# BIOTROPICAL HORTICULTURE: INTEGRATED AND PERSONALIZED PRODUCTION OF VEGETABLES, FRUITS AND THEIR ALLIES

***Hugo Ramirez-Guerrero*. Crop Science Department, Agronomy Faculty. Universidad Centroccidental Lisandro Alvarado (UCLA). Cabudare, Lara State of Venezuela. February 2018.**

## SUMMARY

**HEALTH will always be the first factor determining our quality of life, even if we do refer to the health of any organism on this planet. The loss of health is a direct consequence of the inheritance, aging, nutrition, lifestyle and the particular characteristics of the resources and the environment that surround us. The prevention and solution to all these growing health problems has always focused on the application of orthodox and foreign paradigms, which were created in and for different latitudinal regions, where DIVERSITY does not play a crucial role. It is especially referred to Chronic Non-communicable Diseases (CNCDs), and its direct connection with human nutrition. Numerous evidences show that the wonderful BIODIVERSITY of natural resources in subtropical and temperate regions is not exposed as in the tropics to the diverse and erratic changes that occurred during each day of the year. In this sense, here an invitation to rethink a little beyond the traditional, continue to learn from it and integrate it in the rescue, enrichment and conservation of this still rich TROPICAL Biodiversity with the introduction of a BioTropical Horticulture as a personalized agricultural system by local needs and challenges.**

## INTRODUCTION

The current reality shows us that in every tropical corner of this wonderful planet, an irrational application of the different foreign models of education, research, extension and production in Agriculture continues to occur. Similar situation with Agriculture is notable with other applied sciences such as Medicine, Engineering and Architecture, among many others. That is, we have a very important population in the world that has structured its form, quality of life and its production systems with the use of technologies and inputs that were not initially created for their own environment. With this paper, I would like to encourage you to rethink a bit beyond the current models, without having to exclude them, but rather, continue to learn from them and integrate them in favor of this still very rich LOCAL BIODIVERSITY. Thus, now is the time to initiate the transition towards strengthening and improvement of a Nutrition, Health (Vegetal, Animal, Human) and an Agricultural Production (BioTropical Horticulture) really tailored with local latitude, conditions, situations, needs, resources, inputs and realities.

## BIOTROPICAL HORTICULTURE

For several decades, the quality of soil, water and crop resources has been explored, as well as the diversity, availability, integration and adaptation of technologies and inputs necessary for regional and national horticultural/agricultural production. Here, we have adopted the principles and good examples of traditional, natural, ecological, conventional, sustainable, integrated and organic agriculture, permaculture and agroecology among others. In addition, it takes as reference the valuable evolutionary knowledge of the rich tropical gastronomic biodiversity that´s in harmony with the development of several applied research projects, such as "Aurora Tropical" case carried out with local horticultural producers.

In this sense, in the search of an agricultural - horticultural system really adapted and integrated with local challenges and needs, the BioTropical Horticulture is born as a system of food production from the "***Seed to the Plate and beyond***", adjusted according to latitude, biodiversity and other local human and natural resources. Currently, in agreement with local growers, the BioTropical Horticultural management of several commercial crops is applied (Tables 1, 2, 3 and 4).

Table 1. Integrated and Personalized Solanaceaes management, case greenhouse BELL PEPPER.

