CONTROL OF STRAWBERRY SOIL-BORNE PATHOGENS IN SOIL LIKE SUBSTRATE OF RECYCLED RICE STRAW

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Abstract

Rice straw decomposition was done within 45-60 days with 6 different biological and chemical methods using *Trichoderma harzianum*, *T. album*, ruminant fluid microflora from large animal's stomach, 3 different species of decomposition bacteria; chicken manure water extract and chemical fertilizers. Two strawberry cultivars (Festival and Susana) highly susceptible to crown rot, root rot, wilt and anthracnose diseases were used and its fresh seedlings were cultivated in decomposed rice straw and naturally infested soil in two locations at Ismailia and El-Behera governorates. Data recorded 120 days after sowing showed clear reduction of infected plants with soil-borne pathogens grown in decomposed rice straw bags to 0.7 and 1.6% while it increased to 8.5 and 76.6 % for plants grown in natural soil treated with methyl bromide in El-Behera and Ismailia, respectively. Strawberry plants grown on rice straw bags showed better growth and an increase in strawberry fruits of good quality and quantity as compared with the control plots under natural soil conditions. The pH around the roots in decomposed rice straw bags ranged from 5.5 to 6.5, slightly acidic, while it ranged from 7.5 to 8.5 (alkaline) around root system in natural soil. Infected plants with different symptoms of crown rots and black root rots yielded several fungi and fungus like organisms identified as *Phytophthora cactorum*, *Colletotrichum acutatum*, *Rhizoctonia solani*, *Scelerotium bataticola*, *Fusarium oxysporum*, *F. solani* and *Pythium ultimum*. Based on the above result, it could be recommended that using decomposed rice straw bags as a growing substrate that improve the production and quality of strawberry under open field conditions in Egypt. This method provided new options for farmers wishing to be more environment friendly and add new economic value to rice straw waste as cheaper substrate compared with commercial grow-bags.

Keywords: Strawberry, decomposed rice straw bags, *Trichoderma harzianum, Colletotrichum acutatrum, Phytophthora cactorum*, alkaline pH.

INTRODUCTION

Strawberry (Fragaria × ananassa Duchesne) production in Egypt is by using two genotypes called “Frigo and Fresh” (**Picha 1999 a**). A fresh type seedling is cultivated for early crop in November and December and for exportation with high economic profit while, Frigo type seedling is cultivated for late crop in February and March for local markets. Strawberry cultivation in new reclaimed or old Nile Delta soils may have problems due to high infestations with soil borne diseases as occurred in Susana and Festival strawberry cultivars and resulted in a significant reduction in yield and fruit quality. Increasing use of soil fumigation or chemical pesticides creates serious environmental, safety and health hazard. Among the crop residues, rice straw is one of the most plentiful crop residues in the world, and is produced at the rate of approximately 731 million tons per year and estimated about 6 million tons per year in Egypt. Customarily, most farmers in the world openly burn rice straw since this practice offers a cost effective method for disposing of the straw and clearing the rice field for planting the next crop (**Harun *et al.*, 2013**). However, this practice creates serious environmental, safety issues, and there is a strong desire to find alternative ways to remove the rice straw after each harvesting season. Recent research findings on recycling rice straw in Egypt to be used as soil like substrate was done by **Abdel-Sattar, (2005)** who had provided new options for farmers wishing to be more environment friendly and add new economic value to rice straw waste. He used compacted rice straw bales, as a growing or soil like substrate instead of naturally infested soil with soil borne pathogens for improving cucumber production under greenhouse conditions. Also; new soil borne diseases and root knot nematodes in strawberry plants was recorded by **Abdel-Sattar *et al.*, (2008)**.

The present investigation deals with the biological recycling of rice straw with non pathogenic soil microorganisms and possible use of decomposed rice straw as a "soil like substrate" for cultivation of fresh strawberry plants in open fields for the first time in Egypt and to avoid disease problems inherent in the natural soil occurred to common commercial strawberry cultivars "Susana and Festival" highly susceptible to crown rot, root rot, wilt and anthracnose diseases.

