ENSAYO DE NUEVOS FERTILIZANTES

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KIMITEC COMPARATIVE STUDY
UREA versus ESPARTAN

Comparative trial between the Nitrogen fertilisation with UREA and the fertilisation with ESPARTAN (KIMITEC) and the effect on the development and production of tomato plant, var. Pitenza, in none modify soil.

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ABSTRACT

The following trial was made due to the need of looking for some alternative fertilization to the nitrogenous fertilization with urea and, in that way, avoids problems derived from the urea use such as loss of efficiency of application, phyto-toxicity or increase of the plant sensibility against diseases.

These problems get improved with **ESPARTAN**'s application from the following approaches:

1.- IMPROVEMENT OF THE SOIL: **ESPARTAN** is a strong soil improver due to the fact that contribute with organic matter, as well as humic and fulvic acids. The product improves the development of the plant and reduces the mortality of the plant because produces a rooting growth and reduces the water logging.

2.-REDUCTION OF PESTICIDES APPLICATIONS: On having contributed a more balanced nutrition, the plants develop the self-defences against external aggressions.

3.-OTHERS: **ESPARTAN** contributes, apart from the nitrogenous fertilization, with other elements as phosphorus (increases the flowering and consequently the production), potassium (increases the fruit consistency giving them better post harvest life) and other elements as calcium, magnesium or amino acids that improve the plant activity in adverse conditions.

All these factors, previously mentioned, affect on other two parameters, which ended up by having major importance for the producer. These two parameters are:

INCREASE OF PRODUCTIVITY AND QUALITY: the results of this study show that **ESPARTAN** produce and increase in productivity and quality of 13,58% comparing with the same treatment with Urea. The results also show that the fruits were obtained with less accumulated active matters and with a major post harvests life.

COST REDUCTION: This reduction in the cost is due to the number of applications with phyto-sanitary products are lower.

1.- INTRODUCTION

1.1.- UREA description.

Urea, as well called carbamide, carbonyldiamide or arbamidic acid, is the name of the carbonic acid of the diamide. The chemical formula is $(NH_2)_2CO$. It is a nitrogenous substance produced by some living being as way of elimination of the ammonia, which is highly toxic for them. In the animals it is found in the blood, urine, bile and sweat.

Urea appears like crystalline solid and white colour with spherical or granular form. It is a hygroscopic substance, so it can absorb water from the atmosphere and it presents a slight smell of ammonia.

It is possible to find Urea in different presentation such as pellets, granule, dissolved, depending on the application.

Molecular Weigh	60.06 g/mol
Density	768 Kg/m^3
Melting Point	132.7 ºC
Melting Heat	5.78 to 6 cal/gr
Heat of Combustion	2531 cal/gr critical relative humidity (to 30°C): 73%
Calcium Carbonate equivalent	84 (Parts of calcium carbonate needed to neutralize the acidification effect of 100 parts of urea)
Salinity Index	75.4
Heat of Dissolution (in water)	57.8 cal/gr (endothermic)
Free energy of formation to 25 ºC	47120 cal/mol (endothermic)
Corrosivity	Highly corrosive to the steel and carbon. Little to the aluminium, zinc and copper. Non corrosive to the glass and special steels

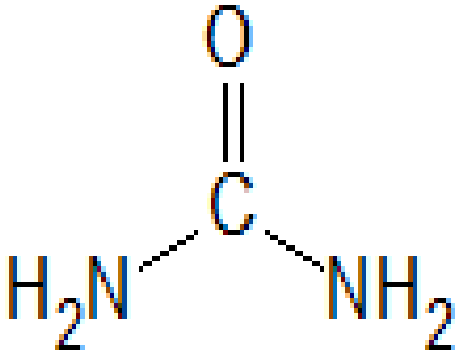
Chart 1: Urea Physical Properties

The urea is one of the most used nitrogenous fertilization. Some of the reasons that explain its general use are: the cheap price, the high concentration of nitrogen (N) for product unit (46 % of N) and the great solubility in the edaphic solution.

Nevertheless, the efficiency of its use it is reduced due to the following factors:

● Loss of Nitrogen (N) due to ammonia (NH_3) **volatilization.**

● **Phyto-toxicity** due to the high doses of Urea together with the seed..



