EFFECT OF RICE STRAW INCORPORATION AND INOCULATON WITH *Cyathus stercoreus* ON GROWTH, BIOMASS, DROUGHT RESISTANCE AND NODULATION OF *Casuarina glauca* and *Leucaena leucocephala* SEEDLINGS

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Received on: 26/5/2009 ***Accepted: 8/7/2009***

ABSTRACT

Four experiments were carried to capitalize on rice straw as a mulch to ameliorate physical properties of the soil, exaggerate water use efficiency in addition to mineral input for growing of 3 months old Casuarina glauca and Leucaena leucocephala seedlings in two seasons at the Experimental Station of Forestry and Wood Technology Department, Faculty of Agriculture, Alexandria University, Alexandria, and model nursery at Wadi El- Natroon Region, Beheira Governorate, Egypt (from 2005- 2008). The first experiment was conducted to study the effect of depth of straw story on the growth and biomass of seedlings, using two depths, 10 cm (D_{10}) and 20 cm (D_{20}) and unmulched soil (control). For both species studied, in both season, the results showed that the mulched seedlings displayed growth and biomass higher than that of unmulched ones. However, the deeper the mulch incorporated (D_{20}) in soil, the higher the growth and biomass characteristics were obtained. The second experiment was done to study the impact of inoculation with bird's nest fungus (Cyathus stercoreus) on the growth and biomass yield of seedlings, degradation rate of the straw and relative infiltration rate of rhizosphere. Fruit bodies of C. stercoreus were upward emerged after four months of inoculation. Inoculated C. glauca seedlings displayed the highest shoot height, stem diameter, shoot growth rate, branchlets, roots and total biomass compared with uninoculted straw and control treatments. Inoculated Leucaena leucocephala seedlings displayed the highest growth and yield characteristics for both season. There were no significant differences between inoculated and uninoculated ones in both of total dry weight of stem in the first season and values of both were higher than that of the control, but there were no significant differences between inoculated and uninoculated ones. As for L. leucocephala, total biomass was significantly higher than those of uninoculated and control ones. The third experiment was conducted to study the effect of 11- day drought stress on survival characteristics of seedlings. However, inoculated and uninoculated plants displayed survival, life shoot ratio, both based on height (LSR_H) and on dry weight (LSR_w) higher than those of the control. Monitoring degradation rate of straw along year, more than 90% of the total dry weight of straw lost by aid of inoculation with bird's nest fungus at rhizosphere of seedlings. Relative infiltration rates (RIR) at rhizosphere of mulched seedlings and inoculated with bird's nest fungus were lower than those of uninoculated ones. The fourth experiment was targeted to study the effect of straw mulching on nodulation characteristics of C. glauca inoculated with Frankia and L. leucocephala with Rhizobium. Data obtained from this experiment revealed that the nodulation by Rhizobium was delayed in L. leucocephala roots. On the other hand, nodulation of C. glauca roots by Frankia was failed. It is recommended, however, to exploit rice by-products by incorporate it in the soil of plantation or man made forest in marginal lands instead of its burning to ameliorate chemical, physical properties of the soil, water use efficiency, reduce weed population especially in strips and to test more economic fungus to grow under such condition.

INDRODUCTION

Nowadays, there are increasing attentions towards crop by-product recycling and pollution issues. In Egypt, there are plenty quantities of crop by-products annually produced, yet there is no organized plan to manage it. Rice straw, however, regarded one of the most common field-crop by-products. About 4.9 and 1.6 millions tons of rice straw and rice husk annually produced, respectively (Morssy and Joas, 2008). Most of such by-products burnt at the field by farmers, in turn, brought about an air-pollution along with the other pollutants that may *in situ* affect human, animal and plant health.

In many countries that produce rice crop incorporate its straw for many purposes; amongst which, production of pulp, paper and cellulose (Zerrudo, 1984; Lam *et al.*, 2005; Jinsheng *et al.*, 2008 and Rodríguez *et al.*, 2009), Biomethanation production (Somayaji and Khanna, 1994), ethanol production (Jinsheng *et al.*, 2008), animal feeding after primary treatments (Pathirana and Orskov. 1995), use it as adsorbent (Marshall, 2004), production of potassium, chlorine and ash by leaching (Bakker and Jenkins, 2003) and used as a medium for mushrooms production, particularly, *Pleurotus* spp (Hamlyn, 1989).

Under both field and laboratory conditions, it has shown that use of a surface organic (notably, straw) mulch can result in storing more precipitation water in soil by reducing storm runoff, increasing infiltration, decreasing evaporation, improving several physical, biological and chemical characteristics and thereby improving soil quality (Bond and Willis, 1969; Unger,1983; Smika and Unger, 1986; Schertz and Kemper, 1998; Karlen *et al.*, 1994; Franzluebbers, 2002 and Yajun *et al.*, 2009). Most available information on the effects of planting depths for trees is anecdotal (Watson and Himelick 1997) and few studies dealt with such subject in timber tree management, although it was practically investigated in crop field trials, notably, by Jing *et al.*, (2009).

