ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

Preliminary Economic Evaluation of Fungicide Alternatives Approaches against Root Diseases Incidence of Some Vegetables Grown under Protected Cultivation System in Egypt

Nehal S. El-Mougy, M. M. Abdel-Kader, S. M. Lashin

***Abstract** - A simple study for the economic importance of fungicides alternatives against root rot diseases affecting vegetables growing under protecting cultivation system was carried out during two successive growing seasons 2012-2013. This study was conducted with different vegetables, i.e. Cucumber, tomato and pepper grown in commercial plastic houses at different locations. The economic calculations for the applied cost-effective fungicide alternatives comparing with fungicidal treatments were conducted for soil treatment against root rot diseases and its benefit effect on plant stand and their effect later on the yield loses. The applied fungicide alternatives were a mixture of: [Humic & Folic acids + Furfural + Thricoderma harziamum] and a mixture of: [Furfural +Thricoderma harziamum], meanwhile Rhizolex-T 50% was used as transplants dipping for fungicide treatment. The applied fungicide alternative approaches resulted in a significant reduction in root rot incidence of tested vegetables, Cucumber, Tomato and Pepper under plastic houses conditions comparing with fungicide treatment. Furthermore, these applied treatments reflected on higher profitability over fungicide treatment. The gained benefit over fungicide treatment was 68.8, 98.5 and 45.8 L.E. for cucumber, tomato and pepper at the soil applied treatment of [Humic & Folic acids + Furfural + T. harziamum] as well as reduction in costs were recorded as 42.5, 54.5 and 35.3% at the same treatment for grown vegetables, respectively. Meanwhile, at soil treatment with [Furfural +T. harzianum] the calculated benefit over fungicide treatment was 85.4, 122.7 and 70.2 L.E. for cucumber, tomato and pepper, respectively. As for reduction in costs for grown vegetables at applied treatment of [Furfural +T. harzianum] the recorded percentages were 52.8, 67.9 and 54.1% for cucumber, tomato and pepper, in respective order Taken in consideration that each L.E. equal 0.15 USD. On the light of the obtained results it may be concluded that these approaches are considered an applicable, safe and cost-effective method for controlling such soil-borne diseases.*

Index Terms—**Fungicide alternatives, profitability, root rot, soil treatment, vegetables.**

I. INTRODUCTION

Growing vegetables, *i.e.* Cucumber, Tomato and pepper grown under protected cultivation system are representing Egypt's largest national crops export. Protected cultivation system is an important practice which approximately occupied about 60.000 feddans (24.000 Hectares) in Egypt [1]. This practice is rapidly expanding especially in newly reclaimed and desert areas. Economic importance of protected cultivation in Egypt attributed directly to its production affects severely its local and more importantly export impact, during their off-seasonal plantations. Vegetable crops grown under protected cultivation facing a serious problem due to root diseases infection that cause loss in plant stand and then re-planting processes are needed. Root rot in vegetables strikes quickly and then ruin a whole crop. However the largest instruction course of actions is preventative measures, as therapy with fungicide does not normally work. Not all vegetables can arrangement root rot, but many standard vegetable crops are susceptible. Several fungi may cause root rot in vegetable plants, transmitting the disease through the soil. Some common fungi include *Fusarium, Rhizoctonia, Sclerotinia, Pythium* and others each of which causes a root rot named for the specific fungi that cause it. While the presence of one of these fungi is the primary cause for disease, plants exposed to poor growing conditions, such as soil that doesn't drain well, are most susceptible to root rot. The best way to avoid root rot is by eliminating these contributing causes, and practice sound cultivation techniques. The soil borne pathogens *Rhizoctonia solani*, *Pythium ultimum*, and *Fusarium* spp. can cause severe economic losses to field and greenhouse cucumber [2,3]. Also, Fusarium stem and root rot on greenhouse long English cucumber (*Cucumis sativus* L.) cvs. Bodega and Gardon was observed at four commercial greenhouses in Leamington, Ontario, Canada. Losses of 25 to 35%, representing 2.5 ha, were noted. *Fusarium* spp., *Rhizoctonia* spp. and *Pythium* spp. were isolated from tomato plants showing root and crown rot symptoms [4]. The pathogens, *Alternaria solani Fusarium solani, F. oxysporum, Rhizoctonia solani, Scle-rotium rolfsii, Macrophomina phaseolina* and *Pythium* sp. Were isolated from Cucumber, Cantaloupe, Tomato and Pepper plants grown in plastic houses and showing root rot disease symptoms [5]. The management of soil-borne plant pathogens is particularly complex because these organisms live in or near the dynamic environment of the rhizosphere, and can frequently survive a long period in soil through the formation of resistant survival structures. The impact of plant pests on the aspiring producer of greenhouse vegetables is direct and significant. The current management strategy relies on the intensive use of fungicides. In addition, chemical control does not give satisfactory control of the root disease. Therefore, many control practices need to be

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

integrated in order for minimizing this figure to occur. The use of agrochemicals to improve crop yield and manage pests and diseases continue to be an important input [6]. Fungicides are commonly applied to control root fungal diseases of vegetables grown under protected cultivation system and often are routinely recommended. However, economic benefits from fungicide alternatives application in plastic houses have rarely been quantified. On the other hand, the need for IPM programs to offer cost advantages over conventional strategies is often cited as a major incentive for IPM adoption [7]. Accordingly, one can suppose that the likelihood of adoption of tactical models by farmers is highly correlated with the financial advantage that this strategy can offer over conventional crop protection strategies. Although the financial dimension of disease management probably is quite important to those who decide whether to use IPM, it often is not considered by those that develop the models [8]. The profitability of seed or soil treatments for any crop protection strategy against root diseases depends on the potential of plant stand and the cost and efficiency of the protection measure. Therefore, the aim of the present study was to carry out economic assessment on the benefits of using fungicide alternatives against root rot diseases affecting some vegetables comparing with the adoption of fungicide practices used in plastic houses under protected cultivation system.

