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OCCURRENCE OF SOILBORNE DISEASES AND ROOT KNOT NEMATODES IN STRAWBERRY PLANTS GROWN ON COMPACTED RICE STRAW BALES COMPARED WITH NATURALLY INFESTED SOILS

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Abstract: The present investigation deals with a possible use of rice straw bales as "soilless" cultivation medium, thus escaping the problems inherent in the natural soils and avoiding a serious pollution when disposed about 5°C million tons of rice straw annually by burning. Strawberry fruits of good quality and quantity were harvested from plants cultivated on compacted rice straw bales in comparison with the control plots under natural soil conditions. A higher temperature of 2 to 5 in comparison to natural soil conditions favours all physiological activities including the absorption of nutrients by roots and thus stimulating the vegetative and the generative growth of strawberry plants. The pH values around the roots in straw bales ranged from 5.5 to 6.5, while values obtained around the root system in natural soil ranged from 7.5 to 8.5. So, growing strawberry on rice straw bales helps avoid and overcome the problem of alkalinity and salinity in the rhizosphere. This is very important, as strawberries are very sensitive to salinity. Fruit rot diseases reached 0.8% on rice straw bales while on the control plots these were about 52% of fruits were infected with fungi. Cultivating strawberry on rice straw bales keeps the fruits away from contacting the soil and thus limits the possibility of injection by soilborne fungi. The occurrence of damping-off, root rot, crown rot and root knot nematodes in strawberry plants grown on rice straw bales reached 4.0, 0.85, 0.35 and 0.0%, respectively. However, the corresponding figures for strawberry plants grown in natural soil under the same conditions were 27.0, 16.15, 11.70 and 13.20%, respectively, 135 days after planting. Isolation from strawberry plants grown in natural soil showing symptoms of crown rot and black root rot yielded several fungi identified as *Phytophthora cactorum*, *Colletotrichum fragariae*, *Pythium ultimum*, *Rhizoctonia solani* and *Fusarium oxysporum*. The wilt symptoms observed on few strawberry plants on rice straw bales might be attrib-

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uted to very sporadic contamination with soil particles or through irrigation water. Based on the above results, it could be recommended using rice straw bales as growing media to replace naturally infested soil, this can improve the production of strawberry under open field conditions in Egypt. Also, it is important to avoid the serious pollution when disposed rice straw by burning.

Key words: Strawberry, compacted rice straw bales, *Colletotrichum fragariae*, *Phytophthora cactorum*, alkalinity, salinity, rhizosphere

INTRODUCTION

The new cultivated lands and Nile Delta soils may have high infestation of with soilborne fungi, plant–parasitic nematodes, insects and weeds. The lack of control can result in a significant reduction in strawberry yield and fruit quality. Feeding of plant parasitic nematodes in large numbers on strawberry roots can reduce plant growth, fruit yield, and quality. They also predispose strawberries to other soilborne pathogens such as *Rhizoctonia* and *Pythium.* Soilborne fungi such as *Phytophthora* or *Verticillium* can totally destroy a straweebery culture. Soil fumigation is very effective in reducing nematode populations as well as in controlling soilborne pathogenic fungi that infect strawberry roots. Methyl bromide (MB) the most effective soil fumigant for strawberries in Egypt, beside other nematicides and fungicides has played an important role in increasing agricultural productivity achieved during the last few decades. The increasing use of these pesticides has lead to widespread concern about their potential ill effects to human health. The original aim of this study was to introduce safe alternative control methods against soilborne pests and diseases causing agents that can replace the use of methyl bromide and other pesticides in horticulture. The use of compacted rice straw bales as organic medum in open field production is a new approach in Egypt. Hassan (1988) referred to straw bales of wheat and barley for growing cucumber and tomato in greenhouses in some European and Arab countries**.** Choe *et al.* (1991) studied the effect of rice straw application on improvement of soil conditions for growing green pepper in greenhouses. Salama and Mohamnedien (1996) reported that rice straw covered with legume waste (peas and beans) and thick layer of clay and fertilizers was added alternatively in five trenches dug into the soil of plastic house gave the highest yield and improved fruit quality of sweet pepper. Jarvis (1997) reported that wheat straw bales have traditionally been used for cucumber and tomato production in the United Kingdom. Cucumbers have often been planted in ridges.