Picture 1: Urea Molecule **Picture 2: Urea granule**

● **Urea reaction in the soil and volatilization process.**

In soils with pH major that 6.3 (what is very common), Urea is hydrolysed when it is applied to the soil, obtaining as products of the reaction ammonium (NH_4 +) and bicarbonate anion (HCO_3-). The ammonium liberated in the Urea hydrolysis stays in dynamic balance with the ammonia of the atmosphere:

$$NH_4^+\ (\text{Adsorbido}) \rightleftharpoons NH_4^+ + OH^-\ (\text{Sol. Suelo}) \rightleftharpoons NH_3 + H_2O\ (\text{Sol. Suelo}) \rightleftharpoons NH_3\ (\text{Atm.})$$

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The hydrolysis generates a pH increase around the urea granule because of the protons consumption. This pH increase displaces the balance

of the ammonium and ammonia favouring the volatilization of the NH_3 to the atmosphere.

The factors that regulate the ammonia volatilization are represented in the following chart:

Soil Factors	Use of fertilizers Factors
• Ureasic activity • Temperature • Water content • pH and buffer capacity • Cationic interchange capacity (CIC) • Air interchange	• Application method • Fertilizer's source and dose • Presence of residues • Use of inhibitors

Chart 2: Factors that regulate the ammonia volatilization.

● **Phyto-toxicity by ammonia**

If high quantities of urea are applied close to the seed, it is possible to produce seed's damage or inhibit the germination due to the ammonia's phyto-toxic action.

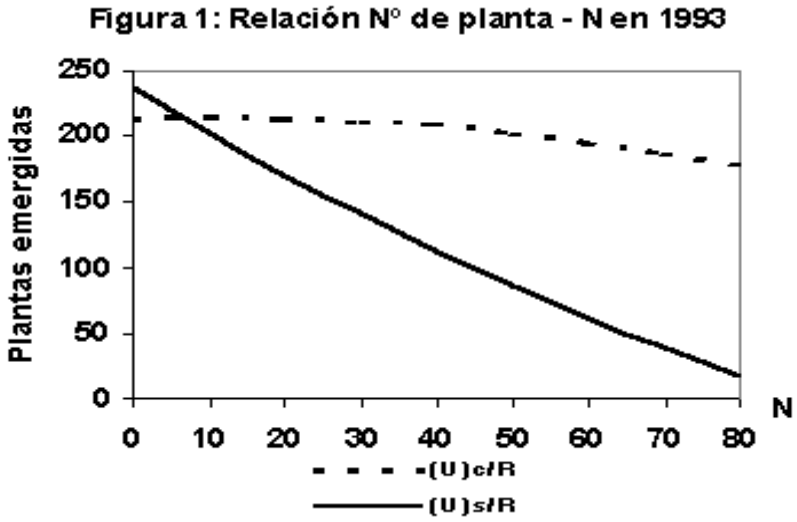


Figure 1: Relation between the Nitrogen applications as UREA with the emergency of wheat seed.

1.2.- ESPARTAN Description

ESPARTAN is a product formulated from organic matter obtained of selected vegetables. The product stimulates the development of the green organs and fruits of the plants in adverse situations.

Product rich in organic material obtained from the concentration of vegetal remains that covers all nutritional necessities of the cultures. It also contributes with elements like N (3,35%), P (3,76%), K (3,22%), Ca, Mg, Fe and natural substances bio stimulants such as amino acids, betaines, proteins, enzymes and vitamins.

It can be used as quick source of nitrogen, in the moments of maximum vegetative activity (budding, flowering, growth and fructification) and in the recovery of diseases, frosts and hailstorms. Thus it can be applied in all kinds of cultures.

The colour of the product is black - brown typical of the organic matters. The density is 1.24 gr/cc and the pH is 5.36.

ESPARTAN is a product obtained after several fermentations of molasses of beet, which have not been modified genetically, in the manufacture of alcohol in which extraction ammonia products are not in use.

ESPARTAN is a product that has to be applied to the soil and the main effect is to correct the lack of organic matter, since the intensive cultures produce decreases in the levels of organic matter. The product improves the soil texture and structure, favours the plant metabolism, increases the development of the roots, returns the microbial life and favours the nutrients absorption.