Fungi play an important role in plant litter decomposition in forest ecosystems through nutrient recycling and humus formation in soil (Swift *et al.*, 1979). Bird's nest fungi (*Cyathus* spp) is one of the higher

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Basidoimycota that capable of litter or mulch decomposition (Takashi *et al.*, 2003) under certain circumstances, e. g., in calcareous soil, that contained high levels of calcium (Lu, 1973). By their strong enzymes produced, these fungi are capable of breakdown lignin, cellulose and nitrocellulose (Abbott and Wicklow, 1984; Wicklow *et al.*, 2005 and Sundaram *et al.*, 2008). For this reason, it was used to ameliorate fiber digestion by animals when it previously inoculated with such fungi (Karunanandaa and Varga, 1996). Furthermore, these fungi produce essential substances notably; laccase (Vasdev and Kuhad, 1994; Dhawan and Kuhad, 2002, Dhawan *et al.*, 2002), that used in several purposes, amongst which, dye decolorization (Vasdev and Kuhad, 1993 and Leung and Pointing, 1994) and antimicrobial metabolites (Ya-Jun and Zhang. 2004).

This work aimed to study the impact of incorporation of rice straw with soil as medium for growing seedlings of *Casuarina glauca* and *Luecaena leucocephala* to capitalize on its potential, if any, to improve soil characteristics, minimizing evaporation, growth of seedlings. The study aimed also to pinpoint the effect of straw on water relation in rhizoshere as well as on nodulation of roots of both species by *Frankia* and *Rhizobium* as nitrogen fixing symbiotic agents in *Casuarina glauca* and *Luecaena leucocephala*, respectively.

MATERIAL AND METHODS

This study implied 4 experiments, carried out in four years (from 2005- 2008) to assess the possibility of capitalizing on rice straw as a source of organic matter in soil medium to minimize soil evaporation and ameliorate its physical properties, in addition to mineral input for growing *Casuarina glauca* and *Leucaena leucocephala* seedlings. Certified seeds of the two species mentioned above were sown in the seedbeds (30 cm diam. pots) and obtained seedlings were raised in the nursery of the Experimental Station of Forestry and Wood Technology Department, Faculty of Agriculture, Alexandria University, Alexandria. The experiments were conducted in a model nursery at Wadi El- Natroon Region, Beheira Governorate, Egypt (from 2005- 2008).

2.1. Experiment 1: Effect of straw story depth on the growth and biomass yield of seedlings

Seedlings of *C. glauca* and *L. leucocephala*, aged 3 months were transplanted in 35 × 35 × 60 cm woody- containers, contained 1:4- clay: sand–soil mixture. The straw mulch was incorporated in two depths, 10 cm (D_{10}) and 20 cm (D_{20}) at two different treatments besides the control (without straw mulch).

The straw was represented about 1.0 % of the total weight of soil mixture. The plants were irrigated every 2 and 3 days in winter and summer, respectively. Growth parameters and biomass characteristics were determined after one year in two successive seasons (June15, 2005- May 14, 2006 and June15, 2006– May 14, 2007). The experimental design used was complete randomized design (CRD) according to Steel and Torrie (1980), with 5 replicates for both of the two species studied in separated arrangement due to their growth, physiological, morphological, anatomical natures in addition to their different symbiotic agents.

2.2. Experiment 2: Effect of the Inoculation with Bird's nest Fungus (*Cyathus stercoreus*) on the Growth and Biomass of Seedlings, Straw; Degradation and relative infiltration rate of rhizosphere.

As it described in experiment (1), seedlings were transplanted in woody containers, that previously formentioned, but contained straw layer at depth of 20 cm. The soil and straw were previously sterilized with formaldehyde for 10 days then aerated 2 weeks. The inoculation with *C. stercoreus* was done 2 weeks after transplanting by applying 5 propagules (peridioles) per container. This experiment was carried out in two seasons (June15, 2006- May 14, 2007 and June15, 2007– May 14, 2008).

The experiment was arranged in CRD with 5 replicates. The control was similarly inoculated, but with boiled peridioles. The establishment of the fruit bodies of *C. stercoreus* was monitored and growth and biomass (Shoot height; shoot growth rate; stem diameter; dry weight of stem, branchlets, leaves, roots and total biomass) were assessed after one year of the inoculation.

2.2.1. Determination of degradation rate of straw

The rate of rice- straw degradation was determined in 7 treatments.

Five g of oven-dried rice straw, sealed with fine porous polyester bags (5 pores/ mm^2) then placed in 7 conditions (as treatments) as follows:

1- Under soil surface at depth of 10 cm.
2- Under soil surface at depth of 20 cm.
3- Under soil surface at depth of 10 cm at rizosphere of *C. glauca.*
4- Under soil surface at depth of 20 cm at rizosphere of *C. glauca.*
5- Under soil surface at depth of 10 cm at rizosphere of *L. leucocephala.*
6- Under soil surface at depth of 20 cm at rizosphere of *L. leucocephala.*
7- On the surface of soil.