In Egypt, the annual production of rice straw reached more than 5 million tons, which causes serious pollution when disposed by burning. On the other hand, the major components of rice straw are silica, lignin and hemicelluloses which are not attractive or favourable for soil fungi or nematodes. At the same time, the raw material of rice straw is very cheap as the ton of rice straw equals to 60 Egyptian pounds, so it could represent a good substrate for sowing instead of natural infested soil under open field conditions. Abdel-Sattar (2002, 2004) published a new technique for the first time in Egypt in two bulletins for growing cucumber, tomato, pepper, melon and strawberry in greenhouses and open field on compacted rice straw bales, using dissolved fertilizers only. The present investigation deals with a possible use of rice straw bales as a "soilless" cultivation medium for strawberry plants in open field thus escaping the problems inherent in the natural soils.

MATERIALS AND METHODS

The experiment was carried out in highly natural infested field at Faculty of Agriculture Farm, Suez Canal University – Ismailia Governorate during the two winter seasons of 2005–2006 and 2006–2007. Strawberry frigo seedling cv. Montakhab were planted on compacted rice straw bales and naturally infested soil.

Fermentation of compacted rice straw bales

Eighty compacted rice straw bales (50 cm height x 70 cm width x120 cm length) obtained from commercial suppliers were arranged in mid September 2005–2006 and 2006–2007 seasons to form four rows for strawberry cultivation under open field conditions. Drip irrigation lines were extended on top of the rice straw bales with two drip lines on each row installed at a distance of 40 cm. The straw bales were first irrigated for six hours for washing out soil particles, and then the dissolved ammonium and potassium sulphate and phosphoric acid 85% fertilizers were applied daily through the irrigation system, 10–12 days before planting, for rice straw fermentation.

Transplanting

Strawberry frigo seedlings were planted in the fermented rice straw bales and naturally infested soil 40 cm apart. The holes in fermented rice straw bales and naturally infested soil were 8 to 10 cm wide and deep enough to set in the plants. The plants were planted as soon as possible the base of the transplant.

Frigo transplant crown diameter was at least 0.5 cm. A Proper planting depth is critical to the survival of transplants. Transplants would die if planted too deep or too shallow. The plants were watered by the drip irrigation system until the end of the season.

Fertilization

The nutrition management in rice straw baled culture was similar to that applied in a sandy soil culture. The exception to the sandy soil culture was the higher use of nitrogen as soon as the rooting process in the straw bales started.

The fertilization scheme with N, P, K and Mg depended on a physiological status of the growing strawberry plants during different stages of their development. In the natural soil, about 25% of the total recommended amount of nitrogen, phosphorus and potassium fertilizer and 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 the nitrate (No3) according to Picha (1999a).

Occurrence of fungal diseases and root knot nematodes

The occurrence of root rot , crown rot , wilt diseases and fruit rots as well as root knot nematodes on and in roots of strawberry plants at different stages of growth in rice straw bales as compared with natural soil under open field conditions were also recorded.

Isolation and identification of the causal pathogens and occurrence percentages of fungi were also investigated.

Strawberry plants showing characteristic symptoms of root and crown rot were thoroughly washed in running tap water. Small fragments of infected tissues were surface –disinfected with sodium hypochlorite solution for one minute, rinsed several times in sterile distilled water and dried between sterilized filter papers, then placed in PDA plates and developing fungal colonies were recorded as percentage of frequency for each fungus, and 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) and Plaats–Niterink and Vandler (1981) and then kindly confirmed by the staff of the Fungal Research and Plant Disease Survey Depart. Plant Pathology Research Institute, Agric. Centre.

Vegetative growth characters

Some important growth parameters of strawberry plants at different stages after planting such as the number of leaves/plant, fresh weight/plant g (mean of 10 plants) as well as fruit yield/plant as affected by planting in rice straw bales and the total sum of the several harvesting dates carried out at 2–3 days intervals during the season were continuously recorded.

Temperature, Electric conductivity (EC) and pH

Temperature in rhizosphere of strawberry plants, electric conductivity (EC) in nutrient solution and around the root system and pH were determined in rice straw bales. These were compared with a check plot cultivated in natural soil.