II. MATERIALS AND METHODS

The tested vegetables were grown in plastic houses at different locations under protecting cultivation system during two successive growing seasons 2012-2013. Cucumber grown for the two seasons in plastic houses - Ministry of Agriculture and Soil reclamation at Tookh location. Tomato and pepper grown for the first season in plastic houses - Ministry of Agriculture and Soil reclamation at Haram location, while the second season was carried out in plastic houses - Researches and Experimental Station – National Research Centre at Nubaria location. Cantaloupe was also grown at Nubaria location but for only one season, therefore it was neglected from this study.

MODEL STUDY:

The experimental plastic house (9mX60m) consists of 5 rows; each contains two cultivated row sites. Each cultivated row site (0.9 x 60m, width x long) divided into 3 parts 20m long each, and every part considered as one replicate. Five replicates were used for each particular treatment in complete randomized design. The proposed treatments were prepared in laboratory of Plant Pathology Dept., NRC and sent to certain locations for application. The soil application processes were carried out. The prepared solution mixture was incorporated into the cultivated row site at the rate of 20L/row 5 days before vegetables transplants. Certain vegetables, (Cucumber, Tomato and Pepper) transplants were planted and received recommended agriculture practices, *i.e.* irrigation and fertilization. Monitoring and scouting of root rot incidence were recorded up to 45 days from transplanting. Percentage of root rot disease incidence was recorded as the number of diseased plants relative to the number of planted seedlings, and then the average of disease incidence in each treatment was calculated. The applied soil drench treatments were as follows:

1. A mixture of: [Humic & Folic acids (5ml/L) + Furfural (10ml/L) + *Thricoderma harziamum* $10x10^{10}$ cfu/mL (10ml/L)]
2. A mixture of: [Furfural (10ml/L) +*Thricoderma harziamum* $10x10^{10}$ cfu/mL (10ml/L)].
3. Fungicide treatment (received only the followed recommended fungicide treatment program stated in Table, 2).

The other crop production costs, *i.e.* soil preparation the cost price of transplants, transplantation process and labors costs were the same regardless of soil and foliar pesticide treatments approaches, and hence not included in the analysis. The profitability of using the fungicide alternatives against root diseases comparing with chemical fungicides application was estimated according guidance and suggestions provided in previous reports [9,10,11].

Statistical Analysis

The obtained data of plastic house experiments were set up in Completely Randomized Design (CRD). The data collected were analyzed by analysis of variance (ANOVA) test was used to analyze some other obtained data. General Linear Model option of the Analysis System SAS [12] was used to perform the analysis of variance. Duncan's Multiple Range Test was used for means separation [13]. The statistical analysis procedures were kindly carried out by Statistical Consulting Office, National Research centre, Egypt.

III. RESULTS AND DISCUSSION

For the experimental conditions model in this study the estimated net return (Rn) for alternatives approaches was used to determine the soil treatments cost per plastic house. The actual cost of each treatment achieved through calculated parameters, *i.e.* alternatives and fungicide application costs, transplants count/plastic house and re-planting costs price in the applied treatments. Thereafter benefit over fungicidal treatment and reduction in costs was calculated as net return.

The net return from fungicide alternatives application was calculated as the following equation:

$$Rn = (Y + P) - (Fc + Ac)$$

Where

Rn: the net return from fungicide alternatives application.
Y: the fungicide application cost.
P: the re-planting costs price.
Fc: the fungicide alternative cost.
Ac: the re-planting costs price.

The obtained results in Fig. (1) Shows the average root rot incidence of cucumber, tomato and pepper seedlings grown in plastic house at different locations throughout two successive growing seasons 2012-2013.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

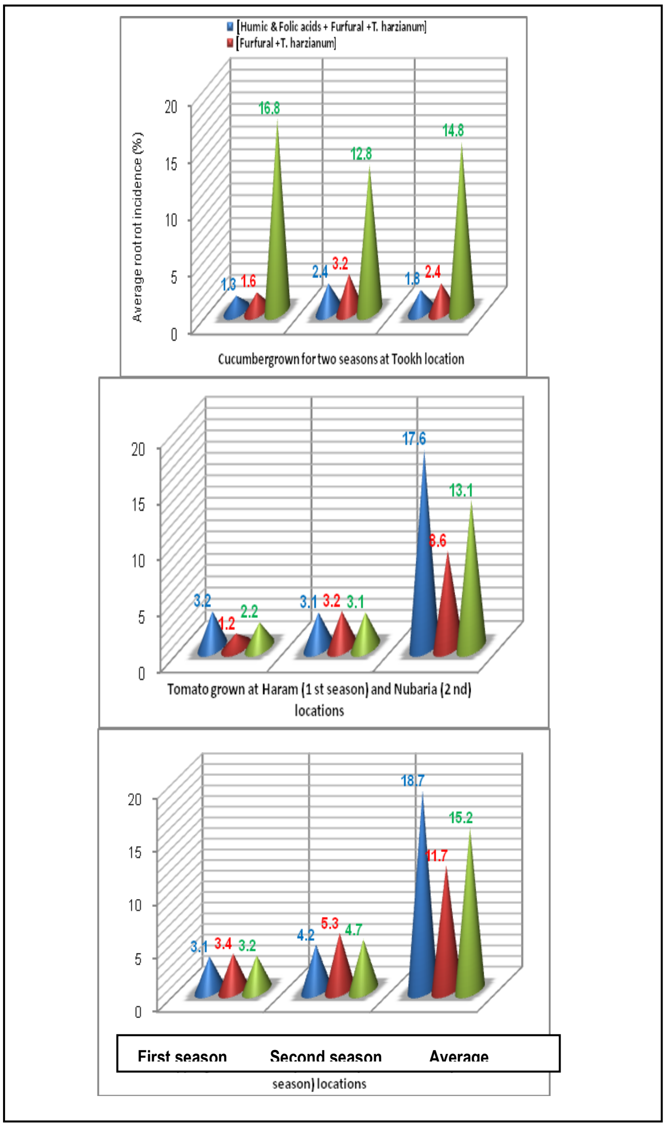


Fig. (1) Average percentage of root rot incidence in response to application of different formula against root diseases of Cucumber, Tomato and Pepper grown in plastic houses under protected cultivation system at different locations during two successive growing seasons

