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Development of Eco Materials and Use of TIC as New Technology to Improve the Use of Water and Soil that Optimizes the Crop of Asparagus in Arid Environments of the Northwest of Mexico

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Abstract - *The efficient use of water and the adequate preparation of soils in cultivation areas of the northwestern region of the Mexican Republic, where the state of Baja California is located, have managed to improve the yield of vegetable crops based on the development of computerized technology and the application of an eco material such as those that have been evaluated to be used as pipes through which water circulates for cultivation activities. The applied eco material is fiberglass or also called glass wool, from crashed cars in the city of Mexicali and that were recycled, and with a manufacturing process tubes were made, creating pipes through which water circulates with controlled temperature for activities of crops. This type of material was used because it has the physicochemical property of being able to keep the water temperature around 25 ºC, which is suitable for growing vegetables such as asparagus in the Mexicali Valley, which is considered a zone arid To optimize the cultivation of asparagus, an evaluation of physicochemical factors such as pH and water temperature was made, as well as the amount of vital liquid per hectare for irrigation of asparagus, in addition to soil salinity, to obtain the best yield in the cultivation of this valued vegetable. To control the physicochemical factors mentioned, computerized technology was used with a low-cost electronic system and using the C language for computer control of the systems or sensors of the physicochemical factors of agricultural activities. The research study reflected an increase in the productivity of asparagus in this area of the Mexican Republic and with this an action was generated to be used in cultivation processes in other types of regions as a comparative analysis. This investigation was made from 2018 to 2020. In the Covid19 pandemic was made the investigation with strict regulations.*

Keywords: Computerized technology, materials, agricultural industry, asparagus.

1. INTRODUCTION

The Mexican Republic, as in many countries of the world, is made up of different types of climate and

soils, and where temperatures have increased in the last five years, and in addition to the fact that water extinction has spread, especially in arid zones. (CA, 2022), and where the promotion of crops and the development of systems with technology and innovation are promoted with great intensity. These innovative techniques have helped improve crop yields, by obtaining a greater quantity of products, with improved quality and especially the optimal use of water and soil resources. Asparagus should be sown usually in the spring time, in beds at a depth of 2.5 cm deep with a distance of 7 cm between each vegetable (Yanet Villarreal et al, 2021). This investigation was focused on the Mexicali Valley, where various analyzes were made, which are mentioned below:

1. Analysis of the quantity and quality of water for the use of crops. It was prepared to determine the amount of water that would be used in this case for the cultivation of asparagus, which requires 200 to 300 m3 per hectare, this data being necessary because the Mexicali Valley, in addition to this type of vegetable, produces other types. of crops and the water coming from the United States through the Colorado River has decreased (Mora et al ,2016). This is why, based on the required amount of the vital liquid, new and recycled water was used for growing asparagus. Said system of efficient use of water and optimal recycling process, was elaborated by automated devices manufactured for this scientific study and controlled by a computerized system.

2. Evaluation of the pH of water and soil. This evaluation was carried out to determine the pH of the vital liquid and soil, and to be considered optimal for the cultivation of asparagus, where in the water resource the pH must be between 6.5 and 7.5, and in the soil, it must be between 6.0 and 7.0. With this activity, it was possible to control the pH of both physicochemical factors and with this, a better yield was obtained in the cultivation of asparagus in the northwestern region of our country, where the scientific study was made (Leo O. et l, 2014).

3. Analysis of eco materials. This part of the investigation was developed to detect certain types of materials that can be reused for agricultural activities as ecomaterial (Leticia Torres, 2019), especially for the pipes where the vital liquid circulates that goes to the cultivated soils of some vegetables that are grown in the Mexicali Valley. This scientific study focused especially on the cultivation of asparagus, which is a highly appreciated product in the food and nutritional process in most of the population of the Mexican Republic. On this occasion, the material to be recycled was fiberglass, also called glass wool, which has the physicochemical property in pipes through which the water resource for agricultural activities circulates, of keeping the temperature below 30 °C, where the optimum temperature for growing asparagus is 18 °C to 25 °C.