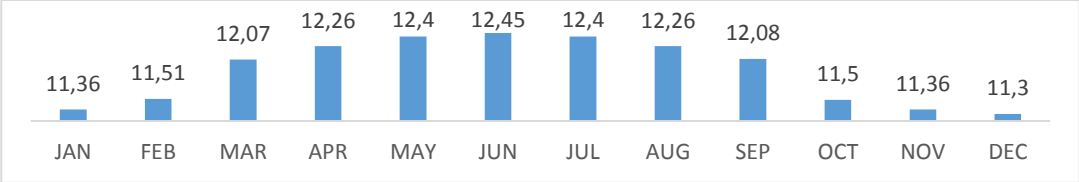
<table>
<tr><td>Climate and Biodiversity of Natural Resources</td><td colspan="4">It is fundamental to know local climate conditions and the rich biodiversity. We must explore locally the flora, fauna, natural enemies, pests and potential limitations (weeds, insects, diseases, others). Additionally we need to be aware of climatic information of the past and present with predictions (duration of the day, temperature, rainfall, humidity, wind). Including a good knowledge of the crop to be produced, as well as the quality and quantity of the soil or growth media (soil, substrate) and irrigation water.</td></tr>
<tr><td>Key example: Trend of day length (daylight hours/day) in Duaca (Lara state), 2017</td><td colspan="4"> 
</td></tr>
<tr><td>Seeds and Seedlings</td><td colspan="4">Use seeds and seedlings of bell pepper known, certified, appropriate and adapted to the relevant area and planting season, as well as the applied horticultural system (greenhouses, other technologies). It is important to keep informed, updated, learning and ready to the exploration of new cultivars (local, heirloom, tropical), propagation systems and new inputs.</td></tr>
<tr><td>Crop setting (Integrated Tillage and Irrigation)</td><td colspan="4">Explore, establish and adapt new population densities, planting systems (big plants and grafting, direct sowing, others) and some good horticultural practices (Soil hilling, raised beds or furrows, pruning, trellising, mulching). Promote aerial and soil biodiversity using live barriers, cover, repellents, allies, traps or companions crops (sunflower, cilantro, basil), either around the main crop or intercropped. Maintain free of weeds and floods (flooded areas) the internal and external environments of the greenhouses o field crop areas.</td></tr>
<tr><td rowspan="2">Crop cycle (days after transplant - dat)</td><td>Seedling Growth and development</td><td>A: Vegetative Growth (postransplant)</td><td>B: Development: Flowering and Fruiting</td><td>A + B + Production: Ripening and Harvests</td></tr>
<tr><td>30 – 40 days</td><td>40 - 60 days and continues to rely on management</td><td>Beginning of Flowering (~ 30 dat) and fruiting (~ 40 dat)</td><td>First harvest ~ 70 dat and more than 30 crops depending on management</td></tr>
<tr><td>Buenas Practicas Hortícolas</td><td>Integrated Irrigation, Fertilization and Pests Management (IIFPM)</td><td>IIFPM, Soil Hilling, Mulching, Pruning of shoots, flowers, branches, stems and leaves. Plant training (trellising).</td><td>IIFPM, Soil Hilling, Pruning of branches or stems (quantity to define) and leaves. Plant training (trellising).</td><td>IIFPM, Pruning of shoots, fruits (harvests), leaves. Plant training (trellising).</td></tr>
<tr><td>Plant Nutrition and Fertilization (Tables 2 and 3)</td><td>Water + OMNTD (Organic and Minerals Nutrients to Discover) + Phosphorus + micronutrients</td><td>Water + OMNTD + Nitrogen (N) + Calcium (Ca) + Magnesium (Mg) + Sulphur (S) + micronutrients</td><td>Water + OMNTD + Potassium (K) + Ca + Mg + micronutrients (Boron, Zinc, Molybdenum…)</td><td>Water + OMNTD + N + P + K + micronutrients</td></tr>
<tr><td>Insect Pests</td><td>Leaf miners, Fungus gnat, mites, thrips</td><td>Mites, thrips, aphids, whiteflies, worms and caterpillars</td><td>Whiteflies, thrips, worms and caterpillars</td><td>Whiteflies, thrips, worms and caterpillars</td></tr>
<tr><td>Diseases</td><td>Fungus, bacteria</td><td>bacteria, fungus (Mildews, fusarium), nematodes</td><td>bacteria, fungus (Mildews, fusarium), nematodes</td><td>Mildews, fumagine</td></tr>
<tr><td>Harvests, Market and culinary uses</td><td colspan="4">A good vegetable grower knows in advance the requirements of the market, consumers and cooks. She/he also estimates its yields, harvest days, prices and is willing to give benefits (added value) to the final product, whether fresh or processed.</td></tr>
</table>