Presented data revealed that all applied treatments have drastic effect on root rot incidence comparing with fungicide treatment. Announced highly significant effect of both treatments, mixtures of [Humic & Folic acids + Furfural + *T. harziamum*] and [Furfural +*T. harzianum*] were recorded for the incidence of root rot disease of all growing vegetables seedlings.

Moreover, regardless the cultivated area the efficacy of applied soil treatments [Humic & Folic acids + Furfural + *T. harziamum*] and [Furfural +*T. harzianum*] could reduce root rot disease incidence over fungicide treatment of grown vegetables. In this regard the highest reduction in disease incidence was recorded as 86.7%, 82.2%; 83.9%, 72.5% and 77.1%, 66.1%, respectively for cucumber at Toohk location, tomato and pepper at Haram and Nubaria location at the two growing seasons (Fig. 2).

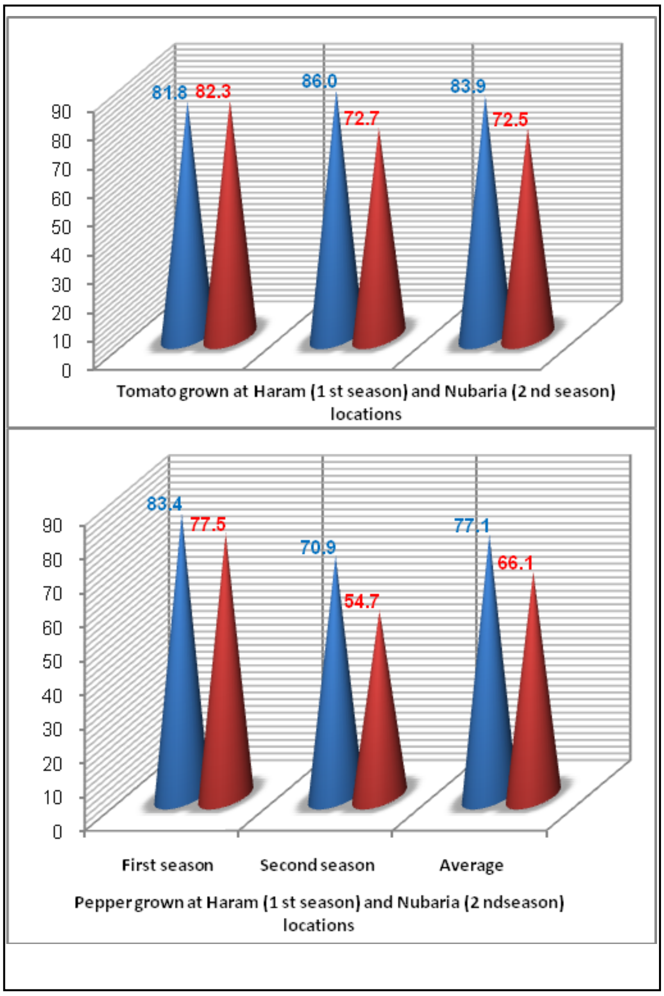


Fig. (2) Average reduction (%) in root rot incidence in response to application of different formula against root diseases of Cucumber, Tomato and Pepper grown in plastic houses under protected cultivation system at different locations during two successive growing seasons.

DATA ANALYSIS:

Data in Fig. (3) Show the average numbers of lost transplants due to root rot incidence of cucumber, tomato and pepper grown in plastic houses in response to soil application of fungicide and fungicide alternatives approaches during two successive growing seasons. The transplants count and the lost transplants due to disease infection were calculated by converting the percent of diseased seedlings into seedlings numbers taken in consideration that each plastic house contains 1200 transplant and each 12 transplant represent 1% of the total transplants in one plastic house. Presented data in Fig. (3) show that the average numbers of cucumber lost transplants was 22.2, 28.8 and 177.6 seedlings at applied treatments, [Humic & Folic acids + Furfural + *T. harziamum*], [Furfural +*T. harzianum*] and Fungicide treatment, respectively. Also, at the same treatments the lost tomato and pepper transplants counts were 26.4, 37.8, 157.2 and 39.0, 57.0, 182.4 seedlings, in respective order. Thereafter, the cost of re-planting seedlings was calculated in accordance to their commercial price and presented in Table (1). The total cost of re-planted cucumber transplants (1.0