Total soluble solids

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

RESULTS AND DISCUSSION

Occurrence of wilt and root knot nematodes on /in roots of strawberry plants at different growth stages as affected by planting in rice straw bales compared with natural soil under open field conditions (mean of the two seasons)

It is clear from the obtained data (Table 1) that the occurrence of damping-off, root rot, crown rot and root knot nematodes in strawberry plants grown in rice straw bales reached 4.0, 0.85, 0.35 and 0.0%, respectively. However, the corresponding figures for strawberry plants grown in natural soil under the same conditions were 27.5, 16.15, 11.70 and 13.20%, respectively, 135 days after planting. At the same time, percentage of plants regrowth reached 96% in strawberry grown in rice straw bales, 15 days after planting. However, the corresponding figure for strawberry plants grown in natural soil under the same conditions reached 72.5%, respectively. A possible with root rot and /or crown rot (wilting) of strawberry plants grown in rice straw bales was attributed to contaminated rice straw with soil particles or contaminated irrigation water. Similar conclusion was reported by Abdel- Sattar (2005).

Table 1. Occurrence of wilt and root knot nematodes on /in roots of strawberry plants at different dates as affected by planting in rice straw bales under open field conditions (mean of the two seasons 2005–2006 and 2006–2007)

Days after planting	Planting in rice straw bales					Planting in natural soil (control)				
	Percentage of occurrence					Percentage of occurrence				
	% of regrowth	damping-off	wilted plants		root knot nematodes	% of regrowth	damping - off	wilted plants		root knot nematodes
			root rot	crown rot				root rot	crown rot	
15	96.0	4.0	0.0	0.0	0.0	73.0	27.0	0.25	0.10	0.30
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.50	0.50	0.80
45	0.0	0.0	0.0	0.10	0.0	0.0	0.0	1.45	1.30	1.40
60	0.0	0.0	0.15	0.0	0.0	0.0	0.0	1.20	2.70	1.50
75	0.0	0.0	0.10	0.15	0.0	0.0	0.0	2.50	0.80	1.95
90	0.0	0.0	0.10	0.0	0.0	0.0	0.0	2.15	1.20	0.90
105	0.0	0.0	0.25	0.0	0.0	0.0	0.0	3.20	2.40	1.50
120	0.0	0.0	0.10	0.10	0.0	0.0	0.0	2.40	2.70	2.10
135	0.0	0.0	0.15	0.0	0.0	0.0	0.0	2.50	0.0	2.75
Total	96.0%	4.0	0.85	0.35	0.0	72.5	27.5	16.15	11.70	13.20

Samples of wilted strawberry plants showing root and crown rot symptoms grown in naturally infected soil were used for isolation of the associated fungi. Plating internal pieces of rotted tissues on PDA yielded five fungal genera. Counts of fungal colonies of identified genera were recorded on the segmented parts of 25 wilted seedlings in order to determine their frequency of occurrence. Disease symptoms observed were described (Fig. 1). The frequency of *Phytophthora cactorum* occurrence reached 15% of infected crown rots. The youngest leaves wilted suddenly and wilting spread to the entire plant, which died 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 sometimes on intermediate places. At the same time, the occurrence of *F. oxysporum* in crowns caused a distinct reddish brown discoloration reaching 7% of affected plants.