MATERIALS AND METHODS

Biological recycling/decomposition of rice straw:

One experiment was conducted in two locations in Egypt at Abo-Swear in Ismailia governorate and El-Amria in El-Behera governorate during September 2010 -2011. Two strawberry cultivars "Festival and Susana" highly susceptible to anthracnose and soil borne diseases were used in both locations. Rice straw was obtained from commercial suppliers. Six treatments for straw biological decomposition with individual spore suspensions of non-pathogenic soil microorganisms, chicken manure water extract and chemical fertilizers were carried out before planting strawberry seedlings. All treatments were replicated four times and data values were analyzed and presented in histograms for different means of recorded measurements. All treatments were covered with white transparent plastic sheets to provide favorable conditions for the quick decomposing of rice straw (45-60 days). Black or white plastic grow bags (150-200 microns), and ditches were filling with decomposed rice straw. Drip irrigation lines were extended on the top of the rice grow-bags and ditches installed at a distance of 20 cm. A control treatment was determined for comparison in naturally infested soil treated with methyl bromide ($50 g/m^2$). Each treatment was applied on one ton of rice straw bales saturated with water by sprinklers or misting system and divided to four replicates (250 kg. for each replicate). The following are description and details of conducted treatments.

1. **Inoculation with *Trichoderma* species**: Rice straw was individually inoculated with two *Trichoderma* species growth on liquid Potato Dextrose medium.

Amounts of 1500 ml of *Trichoderma harzianum* and *Trichoderma album* spore suspension ($10X10^6$ spores /ml) were used in straw inoculation process. The inocula of both *Trichoderma* species were obtained from Plant Pathology Research Institute, Agriculture Research Center, Giza, Egypt.

2. **Inoculation with bacteria**: rice straw were individually inoculated with three different bacterial suspension growth ($1x10^8$ cfu/ml) was used for each *Acinetobacter* sp., *Streptococcus rumen* and *Enterobacter aerogenes*. The three bacterial species were obtained from Faculty of Veterinary, Suez Canal University.
3. **Inoculation with rumen fluid**: rice straw was inoculated with crude extract of rumen fluid microflora (500 ml. for each of the four replicates) obtained from large animal's stomach from slaughterhouse of Ismailia city.
4. **Inoculation with manure extract**: rice straw was inoculated with poultry manure water extract, about 25 Kg poultry manure for each replicate in polyethylene bag soaked in water three days and the dark water extract was used.
5. **Old recycled rice straw**: used rice straw planted with other vegetables crops for two years were collected, water sprayed, and solar sterilized for two months in summer before application.
6. **Chemical fertilizers**: rice straw was treated individually with 3 chemical fertilizers; ammonium sulfate, calcium super phosphate and urea (2 g of each fertilizer per Liter of water).

Transplanting:

Strawberry fresh seedlings were planted/ on decomposed rice straw bags, ditches and naturally infested soil. The distances between transplants were 15-20 cm apart. The holes in fermented rice straw and naturally infested soil were 8 to 10 cm wide and deep enough to set the plants. The plants were watered by the drip irrigation system until the end of the season.

Fertilization:

The nutrition management in rice straw grow-bags culture was similar as the sandy soil culture. The exception to the sandy soil culture was the higher use of nitrogen as soon as the rooting process in the rice straw bags started. The fertilization scheme with N, P, K and Mg depended on the physiological status of the growing strawberry plants during different stages of development. In the natural soil only, about 25 % of the total recommended amount of nitrogen, phosphorus and potassium fertilizers and all micronutrients were applied prior to forming the beds. The remaining N, P and K were fed to the crop via the drip irrigation system throughout the growing season. At least 50 % of the N should be in form of Nitrate (No3) according to Picha (1999 b).

Detection of fungal and root knot nematodes disease symptoms

The occurrence of root rot, crown rot, wilt and fruit rots symptoms as well as root knot nematodes on and in roots at different strawberry growth stages on rice straw bags or ditches as compared with natural soil under open field conditions were recorded. Isolation and identification of the causal pathogens were also carried out.
Any detected plants had characteristic symptoms of root and/or crown rots were thoroughly washed in running tap water and small fragments of the infected tissues were surface – disinfested with sodium hypochlorite solution (Chlorine 1%) for two

minutes , rinsed several times in sterile distilled water and dried between sterilized filter papers , then placed on PDA plates and incubated at 25 C^o for 7 days. Frequency percentage of fungal colonies were recorded as for each fungus, then purified using single spore and hyphal tip techniques suggested by Dhingera and Sinclair (1985). Identification of the purified fungi was carried out according to Booth (1971), Domsch *et. al*. (1980); Plaats – Niterink and Vandler (1981) and then kindly confirmed by the staff of the Fungal Research and Plant Disease Survey Dept. at Plant Pathology Research Institute, A R C, Egypt.