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

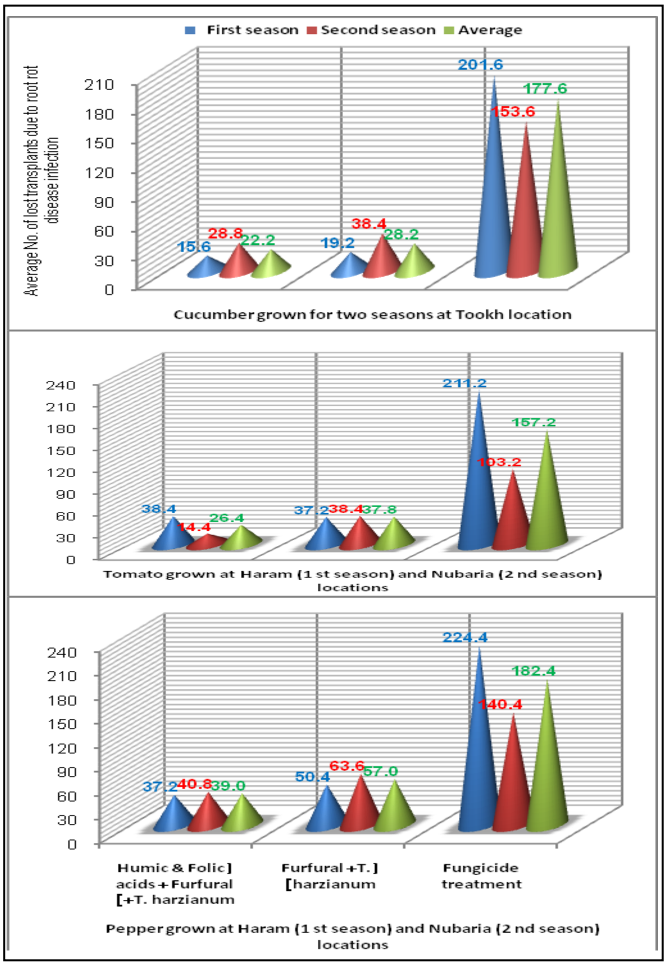
L.E./transplant) was calculated as 22.2, 28.8 and 177.6 L.E. for the applied treatments, [Humic & Folic acids + Furfural + *T. harziamum*], [Furfural +*T. harzianum*] and Fungicide treatment, respectively. As for cost of re-planted tomato transplants (1.25 L.E./transplant) was calculated as 33.0, 47.2 and 196.5 L.E. for the same applied treatments. Also, 31.2, 45.6 and 145.6 L.E. were the calculated cost of re-planted pepper transplants (0.80 L.E./transplant) in respective order with the applied treatments. Estimated minimization in re-planting loosing costs in response to different applied treatments for cucumber, tomato and pepper grown in plastic houses under protected cultivation system at different locations during two successive growing seasons, 2012-2013 was then carried out. The cost for each applied treatment, re-planting process, actual cost (obtained by addition the cost of re-planting plus cost of treatment), benefit over fungicide treatment (obtained by subtracting actual cost in fungicide treatment from actual cost in certain treatment) and reduction in treatment cost (actual cost in treatment in relative to fungicide treatment %) were calculated in consideration of the following:

- Each plastic house contains 5 rows and each row treated with 20L and then, each plastic house treated with 100L.
- Each Liter contains [Humic & Folic acids (5ml/L) + Furfural (10ml/L) + *T. harzianum* $10x10^{10}$ (10ml/L)].
- For Humic & Folic acid (5mL x 20L x 5rows= 500mL) each liter =20 L.E., So the cost of treatment = 10.0 L.E
- For Furfural (10mL x 20L x 5rows= 1000mL) each liter =100 L.E., So the cost of treatment = 100.0 L.E.
- For the antagonist *T. harzianum* (10mL x 20L x 5rows= 1000mL) each liter =5 L.E., So the cost = 5.0 L.E.
- Total cost of the first treatment (T_1) per plastic house = 10.0 +100.0+5.0=115.0 L.E.
- Total cost of the second treatment (T_2) per plastic house = 100.0 + 5.0 = 105.0 L.E.
- Referring to presented data in Table (2) considering the commercial price of applied fungicides and their used amounts, the total cost of the third treatment (T_3) =170.0, 167.0 and 240.0 L.E. for cucumber, tomato and pepper, respectively.

The calculated data presented in Table (3) revealed that the gained benefit over fungicide treatment was 210.4, 215.5 and 239.4 L.E. for cucumber, tomato and pepper at the soil applied treatment of [Humic & Folic acids + Furfural + *T. harziamum*] as well as reduction in costs were recorded as 60.5,59.2 and 62.0% at the same treatment for grown vegetables, respectively. Meanwhile, at soil treatment with [Furfural +*T. harzianum*] the calculated benefit over fungicide treatment was 213.8, 211.3 and 235.0 L.E. for cucumber, tomato and pepper, respectively. As for reduction in costs for grown vegetables at applied treatment of [Furfural +*T. harzianum*] the recorded percentages were 61.5, 58.1 and 60.9% for cucumber, tomato and pepper, in respective order.

IV. DISCUSSION

Under protected cultivation system, fungicide treatment of vegetables is prevalent and recommended almost routinely against root diseases. However, plant stand increases and hence the resulting net returns from fungicide alternatives use are highly variable within and between years. These variations raise questions about whether, when and how fungicide alternatives should be used. To help answer these questions, a thorough economic evaluation of fungicide alternatives use was carried out, based on results from alternatives plots and fungicide-treated plots in the present study. The optimization of plant natural compounds fungicides against fungal diseases for agriculture is an important research because it would permit to search some important alternatives to the use of synthetic fungicides. Although new fungicides based on natural plant extracts, essential oils are continually developing, more research is necessary for optimizing applications and become a safe alternative for eliminating the chemical fungicides from agriculture. Meantime these types of fungicide alternatives are safe under some conditions and applied together with synthetic fungicides in order to reduce residues in an IPM strategy [14].