All these effects are provided by the humic and fulvic acids properties that are contained in the vinasse and that are contributed by ESPARTAN.

In general, ESPARTAN's effects can be divided in two: Effects on the soil and effects on the plant.

I. EFECTS ON THE SOIL

An important and fundamental fraction of the materials that form the soil is the organic matter or humus. The organic part of this soil represents itself a complex system of diverse substances such as humic substances or humic acids and fulvic acid. These humic and fulvic acids they join the clay particles to form the clay-humic complex that provides sponginess to the soil, increasing the soil permeability and aeration and better absorption and water retention. This improvement of the aeration provides the entry of oxygen and, as consequence, the micro organism population is increased in the soil. Likewise the improvement in the structure of the soil favours the correct aeration of the roots.

Humic and fulvic acids will give major tampon power to the soil avoiding problems come from sudden pH alterations in the rhizosphere and, at the same time, the clay-humic complex increase powerfully the absorption capacity of nutritive cations.

Humic and fulvic acids have also the capacity to form complex and intracomplex compounds with cations as iron, calcium, copper, etc. These cations are normally immobilized in the soil and, due to the great capacity of humic and fulvic acids of cationic exchange, they are used as store or reserve of these nutrients staying at the disposal of the plant. For all this reasons, humic and fulvic acids contained in **ESPARTAN** improve the fertility of the soil.

Another **ESPARTAN**'s effect on the soil is that, thanks to the already mentioned increase of the capacity of cationic exchange, it will reduce the salinization and sodification (sodium excess) process of the soils because it improves the change of this cation for others in the clays, being able to be washed by irrigation waters. Moreover, it stops possible desertification phenomenom.

II. EFECTS ON THE PLANT

The organic matter has the important role of acting not only on the soil but also on the plant, fundamentally due to two aspects

- Humic and fulvic acids (contained in the organic matter) give more vitality to the plant improving the physiological and biochemical processes of the

metabolism. It also favours and stimulates the roots growth. It facilitates the plant absorption of macro elements being necessary less contribution of inorganic fertilizers and it improves the seed germination.

● The vegetal extract of beet contains amino acids. The plants produce L-amino acids as principal support for the proteins biosynthesis and proteic enzymes biosynthesis, as well as material for the development of other essential substances as hormones and chlorophyll. Thanks to his high L-amino acids richness and once applied by foliar and irrigation, the principal effect is the stimulation of the metabolic activity and the activation of enzymes of the plant, better production and quality of the crop, better absorption of the soil nutrients and increase of the stress resistance of the plant.

Likewise, the L-amino acids that **ESPARTAN** contributes are characterized by his facility to form a part of the plant without need of a biochemical transformation of the nitrogen in amino acids through the chlorophyll function. This property makes them advisable in critical moments in which it is necessary to obtain a major vigour as in cases of "stress" (both water and thermal or saline), or when it is necessary to improve and promote the plant defences against microbial infections.

L-amino acids also favour other vital processes as: improvement in the nitrogen metabolism, synergism with other nutrients and phyto-sanitary products, improvement of the pollination and fructification processes. So, in general, a high increase in the productivity and quality of the crop is obtained.

1.3.- Trial Aim.

This trial arises from the need to solve the existing problematic in the nitrogenous fertilization of the cultures. For that reason, KIMITEC GROUP based on his experience provides an alternative in the contribution of nitrogen. The above mentioned alternative has been developing in KIMITEC ORGANIC FARMING Divison, but it can be used not only in Organic Farming but also in conventional.

The aim of this trial is to evaluate the viability, from different agronomic points of view, in the application of the product **ESPARTAN** instead of nitrogenous fertilization based on urea.

Thus, we could avoid problems derived from the use of urea such as: loss of efficiency in the application, phyto-toxicities of the cultures, increase of the plant sensibility against diseases, etc. …

Due to the great quantity of factors to take into account when a trial is made, from the Technical Dpt. of **KIMITEC GROUP** we consider to make the trial in a plastic multitunnel greenhouse because the control on the results is high and provides more guarantees on the reliability of the results. These results can be extrapolated to the different agriculture production system, because greenhouses production only allows us to control the climatic conditions without interfering in a special way in the metabolism of nitrogen assimilation in the plant.