The experiment was arranged in CRD design with five replicates.

Samples of straw were watered every 2^{nd} and 3^{rd} day in summer and winter, respectively. After one year, samples were collected then carefully washed and oven dried. Degradation rate (DR) of straw was calculated as a percentage by the following equation:

$$DR = \frac{W_0 - W_1}{W_0} \times 100$$

Since,
W_0 is the oven dry weight (g) of straw sample before degradation, and
W_1 is the oven dry weight (g) of the same sample after one year of degradation.

2.2.2. Relative infiltration rate (RIR)

Relative Infiltration Rate (RIR) is a parameter to express the filtration rate of mulched soil relative to that of unmulched one of the same condition. Three samples (about 300 g) were taken from rhizospere of *C. glauca* and *L. leucocephala* seedlings after 3 months of inoculation with *Cyathus stercoreus* fungus. In addition, samples of uninoclulated mulched soil and unmulched soil were taken, oven dried then tested for its infiltration rate (mm/ hour) adopted to the method described by Brouwer *et al.* (1985). However, RIR was calculated according to the following equation:

$$RIR = \frac{IRT}{IRC}$$

Since, IRT is the infiltration rate (mm/ hour) of the mulched soil of given treatment, and
IRC is the infiltration rate (mm/ hour) of the unmulched soil of the same treatment.

2.3. Experiment 3: Effect of drought stress on survival of the seedlings grown on mulched Soil

This experiment was carried out in June 5, 2007 using the same experimental design described in experiment (2), yet with 10 replicates. Seedlings of *C. glauca* and *L. leucocephala* were subjected to 5 drought stress cycles, by prevention of the irrigation for 10 days until the moisture potential reached –1.2 megapascal, then they irrigated again every 11th day to assess survival, live shoot ratios (LSR) of seedlings, if any. The symptoms of drought were monitored and survival (%) and LSR values were estimated based on two bases as the following:

1)LSR on height basis (LSR_H).

$$LSR_H = \frac{\text{Living height of the shoot}}{\text{Total height of the shoot}}$$

2) LSR on dry weight basis (LSR_W).

$$LSR_W = \frac{\text{Dry weight of living part of the shoot}}{\text{Total dry weight of the shoot}}$$

2.3.1. Determination of evaporation and evapotranspiration of plants

During drought span (10 days), samples of the soils were daily taken; In addition, transpiration rate of *C. glauca* and *L. leucocephala* was determined. Soil samples were taken by 7.5- cm-diam. cylinder to get soil column from soil surface to the base of box to determine concomitant moisture contents (%).

2.4. Experiment (4): Effect of mulching on nodulation of *Casuarina glauca* and *Leucaena leucocephala*

Four months old seedlings of *Leucaena leucocephala* were artificially inoculated with *Rhizobium* inocula (designated strain RAAG1), whilst *Casuarina glauca* ones were inoculated with *Frankia* (designated strain COAAS2). Seedlings were grown in boxes (as described in Experiment 1) under the same growth specification in two seasons (July 20, 2006 - May 14, 2007 and June 20, 2007– May 19, 2008). The treatments were:

1-Inoculated seedlings with bird's nest fungus with grown in 10 cm-depth mulch medium (ID_{10}),
2- Inoculated seedlings with bird's nest fungus grown in 20 cm-depth mulch medium (ID_{20}),
3-Uninoculcatated seedlings grown in 10 cm-depth mulch medium (UID_{10}),
4-Uninoculcatated seedlings grown in 20 cm-depth mulch medium (UID_{20}) and
5-Uninoculcatated and unmulched seedlings (Control).

The experimental design used was CRD with 3 replicates. Seedlings were tested every week after inoculation to check the formation of prenodule which may offspring and after 10 months, seedling roots were gently extracted, washed free from debris to examine nodulations (nodule number total dry weight of nodules).

RESULTS AND DISCUSSIONS

3.1. Experiment (1): The statistical analysis of variance revealed that there were significant differences among treatments, rice straw at depth of 10 cm (D_{10}), at 20 cm (D_{20}) and control in both seasons and in both of *Casuarina glauca* and *Leucaena leucocephala*.

As for *C. glauca*, growth and biomass characteristics, notably, shoot height, stem diameter, growth rate, dry weight of branchlets, stem, roots and total dry weight of treatment D_{20} were significantly higher than those obtained in D_{10} (Tables 1 and 2).

Except for dry weight of leaves, *L. leucocephala* seedlings of treatment D_{20} displayed the highest growth and yield characteristics that above mentioned in case of *C. glauca* in both seasons. On the other hand, treatment D_{10} displayed dry matter of leaves higher than those of the other treatments in both seasons (Tables 3 and 4).