* Each plastic house contains 1200 transplant and each 12 transplant represent 1% of the total transplants in one plastic house

Fig. (3) Average numbers of lost transplants affected with root rot incidence in response to application of different formula against root diseases of Cucumber, Tomato and Pepper grown in plastic houses under protected cultivation system at different locations during two successive growing seasons

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

The obtained results in the present work showed superior efficacy of applied fungicide alternatives as soil drench than that of fungicide seed treatment which reflected in a drastic significant effect on both root rot diseases incidence and its reduction percent. All applied fungicide alternative treatments reduced significantly root rot incidence of Cucumber, Cantaloupe, Tomato and Pepper plants comparing with fungicide treated check control. The economic income return of the applied cost-effective fungicide alternatives as soil treatment against root rot diseases showed its benefit effect not only on plant stand and their effect later on the yield loses but also minimize the cost of applied treatments. In the present work, the applied fungicide alternative treatments could provide a protection to growing transplants and minimize the estimated costs for re-planting processes ranged between 22.2-47.2 L.E. for applied alternative treatments comparing with the fungicide treatment which was 145.6-196.5 for different grown vegetables. Moreover, the profitability of using alternative treatments ranged between 210.4-239.4 L.E. for tested vegetables comparing with the fungicide treatment. In addition to the number of fungicides application and sprayer machine used in fungicide treatment which was not included in cost calculations. On the other hand, the applied fungicide alternative treatments were reported to have significant inhibitor effect against root rot pathogenic fungal growth under *in vitro* [14,16,17,18]. and greenhouse conditions [19,20]. Similar results were also reported using fungicide alternatives, *i.e.* chemical inducers and bio-agent for controlling root diseases. In this concern, the effective biological control of soil-borne plant pathogens, a major consideration has been given to proliferation of the antagonist after introduction into the soil. Among the desirable attributes of a successful antagonist is its ability to produce inoculum in excess and to survive, grow, and proliferate in soil and the rhizosphere [21]. The antagonistic organisms have been known to be capable of colonizing in the rhizosphere com-patibly responding to the crops [22,23]. One interesting aspect of bio-control agent-induced suppression of disease is the reported affect of *T. harzianum* on development of gray mould disease caused by *B. cinerea* through a reduction in its pathogenicity [24,25]. In many cases, bio-logical control of soil-borne plant pathogens was successfully conducted in greenhouse or fields [26,27]. Also, in the present study combination of bio-agents and fungicides alternatives was also investigated. Similar report [28] reported that several tests revealed that soil drenches or seed treatments of a number of compounds, especially inducers of resistance, combined with strain BS8651 enhanced effectiveness and consistency of the biological control agents against Pythium-damping off in cucumber. Many investigators, explain the role of humic acid in plant diseases reduction. The role of Humic acid in plant diseases may be due to the correlation between these acids and plant health. However, not much can be found in the literature regarding the efficacy of furfural against fungi and bacteria, the metabolism and effects of furfural in eukaryotic cells have been investigated for yeast cells. In this case, the conversion of furfural depends on the rate of oxidizing in yeasts. Furfural is oxidized to furoic acid under aerobic conditions, and it is reduced to furfuryl alcohol in anaerobic fermentation [29].

Table (1) Average costs of re-planting transplants in response to application of different formula against root diseases of Cucumber, Tomato and Pepper grown in plastic houses under protected cultivation system at different locations during two successive growing seasons

Treatment	Cucumber [1]			Tomato [2]			Pepper [3]		
	Av. No. [1]	Price[2]	Total cost[3]	Av. No. [1]	Price[2]	Total cost[3]	Av. No. [1]	Price[2]	Total cost[3]
T_1	22.2	1.0	22.2	26.4	1.25	33.0	39.0	0.80	31.2
T_2	28.8		28.8	37.8		47.2	57.0		45.6
T_3	177.6		177.6	157.2		196.5	182.4		145.6

T_1 = A mixture of: [Humic & Folic acids + Furfural +*T. harzianum*]
T_2 = A mixture of: [Furfural +*T. harzianum*]
T_3 =Fungicide treatments
[1] Av. No. of re-planted transplants
[2] Price of each transplant in L.E. (the commercial transplants price of cucumber, tomato and pepper)
[3] Total cost of transplants in L.E.

Table (2) Protective program against fungal diseases for growing cucumber, pepper and tomato in plastic houses and its financial cost [*]

Vegetable	No.	Time of Treatment	Fungicide used	Concen. (ml & gm/ 100 liter)	Dose / plastic house (gm & ml)	Cost (L.E.)
Cucumber	1	After 3 days from cultivation	Chagrin	100 ml	70 ml	80.0
	2	After 7 days from previous spray	Maxim-L	100 ml	100 ml	40.0
	3	After 7 days from previous spray	Rizolex –T	200 gm	200 gm	50.0

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

	Treatments cost					**170.0**
Pepper	1	After 6 days from cultivation	Topsim-M	200 gm	500 gm	80.0
	2	After 7 days from previous spray	Maxim-L	100 ml	100 ml	40.0
	3	After 7 days from previous spray	Rizolex –T	200 gm	200 gm	50.0
	4	After 10 days from previous spray	Chagrin	100 ml	100 ml	70.0
	Treatments cost					**240.0**
Tomato	1	After 7 days of seedlings emergence	Chagrin	1 ml	20 ml	12
	2	Before transplanting	Acrobate copper	250 ml	75 ml	15
	3	Second day after transplanting	Chagrin	1 ml	60 ml	60
	4	After 7 days from previous spray	Rizolex –T	3 gm	225 gm	80
	Treatments cost					**167.0**

* The followed protective program is recommended by Protected cultivation sector, Agriculture Research Centre, Protected Cultivation, Ministry of Agriculture and Reclaimed soil

Table (3) Average minimization the loose in costs of transplants re-planting in response to application of different formula against root diseases of Cucumber, Tomato and Pepper grown in plastic houses under protected cultivation system at different locations during two successive growing seasons

Treatment	Cucumber					Tomato					Pepper				
	Treatment coast In L.E.	re- planting coast [1]	Actual cost [2]	Benefit [3]	Reduction % [4]	Treatment coast In L.E.	re- planting coast [1]	Actual cost [2]	Benefit [3]	Reduction % [4]	Treatment coast In L.E.	re- planting coast [1]	Actual cost [2]	Benefit [3]	Reduction % [4]
T_1	115.0	22.2	137.2	**210.4**	**60.5**	115.0	33.0	148.0	**215.5**	**59.2**	115.0	31.2	146.2	**239.4**	**62.0**
T_2	105.0	28.8	133.8	**213.8**	**61.5**	105.0	47.2	152.2	**211.3**	**58.1**	105.0	45.6	150.6	**235.0**	**60.9**
T_3	170.0	177.6	347.6	-	-	167.0	196.5	363.5	-	-	240.0	145.6	385.6	-	-