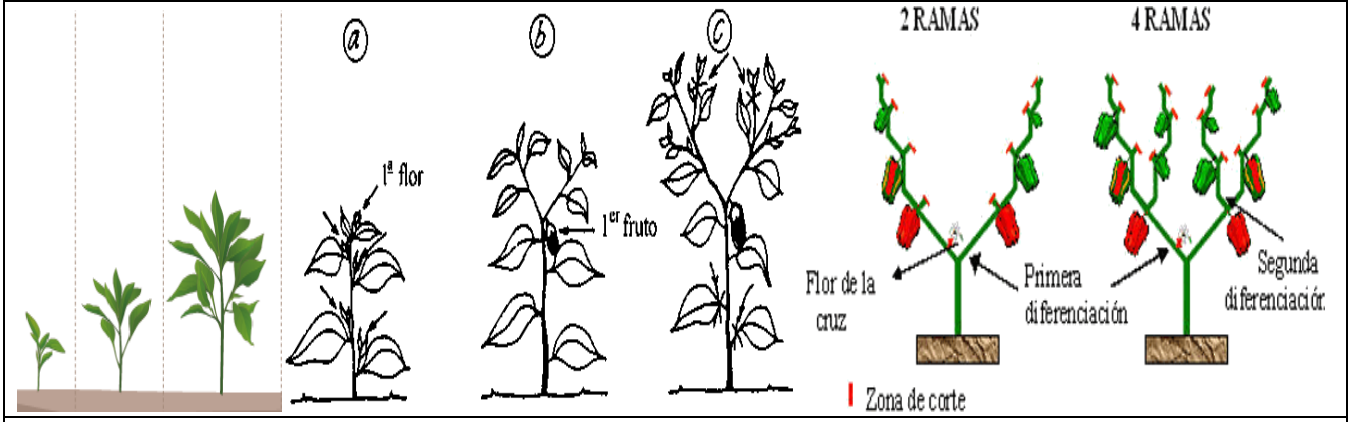
Table 2. Personalized nutrition and health plan of bell pepper under greenhouse in Duaca (Lara).

**SOIL QUALITY:** Medium levels of OM and Mg. The EC (salinity) and pH with alkaline tendency. High and very high levels of P, K, Carbonates and Ca. Soil of Clay-Loam texture.

**Bell pepper NUTRIENT REQUIREMENTS of** N, $P_2O_5$ and $K_2O$, soil availability and actual nutrient requirements to obtain approximate yields of 75 ton/hectare (ha) or 10 kg fruits/plant:

| (kg/ha) | N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|
| **Crop needs** | 205 | 71 | 444 |
| **Soil nutrients** | 75 | 147 | 500 |
| **Actual needs** | 130 | - | - |

**RECOMMENDATION:** Improve the physical-chemical-biological soil quality (integrated tillage and manual and localized incorporation of organic-mineral amendment). Subsequent Integrated Fertiirrigation Plan (IFP). The time of application of Nitrogen and other macro and micronutrients will depend on the crop cycle and climate (See IFP). The application of Nitrogen for the crop will correspond to 60% during its vegetative period and 40% after fruiting starts (cycle A). ***The Integrated Irrigation, Fertilization and Pests Management (IIFPM) will include a planning of Good Horticultural Practices (Soil hilling, mulching, shoots pruning and plant training or trellising among others).***