These findings indicated that the deeper the mulch incorporated in soil, the higher the beneficial effects of straw applied on growth and biomass characteristics. This in harmony with findings of Dobermann and Fairhurst (2002) and Bu *et al.* (2002). They ascribed the increased

Spreading and incorporation of straw, however, are labour-intensive tasks, and farmers consider burning to be more expedient (Dobermann and Fairhurst, 2002), but its detrimental impacts on environment will take place on one hand and its intrinsic value would be lost on the other hand.

Table (1): Growth and biomass characteristics of *Casuarina glauca* seedlings grown on straw-mulched soil at depth 10 cm (D_{10}), 20 cm (D_{20}) and normal soil (cont) in the first season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	Branchlets dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g)	Total biomass (g/ plant)
D_{10}	63.66^b	3.0^b	2.27^b	9.36^b	7.71^b	3.3^b	20.37^b
D_{20}	81.05^a	5.40^a	5.18^a	11.09^a	8.45^a	4.50^a	24.04^a
D_{cont}	46.00^c	3.26^b	1.85^c	9.01^b	3.21^c	2.36^c	14.58^c

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (2): Growth and biomass characteristics of *Casuarina glauca* seedlings grown on straw-mulched soil at depth 10 cm (D_{10}), 20 cm (D_{20}) and normal soil (cont) in the second season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	Branchlets dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g)	Total biomass (g/ plant)
D_{10}	68.21^b	3.44^b	5.33^b	10.08^a	8.06^b	4.62^b	22.76^b
D_{20}	87.25^a	5.90^a	6.90^a	12.32^a	10.14^a	5.72^a	28.18^a
D_{cont}	55.66^c	3.15^b	4.20^c	8.33^c	4.42^c	2.94^c	15.69^c

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (3): Growth and biomass characteristics of *Leucaena leucocephala* seedlings grown on straw-mulched soil at 10 cm- depth (D_{10}), 20 cm (D_{20}) and normal soil (cont.) in the first season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	Leaves dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g)	Total biomass (g/ plant)
D_{10}	75.9^b	4.13^b	5.53^a	13.6^a	10.64^b	4.00^c	28.24^b
D_{20}	82.50^a	5.25a	5.45^a	8.58^b	13.60^a	8.96^a	31.21^a
D_{cont}	66.00^c	3.82^c	4.90^b	4.40^c	6.88^c	5.76^b	17.04^c

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (4): Growth and biomass characteristics of *Leucaena leucocephala* seedlings grown on straw-mulched soil at 10 cm- depth (D_{10}), 20 cm (D_{20}) and normal soil (cont.) in the second season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	Leaves dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g)	Total biomass (g/ plant)
D_{10}	84.20^{b}	4.13^{b}	6.36^{b}	11.20^{a}	10.88^{b}	5.60^{b}	27.68^{b}
D_{20}	95.20^{a}	6.32^{a}	7.27^{a}	8.72^{b}	14.00^{a}	9.44^{a}	32.16^{a}
Cont.	70.3^{c}	4.50^{b}	5.02^{c}	5.85^{c}	7.28^{c}	4.80^{c}	17.93^{c}

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (5): Growth and biomass characteristics of *Casuarina glauca* seedlings grown on soil-straw medium, inoculat Degra-dation rate of straw ed, uninoculated with bird's nest fungus (*Cyathus stercoreus*) and unoculated normal soil, degradation rate of straw (DRS) and relative infiltration rate of soil (RIR) in the first season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	Branchlets dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g/ plant)	Total biomass (g/ plant)	DRS (%)/ year	RIR
Cyathus.	92.50^{a}	6.27^{a}	6.58^{a}	11.9^{a}	8.93^{a}	5.62^{a}	26.45^{a}	88^{a}	2.76^{b}
Straw.	82.60^{b}	5.24^{b}	4.24^{b}	10.12^{b}	8.31^{a}	4.03^{b}	22.46^{b}	76^{b}	4.35^{a}
Cont.	53.18^{c}	3.22^{c}	2.10^{c}	8.16^{c}	2.8^{b}	2.61^{c}	13.57^{c}	-	-

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (6): Growth and biomass characteristics of *Casuarina glauca* seedlings grown on soil-straw medium, inoculated, uninoculated with bird's nest fungus (*Cyathus stercoreus*) and unoculated normal soil, degradation rate of straw (DRS) and relative infiltration rate of soil (RIR) in the second season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	Branchlets dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g/ plant)	Total biomass (g/ plant)	DRS (%)/ year	RIR
Cyathus	88.14^{a}	5.94^{a}	6.01^{a}	12.62^{a}	8.94^{a}	5.79^{a}	27.53^{a}	90^{a}	3.25^{b}
Straw	76.18^{b}	5.84^{a}	5.10^{b}	11.01^{b}	8.82^{a}	4.06^{b}	23.89^{b}	82^{b}	4.99^{a}
Cont.	49.84^{c}	3.17^{b}	2.72^{c}	9.11^{c}	3.17^{b}	3.15^{c}	15.43^{c}	-	-