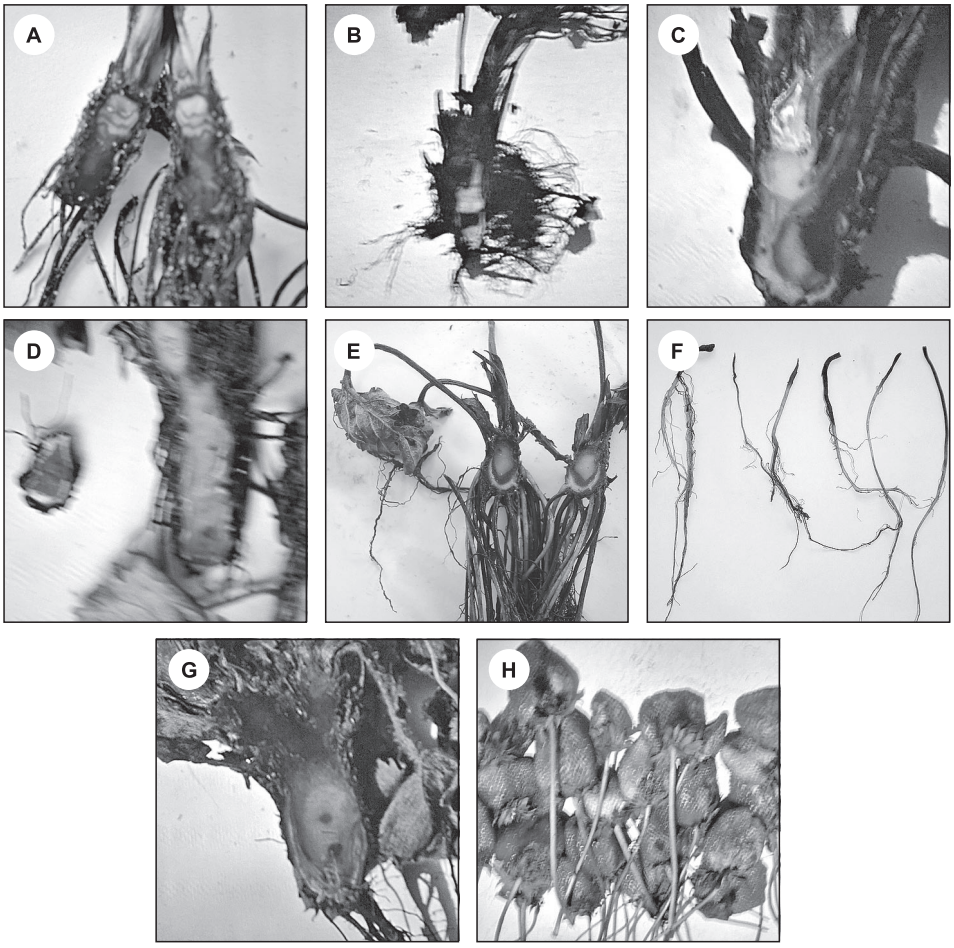

Fig. 1. Strawberry plants grown in natural soil showing symptoms of crown rot and black root rot from which *Colletotrichum frgariae* (A), *Phytophthora cactorum* (B and C), *Pythium ultimum* (D), *Fusarium oxysporum*, *Rhizoctonia solani* (E and f) and *F. solani* were isolated (G). Notice the different symptoms of strawberry fruit rots on naturally infested soil (H).

In this concern, *C. fragariae* was isolated from strawberry plants with crown rot growing normally for some time after transplanting, then wilted suddenly and died. A reddish brown streaking occurred in portions of the interiors of crowns of wilted plants. The occurrence of this fungus in infected crowns was 5%. On the other hand, *R. solani* and *P. ultimum* reached 16 and 11% occurrence during isolations from black root rots, respectively. Infection with both fungi kills structural roots as well as feeder rootlets of strawberry. Lesions on young roots are at first reddish brown, but darken with age.

Vegetative characteristics of strawberry plants as affected by planting in rice straw bales compared with natural soil under open field conditions

Strawberry plants growing in rice straw bales under open field conditions showed better growth and an increase in shoot and root systems.