1= Cost of re-planting processes in L.E.
2= Actual cost in L.E.
3= Benefit over fungicidal treatment In L.E.
4= Reduction in costs %

The authors indicated that when furfural was added to the culture medium, both cellulose and *β*-glucosidase activities decreased with increasing furfural concentration. The activity of both enzymes de-creased by 50% when concentration of furfural increased from 0 to 1.2 g/l (1200 ppm). Furthermore, [30] first studied the fungicidal properties of furfural, reporting control of *R. solani* in potato. More recently, [31] demonstrated that soil treatments with furfural control southern blight caused by *S. rolfsii* in lentil, while stimulating development of *Trichoderma* spp. and bacteria antagonistic to *S. rolfsii*. These reports confirm the present findings. Furfural caused the reduction in root-rot incidence, being 75.43% comparing with untreated control when applied alone. Combined treatments with furfural and either bacterial or fungal bio-agents showed a lower effect, although they reduced the disease incidence by more than 41% [32]. A similar effect was also reported for tomato wilt caused by *F. oxysporum* [33] and stem rot of liatris (*Liatris punctata*) caused by *S. sclerotiorum* [34]. Moreover, botanical aromatics, furfural, citral and benzaldehyde showed potential for control of both fungal pathogens and phytoparasitic nematodes [35] and they did not reduce colonization of cotton roots by plant growth promoting rhizobacteria (PGPR). Furthermore, Pamphlet sheet of Protect [36,37] has demonstrated efficacy in the control of plant parasitic nematodes and fungal pathogens, *i.e. Pythium, Fusarium, Phy-tophthora* and *Rhizoctonia.*In literature reports conducted with the economic beneficial use of fungicide alternatives, were not found, meanwhile several studies concerning the economic benefit of using fungicides were only found. In this regard, [38] reviewed the economic basis for protection against plant diseases. They declared the economics of diseases to be a somewhat neglected theme. Some years later [39] found economic models of biological systems to be too simple compared with the complex nature of such systems. Since then, the economic importance of plant diseases and the net return from control measures have been estimated now and then, [9,40,41,42,43,44]. However, this subject has still not been studied sufficiently to provide a good base for limitation and optimization of control measures. Also, [45] made a rough estimate of crop losses in agricultural crops in Sweden during the late 1970s and evaluated the possibilities of reducing these losses and the economic consequences of different restrictions. He found host plant resistance to be the most profitable measure in the controlling of a number of fungal diseases, but he also found a considerable short-term potential for increased use of fungicides and a marked increase in net production costs when the use of pesticides was stopped. In a later evaluation by the Royal Swedish Academy of Agriculture and Forestry, the economic losses caused by total omission of fungicides and a 50% decrease of herbicides in cereals was estimated at 77 € ha-1 [46]. More specifically, in winter wheat [47] found fungicide treatment to be decreasingly profitable at increasing cost levels (calculated in dt grain ha-1); 81% at cost level 1 dt ha-1 and 33% at cost level 6 dt ha-1 for 167 field trials in southern Sweden, and 68% and 13% respectively for 96 field trials in central Sweden. Recently, [11] stated that fungicides are commonly applied to control foliar fungal diseases of winter wheat in the central Great Plains of the United States and often are routinely recommended. They studied the cost benefit of using fungicides. The results from their study indicate that foliar fungicide application to winter wheat can be profitable in years with moderate to high disease severity; however, net loss can result if fungicides are applied in years with low disease severity. Also, an IPM practice in paddy region, Malaysa was carried out conducted with the production initiatives includes research on the optimal use of pesticides, complementary weed control strategies, and alternative cultural and biological controls (Amir et al. 2012). Results of this study showed that the program would generate economic benefits which include improvements in water quality, food safety, pesticide application safety, alternative cultural and biological controls and long term sustainability of pest management systems. In general further studies are needed concerning the economic benefits and net return of application fungicides alternatives against root diseases affecting various crops and their effect on the produced yield.

V. CONCLUSION

The advantages of fungicide alternative are reduced risks to the applicator, reduced number of applications, a potential to control both soil-borne pathogens. Plant parasitic fungi are an implacable foe of vegetables production; hence the benefit of fungicide alternative use in agriculture is a significant increase in the production of vegetables which are important for healthy diet. The results of the present study show that fungicide alternatives used can provide growers a comparable level of control to conventional fungicides to control root rot diseases of vegetables. Also, the present study demonstrated that the applied fungicide alternative approaches resulted in a significant reduction in root rot incidence of tested vegetables, Cucumber, Tomato and Pepper under plastic houses conditions comparing with fungicide treatment. Furthermore, these applied treatments reflected on higher profitability over fungicide treatment. It may be concluded that these approaches are considered an applicable, safe and cost-effective method for controlling such soil-borne diseases. Therefore, it can be inferred that fungicide alternatives may be a suitable approach to conventional fungicides in controlling root rot diseases in a plastic house setting. Fungicide alternatives are good alternatives to conventional fungicides because they have lower risks to the person spraying, they have a short re-entry interval which would allow workers to re-enter the treated area sooner, and they could save the grower money by reducing the number of fungicide applications.

VI. ACKHNOLEDGEMENT

This work was supported financially by the Science and Technology Development Fund (STDF), Ministry of Scientific Research and Technology, Egypt, Grant No. 1059.

REFERENCES

[1] Anonymous, 2010. Yearbook of statistics of Ministry of Agriculture.' (Agricultural Economical and Statistical Department, Arab Republic of Egypt: Cairo. pp: 148 [In Arabic].