2.- TRIAL

2.1.- Location

Town: Dolores de Pacheco
Province: Murcia
Farm: Los Rizaos
Place: Los Rizaos
Greenhouse: 2
Number of plant treated: 1560

2.2.- Crop data

Crop: Tomato
Variety: Pitenza
Distance between plants: 1 m x 0.3 m
Greenhouse: 120x50 m
Surface: 6000 m2
Transplantation date: 22 de July
Picking date: 18 de February

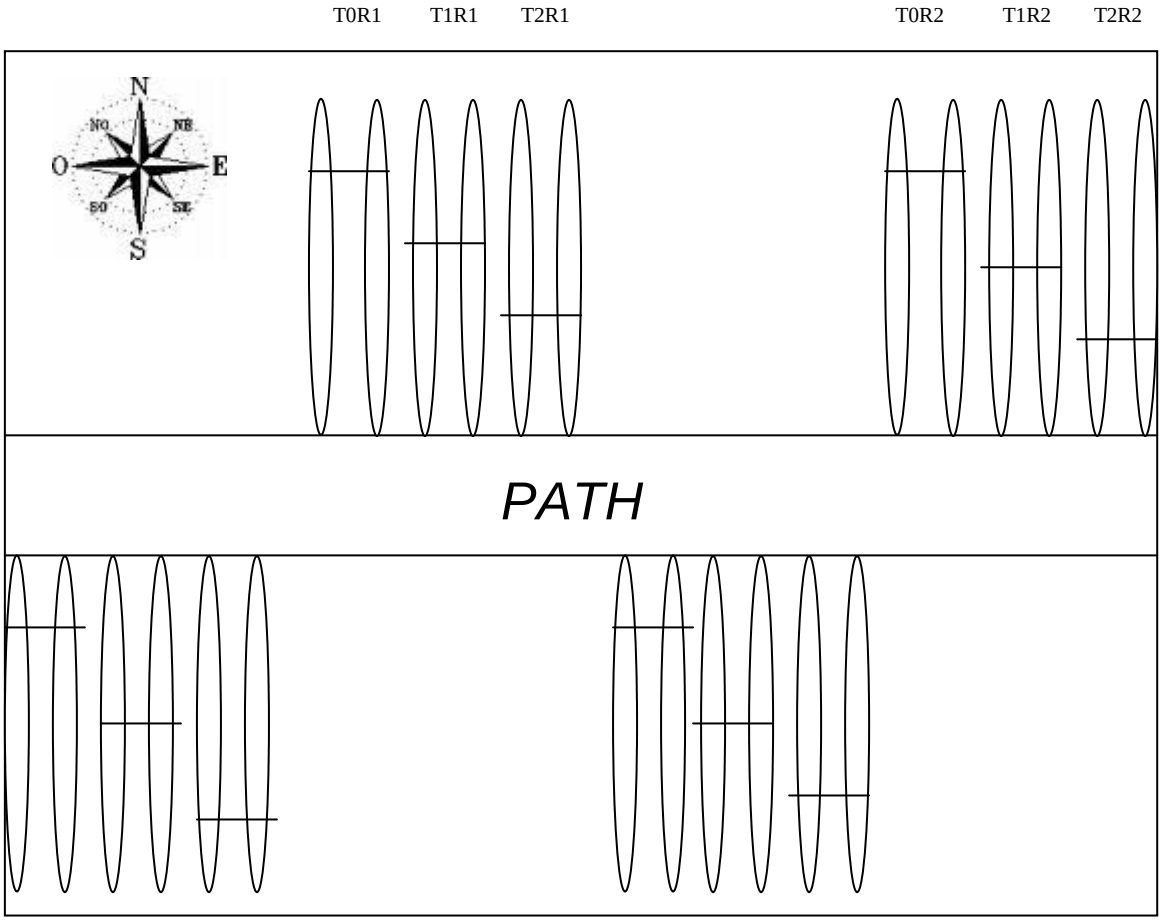
2.3.- Products

- AMMONIUM NITRATE (33,5-0-0) Treatment 0: **T0**

- UREA (46-0-0) Treatment 1: **T1**

- ESPARTAN (**KIMITEC GROUP**) Treatment 2: **T2**

2.4.- Experimental Design



2.5.- Application description

- The trial consists of 3 treatments, with 4 repetitions each one. In every repetition there are 2 lines of plants with 65 plants each one.
- TOTAL PLANTS:

3 treatments X 4 repetitions X 2 lines X 65 plants = 1560 plants

- The treatment was by irrigation, applied with every daily irrigation. First, the greenhouse is irrigated in a general way with the Treatment T0

(keeping closed the irrigation keys to the lines T1 and T2) and later T1 and T2 are irrigated from the extra contributions tank, existing in the irrigation head.