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (7): Growth and biomass characteristics of *Leucaena leucocephala* seedlings grown on soil-straw medium, inoculated, uninoculated with bird's nest fungus (*Cyathus stercoreus*) and unoculated normal soil, degradation rate of straw (DRS) and relative infiltration rate of soil (RIR) in the first season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	leaves dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g/ plant)	Total biomass (g/ plant)	DRS (%)/ year	RIR
Cyathus	94.35^{a}	6.03^{a}	7.18^{a}	11.26^{a}	11.00^{a}	10.48^{a}	32.74^{a}	94^{a}	1.87^{b}
Straw	76.65^{b}	5.57^{b}	5.60^{b}	11.48^{a}	7.75^{b}	9.36^{b}	28.59^{b}	86^{b}	5.42^{a}
Cont	59.58^{c}	7.59^{c}	4.14^{c}	10.04^{b}	6.32^{c}	5.4^{c}	21.76^{c}	-	-

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (8): Growth and biomass characteristics of *Leucaena leucocephala* seedlings grown on soil-straw medium, inoculated, uninoculated with bird's nest fungus (*Cyathus stercoreus*) and unoculated normal soil, degradation rate of straw (DRS) and relative infiltration rate of soil (RIR) in the second season.

Treatment	Shoot height (cm)	Stem diam. (cm)	Shoot growth rate (cm/month)	leaves dry weight (g/ plant)	Stem dry weight (g/ plant)	Root dry weight (g/ plant)	Total biomass (g/ plant)	DRS (%)/ year	RIR
Cyathus	85.75^{a}	6.32^{a}	6.93^{a}	10.26^{b}	13.84^{a}	10.08^{a}	34.18^{a}	96^{a}	2.22^{b}
Straw	71.49^{b}	4.48^{b}	5.09^{b}	13.44^{a}	11.28^{b}	7.84^{b}	32.56^{b}	90^{b}	6.06^{a}
Cont.	63.02^{c}	4.65^{b}	4.31^{c}	5.07^{c}	7.22^{c}	7.99^{b}	20.28^{c}	-	-

For each column, mean values of the same postscript letters are not significantly different at < 0.05 of probability level.

Table (9): Nodulation Characteristics of *Leucaena leucocephala* plants, uninoculated with bird's nest fungus grown in straw- mulched soil at 10-cm depth (UID_{10}), 20 cm-depth(UID_{20}), inoculated with bird's nest fungus (*Cyathus stercoreus*) grown in straw- mulched soil at 10-cm depth (ID_{10}), 20 cm- depth (ID_{20}) and unmulched soil (Control).

	First Season			Second Season		
Treat-ment	Prenodulation offspring (day)	Nodules number/ plant	Total dry matter of nodules/ plant	Prenodulation offspring (day)	Nodules number/ plant	Total dry matter of nodule/ plant
UID_{10}	70^{a}	2.50^{d}	0.43^{d}	84^{a}	1.90^{e}	0.40^{c}
UID_{20}	63^{b}	4.37^{c}	0.80^{b}	70^{c}	3.20^{0}	0.60^{b}
ID_{10}	56^{c}	5.70^{c}	0.43^{d}	77^{b}	4.00^{c}	0.58^{b}
ID_{20}	56^{c}	7.70^{b}	0.86^{b}	70^{b}	5.20^{b}	0.97^{a}
Cont.	49^{d}	11.66^{a}	1.25^{a}	56^{d}	11.66	1.10^{a}

For each column, mean values of the same postscript letters are not significantly
Different at < 0.05 of probability level.