Vegetative growth characters:

Some important parameters of strawberry plant at different growth stages were recorded after sowing including; number of leaves/plant, fresh weight (g/plant), mean weight of 10 plants, as well as fruit yield (g/plant) as affected by sowing in decomposed rice straw bags under open field conditions. All measurements were continuously calculated at the total sum of the several harvesting carried out at 2-3 days intervals during the season.

Electric conductivity (EC) and pH value;

Electric conductivity (EC) in nutrient solution and around the root system and the degree of pH were determined in rice straw bags compared with a check plot cultivated in natural sandy soil.

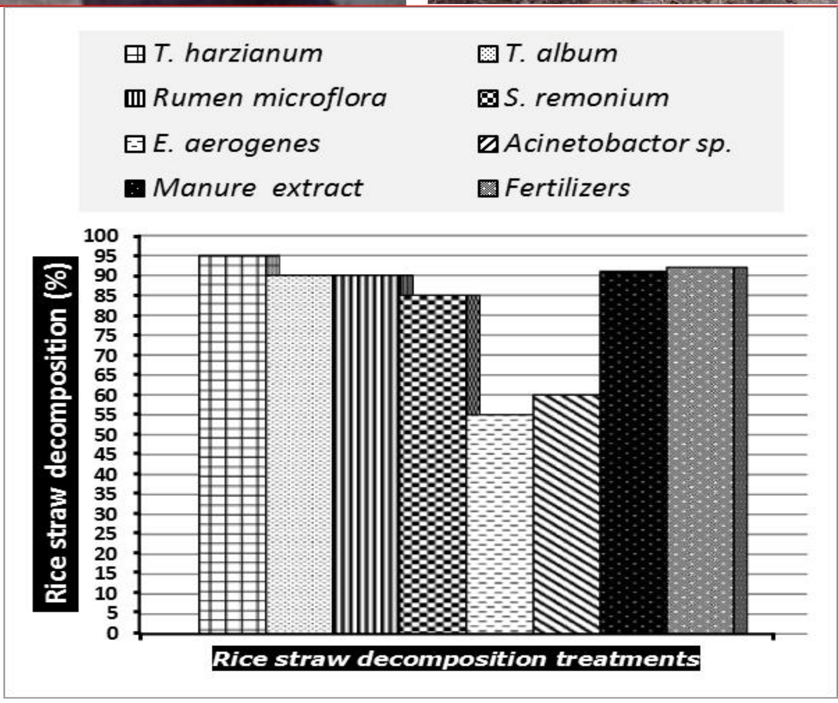
Total soluble solids:

Few drops of the filtrated juice of 10 strawberry fruits of each cultivar as affected by sowing on rice straw bags were placed on the plate of a hand refract meter. The percentage of total soluble solids was determined in both fruits grown on rice straw bags and natural sandy soil.

RESULTS AND DISCUSSION:

1-Biological recycling of rice straw:

Decomposition of rice straw components of cellulose, hemicelluloses and lignin with different treatments of non-pathogenic microorganisms, crude extract of rumen fluid microflora, poultry manure water extract as well as chemical fertilizers were evaluated. Results of visual and straw texture decomposition after 60 days observed that inoculation with Trichoderma harzianum followed by T. album showed the best analysis and decomposing of fresh rice straw (about 90-95%) after 45-60 days during summer season (Fig.1 and Histogram 1). Crude extract of rumen fluid micro flora showed best analysis (about 85-90%) when compared to the other treatments with Streptococcus remonium (80-85 %), Enterobactor aerogenes and Acinetobactor sp. (55-60%). Borji et al. (2003) has isolated and identified some bacteria capable of degrading straw lignin and polysaccharides and they were identified as Bacillus sp., Enterobactor sp. and Agrobacterium. They also reported that rumen fluid micro flora consists of protozoa, bacteria, fungi and other microorganisms. Digestion of rice straw by microflora from rumen in vitro was reported by Ramin et al, (2008). Force necessary to break the straw was highly related to loss by decomposition, straw decomposed so rapidly that straw strength approached zero within 2 months. Straw partially buried or maintained under plastic cover more than on the soil surface and it would be decompose more rapidly and loss its strength, but weight loss and strength would probably have the same relationship as buried straw.



Histogrm(1): Decomposed rice straw with different microorganisms after 45 days during summer season; (A) Decomposition by *Trichoderma album;* (B) Decomposition by *Streptococcous remonium*; (C): Decomposition by *Trichoderma harzianum*; (D) Decomposition by crude extract of rumen microflora and pasteurization rice straw by solar heat during summer season for 60 days.