- The doses of the treatments where the equivalence of the fertilizer units and fertilizers used is a unit of fertilizer, equal to 1 kg of nitrogen, were the following ones:

Fertilizer equivalence	Fertilizer	Richness%	TREATMENT
1 Nitrogen Unit (N)	2.5 kg of pearled Urea	46	T1
	2.5 kg of Ammonium Nitrate	33	T0
	6.5 kg of lime nitrate	15	COMMON
	7.7 kg of Nitrate of Potassa	13	COMMON

- **ESPARTAN** was applies to a dose of 2,5 l/ha /irrigation
- The irrigation system is by dripping, with 3 l/h auto compensating drippers and a density of 2 dripp./m^2.
- The irrigation distribution and timing was:

Nº IRRIGATION	DAY	TIME (MIN)
1	10-aug	60
2	13-aug	60
3	15-aug	60
4	17-aug	60
5	19-aug	60
6	22-aug	60
7	25-aug	60
8	28-aug	60
9	1-sep	60
10	5-sep	60
11	9-sep	60
12	13-sep	45
13	17-sep	45

14	21-sep	45
15	25-sep	45
16	29-sep	45
17	2-oct	45
18	7-oct	45
19	12-oct	45
20	18-oct	45
21	23-oct	45
22	29-0ct	45
23	2-nov	30
24	9-nov	30
25	15-nov	30
26	21-nov	30
27	27-nov	30
28	2-dec	30
29	9-dec	30
30	15-dec	30
31	21-dec	30
32	28-dec	30
33	2-jan	30
34	8-jan	30
35	13-jan	30
36	17-jan	30
37	25-jan	30
38	28-jan	30
39	3-feb	45
40	10-feb	45

Chart 3: Irrigation distribution and timing when fertirrigation starts.

2.6.- Parameters to measure

● Production: Follow-up of the production for treatments and repetition, with absolute values at the end of crop.

Kg / m^2

● Treatments Rate: We will Count n º of phyto-sanitary treatments for treatment and repetition

Nº treatment/TXRX

● Mortality Rate: We will count the number of died plant by treatment and repetition; distinguishing between root and aerial diseases