2. AGRICULTURAL INDUSTRY

It is one of the most relevant worldwide due to the process of generating food in large quantities to cover the needs of the market in each region for the world's populations, and it is one of the most regulated for the efficient control of water resources that each time is less in the globe, as well as the quality of the vital liquid that is more polluted every day by society and industrial activities (Cheng, 2008). This type of industry is located in several regions of the Mexican Republic, one of them being the Mexicali Valley, where various crops are grown and marketed in this region of our country and in the states of California and Arizona in the United States. States, and being highly appreciated by the population of both countries. In this region of Mexico, asparagus is grown, which is a vegetable widely consumed by the population as an accompaniment to certain foods and the preparation of soups (Benavidez et al, 2011). This vegetable grows with certain special amounts of water (from 200 to 300 m3 per hectare), as well as the optimal pH of water (6.5 to 7.5) and soil (6.0 to 7.0), mentioned above. The agricultural industry in the Mexicali Valley region

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has been one of the most prosperous in the northwestern region, where vegetables and fodder are mainly grown. An agricultural process in the Mexicali Valley of asparagus cultivation is shown below (Figure 1).

Fig -1: Figure 1 Asparagus cultivation (a) and packaging (b) activity in the Mexicali Valley

3.PHYSICOCHEMICAL CHARACTERISTICS OF WATER AND SOIL

The vital liquid and the soil are important aspects in the cultivation processes of agricultural industries in any region of the world, where various types of scenarios of the quality of water resources and soils are presented (Sukhotu et al, 2016). In most of the world, water contains polluting impurities generated by the unconsciousness of the population that throws solid waste, as well as industrial waste discharged into aquifers in the open air, and into soils that filter into underground aquifers that are used for agricultural activities. and whose vital liquid must be decontaminated. The main physicochemical characteristics are the pH and amount of nutrients in the water and soil used for agricultural activities. The action of measuring the pH in water and soil was made by a pHmeter, as shown in figure 2.

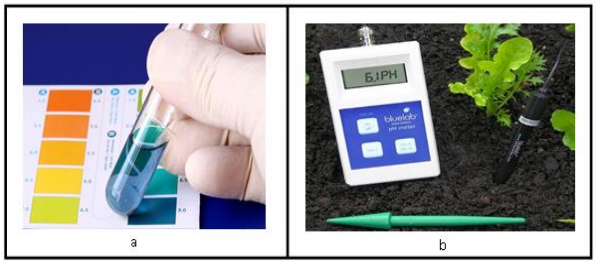

Fig -2:Measurement process of PH in (a) water (¿Qué es el ph? ph en el agua y en el cuerpo - Alkanatur | Expertos en Agua Alcalina Antioxidante) and (b) soil (Cómo funcionan los medidores de pH, y su importancia en los cultivos - Como Funciona Que)

4.USE OF ECO MATERIALS

Eco materials are developed for the care of the environment, where reduction, recycling and reuse (3R) activities are involved, to avoid continuing to pour materials into ecosystems that damage them and generate areas that are uninhabitable by vegetation, fauna and the environment. human being (Leticia Torres, 2019). This is why the use of eco materials, with the reuse of materials of various types and are reused in other types of activities different from the actions carried out in their first use. One of the materials that can be recycled is fiberglass, widely used in car covers or also called hood bodywork, doors and helmets, essentially. In this investigation, a descriptive analysis was carried out as a first phase of materials that preserve the temperature of fluids, including water, and in this way, the physicochemical properties of the fiberglass were evaluated to be reused as it might be for agricultural activities (Lopez et al, 2013). With the support of an industry located in the city of Tijuana, enough fiberglass material was manufactured in the form of pipes and the experimental tests of the conservation of the temperature of the water used for irrigation of the asparagus crop were elaborated. In this phase, microcopy analyzes were carried out to determine if the structure of the pipes made of fiberglass was suitable for the cultivation of this vegetable. In figure 3 is showed an ecomaterial used a new material to fabricate pipelines.

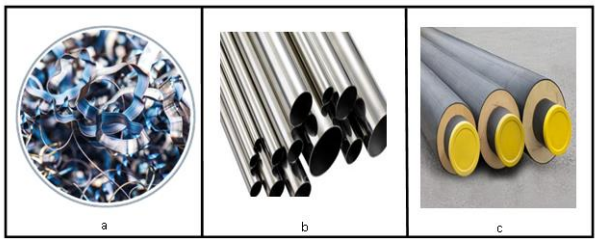

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Fig -3:Crushed ecomaterial (a) (Scopriamo i materiali: il rottame. - Gervasi Ecologica), and eco pipelines manufactured with fiberglass (b) (Productos en acero :: Soluciones tubulares :: :: Tuberia para petroleras :: (tuberiasyaccesorios.com) Productos en acero :: Soluciones tubulares :: :: Tuberia para petroleras :: (tuberiasyaccesorios.com) and (c) (Aislamiento de tuberías: selección de materiales y su instalación. (techinfus.com)

5.USE OF THE TIC IN THE AGRICULTURAL INDUSTRY

The use of TIC as new technology to control the actions of automated devices is highly relevant in any type of industry and especially in the case of this research, in the activity of asparagus cultivation in an agricultural industry (Lopez Badilla Gustavo et al, 2015). The applications of computerized systems generate confidence in the generation of activities (Hicks, 2018), being important for actions of control, recording and analysis of information, in this case numerical data of quality levels of water and soil where the scientific study was made, as well as of the pH and efficient control in the use of water resources in the agricultural activity evaluated. In figure 4 is represented the control system of the physicochemical data.