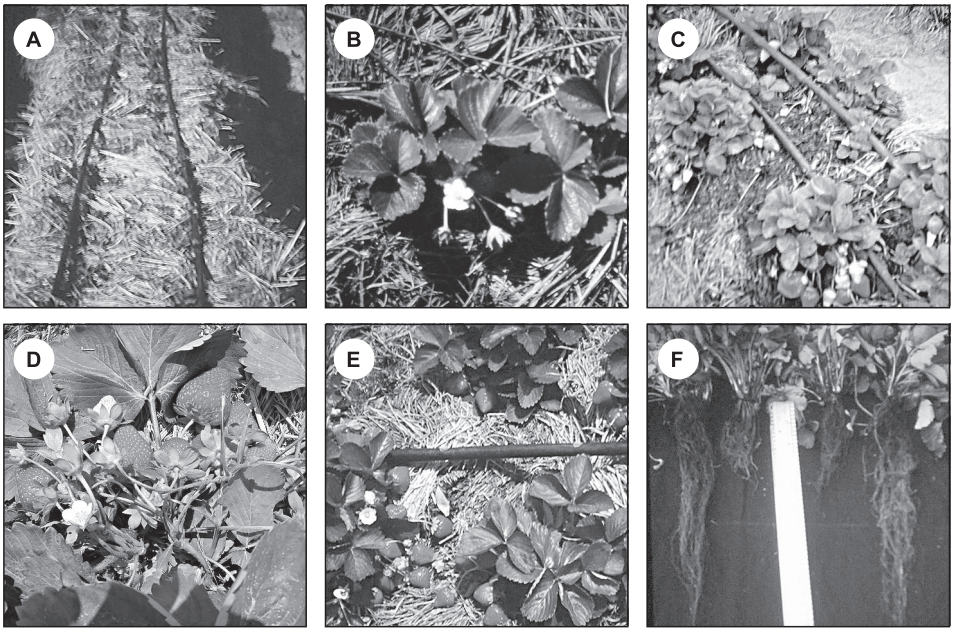

Fig. 2. Strawberry plants grown on compacted rice straw bales produced fruits of good quality and quantity during different stages of development (A, B, C, D, E). Notice clear differences between root length in rice straw bales, about 70 cm, as compared with roots in natural infested soil, length about 25–30 cm (F).

It is evident from Table 2 and illustrated in Fig. 2 that strawberry plants grown in rice straw bales increased the number of leaves/plant, plant height, shoot system wt/plant, root length, the number of roots and weight of roots as compared with those grown in natural soil. These results agreed with Gasperavicute (1977) who reported that the growth of cucumber plants was more vigorous when grown in loose or pressed straw than in the soil. Hartmann and Waldhor (1973); Sady (1979) and Omel' Chenko *et al.* (1983) found that artificial substrates increased the total yield of

cucumber plants. At the same time, Abdel-Sattar (2005) found that cucumber plants grown in rice straw bales under greenhouse conditions showed better growth and increased fruit number and weight compared with those grown in natural soil.

Table 2. Some vegetative growth characteristics of strawberry plants as affected by planting in rice straw bales under open field conditions

Root system (mean of 10 plants)			Shoot system (mean of 10 plants)			Treatments
Weight of roots [g]	no. of roots	root length	fresh wt/ plant [g]	plant height [cm]	no. of leaves/Plant	
24.7	29.0	64.3	162.8	31.0	30.7	rice straw
12.6	21.3	29.3	93.5	23.7	18.7	natural soil

Temperature in rhizosphere of strawberry plants as affected by planting in rice straw bales

It appears from Table 3 that the temperature around roots in rice straw bales increased by about 2 to 5°C compared to those cultivated in the natural soil during the winter season. The increase of temperature in rice straw bales may be due to fermented and degraded straw. The higher temperature in fermented rice straw bales favoured the plant growth, increasing root length and the development of leaves. It influenced the number of fruits and finally the yield that was considerably higher in rice straw bales than that in the natural soil under open field conditions. This may have favourably the status and absorption of nutrients, thus contributing to better growth and yield.

Table 3. Temperature in rhizosphere of strawberry plants as affected by planting in rice straw bales under open field conditions

Temperature (°C) at 15–20 cm depth		Date of the test
In natural soil	In straw bales	
23.8	24.7	25/10/2006
21.0	23.2	10/11/2006
21.8	24.3	25/11/2006
19.6	23.5	10/12/2006
15.5	20.5	25/12/2006
15.8	19.4	10/1/2006
20.2	23.7	25/1/2007
17.9	20.1	10/2/2007
18.7	19.9	25/2/2007
24.9	25.9	10/3/2007

pH around roots of strawberry plants in compacted rice straw bales

Data in Table 4 shows pH levels around roots of strawberry plants as affected by planting in rice straw bales compared with the natural soil. The pH values around the roots in straw bales ranged between 5.8 to 6.6 being acidic. It is known that acidity of the soil plays the role in the growth and development of cultivated plants

and pH 6–6.5 is favourable for dissolving insoluble salts. However, pH around the roots of strawberry plants grown in natural soil under open field conditions ranged between 7.4 to 8.3 (alkaline soil). Picha (1999b) 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 pH of 8.0 or greater. Alkaline soils lower strawberry yield by tying 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, planting in rice straw bales (pH 5.8–6.6) instead of natural soil (pH 7.4–8.3) can solve the problems of alkalinity and salinity in rhizosphere of strawberry plants. A nearly optimal pH around the root zone may have affected the status and absorption of nutrients, thus contributing to a better growth and yield.