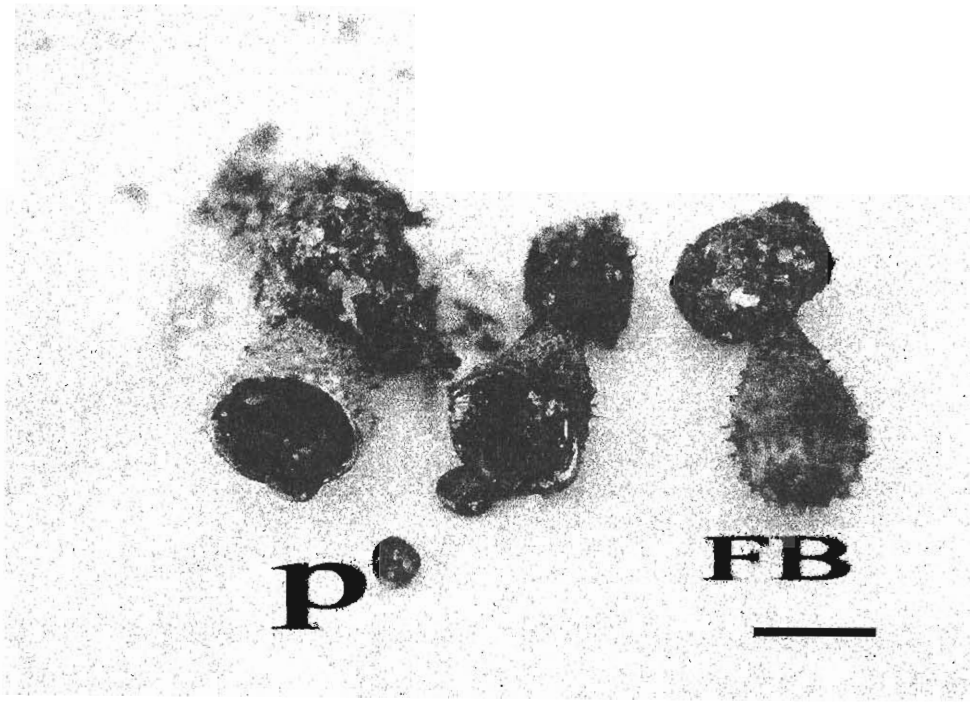

Fig. 1: Cup-shaped fruit bodies (FB) of *Cyathus stercoreus* contained peridioles (P). Scale: 3.5 mm.

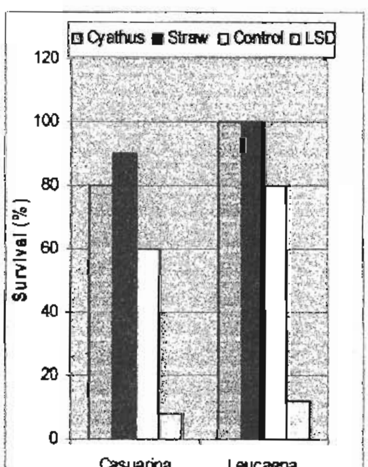

Fig. 2: Survival (%) of casuarina and leucaena seedlings after 10-day drought span.

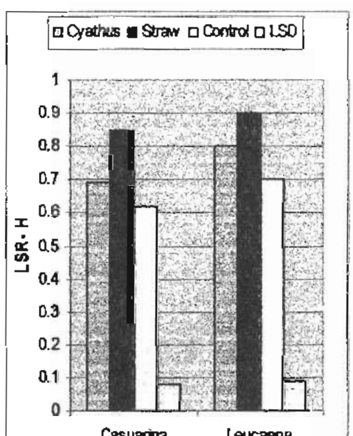

Fig. 3: Live shoot ratio, based on living length of shoot after subjection of *C. glauca* and *L. lucocephala* seedlings to drought.

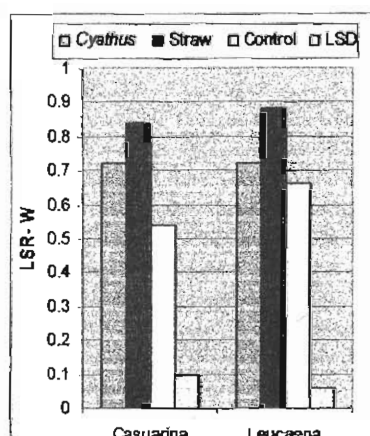

Fig. 4: Live shoot ratio of *C. glauca* and *L. leucocephal* a seedlings based on dry weight of living shoot subjected to drought

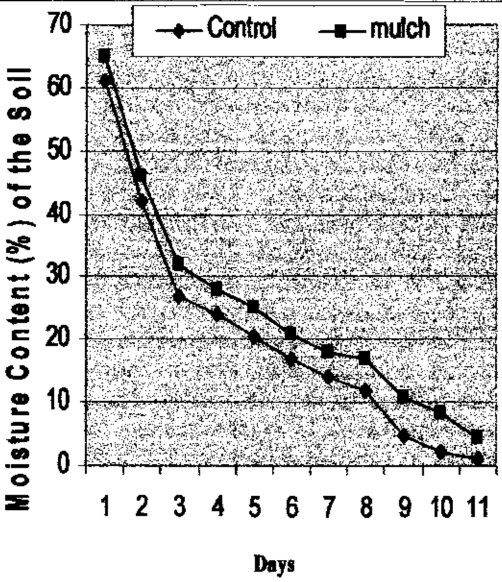

Fig. 5: Changes of moisture content (%) of straw mulched and unmulched soil after stopping of irrigation due to evaporation.

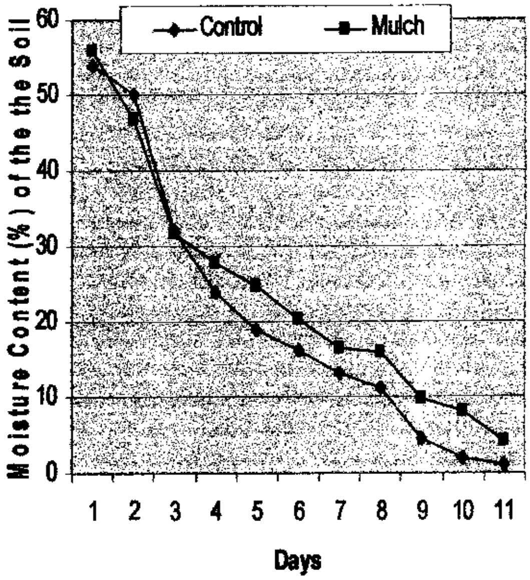

Fig. 6: Changes of moisture content (%) of straw mulched and unmulched soil of *C. glauca* after stopping of irrigation due to evapotranspiration.

