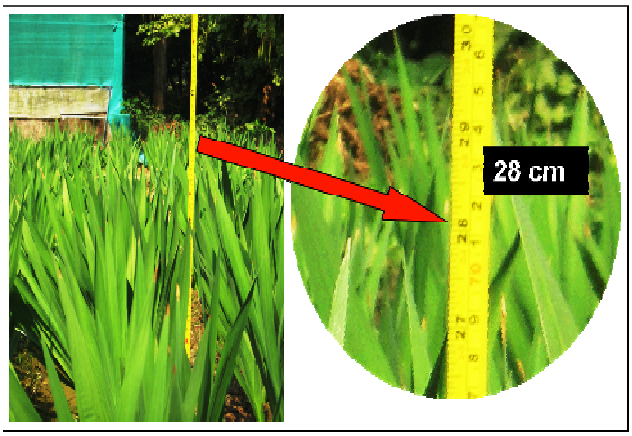
At twelve weeks post sowing 21% more number of leaves and 15% higher leaf size were recorded under organic treatment as compared to chemically treated plants. Also 85.4% ball formation was observed in organically treated plots as compared to 75.0% noted in case of chemically treated plots. About 12% more ball formation in organically treated plots may have been induced by IRF plant management package which work towards activation of plant physiology leading to harmonious growth. Agronomic growth noted in case of both the treatments was well corroborated with their respective crop yield. Average weight of mature cabbage in organically treated plots was

1.54 kg as compared to 1.25 kg in conventionally treated plots, which means about 19% higher value in case of the former. Similar results in organically treated plots under IRF Package of Practice *vis-a-vis* conventional treatment were also observed by other workers for tomato, paddy, okra, greengram and blackgram [2, 3, 11, 24].

**Agronomic growth performance of gladiolous (*Gladiolus X hortulanus*)**

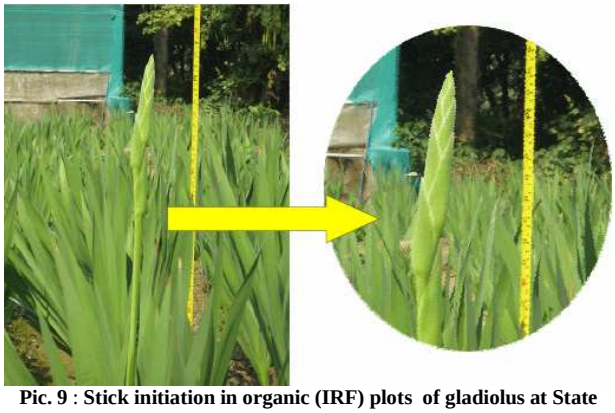
Gladiolus was taken as a test crop for comparative growth study under conventional and organic (IRF) package of practice. Organic management of flower was aimed at higher number of sticks, longer shelf life and brighter colour. Agronomic parameters in terms of plant height and percent stick initiation were studied at 6$^{th}$, 8$^{th}$, 9$^{th}$ and 11$^{th}$ week post sowing. At 8$^{th}$ week, plant height in organically treated plots was 2 inches more than conventional plots, but stick initiation was yet to take place under both the treatments. At 9$^{th}$ week significant difference in plant height was noted between organic (IRF) and chemically treated plots.

**Pic. 7 : Spraying of Inhana Plant Management Solutions in organic (IRF) treatment plots of gladiolus at State Hort. Res. & Dev. Station, Krishnagar, W.B.**




**Pic. 8 : Growth of gladiolus in Organic plots under application of Inhana Solutions at State Hort. Res. & Dev. Station, Krishnagar, W.B.**

Plant height was 6 to 7 ″ inches higher (average height of plants in organic plots were 28 inches *vis-à-vis* 22 inches for conventional plots) in organic plots as compared to their conventional counter parts. At 11$^{th}$ week, stick initiation was noted in case of both the experimental plots.



**Pic. 9 : Stick initiation in organic (IRF) plots of gladiolus at State Hort. Res. & Dev. Station, Krishnagar, Nadia, West Bengal**

8 percent more number of sticks were noted in organically (IRF Package of Practice) treated plots as compared to conventional treatment (stick initiation was 30.6% in organic plots where as 22.2% for conventional plots). IRF package of practice was once again found to induce better agronomic growth as compared to conventional treatments. This might be due to application of Inhana Plant management solutions which works towards activation of plant physiology leading to better nutrient utilization efficiency.

**Table 8 : Physico-chemical properties and fertility status of soils of experimental plots**

| Experimental Plots | Soil physicochemical properties | | | | Soil fertility parameters | | |
|---|---|---|---|---|---|---|---|
| | pH ($H_2O$) | EC (1 : 5) | Org. C (%) | Texture | N | $P_2O_5$ | $K_2O$ |
| | | | | | < ---- ($Kgha^{-1}$) ---- > | | |
| Tomato (*Solanum lycopersicum*) | | | | | | | |
| Conventional (Chemical Practice) | 6.8 | 0.065 | 0.59 | cl | 472 | 64.4 | 320.7 |
| Organic (IRF Package of Practice) | 6.7 | 0.058 | 0.60 | cl | 485 | 68.3 | 333.4 |
| Cabbage (*Brassica oleracea* Linn) | | | | | | | |
| Conventional (Chemical Practice) | 6.7 | 0.055 | 0.63 | cl | 447 | 67.1 | 372.3 |
| Organic (IRF Package of Practice) | 7.2 | 0.071 | 0.61 | cl | 455 | 66.5 | 342.4 |
| Gladiolous (*Gladiolus X hortulanus*) | | | | | | | |
| Conventional (Chemical Practice) | 6.7 | 0.056 | 0.60 | cl | 440 | 61.3 | 354.2 |
| Organic (IRF Package of Practice) | 6.8 | 0.073 | 0.69 | cl | 438 | 62.6 | 348.5 |

Analysis of soil samples from the different treatment plots indicated neutral pH value ranging from 6.7 to 7.2 along with clay loam surface texture. Electrical conductivity of the soils ranged from 0.055 to 0.073 indicating absence of soil salinity. Organic carbon status of the soils was found to be medium ranging from 0.59 to 0.69 percent. Evaluation of soil fertility revealed medium status of available nitrogen and phosphate, with high content of available potash.

## CONCLUSION

Evaluation of Novcom compost and Inhana Rational Farming® (IRF) Technology at Krishnagar Farm indicated their effectivity towards meting out the set objectivities within shortest possible time. Analytical interpretation of Novcom compost also defined its uniqueness in terms of higher nutritional content which meant same effectivity even at low application rate, while maturity and phytotoxicity bioassay confirmed positive influence towards seed germination and seedling growth. However, the main strength of Novcom compost was defined by its microbial potential of $10^{16}$ c.f.u., which is one million billion times higher than any good quality vermicompost. As microbes are the main driving force behind almost every soil function starting from soil formation to its nutrient dynamics, these naturally generated and huge microflora population in Novcom compost could bring about soil rejuvenation within shortest time frame at affordable economics.

Effectivity assessment of Inhana Rational Farming® (IRF) Technology as an organic package for vegetables and flower cultivation revealed better performance as compared to conventional (chemical) practice. Observation of growth performance of the different trial crops in terms of flower initiation, fruit setting, leaf size and yield/ plant etc., confirmed not only crop sustenance but also better effectivity of organic package (IRF) as compared to conventional practice; if the same is implemented from crop initiation. Hence, dissemination of IRF, which ensures crop sustainability without any cost hike even from the very initial year of organic conversion, could bring forth a conclusive road map for large scale organic crop production in a sustainable manner.

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