**Integrated Fertiirrigation (Fertigation) Plan (IFP)**

| **0 – 15 dat** | **16 – 40 days after transplanting (dat)** | **41 – 45 dat** | **Cycle A: 46 – 80 dat, Cycle B: 81 - $X^n$ dat** |
|---|---|---|---|
| Checking entry and supply of irrigation water. As well as the adaptation and irrigation efficiency and seedlings setting. Start of daily organic fertiirrigation events. Use diverse biofertilizers (Preferable acid tendency). In addition use **beneficial microorganisms** (Trichoderma, bacteria, mycorrhizae, EM, others). | Starting with a daily application of Organic (OF) - mineral (MF) Fertiirrigations. The doses of OF will be those indicated by the manufacturing industries. The application of mineral fertilizers (FM) will be 40 kg of Nitrogen / ha during this period. It is estimated that more than 20% of nitrogen and other nutrients are contributed by the great variety of biofertilizers, biostimulants and amendments (compost, others) applied. | *Only irrigation water at a lower volume or quantity. ***To promote the initiation and uniformity of flowering and fruiting.** | **A:** Daily application of Organic (OF) - mineral (MF) Fertiirrigations. During this period, the application of mineral fertilizers (FM) will be 20 kg of Nitrogen / ha + 50 kg $K_2O$. **B:** Daily application of Organic fertilizers (OF) - minerals (MF) fertirrigations. These fertiirrigation events have to be updated and adjusted by then. |

**Orgánic Fertilizers** (OFs): Biostimulants, Biofertilizers and/or Humic substances (Local commercial brands such as Melagro40, HVR15, Makron, Gold12, Biol Forte, Vida, CarboVit, Fitofol, Nutrivit, Nutri K, Biofert Humic, Biofert 96, Terra Humus, Venagro-Chitosan), Lime Sulphur and some other amendments and substances (compost teas, vinasses, extracts) to explore, including solid and liquid ones for foliar, fertigation, drench and edaphic uses.

**Mineral Fertilizers** (MFs): Urea, URFOS (Urea Phosphate), Potassium nitrate, formulas and others to explore, including **foliar fertilizers (micronutrients), acids (Phosphoric, nitric), gypsum and Silicon among others.**

**"PROMOTING AND STRENGTHENING THE BIODIVERSITY OF SOIL, CROP AND ITS ENVIRONMENT"**

Table 3. Organic and Mineral Fertigation Schedule. Crop: Bell Pepper (Hybrid Magistral - Seminis, USA)