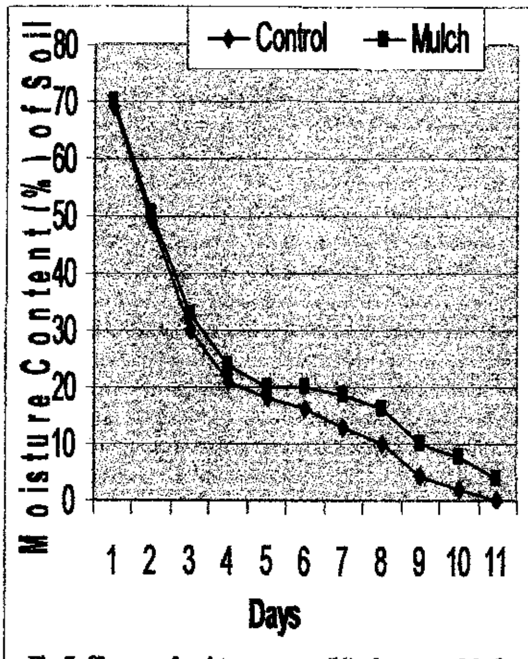

Fig. 7: Changes of moisture content (%) of straw mulched and unmulched soil of *L. leucocephala* after stopping of irrigation due to evapotranspiration.

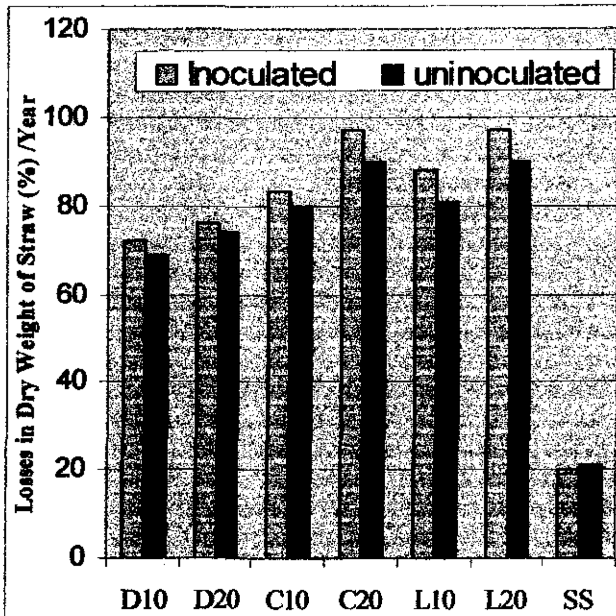

Fig. 8: Losses in dry weight of uninoculated and inoculated straw with *C. stercoreus* incorporated in control soil at depth of 10 cm (D10), 20 cm (D10); in rhizosphere of *C. glauca* at depth of 10 cm (C10), at 20 cm (C20); rhizosphere of *L. leucocephala* at depth of 10 cm (L10), at depth of 20 cm (L20) and surface of soil (SS).

CONCLUSIONS AND RECOMMENDATIONS

- Incorporation of rice straw into soil brought about an increased shoot height, stem diameter, growth rate, dry weight of branchlets, stem, roots and total dry weight of *Casuarina glauca* and *Luecaena leucocephala* .Growth and biomass characteristics of seedlings of both species studied grown on 20cm (D_{10}) were more than those of and 10 cm (D_{20}). Inoculation with bird's nest fungus (*Cyathus stercoreus*) promoted growth and biomass characteristics of seedlings compared with uninoculted (sterilized) straw and control treatment, but impeded nodulation of *C. glauca* and delayed it in *L. leucocephala*. Survival (%) in both inoculated straw mulch with *C. stercoreus* and uninoculated ones was higher than that of the control (absolute soil). The enhanced field capacity cast by straw, relative to unmulched soil and relative latency of its depletion may interpret increased survival parameters of plants grown on. Moisture content of mulched soil either inoculated with *C. stercoreus* or uninoculated, was higher than that of unmulched ones, yet advanced degradation of straw may decrease water retention. Infiltration rate of mulched soil was higher than that of unmulched one and progressed degradation of straw by bird's nest fungus led to decrease relative infiltration rate. Under rhizosphere condition, straw can be totally mineralized within 15 months or less.
- It recommended, however, to capitalize one rice straw for mulching plantation (man-made forest) particularly in strips fashion to increase water use efficiency, recycling of its minerals, reduction of weed population and to grow more beneficial economic fungi, since lignified roots of trees is more tolerant to gases emitted during fermentation as it compared with the other annual plants. Management of rice straw as mulch in plantation merits more research using many other species and management fashions as well.