In the same time, poultry manure water extract and chemical fertilizers decomposed more than 90 % of rice straw after 60 days. May be poultry manure consist of similar non–pathogenic microorganisms which hydrolysis cellulose and hemicelluloses' of rice straw. Rice straw get mature within 45-60 days, temperature reached about 55-56C^{o} during decomposition and has gone down after that. The volume of the straw is only 40-45 % of that it was before and the substrates are brown to black and become like soil in appearance. It results in improved texture, better aeration and water-holding capacity, increased fertility and less acidity. Filling black or white plastic grow bags , 150-200 microns , and ditches with decomposed rice straw represented good and very cheaper local soil less media instead of imported very expensive grow-bags.

2- Detection of fungal and root knot nematodes disease symptoms

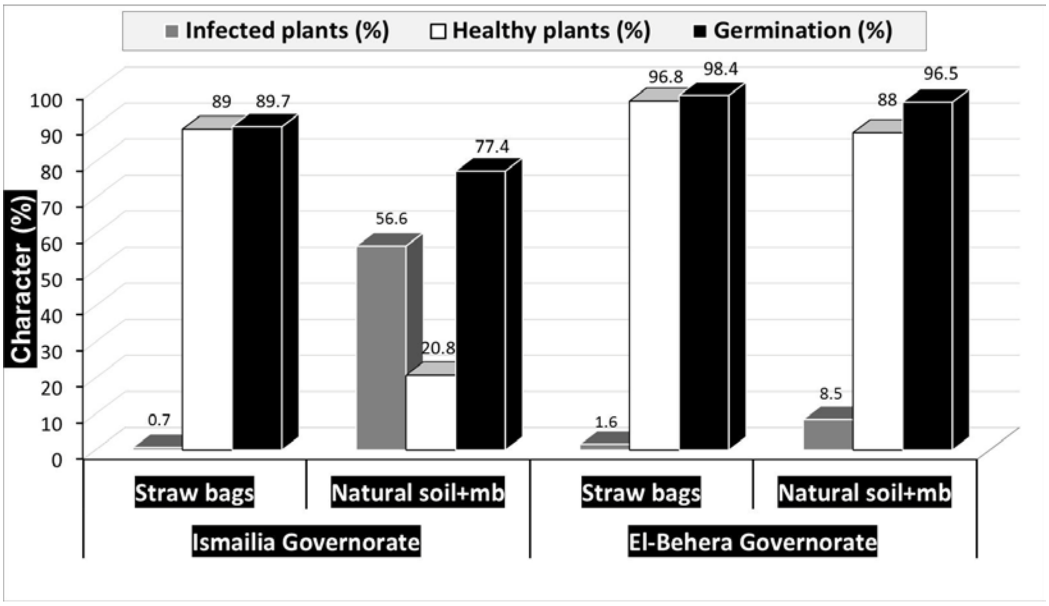
The following data are the mean of the two locations result but the figures of each location will illustrated separately. It is clear from the obtained data in Histogram (2) that the occurrence of infected strawberry plants (root-rot, crown –rot, anthracnose, wilt and root knot nematodes) grown in decomposed rice straw bags reached, 1.6 and 0.7% in El-Behera and Ismailia, respectively. However, the corresponding figures for strawberry plants grown in natural soil sterilized with Methyl Bromide under the same conditions were 8.5 and 76.6 % (Fig.2), respectively, 120 days after sowing.

In the same time, percentage of seedling germination reached 98.7and 89.7 % in El-Behera and Ismailia, respectively in strawberry seedling grown on decomposed rice straw bags, 15 days after sowing. However, the corresponding figure for strawberry seedlings grown in natural soil under the same conditions reached 96.5 and 77.4 respectively. The infection with root rot and /or crown rot (wilted plants) of strawberry seedlings grown on rice straw bags may be attributed to contaminated rice straw with soil particles or through contaminated irrigation water or latent infected seedlings of the highly susceptible cultivars.

3-Isolation of associated strawberry pathogens:

Plating internal pieces of rotted tissues on PDA yielded six fungal and fungal like organism genera according to their frequency of occurrence as follows: *Phytophthora cactorum,* followed by *Scelerotium bataicola, Colletotrichum acutatum, Fusarium oxysporum, Rhizoctonia solani, F. solani* and *Pythium ultimum*. Disease symptoms observed were shown in (**Fig.3**). The youngest leaves wilted suddenly and wilting spread to the entire plant, which dies within a few days. Intensive browning and disintegration of the vascular tissues of the crowns is characteristic of the disease. Symptoms in most cases appear first at the upper part of the crown and sometime symptoms appear from intermediate places (*Phytophothora cactoram*). In the same time, the occurrence of *F. oxysporum* in crowns showed distinct reddish brown discoloration.