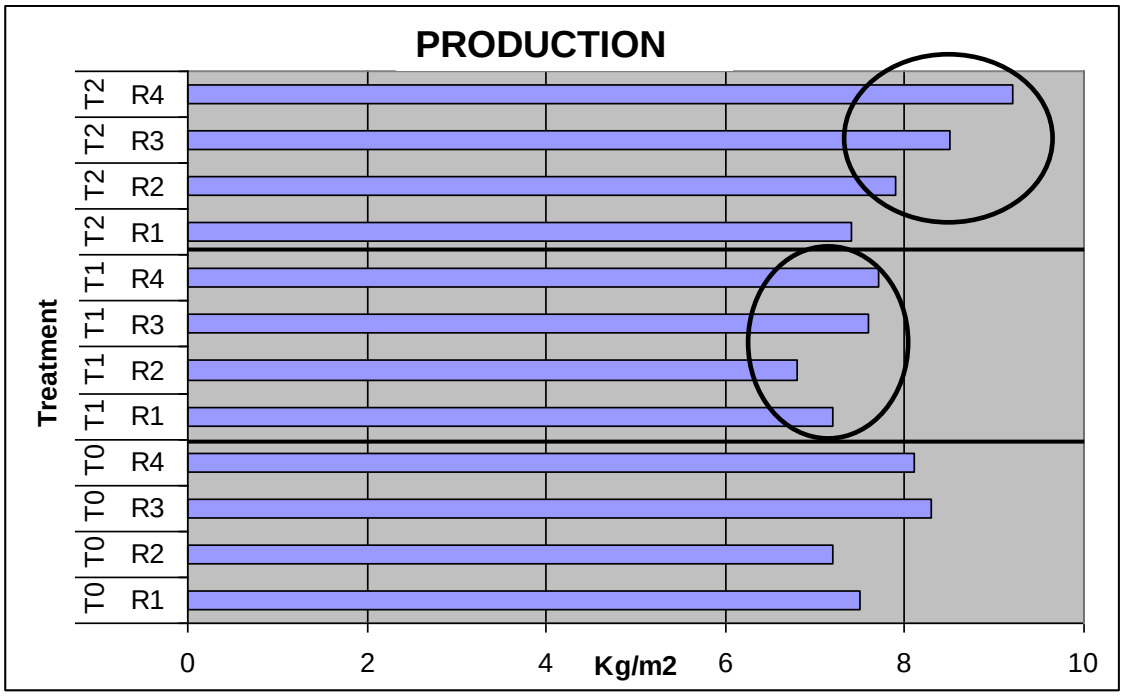
Nº died plants (root)/TXRX

Nº died plants (aerial)/TXRX

3.- RESULTS

3.1.- Production

The production results obtained at 18th February in crop absolute values are:



This results show that, on average, with **ESPARTAN** treatment it is obtained an increasing in the production of **13,58%** comparing with **UREA** treatment.

	Average Production	% increase
T0	6,72	7,35
T1	6,26	0
T2	7,11	13,58

Chart 4: Average production **2007/08** season and increasing in the production (%) regarding the less production value.

This trial has been repeated during the two previous seasons to the current one, in the same culture and variety, due to the farmer request.

In all the trials the following parameters have kept the same: the tree treatments with the products, the area and the number of repetitions in the farm.

The only parameters that have changed are the transplantation and picking date and the climate conditions.

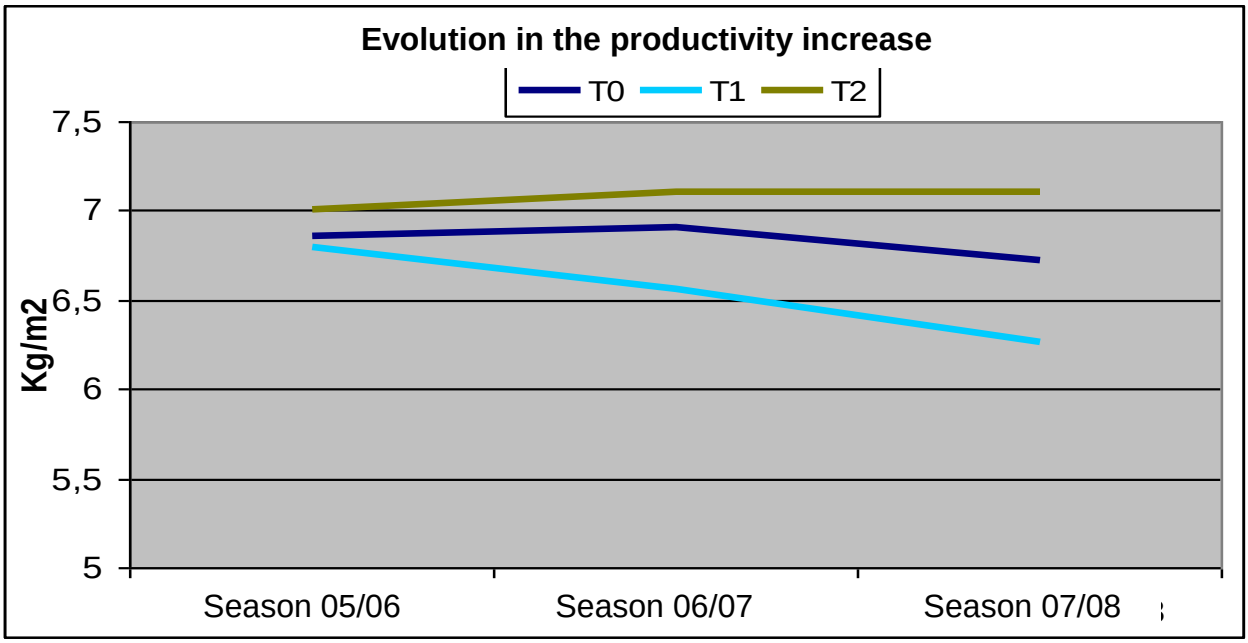
	Average Production	% increase
T0	6,86	1,03
T1	6,79	0
T2	7,00	3,09

Chart 5: Average production **2005/06** season and increasing in the production (%) regarding the less production value.