| dat | Fertigation doses (1/4 ha) | dat | Fertigation doses (1/4 ha) |
|---|---|---|---|
| 1 - 15 | 1 L/day assorted Bio substances | 51 | 1 L Venagro + 2 kg $KNO_3$ |
| 16 | 1 L Biol Forte (BF) +1 kg Urea (U) | 52 | 1 L Gold+1kg UF +1kg $KNO_3$ |
| 17 | 1 L Melagro + 2kg U-$PO_4^{3-}$ (UF) | 53 | 1 L Terra Humus + 2 kg $KNO_3$ |
| 18 | 1 L NutriVit + 1 kg U + 1 kg $KNO_3$ | 54 – 55 | Only Water (Saturday & Sunday) |
| 19 | 1 L HVR15 + 1 kg Urea | 56 | 1 L Biofert96 + 2 kg $KNO_3$ |
| 20 - 21: | Only Water (Saturday & Sunday) | 57 | 1 L NutriK + 1 kg U + 1 kg $KNO_3$ |
| 22 | 1 L Makron + 1 kg Urea (U) | 58 | 1 L Lime Sulphur + 2 kg $KNO_3$ |
| 23 | 2 L Vinasse + 1 kg U + 1 kg UF | 59 | 1 L BF +1kg UF +1kg $KNO_3$ |
| 24 | 1 L Fitofol .+ 1 kg Urea | 60 | 1 L Melagro + 2 kg $KNO_3$ |
| 25 | 1 L Vida .+ 1 kg U + 1 kg $KNO_3$ | 61 – 62 | Only Water (Saturday & Sunday) |
| 26 | 1 L Venagro + 1 kg Urea | 63 | 1 L NutriK + 2 kg $KNO_3$ |
| 27 - 28 | Only Water (Saturday & Sunday) | 64 | 1 L HVR15 + 1 kg U + 1 kg $KNO_3$ |
| 29 | 1 L Gold .+ 1 kg Urea | 65 | 1 L Lime Sulphur + 2 kg $KNO_3$ |
| 30 | 1 L CarboVit +1 kg U +1kg UF | 66 | 1 L Makron+1kg UF +1kg $KNO_3$ |
| 31 | 1 L Biofert96 + 1 kg Urea | 67 | 3 L Vinasse + 2 kg $KNO_3$ |
| 31 | 1 L NutriK + 1 kg U + 1 kg $KNO_3$ | 68 – 69 | Only Water (Saturday & Sunday) |
| 32 | 1 L Lime Sulfhur + 1 kg Urea | 70 | 1 L Fitofol + 1 kg $KNO_3$ |
| 33 – 34 | Only Water (Saturday & Sunday) | 71 | 1 L Vida + 1 kg $KNO_3$ |
| 35 | 1 L Biol Forte .+ 1 kg Urea | 72 | 1 L Venagro + 1 kg $KNO_3$ |
| 36 | 1 L Melagro +1 kg U +1kg UF | 73 | 1 L Gold + 1 kg $KNO_3$ |
| 37 | 2 L NutriVit .+ 2 kg Urea | 74 | 1 L Terra Humus + 1 kg $KNO_3$ |
| 38 | 2 L HVR15 +2kg U +3kg $KNO_3$ | 75 – 76 | Only Water (Saturday & Sunday) |
| 39 | 2 L Biol Forte (BF) + 2 kg Urea | 77 | 1 L Biofert96 + 0.5 kg $KNO_3$ |
| 40 - 43 | Only Water (less volume & time) | 78 | 1 L NutriK + 0.5 kg $KNO_3$ |
| 44 | No irrigation | 79 | 1 L Lime Sulphur + 0.5 kg $KNO_3$ |
| 45 | 2 L Makron + ***Trichoderma*** | 80 | 1 L Biol Forte (BF) + 0.5 kg $KNO_3$ |
| 46 | 1 L BiofertH + 2 kg $KNO_3$ | 81 | 1 L Melagro + 0,5 kg $KNO_3$ |
| 47 – 48 | Only Water (Saturday & Sunday) | 82 – 83 | Only Water (Saturday & Sunday) |
| 49 | 1 L Fitofol .+ 2 kg $KNO_3$ | 84 - $X^n$ | Daily organic - mineral fertiligation doses for updating and adjusting |
| 50 | 1 L Vida .+ 1 kg U + 2 kg $KNO_3$ | | |

**REMARKS**

**1.** Transplanting date: October 30, 2017.

**2.** Integrated fertigation start at 16 days after transplanting (dat). Maintain fertilizer sequence regardless of the start date of fertigation. Saturdays and Sundays only water**. Daily pH & electrical conductivity (EC) monitoring of water & nutrients solution (Example: Table 4).**

**3.** At 37 dat; fertilizer doses will be increased for three days. **Integrated Foliar Fertilizations will also be scheduled and applied.** Additionally, Soil and Crop´s Health and Nutrition should be monitored.

**4.** From 40 to 43 dat only water applied. Water volume and Irrigation time will be reduced and should be "Subject to check-up"

**5.** At 44 dat no irrigation will be applied. Then at 45 dat a new nutrition plan will be adjusted, including others diverse and integrated foliar fertilization.

**6.** At 84 dat an update, adjustment and the respective new fertigation plan will be carried out.

***PLAN SUBJECT TO MODIFICATION, ADJUSTMENT AND UPDATING BY CLIMATE AND HEALTH OF SOIL AND CURRENT CROP AMONG OTHERS**

Table 4. BioTropical Horticulture in the Production of Leafy Vegetables in Cabudare, Lara State.