[2] Kaulizakis, M. 1997. National Agricultural Foundation, Sub-tropical plant and olive trees. Instt. China Lab. Pl. Pathol. Agrokipio Chinia Crete Greece, 4: 383–6

[3] Roberts, D.P., Lohrke, S.M., Meyer, S.L.F., Buyer, J.S., Bowers, J.H., 2005. Bio-control agents applied individually and in combination for suppression of soil borne diseases of cucumber. Crop Prot., 24: 141–155

[4] Erol, F.Y. and Tunali, B. 2009, Determination of root and crown rot diseases in tomato growing area of Samsun province. Acta Hort. (ISHS), 808: 65-70.

[5] El-Mougy, N.S., Abdel-Kader, M.M., Abdel-Kareem, F., Embaby, E.I., El-Mohamady, R. and Abd El-Khair, H. 2011, Survey of Fungal Diseases Affecting Some Vegetable Crops and Their Rhizospheric Soil borne Microorganisms Grown under Protected Cultivation System in Egypt. Research Journal of Agriculture and Biological Sciences, 7(2): 203-211.

[6] Nasir, S., Hairuddin, M. A., Ariff, H., and Alias, R. 2010. "Economic Benefits of Sustainable Agricultural Production". Journal of Environment Asia, 3: 168-174.

[7] Wearing, C. H. 1988. Evaluating the IPM implementation process. Annu. Rev. Entomol., 33:17-38.

[8] Jeger, M. J. 2004. Analysis of disease progress as a basis for evaluating disease management practices. Annu. Rev. Phytopathol., 42:61-82.

[9] Fabre, F., Plantegenest, M. and Yuen, J. 2007. Financial Benefit of Using Crop Protection Decision Rules Over Systematic Spraying Strategies. Phytopathology, 97: 1484-1490.

[10] Wiik, L., Rosenqvist, H. 2010. The economics of fungicide use in winter wheat in southern Sweden. Crop Protection, 29: 11-19.

[11] Stephen, N.W., Michael, V.Z., Julie, A.B. and Baenziger, P.S. 2011. Economic returns from fungicide application to control foliar fungal diseases in winter wheat. Crop Protection, 30: 685–692.

[12] SAS 1988. Statistical Analysis System. User's Guide: Statistics (PC-Dos 6.04). SAS Institute Inc., Cary, NC, USA.

[13] Winer, B.J. 1971. Statistical Principles in Experimental Design. 2nd ed. MiGraw-Hil Kogakusha, LTD, 596 pp.

[14] Martinez, J.A. 2012. Natural Fungicides Obtained from Plants, Fungicides for Plant and Animal Diseases, Dr. Dharumadurai Dhanasekaran (Ed.), ISBN: 978-953-307-804-5, InTech, Available from: http://www.intechopen.com/books/fungicides-for-plant-and-animal-diseases/natural-fungicides-obtained-fromplants.

[15] Abdel-Kader, M.M., El-Mougy, N.S., El-Gammal, N.G., Abd-El-Kareem, F., Abd-Alla, M.A. 2012a. Laboratory Evaluation of Some Chemicals Affecting Pathogenic Fungal Growth. Journal of Applied Sciences Research, 8 (1): 523-530.

[16] Abdel-Kader, M.M., El-Mougy, N.S., Abdalla, M.M., Abd-El-Kareem, F., Fatooh, Y.O. 2012b. Effect of Some Plant Resistance Inducers, Essential Oils and Plant Extracts on Antagonistic Ability of Bacteria and Yeast Bio-agents In Vitro. Journal of Applied Sciences Research, 8 (1): 543-555.

[17] Abdel-Kader, M.M., El-Mougy, N.S., El-Mohamady, R.S. El-Gammal, N.G., and Embaby, E.I. 2012c. Influence of Some Fungicides Alternatives on The Growth Viability of Bacterial and Yeast Bio-agents In Vitro. Journal of Applied Sciences Research, 8 (3): 1365-1372.

[18] Abdel-Kader, M.M., El-Mougy, N.S., El-Gammal, N.G., El-Mohamdy, R.S., Fatouh, Y.O. 2012d. In Vitro Assay of Some Plant Resistance Inducers, Essential Oils and Plant Extracts on Antagonistic Ability of Fungal Bio-Agents. Journal of Applied Sciences Research, 8(3): 1383-1391.

[19] Abdel-Kader, M.M., El-Mougy, N.S. and Embaby, E.I. 2012f. Evaluating the efficacy of different plant resistance inducers and/or bio-agents treatments against root diseases incidence of some vegetables under protected cultivation system. Australian Journal of Basic and Applied Sciences, 6(5): 241-248.

[20] Abdel-Kader, M.M., El-Mougy, N.S., Aly, M. D. E., Lashin, S. M., El-Mohamady, R. S. 2012e. Soil Drench with Fungicides Alternatives Against Root Rot Incidence of Some Vegetables Under Greenhouse conditions. International Journal of Agriculture and Forestry 2(2): 61-69.

[21] Yigit, F. and Dikilitas, M. 2007. Control of Fusarium Wilt of Tomato by Combination of Fluorescent Pseudomonas, Non-pathogen Fusarium and Trichoderma harzianum T-22 in Greenhouse Conditions. Plant Pathology Journal, 6 (2): 159-163.

[22] Baker, K.F. and Cook, R.J. 1974. Biological control of plant pathogens. W. H. Freeman & Co., San Francisco, CA, USA.

[23] Cook, R.J. and Baker, K.F., 1983. The nature and practice of bio logical control of plant pathogens. APS. St. Paul, MN, USA.

[24] Kapat, A., Zimand, G. and Elad, Y. 1998. Effect of two isolates of Trichoderma harzianum on the activity of hydro-lytic enzymes produced by Botrytis cinerea. Physiol. Mol. Plant Pathol., 52: 127–137.