In this concern, *C. acutatum* was isolated from strawberry plants with crown rot symptoms. The plants grow normally for some time after they have been transplanted then wilted suddenly and die. A reddish brown streaking occurred in portions of the interiors of crowns of wilted plants. On the other hand, *R. solani* and *P. ultimum* were isolated from black rotted roots. Infection with both pathogens kills structural roots as well as feeder rootlets of strawberry. Lesions on young roots are reddish brown at first, but darken with age.



Histogram (2): Occurrence of infected strawberry plants (root rot, crown rot, anthracnose, wilt and root knot nematodes) in El-Behera and Ismailia governorates as affected by sowing in decomposed rice straw bags and in natural soil treated with methyl bromide (mb).

3- Vegetative characters of strawberry plants.

Strawberry plants grown on rice straw bags under open field conditions showed better growth and an increase in shoot and root systems. It is evident from **Table (1)** that strawberry plants grown on rice straw bags showed increase in number of leaves /plant, plant height, shoot system weight/plant, root length, number of roots and weight of roots as compared with those grown in natural soil **(Fig.4).** These results agreed with finding of Gasperavicute (1977) who reported that the growth of cucumber plants were more vigorous when grown in loose or pressed straw than soil. Also, Hartmann and Waldhor (1978); Sady (1979), Omel' Chenko *et al* (1983) and Abdel- Sattar (2005) found that artificial substrates increased the total yield of cucumber plants.

Fig. (2): Susana the highly susceptible strawberry cultivar to soil-borne pathogens showed 76.6% of infected plants in natural soil treated with Methyl Bromide (50 g/m2).

Note: Probably the infection transmitted through the infected strawberry seedlings.

Fig.(3): Strawberry plants grown in natural soil showing different symptoms of crown rots and black root rots associated with different fungal species isolated *i.e., Colletotrichum acutatum, Phytophthora cactorum, Sclerotium bataicola, Fusarium oxysporum, Rhizoctonia solani, F. solani* and the fungus like organism *Pythium ultimum.*

Table (1): Some vegetative growth characters of strawberry plants, as affected by sowing in decomposed rice straw bags under open field conditions.

Growth characters	**Cultivation strawberry in:**	
	Rice straw bags	**Natural soil**
	Shoot system	
No. of leaves/plant	30.5*	18.4
Plant height (cm)	31.1	23.8
Fresh wt. (g)/plant	162.5	93.7
	Root system	
Root length (cm)	66.5	29.8
No. of hairy roots	29.3	21.4
Weight of roots (g)	24.6	12.9

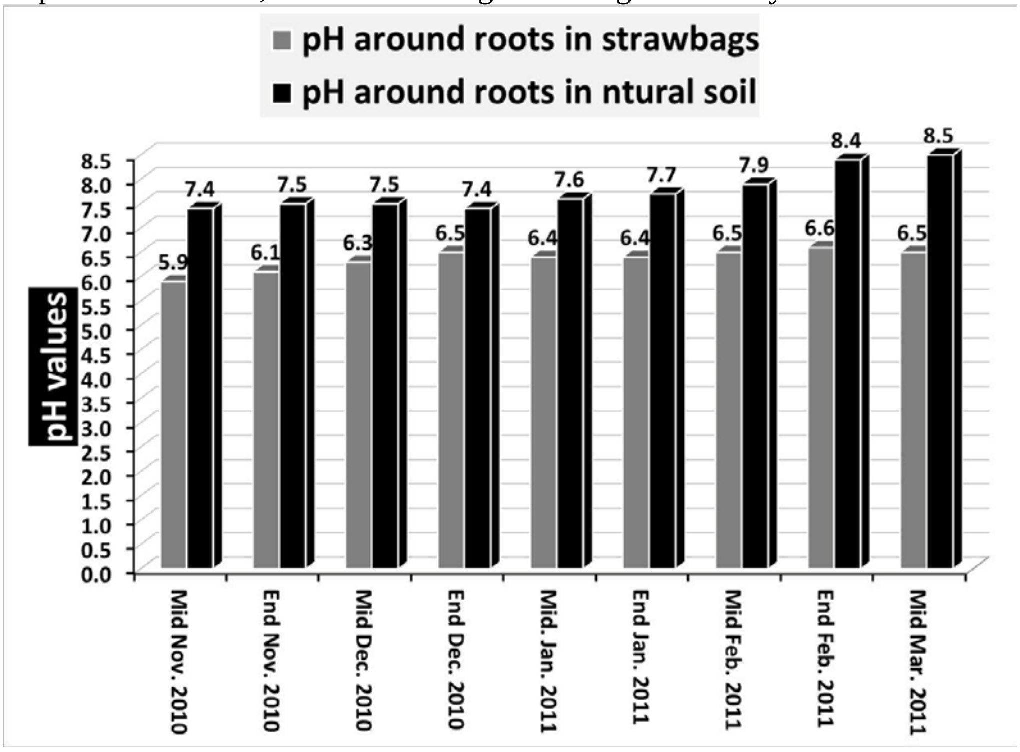
* Values represent mean of 10 plants measurements