**BACKGROUND**

- ✓ Campolara C.A. is a local horticultural company with more than 20 years in the production and market of minimally processed vegetables: specifically leafy vegetables using hydroponics system in substrate (mainly peat). The main items that are produced are Arugula, Basil, several types of Lettuce, Peppermint, Mint, Cilantro, Parsley, Ciboulette, Spinach and Various Aromatics (Thyme, Rosemary, Dill, Salvia, others).
- ✓ The total average cycle of most leafy vegetables in production is equivalent to 45 days (15 days in seedling production and 30 days for the first harvest or final product).
- ✓ Due to the current critical situation of the country, the grower has found certain limitations to find an appropriate diversity of mineral fertilizers. Consequently, according to our recommendation since October 2017, the producer has been producing the leafy vegetables following an integrated and personalised plan under BioTropical Horticulture, including mainly an organic - mineral fertilization (fertigation and foliar).
- ✓ Taking into account the wide variety of leafy vegetables in production all year round, an average nutrient solution for their daily application was established. The new fertilization schedule is shown below.

**Daily Schedule by week of Organic and Mineral Fertigation in Leafy Vegetables**

| Date | Hydro soluble Fertilizers (Composition / doses[1]) | pH | Electrical Conductivity (dS/m) |
|---|---|---|---|
| Monday | Triple 18 (18% N, 18% $P_2O_5$, 18% $K_2O$ / 300 g) + Potassium Nitrate (13% N, 46% $K_2O$ / 200 g) + URFOS 44 (17% N, 44% $P_2O_5$ / 300 g) + Terra Humus (Annex 1/ 1 L). | 5.83 | 1.60 |
| Tuesday | Triple 18 (300 g) + Potassium Nitrate (200 g) + URFOS 44 (200 g) + Melagro (Annex 1 / 1 L). | 5.62 | 1.68 |
| Wednesday | Triple 18 (300 g) + Potassium Nitrate (200 g) + URFOS 44 (300 g) + NutriVit (Annex 1 / 1 L). | 5.80 | 1.55 |
| Thursday | Triple 18 (300 g) + Potassium Nitrate (200 g) + URFOS 44 (200 g) + Biol Forte (Annex 1 / 5 L). | 5.90 | 1.50 |
| Friday | Triple 18 (300 g) + Potassium Nitrate (200 g) + URFOS 44 (300 g) + Fitofol (Annex 1 / 1 L). | 5.65 | 1.70 |
| Saturday | Triple 18 (300 g) + Potassium Nitrate (200 g) + URFOS 44 (200 g) + Lime Sulphur (Annex 1 / 2 L). | 5.95 | 1.61 |
| Sunday | Only irrigation water | - | - |

***[1]Each dose is diluted and mixed in 1000 L of water. There are usually two fertigation events per day. If the climate demands it, there is another irrigation event but it will only be with water. In addition, at least 2 organic-mineral fertilizations are applied during crop cycle by foliar way.***

# PRELIMINARY RESULTS

✓ Quantities and Costs for fertilizers and other inputs have decreased relatively with respect to the conventional hydroponics system previously used. A similar situation is evident with the production of the other crops, such as bell pepper and tomato in the greenhouse and crops at open field condition (potato, maize, soybean, others).

✓ Yields and pre and post-harvest quality of most horticultural products (bell pepper, tomato, potato, leafy vegetables) have improved considerably.

✓ In general terms, it can be observed that Health and Nutrition of the Growing Medium / Soil, Crops and the Tropical Environment has been significantly strengthened.