AKNOLEDEGEMENTS

The author wish to express gratitude to E. Wasfi prof. of Pant Pathology Department, Faculty of Agriculture, Alexandria University and for his guidance and deep sincere appreciation to Mr. K. T. Solayman and Ms. M. G. Saleh, Forestry and Wood Technology Departmant, Faculty of Agriculture, Alexandria University for their assistance and their efforts to finish this work.

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الملخص العربي

تأثير دمج قش الأرز بالتربة و تلقيحه بفطر عش الطائر على النمو، الكتلة الحيوية، مقاومة الجفاف وتكوين العقد المثبتة للنتروجين فى شتلات الكازوارينا البيضاء والليوسينا

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أجريت أربع تجارب للاستفادة من قش الأرز بخلطه مع التربة لتحسين الصفات الطبيعية للتربة وزيادة كفاءة استخدام المياه وإضافة الأملاح لتنمية شتلات الكازوارينا والليوسينا فى موسمين لكل تجربة. التجربة الأولى تمت لدراسة تأثير عمق القش المضاف وقد وضع بعمق ١٠، ٢٠ سم علاوة على المعاملة الكنترول. وكانت المعاملة عند عمق ٢٠سم الأفضل فى صفات النمو والمحصول. وتمت التجربة الثانية بهدف دراسة تأثير فطر عش الطائر *Cyathus stercoreus* على صفات النمو والمحصول وأثره فى معدل تحلل القش والمعدل النسبى للترشيح. وقد تكونت الأجسام الثمرية للفطر بعد مضى ٤ أشهر من العدوى. وأظهرت النباتات الملقحة أو المعداه بالفطر كفاءة أعلى فى صفات النمو (الطول، معدل النمو الطولى، قطر الساق، الوزن الجاف للفريعات والأوراق والكتلة الحيوية الكلية) مقارنة بالتربة غير الملقحة بالفطر وأيضاً المعاملة الكونترول ولكن لم يكن هناك اختلافات معنوية بين النباتات الملقحة وغير الملقحة فى كلٍ من الوزن الجاف للساق ونسبة الأفرع للجذور. بالنسبة لليوسينا، وجد أنه فيما عدا الوزن الجاف للأوراق ونسبة الأفرع للجذور، كانت جميع صفات النمو والكتلة الحيوية أعلى معنويا فى الملقحة عن تلك غير الملقحة والكنترول. التجربة الثالثة: تم تعريض النباتات الملقحة وغير الملقحة لفترة جفاف طولها ١١ يوماً لدراسة مدى تحمل الشتلات للجفاف. وقدرت الحيوية ونسبة الفرع الحى على أساس الطول LSR_L وعلى أساس الوزن LSD_W. وقد وجد أن وجود القش ساهم فى حفظ الماء لفترة أطول وكانت نسبة الرطوبة أعلى من الكنترول ومما يدل على تلك جنوح الجذيرات لإختراق المسالك المجهرية فى القش وبالتالى زادت نسبة الحيوية وكل من LSR_H، LSR_W فى النوعين. وبدراسة معدل تحلل القش المطمور فى العام وجد أنه قد نقص أكثر من ٩٠٪ من وزنه الجاف خصوصاً فى حيز الجذور وعلى عمق ٢٠ سم مقارنةً ببقية المعاملات مما يشير على أن التحلل التام قد يحدث على الأكثر فى ١٥ شهراً. وقد وجد أيضاً أن معدل الترشيح النسبى (RIR) فى نطاق الجذور فى التربة المضاف لها القش الملقح بفطر عش الطائر أقل مقارنة بغير الملقح وذلك بسبب دور الفطر فى الإسراع من تحلل القش ووجود شبكة هيفاتها أو معدنته مما يفيد فى تحسين قوام التربة. فى التجربة الرابعة تم دراسة أثر كمر القش فى مجال جذور كل من الكازوارينا والليوسينا على تكوين العقد البكتيرية المتسببة عن الفرانكيا والرايزوبيوم، على التوالى. وقد وجد وربما بسبب الغازات الناتجة عن تخمر القش (مثل الميثان والنيتريت) حدث تأجيل تكوين بوادىء العقد فى الليوسينا ولم تظهر العقد فى حالة الكازوارينا مما يدل على حساسية الفرانكيا مقارنة بالريزوبيام لتلك الغازات. ويوصى عموماً بالاستفادة من مخلفات الأرز بدمجها فى تربة الغابات الصناعية للاستفادة منها بدلاً من حرقها لتحسين صفات التربة الفيزيقية والكيميائية و زيادة كفاءة استخدام مياه الرى وتقليل عشائر الحشائش. كذلك ينصح بزراعتها فى صفوف وكذلك بالاستفادة من الفطريات الاقتصادية لتنميتها فى مثل هذه الظروف.