Fig. (4): Long and big size of strawberry roots grown on decomposed rice straw bags (A) compared with root system grown in natural infested soil (B).

4- pH values around roots of strawberry plants

Data presented in **histogram (3)**; show the pH values around roots of strawberry plants as affected by sowing on decomposed rice straw bags compared with natural soil. The pH around the root in decomposed straw bags ranged between 5.8 to 6.6, slightly acidic substrate. It is known that the acidity of the soil play a role in the growth and development of cultivated plants. The pH 6-6.5 is favorable for dissolving the insoluble salts. However, the pH values around the roots of strawberry plants grown in natural soil under open field conditions were ranged from 7.4 to 8.5 (alkaline soil). Picha (1999 b) reported that the optimum soil pH for strawberry ranged between 6.4 and 7.3. In order to attain the desired pH, it will be necessary to lower the pH in most Egyptian soils, which typically have a pH of 8.0 or greater. Alkaline soils lower strawberry yield by tying up P and the micronutrients Fe, Mn and Zn. He also added that strawberries are sensitive to salt damage and should not be planted in soils having a salt content above 400 ppm.

So, sowing on rice straw bags (pH 5.8-6.6) instead of natural soil (pH 7.4-8.5) can solve the conditions of alkalinity and salinity in rhizosphere of strawberry plants. The nearly optimal pH around the root zone may have affected the status and absorption of nutrients, thus contributing to better growth and yield.



Histogram (3): The pH values comparison between strawberry plants grown in decomposed rice of straw bags and natural field soil treated with methyl bromide.

5- Strawberry yield and quality parameters

Data in **Table (2)** show that there was an slight increase in the total soluble solids content in fruits grown on rice straw bags as compared with those grown in natural soil .The increase of T.S.S. may play a role in improving the quality of strawberry fruits. The total soluble solids may be affected by mineral fertilization as mentioned by Deswal and Patil (1984) and Muller *et al.* (1986).

The results obtained also indicate that average of fruit weigh and fruit size as the total yield /plant were much higher in favor of the decomposed rice straw bags (Fig.5) and ditches cultivated crop (Figs.5 &6) than the control check which sterilized with methyl bromide (Fig.2). Salama and Mohmmedien (1996) reported that rice straw covered with legume wastes (peas and beans) and thick layer of clay and fertilizers were added alternatively in five trenches dug into the soil of plastic – house gave the highest yield and improved fruit quality of sweet pepper. Abdel Sattar (2005) reported that cucumber grown on rice straw bales under greenhouse conditions showed better growth and increased fruit number and weight compared with those in natural soil.

In the same time , the fruit rot diseases reached 0.8% in strawberry plants grown on decomposed rice straw bags , while the percent reached 23 % in the natural soil .The isolated fungi from the rotted strawberry fruits grown in natural soil revealed the presence of eight different genera *Rhizoctonia solani*, *Pytophthora cactorum*, *Botrytis cinerea*, *Pythium ultimum* and *Alernaria alternate*, while *Sclerotinia sclerotiorum, Sclerotium rolfsii* and *Rhizopus nigricans* were the least frequently isolated fungi .The isolation from rotted fruits on decomposed rice straw bags recorded only *R. nigricans* , *A. alternate* and *B. cinerea* with lower occurrence . Cultivating strawberry on decomposed rice straw bags keeps the fruits away from contacting the soil and thus limits the possibility of infection by soil – borne fungi.

A

B

Fig.(5): Strawberry plants grown in grow bags (A) and ditches (B) filled with decomposed rice straw at Ismailia Governorate.