**Annex 1.** Some chemical characteristics of humic substances (HS, **MADE IN VENEZUELA**) used in BioTropical Horticulture (**Think Global Go Local**: Globalized Production integrating Local Resources).

| HS | pH | EC dS/m | OM % | N-NH3 % | P % | K % | Ca % | Mg % | S % | Mn ppm | Fe ppm | Cu ppm | Zn ppm | Cl ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fitofol** | 9.6 | 36 | 0.53 | 0.147 | 0.1013 | 1.55 | 0.04 | 0.0020 | 0.04 | 2 | 693 | 409 | 49 | 493 |
| **NutriVit** | 12.2 | 22 | 1.21 | 0.001 | 0.0056 | 0.81 | 0.01 | 0.0025 | 0.07 | 12 | 196 | 18 | 113 | 332 |
| **Terra Humus** | 12.7 | 46 | 1.4 | 0.001 | 0.0001 | 2.15 | 0.02 | 0.0004 | 0.003 | 18 | 1365 | 2 | 2 | 250 |
| **Makron** | 13 | 44 | 0.69 | 0.176 | 0.0008 | 0.42 | 0.05 | 0.0050 | 0.06 | 57 | 169 | 30 | 75 | 230 |
| **HVR** | 13.3 | 138 | 0.38 | 0.230 | 0.0726 | 0.25 | 0.01 | 0.0020 | 0.02 | 2 | 72 | 0 | 90 | 2383 |
| **Gold 12** | 11.1 | 60 | 0.8 | 0.002 | 0.6083 | 0.47 | 0.01 | 0.0005 | 0.02 | 1 | 44 | 1 | 8 | 147 |
| **Melagro** | 4.2 | 120 | 36.67 | 0.180 | 0.1434 | 1.15 | 0.15 | 0.0800 | 0.13 | 459 | 221 | 246 | 66 | 8307 |
| **Vinasse** | 4.6 | 20 | 1.52 | 0.001 | 0.0001 | 0.34 | 0.08 | 0.0190 | 0.08 | 1 | 23 | 3 | 38 | 1259 |
| **Biol Forte** | 4.7 | 7,6 | 0.44 | 0.001 | 0.0031 | 0.09 | 0.04 | 0.0345 | 0.08 | 4 | 54 | 1 | 188 | 460 |
| **Lime Sulphur** | 10.8 | 38 | - | - | <1 | 0.004 | 0.78 | - | 2.94 | 3 | 1 | 0 | 1 | 101 |
| **CarboVit** | 9.3 | 28 | - | - | - | 0.25 | 0.11 | 0.03 | - | 19 | 704 | 0 | 0 | - |

**** EC: electrical conductivity; OM: organic matter and NH3-N: Ammoniacal nitrogen.***

| HS | OTHER CHARACTERISTICS (MAIN SOURCE) |
|---|---|
| **Fitofol** | **Potassium Humate (water-soluble liquid), obtained from the alkaline extraction of Leonardite: oxidized lignite. Enriched with organic and mineral substances.** |
| **NutriVit** | **Potassium Humate (water-soluble liquid): Leonardite. Enriched with organic and mineral substances.** |
| **Terra Humus** | **Potassium Humate (water-soluble liquid), obtained from the alkaline extraction of organic sludge (by-product in the purification process of the waters of the Caroni river).** |
| **Makron** | **Potassium Humate (water-soluble liquid): Leonardite. Enriched with organic and mineral substances.** |
| **HVR** | **HS enriched with organic and mineral substances.** |
| **Gold 12** | **HS enriched with organic and mineral substances.** |
| **Melagro** | **HS of sugarcane molasses base enriched with organic and mineral substances.** |
| **Vinasse** | **HS by-product of the process of extracting alcohol from sugarcane molasses.** |
| **Biol Forte** | **Liquid vermicompost. After traditional vermicomposting process, it is processed in the form of Compost tea and enriched with organic and mineral substances.** |
| **Sulphur Ca** | **Sulphur and agricultural Lime (Calcium Carbonate) solution.** |
| **CarboVit** | **Humate - Leonardite + others. (IMPORTED FROM MEXICO)** |

**NOTE: For additional information and references in full text, consult the website:**

# www.horticulturatropical.org