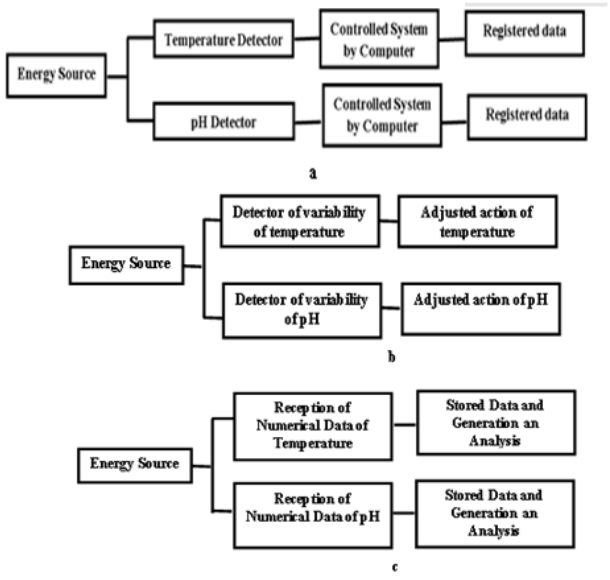

Fig-4: Automatization system to control physicochemical factors constituted by (a) Principal system, (b) Adjusted System and (c) Registration data values

The language of programming used was the C language, which is presented in the next figure a part of the specialized programs (Comer, 2015). Next is expressed a part a program as basic step.

```
#include <stdio.h>
#include <stdlib.h>

int main ()
{
double x1, x2, x3, x4, xm, prom, com;
printf ("Real Temperature Data: ");
scanf ("%lf", &v1);
printf ("Real pH Data: ");
scanf ("%lf", &v2);
printf ("Adjusted Temperature Data: ");
scanf ("%lf", &v3);
printf ("Adjusted ph Data: ");
scanf ("%lf", &v4);
xm=[(x1+x2+x3+x4)]² + [(x1/2) +(x2/2) +(x3/2) +x4/2) – 2/3;
prom=xm/4;
if (prom<1500)
{printf("Alert");}
else
if (prom<=6500)
{com=xm*0.01;
printf ("Temperature Data Adjusted;)
else
{com=xm*0.02; printf ("pH Data Adjusted;}
```

Fig-5: Programming with language C process

6. METHODOLOGY

In this investigation, activities were made to improve the cultivation of asparagus, explaining each of these below:

a) Efficient use of water. As a first action, the new water was used, the quality of the crop was optimal, and since it is considered an arid zone in this region of the country, there is not a large amount of water to be used and discarded, so it was necessary to carry out an action of recycling the water resource once used, with the application of a carbon filter to remove impurities and ammonium ions from the ammonia used as fertilizers to promote improvements of this vegetable in the Mexicali Valley region (Benavidez et al, 2011). For the action of removing ammonium ions, a biological activator (BIOLEN IN 100) controlled by a computerized system was used to determine the removal of ammonium ions from the water and with these two processes reuse the vital liquid again in the asparagus crop. Regarding the flow of water resources, an

automated computer-controlled system was used to control the flow of water, with which the use of water was made more efficient to obtain a better yield from this type of crop. Regarding the quality of the water, a device was developed to recycle the water previously used in the cultivation of asparagus, where ammonium ions from the ammonia used were detected.

b) Control of the pH of water and soil. This process was carried out in order to control the pH of both physicochemical factors, which is necessary for the adequate quantity and quality of nutrients for optimal asparagus cultivation, using a Peak Tech 5310 pH meter, connected to an automated detection device. pH and this in turn to a computer, where the pH values were displayed, and make a data record. When the meter detected a pH out of range, the automated device generated an indication action and when this device was connected to a cylinder with alkalinizing and pH regulating drops, it originated an action of supplying the amount required per hectare of water resource, to be regulated the pH and thus avoid a deterioration of the water and generate a deficient quality in the asparagus crop (Zhao et al, 2010). The evaluation was carried out to determine the pH of the vital liquid and soil, and to be considered optimal for the cultivation of asparagus, where in the water resource the pH must be between 6.5 and 7.5, and in the soil, it must be between 6.0 and 7.0. Microanalyses of soil morphology were performed to determine soil efficiency for asparagus cultivation, using the Scanning Electron Microscopy (SEM) technique.