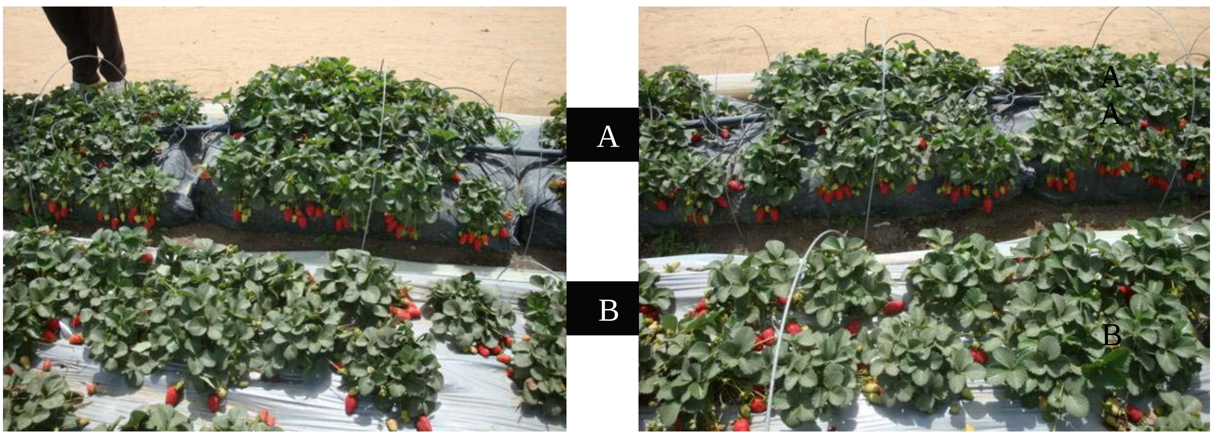


Fig.(6):Strawberry plants grown on decomposed rice straw bags (A) and ditches covered with plastic sheet (B), at El-Behera Governorate .

Table (2): Total soluble solids content and acidity in strawberry fruits, fruit yield/plant and rotted fruit percent as affected by sowing on decomposed rice straw bags compared with natural soil under open field conditions.

Yield and quality characters	**Cultivation strawberry in:**	
	Rice straw bags	**Natural soil**
T.S.S (%)	8.7*	8.2
pH of crude fruit juice	3.45	3.40
Fruit Weight (g)/plant *	575.9	455.3
Single fruit weight (g)**	28.7	20.6
Rotted fruit percent	0.8	23

*** Mean of 100 plants, ** Mean of 100 fruits**

6-Electric conductivity (EC) in nutrient solution and around roots of strawberry plants as affected by sowing on decomposed rice straw bags compared with natural soil:

Data presented in **Table (3)** indicate that plants grown on decomposed rice straw bags recorded lower E.C. (ppm) value around the roots compared with the control (natural soil) during different stages of strawberry development. In the natural soil, EC value increased with increasing the plant age. Accumulation of excessive amounts of nutrients takes place in natural soil more than in decomposed rice straw bags. The EC value reached 1840 ppm around strawberry roots in natural soil, four months after sowing. However, the EC recorded 1070 ppm around strawberry roots in decomposed rice straw bags after 4 months of sowing. These results agreed with D, Anna *et.al*. (2007) who studied the effect of different electrical conductivity levels on strawberry crown in soil less culture.

Also, here the problem of alkalinity and salinity in the rhizosphere of strawberry plants grown on decomposed rice straw bags did not appear. This is very important, as strawberries are very sensitive to salinity. Picha (2001) reported that salt accumulation can cause considerable economic loss to growers, however, an excess of soluble salts is harmful, and strawberry growth generally decreases as salinity increases. Also, Khoyyat *et.al*. (2007) reported that fruit set and quality in strawberry cv. Selva were influenced by salinity (NaCl) and supplementary calcium and potassium treatments applied to the root medium of plants growing in soil less culture under heated greenhouse condition .

Table (3): Electric conductivity (EC) in nutrient solution and around roots of strawberry plants as affected by sowing on decomposed rice straw bags compared with natural soil under open field conditions.