[25] Elad, Y. and Kapat, A. 1999. The role of Trichoderma harzia-num protease in the biocontrol of Botrytis cinerea. Eur. J. Plant Pathol., 105: 177–189.

[26] Schroth, M.N. and Hancock, J.G. 1981. Selected topics in biological control. Annu. Rev. Microbiol., 35: 453-476.

[27] Weller, D.M. 1988. Biological control of soilborne plant pathogens in the rhizosphere with bacteria. Annu. Rev. Phytopathol., 26: 379-407.

[28] Vogt, W. and Buchenauer, H. 1997. Enhancement of biological control by combination of antagonistic fluorescent Pseudomonas strains and resistance inducers against damping off and powdery mildew in cucumber. Journal of Plant Diseases and Protection, 104 (3): 272-280.

[29] Taherzadeh M.J., Gustafsson, L., Niklasson, C. and Lidén, G. 1999. Conversion of furfural in aerobic and anaerobic batch fermentation of glucose by Saccharomyces cerevisiae. J. Bi-osci. Bioeng., 87: 169–174.

[30] Flor, H.H. 1926. Fungicidal activity of furfural. Iowa State College. J. Sci., 1: 199–227.

[31] Canullo, G.C., Rodriguez-Kabana, R. and Kloepper, J.W., 1992, Changes in soil microflora associated with control of Sclero-tium rolfsii by furfuraldehyde. Biocontrol Science and Technology, 2: 159–169.

[32] El-Mougy, N.S., El-Gamal, N.G., Mohamed, M.M. and Abdel-Kader, M.M., 2008. Furfural approaches as control measures against root rot and root-knot incidence of tomato under greenhouse and field conditions. Journal of Plant Protection Research, 48 (1): 93-105.

[33] Stephan Z.A., Al-Hamadany, M.A., Al-Din, S.S. and Dawood, H.B. 2001. Efficacy of furfural treatment in controlling the disease complex of root-knot nematode and Fusarium wilt on tomato and egg plant under Lathouse conditions. Arab. J. Pl. Prot., 19: 97–100.

[34] Gerik J.S. 2005. Evaluation of Soil Fumigants Applied by Drip Irrigation for Liatris Production. Pl. Dis. 89: 883–887.

[35] Bauske, E.M., Backman, P.A., Harper, K.M., Brannen, P.M., Rodríguez-Kábana, R. and Kloepper, J.W. 1997. Effect of bo-tanical aromatic compounds and seed-surface pH on growth and colonization of cotton plant growth-promoting rhizo-bacteria. Biocontrol Science and Technology, 7: 415–421.

[36] Anonymous, 2005. Environmental Fate and Effects Division Review of the New Chemical. U.S. Environmental Protection Agency, Office of Prevention Pesticides. http://www.epa.gov/opprd001/factsheets/furfuralEFEDRA.pdf

[37] Anonymous, 2006, Furfural Chemical Documents. Fact Sheets on New Active Ingredients.U.S. Environmental Pro-tection Agency. http://www.epa.gov/opprd001/factsheets

[38] Ordish, G. and Dufour, D. 1969. Economic bases for protection against plant diseases, Annu. Rev. Phytopathol., 7: pp. 31–50.

[39] Carlson, G. A. and Main, C. E. 1976. Economics of disease loss management, Annu. Rev. Phytopathol., 14 : pp. 381–403.

[40] Cook, R. J. and King, J. E. 1984. Loss caused by cereal diseases and the economics of fungicidal control, Plant Diseases: Infection, Damage and Loss, Blackwell Scientific Publications, Oxford, pp. 237–245.

[41] Zadoks, J. C., Chang, T. T. and Konzak, C. F. 1974. A decimal code for the growth stages of cereals, Weed Res., 14: 415–421.

[42] Cook, R.J., Jenkins, J.E.E. 1988. The contribution and value of pesticides to disease control in cereals. In Control of plant diseases: Costs and Benefits (eds. Clifford BC, Lester E), 3-12.

[43] Priestley, R.H. and Bayles, R.A. 1988. The contribution and value of resistant cultivars to disease control in cereals. In:

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

Control of Plant Diseases: Costs and Benefits, Clifford BC and Lester, E. eds., 53-65.

[44] Cooper, J. and Dobson, H. 2007. The benefits of pesticides to mankind and the environment. Crop Prot., 26: 1337-1348.

[45] Sundell, B. 1980. Växtskadegörare i jordbruket. 3. Ekonomiska effekter av en minskad användning av kemiska bekämpningsmedel (engl. summary). Rapport från institutionen för ekonomi och statistik, 170: pp. 128. SLU Uppsala.

[46] KSLA, 1989. Minskad bekämpning i jordbruket. Möjligheter och konsekvenser. Rapport nr. 36, pp. 88. Kungl. Skogs- och Lantbruksakademien, Stockholm Sweden (ISSN 0349-1811).

[47] Wiik, L. 1991. Ekonomisk betydelse av svampsjukdomar i stråsäd vid förändrade priser (Engl. summary). 32:a svenska växtskyddskonferensen. Uppsala 30-31 januari 1991. Skadedjur och växtsjukdomar, 171-186.

[48] Amir, H.M., Shamsudin, M.N., Mohamed, Z.A., Hussein, M.A. and Radam, A. 2012. Economic Evaluation of Rice IPM Practices in MADA, Malaysia. Journal of Economics and Sustainable Development. 3 (9): 47-55.

AUTHOR BIOGRAPHY

First Author Department of Plant Pathology, National Research Centre – Egypt, Email: Nehal_nrc@yahoo.com,

Second Author: Department of Plant Pathology, National Research Centre – Egypt, Email: mokh_nrc@yahoo.com.

Third Author: Department of Vegetable Research, National Research Centre –Egypt, **Email:** lashin2004@hotmail.com