c) Use of Eco-material for temperature control in pipes for water circulation. This step was developed to obtain information on ecological materials reused in agricultural activities, as is the case of fiberglass used in car covers such as bodywork (Leticia Torres, 2019). This type of material from crashed cars in the city of Mexicali was processed to be reused as pipes through which the vital liquid for the cultivation of asparagus in the Mexicali Valley circulated. The reuse process consisted of grinding the crashed automobile parts with an EPTECH fiberglass grinding machine, to later be taken to a foundry activity and the manufacturing material to be placed in circular molds to form the pipes. This pipe manufacturing procedure is in the process of patent registration, so little information is provided due to registration restrictions. Microanalyses of the morphology of fiberglass pipes were developed to determine the proper structure and efficiency of the pipes, and thus be able to maintain the optimum temperature for asparagus cultivation, using the Scanning Electron Microscopy (SEM) technique (Lopez Gustavo, 2013).

7. RESULTS

Mainly three types of activities were made in this investigation whose experimental processes are shown in the following sections.

7.1 Analysis of quality and efficient use of water and soil

This section was made to detect the characteristics of the physicochemical factors of water and soil to determine the actions to take to have the optimal water and soil to the crop of asparagus, which was monitored in spring and summer from 2018 to 2020. In table 1 is represented the mentioned above.

Table -1: Analysis of physicochemical parameters

Parameters	pH		Ammonium Ions, mg/ppm		Temperature, °C		Water	
Seasons	Soil	Water	Soil	Water	Soil	Water	Quality, %	Quantity,
Spring 2018	7.8	5.7	1.12	1.11	29	30	67	2356
Summer 2018	8.4	6.2	1.33	1.75	38	36	65	387
Spring 2019	6.7	6.6	0.57.	0.70	27	22	90	245
Summer 2019	6.1	7.2	0.68	0.73	27	20	83	296
Spring 2020	6.9	7.1	0.60	0.68	23	21	88	244
Summer 2020	7.0	7.0	0.68	0.59	29	24	84	288

Table 1 show the physicochemical factors that were measured by the specialized equipment mentioned above and registered by the automatized device in according to the computer system instructions. This

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was very relevant to understand about the climatic conditions of the Mexicali Valley and regulated the physicochemical factors measured. The scientific study illustrates two seasons of the year (Spring and Summer), where was obtain the major yield in the crop of the asparagus. At the begin of this investigation (Spring 2018 and Summer 2018), all data values were out of the standardized, as is showed the standard values of pH (6.0-7.0) and water (6.5 to 7.5), represents the data value outside of the standards values. Also, the standard data values of the ammonium ions is 1 mg/ppm, and in this investigation is showed the outside range of the values in 2018 in some seasons evaluated. The temperature analysis showed the same conditions of the last parameters analyzed in 2018 and also were equally the quality and quantity of water used. But in 2019 and 2020, the values were in the standard data, and were controlled by the automatized device with the computer system.

7.2 Analysis of productivity and quality of asparagus

In this step was made an analysis of the quantity of quality of production of the asparagus in the two seasons mentioned above (Spring and Summer from 2018 to 2020). Then was registered in the computer system the levels of productivity and quality factors, that is showed in table 2, where the standard production of asparagus by hectare is from 4.5 to 5 miles of kilograms.

Table-2: Analysis of productivity and quality of asparagus

Parameters	Quantity, miles/ hectar		Quality, %	
Seasons	UPF	CPF	UPF	CPF
Spring 2018	3.5	-	73	-
Summer 2018	3.8	-	70	-
Spring 2019	-	4.6	-	89
Summer 2019	-	4.8	-	93
Spring 2020	-	4.5	-	90
Summer 2020	-	4.7	-	95

UPF. Uncontrolled Physicochemical Factors; UPF. Controlled Physicochemical Factors

Table 2 show the representative values of the productivity and quality indices of the asparagus, being evaluated as a comparative analysis wit the uncontrolled physicochemical factors in 2018 and controlled physicochemical factors from 2019 to 2020 in both seasons evaluated (Spring and Summer). This table illustrate the numerical data of the production of asparagus and when was applied the improvements in this investigation with control of the physicochemical factors and use of ecomaterial, obtaining the increase in the yielding of productivity and quality indices of the asparagus.