Table 4. pH level around the roots of strawberry plants as affected by planting in compacted rice straw bales as compared with natural soil under open field conditions

pH around roots in natural soil	pH around roots in straw bales	Date of the test during both seasons 2005–2006 and 2006–2007
7.4	5.8	Mid Nov. 2006
7.5	6.2	End Nov. 2006
7.5	6.3	Mid. Dec. 20026
7.4	6.5	End Dec. 2006
7.6	6.4	Mid Jan. 2007
7.7	6.4	End Jan. 2007
7.8	6.5	Mid Feb. 2007
7.9	6.6	End Feb. 2007
8.2	6.5	Mid March 2007
8.3	6.6	End March 2007

Total soluble solids content and acidity in strawberry fruits, fruit yield/plant and per cent of fruit rots as affected by planting in rice straw bales under open field conditions

Data in Table 5 shows that there was an slight increase in the total soluble solids (T.S.S) content in fruits strawberries grown in rice straw bales as compared with those of natural soil. The increase of T.S.S. may play a role in improving the quality of strawberry fruits.

The total soluble solids my be affected by mineral fertilization as mentioned by Deswal and Patil (1984) and Muller *et al.* (1986).

The results obtained also indicate that average fruit weigh and fruit size as expressed the total yield/plant were much higher in favour of the straw bales cultivated crop than in the control. Salama and Mohmmedien (1996) reported that rice straw covered with legume waste (peas and beans) and thick layer of clay and fertilizers were added alternatively in five trenches dug into the soil of plastic house and this gave the highest yield and improved fruit quality of sweet pepper. Abdel-Sattar (2005) reported that cucumber grown in rice straw bales in greenhouse conditions

showed better growth and increased fruit number and weight compared with those in the natural soil.

At the same time, the fruit rot diseases reached 0.8% in strawberry plants grown in rice straw bales while in the control plot about 52% of the fruits were infected with fungi. The isolated fungi from rotted strawberry fruits grown in natural soil revealed the presence of eight different genera: *R. solani*, *P. cactorum*, *Botrytis cinerea*, *P. ultimum*, *Alernaria alternata* were the most frequently isolated fungi, while *Sclerotinia sclerotiorum*, *Sclerotium rolfsii* and *Rhizopus nigricans* were the least frequent. The isolation from rotted fruits strawberries on rice straw bales showed only *R. nigricans*, *A. alternat*a and *B. cinerea* with lower occurrence.

Cultivating strawberry on rice straw bales keeps the fruits away from contacting the soil and thus limits the possibility of infection by soilborne fungi.

Table 5. Total soluble solids content and acidity in strawberry fruits, fruit yield/plant and rotted fruit per cent as affected by planting in rice straw bales under open field conditions (means of seasons).

Rotted fruit per cent	Single fruit weight [g] (mean of 100 fruits)	Fruit weight /plant [g] (mean of 25 plant)	pH level of crude fruit juce	T.S.S %	Treatment
0.8	26.7**	510.6*	3.45	8.7	rice straw
52	12.6	425.4	3.4	8.5	natural soil

* Mean of 25 plants
**Mean of 100 fruits

Electric conductivity (EC) in nutrient solution and around roots of strawberry plants as affected by planting in rice straw bales

Data presented in Table 6 indicate that plants grown in rice straw bales showed 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 amount of nutrients takes place in natural soil more often than in rice straw bales. The EC value reached 1 050 ppm around strawberry roots in natural soil, four months after planting. These results agreed with D'Anna *et al.* (2007) who studied the effect of different electrical conductivity levels on strawberry crown in soilless culture. Also here the problem of alkalinity and salinity in the rhizosphere of strawberry plants grown in rice straw bales did not appear. This is very important, as strawberries are very sensitive to salinity. Picha (2001) reported that salt accumulation can a cause considerable economic loss to growers. An excess of soluble salts is harmful, and strawberry growth generally decreases as salinity increases. Khayyat *et al*. (2007) reported that fruit seeting 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 conditions.