Electric conductivity (EC)/ppm					
Oct. 25, 2010	Nov 25, 2010	Dec.25, 2010	Jan. 25, 2011	Feb. 10, 2011	Mar. 10, 2011
In Nutrient solution					
430	535	555	570	645	660
around roots in rice straw bags					
630	690	725	760	1040	1070
around roots in natural soil					
720	750	780	1050	1260	1840

No. of E.C. x 640 = ppm

CONCLUSION

On the bases of the above results, it could be recommended that using decomposed rice straw bags as a growing media in replacing naturally infested soil, can improve the production of strawberry under greenhouses and open field conditions in Egypt. The technical advantages of growing strawberry plants on rice straw bags are listed as follows:

1- Good control of soil–borne fungi and nematodes without pesticide use.
2- Better use of irrigation water and fertilizers.
3- Avoid possible alkalinity and salinity that may develop in rhizosphere of strawberry plants in natural soil.
4- Easier and cheaper cultivation system under greenhouses and open field conditions.
5- Minimizing fungicides, methyl bromide and nematicides, used against soil – borne fungi and nematodes thus reflecting on production cost.
6- Avoiding soil and water pollutions with pesticides and methyl bromide.
7- Avoiding the serious pollution when disposed rice straw by burning every year in Egypt.
8- Minimizing pesticides residues in harvested strawberry fruits.
9- Producing local soil less culture media instead of imported ones.

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مقاومة المسببات المرضية للفراولة والكامنة فى التربة بزراعة الفراولة فى تربة ناتجة من تدوير قش الأرز

محمد انور عبد الستار و حنان احمد المرزوقى
كلية الزراعة جامعة قناة السويس –الاسماعيلية –مصر

الملخص العربى

صنفى الفراولة فيستيفال والصنف سوزانا من اكثر الاصناف قابلية للاصابة بامراض اعفان التاج وعفن الجذور والذبول والانثراكنوز . التدوير البيولوجى و الكيماوى لقش الارز يشمل المعاملة بالفطريات غيرالممرضة *Trichoderma harzianum, T. Album* ومستخلص عصارة كرش الحيوانات الكبيرة المحتوى على الكائنات الحية الدقيقة والستخلص المائى لمنقوع زرق الدواجن (الكتكوت) والاسمدة الكيماوية وقد اوضحت النتائج ان تدوير قش الارز ونضجة يتم خلال 45 -60 يوم. زراعة شتلات فراولة طازجة لتلك الاصناف القابلة للاصابة على قش الارز المتحلل بيولوجيا مقارنة بالزراعة على التربة الملوثة طبيعيا بمنطقتى ابوصوير بالاسماعيلية والنوبارية بالبحيرة اوضح ان حدوث الاصابة بنباتات الفراولة النامية على اكياس قش الارز المتحلل بيولوجيا بلغ 7 ،0 % و6 ،1 % بمنطقتى البحيرة والاسماعيلية على التوالى . بينما كانت الصورة المقابلة لنباتات الفراولة النامية بالتربة الطبيعية المعاملة بغاز الميثيل بروميد بمعدل تحت نفس الظروف بكلا المنطقتين 8,5 % و 6,6 7 % على التوالى وذلك بعد 120 يوم من الزراعة . نباتات الفراولة النامية على اكياس قش الارز المتحلل بيولوجيا تحت ظروف الصوبة والحقل المكشوف اظهرت نمو افضل وزيادة فى عدد ثمار الفراولة كميا ونوعيا وذلك عند مقارنتها بتلك النامية بالتربة الطبيعية تحت نفس الظروف . درجة الحموضة حول جذور النياتات النامية على اكياس قش الارز المتحلل بيولوجيا تتراوح من 5,5 -6,5 حموضة خفيفة بينما القيمة المتحصل عليها حول الجذور النامية بالتربة الطبيعية يتراوح من7,5-8,5 وسط قلوى . زراعة الفراولة على اكياس قش الارز المتحلل بيولوجيا تحافظ على الثمار بعيدا عن ملامسة التربة وهذا يحد من الاصابة بالفطريات الكامنة بالتربة . العزل من نباتات الفراولة المصابة باعفان التاج و اعفان الجذور اوضح وجود الفطريات *Colletotrichum acutatum, Sclerotium bataticola, Phytophthora cactorum, Rhizoctonia solani, Fusarium oxysporum , F. solani* الفطريات وشبيه *Pythium ultimum* .

وبناء على النتائج السابقة فانة يمكن التوصية بان استخدام قش الارز المتحلل بيولوجيا كبيئة انبات بديلة عن التربة الملوثة طبيعيا يمكن ان يحسن من انتاج الفراولة تحت ظروف الحقل فى مصر كذلك فان استخدام هذة البيئة المحلية الرخيصة والفعالة كتربة بديلة يمكن ان تكون بديلا عن استيراد اكياس النمو غالية الثمن والاقل جودة .