7.3 Evaluation of eco material

The use of the ecomaterial was to control the temperature in the pipelines utilized to supply the hectares, where was made the crop of the asparagus, generating the increase of the productivity and quality yielding. The behavior of the ecomaterial is represented in figure 6, where was illustrated with the measurements obtained by a computer system as MATLAB program. In figure 6 are presented eight points that represents the major correlation. This meaning that in these points the control of water is the most adequate to realize the crop of the asparagus. The other aeras as black sections are zones of the graph where can be control the temperature of the water but in the limits of the standard values (18 °C to 25 °C).

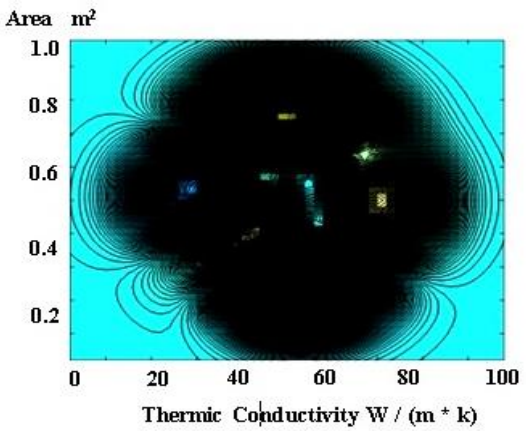

Fig-6: Correlation of Thermic Conductivity and Area of the fiberglass as ecomaterial (2020)

7.4 Microanalysis of soil

This was made to detect the permeability factor as a relevant aspect of the soil, to know the capacity of the soil where was made the crop of the asparagus to maintain the water and the humidity to an optimal process of the crop. This step was very important to improve the soil and with the control of the pH and ammonium ions, to have more yielding of the crop of the asparagus. The microanalysis is showed in figure 7, where the black zones are the areas of this sample that generate more permeability, and generating less capacity to maintain water and humidity and with this less yielding of crop of asparagus.

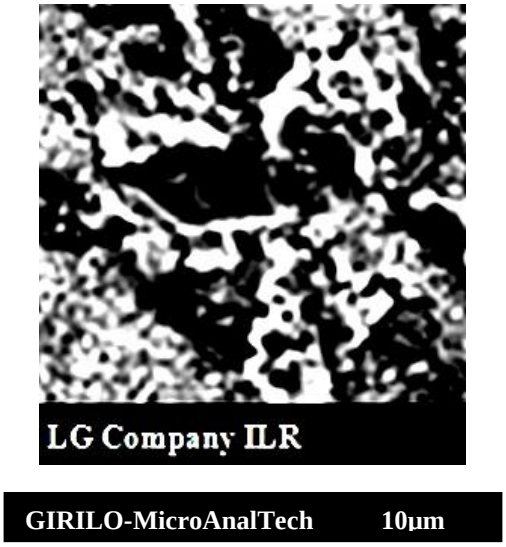

Fig-7: Microphotography of soil (10X) in 2020

8. CONCUSIONS

In this investigation, relevant results were obtained, as is the case of the ecomaterial, which has no history of the use of fiberglass in agricultural activities, for use in pipes for the conservation of water temperature because it is a material with physicochemical characteristics of structuring with low thermal conductivity. With this, the conservation of fluids at a desired temperature and with the computerized control used in this investigation, great expectations were generated to be used this ecomaterial for other types of activities where it is necessary to maintain the temperature at a desired level. This scientific study is of great importance for the agricultural industry, whether in the open field or in greenhouses, in order to obtain a better yield in the productivity and quality of the cultivated vegetable, such as asparagus. It is vitally important to highlight the process of recycling materials of any kind, in order to prevent further contamination of our ecosystems, which are already highly deteriorated and generate negative effects on our society. This is why, thanks to material recycling research, we have managed to maintain a little the already damaged ecosystems of our region, which has given so much to the population of this area of the Mexican Republic, with the generation of vegetable crops and necessary fruits for the human being and for the animal kingdom that requires food such as fodder. Regarding the computerized system, where the C language was used as part of the programming process, it was considered that it had a great influence on the action of detecting the temperature of the water that circulated through the pipes of the ecomaterial and the pH of the vital liquid, as well as well as the temperature and pH of the soil where the asparagus crop was grown.

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