Table 6. Electric conductivity (E.C.) in nutrient solution and around roots of strawberry plants as affected by planting in rice straw bales under open field conditions

E.C. around roots in natural soil [ppm]	E.C. around roots in straw bales [ppm]	E.C. in nutrient solution [ppm]	Date of the test
720	630	430	5/10/2006
750	680	530	5/11/2006
780	730	550	6/12/2006
1050	750	570	5/1/2007
1250	1030	640	10/2/2007
1840	1070	660	10/3/2007

No.of E.C. x 640 = ppm

CONCLUSIONS

On the bases of the obtained results, it could be concluded that using compacted rice straw bales as a growing media for replacing naturally infested soil can improve the production of strawberry under open field conditions in Egypt. The technical advantages of growing strawberry plants in rice straw bales are listed as follows:

1. Good control of soilborne fungi and nematodes without pesticide use.
2. Better use of irrigation water and fertilizers.
3. Avoiding possible alkalinity and salinity that may develop in rhizosphere of plants in natural soil.
4. A higher temperature arising from fermented and degraded straw favours vegetative growth, flowering and fruit setting.
5. Easier and cheaper cultivation system for protected horticulture.
6. Minimizing fungicides, methyl bromide and nematicides, used against soilborne fungi and nematodes thus influencing production cost.
7. Avoiding soil and water pollution with pesticides.
8. Avoiding a serious pollution when disposed rice straw by burning.
9. Minimizing pesticide residues in harvested produce.

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POLISH SUMMARY

WYSTĘPOWANIE CHORÓB PRZENOSZONYCH Z GLEBĄ ORAZ MĄTWIKÓW W ROŚLINACH TRUSKAWEK UPRAWIANYCH NA SPRASOWANYCH BALACH SŁOMY RYŻU W PORÓWNANIU DO NATURALNIE ZAKAŻONYCH GLEB

Badania dotyczyły możliwości użycia bali słomy ryżu stanowiących podłoże nie zawierające ziemi, co pozwala na uniknięcie problemów występujących w przypadku naturalnych gleb, jak również zanieczyszczenia powietrza w wyniku pozbywania się 5 miliardów ton słomy rocznie poprzez jej spalanie. W porównaniu do kontrolnych poletek na naturalnej glebie, z bali słomy ryżowej zebrano dobry plon owoców truskawek o wysokiej jakości. Wyższa o 2 do 5°C temperatura bali słomy ryżu w porównaniu do poletek kontrolnych w naturalnej glebie sprzyja wszystkim procesom fizjologicznym, włącznie z pobieraniem składników pokarmowych przez korzenie stymulując wegetatywny i generatywny rozwój oślin truskawek. Wartość pH wokół korzeni w balach słomy ryżu wynosiła 5,5 do 6,5, a w naturalnej glebie od 7,5 do 8,5. Więc uprawa truskawek na balach słomy ryżu pomaga uniknąć problemu alkaliczności i zasolenia. To jest bardzo ważne, ponieważ truskawki są bardzo wrażliwe na zasolenie. W przypadku bali słomy ryżu gnicie owoców truskawek osiągnęło wartość 0,8%, natomiast na poletkach kontrolnych w ziemi stwierdzono 52% owoców porażonych grzybami. Uprawa truskawek na balach słomy ryżu pozwala na uniknięcie kontaktu owoców z ziemią, a więc ogranicza możliwość zakażenia grzybami przenoszącymi się przez glebę. Występowanie zgorzeli sadzonek, gnicia korzeni, gnicia części nadziemnej roślin i nicieni w uprawie truskawek na balach słomy ryżu wynosiło odpowiednio 4,0, 0,85, 0,35 i 0,0%. Natomiast analogiczne wartości dla truskawek uprawianych w naturalnej glebie w tych samych warunkach wynosiło odpowiednio 27,0, 16,5, 11,70 i 13,20% po 135 dniach od sadzenia. Izolacje wykonane z roślin truskawek rosnących w naturalnej glebie i wykazujących objawy gnicia części nadziemnej i czarnej zgnilizny korzeni wykazały obecność kilku grzybów patogenicznych określonych jako *Phytophthora cactorum*, *Colletotrichum fragariae, Pythium ultimum, Rhizoctonia solani* i *Fusarium oxysporum*. Objawy więdnięcia obserwowane u nielicznych roślin truskawek rosnących na balach słomy ryżu mogły być przypisane sporadycznemu zanieczyszczeniu cząstkami ziemi albo wodzie użytej do podlewania. Na podstawie uzyskanych wyników można zalecić wykorzystywanie bali słomy ryżu jako podłoża do uprawy truskawek zastępującego naturalną glebę, co może być korzystniejsze od uprawy w ziemi w warunkach Egiptu. Pozwala to także na uniknięcie znacznego zanieczyszczenia powietrza występującego podczas spalania bali słomy ryżu.