	Average Production	% increase
T0	6,90	5,18
T1	6,56	0
T2	7,10	8,23

Chart 6: Average production **2006/07** season and increasing in the production (%) regarding the less production value.

In the following chart it is show the improvement in the production in the treatments with ESPARTAN. The reason is because the soil structure is improving gradually due to the addition of organic matter.



3.2.- Treatment Rate

Day	T0	T1	T2
12-aug	X	X	X
19-aug	X	X	X
16-aug	X	X	X
29-aug	X	X	
4-sep	X	X	X
7-sep	X	X	
15-sep	X	X	X
21-sep		X	
26-sep	X		
2-oct	X	X	X
16-oct	X	X	
27-oct	X	X	X
4-nov	X	X	
19-nov	X	X	X
27-nov	X	X	
9-dec	X	X	X
6-dec	X	X	X
3-jan	X	X	
11-jan	X	X	X
26-jan	X	X	X
4-feb	X	X	

Char t 7: Phyto-sanitary treatments aerial or foliar

From these results, the plants irrigated with the treatments T0 and T1 need a frequency of treatment of **66,00%** more than the treatment T2.

	Nº Treatments	% increase
T0	20	66
T1	20	66
T2	12	0

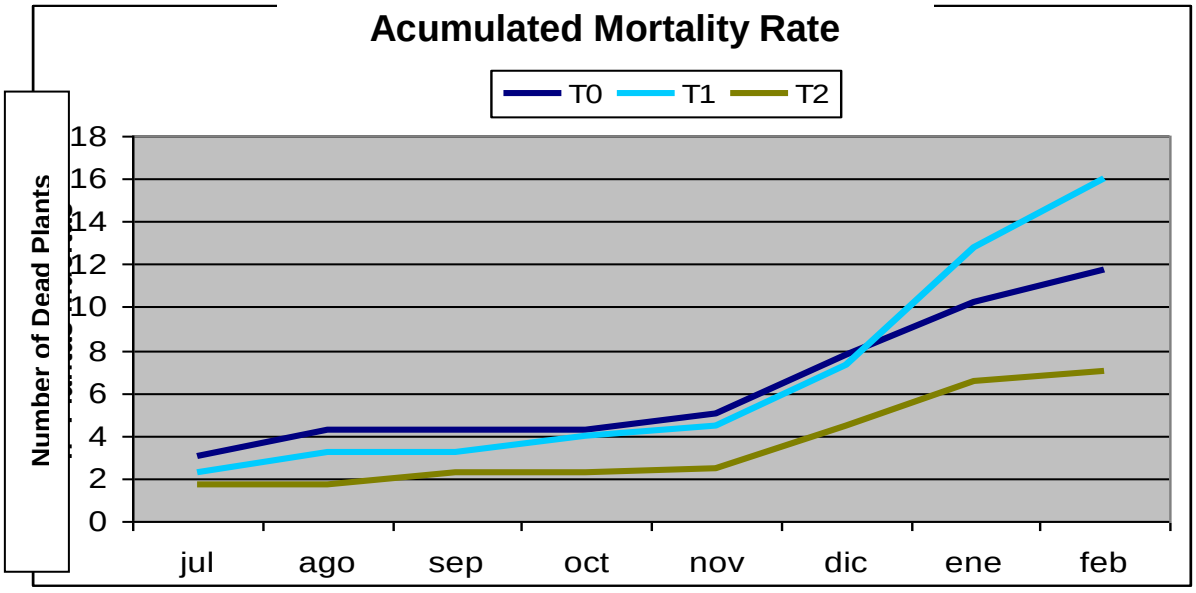
3.3.- Mortality Rate

Mortality results per month, as consequence of root and aerial diseases, not taking into account the mortality due to bad labour management:

Treat	Rep	jul	aug	sep	oct	nov	dec	jan	feb	TOTAL
T0	R1	4	3	0	0	1	5	2	2	17
T0	R2	3	2	0	0	2	3	4	2	16
T0	R3	2	0	0	0	0	2	1	1	6
T0	R4	3	0	0	0	0	1	3	1	8
T1	R1	2	0	0	1	0	5	6	3	17
T1	R2	5	2	0	0	0	5	7	5	24
T1	R3	2	0	0	0	2	0	4	3	11
T1	R4	0	2	0	2	0	1	5	2	12
T2	R1	0	0	2	0	1	4	2	2	11
T2	R2	4	0	0	0	0	2	2	0	8
T2	R3	2	0	0	0	0	0	3	0	5
T2	R4	1	0	0	0	0	2	1	0	4

Chart 8: Monthly plant mortality by treatment and repetition caused by aerial or root disease.

In the next chart is showed an increase of the Mortality Rate in T1 of **128,57%** regarding T2. The Mortality Rate is showed as dead plants accumulated from July to February.



3.- Conclusions

The conclusions obtained in this trial of short cycle tomato var. Pitenza, from July to February and after examining the viability from different agronomic points of view, in the application of the product **ESPARTAN** to replace the nitrogenous fertilization based on urea, are the following ones:

● PRODUCTION: the results show that the plants watered with **ESPARTAN** have an increase of the production, obtained by average between the four repetitions, of **13,58 %** regarding UREA.

This increase of the production is due to different aspects such as an improvement of the soil texture and the consequently root improvement, the decrease of telluric and aerial diseases, besides a correct contribution of nitrogen to the plant; with **ESPARTAN**'s application.

● PESTICIDE TREATMENT INDEX: the results show that in the plants watered with T0 and UREA need a frequency of phyto-sanitary treatments of **66,00 %** more than the plants watered with **ESPARTAN**.
These results are of special interest, due to the fact that the reduction of phyto-sanitar treatments not only is an economic saving, but improvement of the production quality on having reduced the levels of residues. This decrease of the aerial and soil treatments can be explained from two different points of action of **ESPARTAN**:

- Soil: the texture improvement caused by **ESPARTAN** make the plant to having less hipoxy problems, reduction of water logging with the consistent reduction of rot problems in the plant neck, better aeration of the soil with the consistent rooting development, etc. …

- Aerial: having eliminated the risk of phyto-toxicity caused by the excess of nitrogen in the plant, we limit very much the entry in the culture of diseases that may be very aggressive if they were not putting on this type of controls.

● MORTALITY RATE: the results here are spectacular, having the mortality rate in value of dead plants accumulated during the months of culture. The increase of plants watered with UREA is **128,57%** more than the plants watering with ESPARTAN. with regard to plants(floors) watered with ESPARTAN of **128,57 %**, obtained this information with the averages of four repetitions as treatment.
The principal diseases that caused the mortality were: in soil *Fusarium oxysporum, Verticilium dahliae* and rooting hipoxy; while in aerial *Botrytis cinerea and Pseudomone syringae.*

The extra contribution of phosphorus (P) with **ESPARTAN** causes an increase in flowering, which is one of the reasons of the production increase. Phosphorus (P) is an indispensable element in the processes of flowering and rooting of the cultures.

In the same way as with Phosphorus (P), the extra contribution of Potassium (k) with **ESPARTAN** cause an increase of the tomato crop consistency with regard to other treatments, and extend the post harvests life.

The contribution of elements as Calcium (Ca), Magnesium (Mg) and Iron (Fe) with **ESPARTAN** cause an important reduction in the chlorosis, especially in winter time with adverse conditions.

As final conclusion, from **GROUP KIMITEC** we can stated that after the results of this trial, that our product **ESPARTAN** is a strong alternative to UREA for the nitrogenous fertilisation, solving the problems of stability and efficiency of the UREA and problems of phyto-toxicities of nitrogen in plants and seeds.

At the same time, **ESPARTAN** increases the production yield because improve the soil structure and contribute with elements as indispensable as N (3,35 %), P (3,76 %), K (3,22 %), Ca, Mg, Fe, etc. and bio stimulants natural substances such as amino acids, betaines, sugars, proteins, enzymes, auxines and vitamins. So, with **ESPARTAN**, the use of phyto-sanitary products is highly reduced, increasing the self-defences formation in the plant, reducing hereby the effect of pathogenic in the culture.