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Population density of *Meloidogyne incognita* and eggplant growth vigour affected by sucrose-activated bread yeast (*Saccharomyces cerevisiae*)

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Abstract

Active dry bread yeast containing fungus, *Saccharomyces cerevisiae* was used as a bio-agent for controlling root-knot nematode, *Meloidogyne incognita* on eggplant under screen house conditions. Three solutions of yeast and sucrose (as a bio-fermenter) at different yeast concentrations (1, 2 & 3% yeast) + a fixed concentration of 2% sucrose and three solutions of sucrose and yeast at different sucrose concentrations (2, 3 & 4% sucrose), a fixed concentration of 2% yeast were applied. The results indicated that there was a positive correlation (R= 0.097) between average percentage nematode reduction and the applied concentrations of yeast or sucrose. The highest concentrations of bread yeast and sucrose (3% yeast + 2% sucrose) and sucrose + bread yeast solution (4% sucrose + 2% yeast) achieved the highest average percentages nematode reduction of 86% and 87.4%, respectively. On the other hand, eggplant growth parameters were the best by using 2% yeast + 2% sucrose or 2% sucrose + 2% yeast as growth index was 15.4. However, the highest concentration of yeast + sucrose solution (3% yeast + 2% sucrose) or sucrose + bread yeast solution (4% sucrose + 2% yeast) caused less growth indices as compared to untreated check.

Key words: Active dry yeast, *Saccharomyces cerevisiae*, *Meloidogyne incognita*, eggplant.

The application of yeast fungal strains as biological control agents may improve plant growth and productivity and promote resistance against many pathogens and diseases in addition to its safety for humans, animals and the environment (Makower & Bevan, 1963). Therefore, as reported by Youssef & Soliman, 1997 bread yeast containing *Saccharomyces cerevisiae* inhibited numbers of *Meloidogyne incognita* Chitwood, 1949 on Egyptian henbane, *Hyoscyamus muticus* and improved its growth parameters.

Recently, Youssef & El-Nagdi (2011) reported that bread yeast was activated by adding sucrose, black honey and molasses significantly (P≤0.01) decreased *M. incognita* infesting common bean cv. Paulista. They added that there is a positive correlation between the percentages reduction of the number of galls and egg-masses and the different concentrations of the tested treatments. Further, all treatments improved pod quality and quantity.

Saccharomyces cerevisiae was used for controlling root-knot nematode, *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 on cucumber and on tomato (Karajeh, 2013; 2014), respectively which led to reduction in numbers of galls and egg-masses. No studies were carried out on the effect of different sugar or yeast concentrations on root-knot nematode

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and plant growth. Hence, the purpose of this study was to investigate effect of fermentation process of solutions at different increased concentrations of yeast with a fixed concentration of sucrose compared to solutions of a fixed concentration of yeast with different increased sucrose concentrations for controlling root-knot nematode, *M. incognita* on eggplant under screen house conditions.

Materials and Methods

One-month seedlings of eggplant cv. Baladi were planted in 25cm diameter-clay pots filled with 3 kg solarized sandy loam soil (1:1 w/w) at soil temperature 35±5°C. Active dry bread yeast (Commercial product) containing the fungus, *S.cerevisiae* was activated by adding three weights of bread yeast (5, 10 and 15g) each was added to a fixed weight of sucrose (10g) in 500-ml warm distilled water (to help solubility and fermentation process) for 1 hour to form solutions at different concentrations of yeast (1,2 and 3% yeast) and at a fixed concentration of sucrose (2%). Also, a fixed weight of yeast (10g) was added to three weights of sucrose (10,15 and 20g) for 1 hour in 500 ml warm water to form solutions at different concentrations of sucrose (2, 3% and 4 sucrose) and a fixed concentration of yeast (2%).

Fifteen days after transplanting, pots were treated with solutions of yeast or sucrose (at the rate of 100 ml/pot for each concentration). There were three different bread yeast or sucrose concentrations as follows:

1-5 g of active dry bread yeast +10 g of sucrose in 500 ml warm distilled water (1% yeast and 2% sucrose).
2-10 g of active dry bread yeast +10 g of sucrose in 500 ml warm distilled water (2% yeast and 2% sucrose).
3-15 g of active dry bread yeast + 10 g of sucrose in 500 ml warm distilled water (3% yeast and 2% sucrose).
4-10 g of sucrose + 10 g of yeast in 500 ml warm distilled water (2% sucrose and 2% yeast).
5-15 g of sucrose + 10 g of yeast in 500 ml warm distilled water (3% sucrose and 2% yeast).
6-20 g of sucrose + 10 g of yeast in 500 ml warm distilled water (4% sucrose and 2% yeast).
7-Untreated nematode-inoculated control.

At the same time, each pot was inoculated with 1,500 second stage juveniles of root-knot nematode, *Meloidogyne incognita*, reared as pure culture using susceptible cultivar of tomato, by adding nematode suspension in four holes made around plant roots in each pot. Each treatment was replicated five times and all treatments were distributed in a randomized complete block design in screen house and watered as needed. Three months after nematode inoculation, all replicates of treatments were gently uprooted. The plant growth parameters including length and fresh and dry weights of shoot and root were recorded. Plant growth index was calculated on the basis of average plant growth.

Second stage juveniles (J_2) in the soil were extracted by sieving and decanting method according to Barker (1985) and hatched juveniles from egg-masses on roots were extracted as described by Young (1954). Also, the numbers of galls and egg-masses in roots were counted. Correlation coefficient (R) between average percentages nematode reduction and different concentrations (treatments) of yeast or sucrose were calculated.

Statistical analysis: Statistical analysis of the present data was performed through Computer Statistical Package (COSTAT) User Manual Version 3.03, Barkley. All data collected were subjected to analysis (ANOVA) and means were separated with Duncan's Multiple Range Test (DMRT) at 0.05 level according to Snedecor & Cochran (1999).

Results

Effect of sucrose-activated bread yeast on nematode parameters

Data recorded in Tables 1 and 2 shows that the tested rates of active bread yeast or sucrose significantly ($P \leq 0.05$) reduced *M. incognita* population as indicated by the percentages reduction of nematode galls and egg-masses on roots of eggplant cv. Baladi. In Table 1, there was a positive correlation (R= 0.097) between the different concentrations of yeast and sucrose solutions (1, 2 and 3% yeast and 2% sucrose) and the average percentages reduction of nematode. Therefore, as concentration of bread yeast increased, there was a corresponding increase in the average percentage nematode reduction.

The highest average percentage nematode reduction (86%) was achieved by the highest concentration of bread yeast and fixed concentration of sucrose (3% yeast and 2% sucrose) followed by 82.1% caused by 2% yeast and 2% sucrose. In Table 2, a positive correlation (0.90) was found between different concentrations of sucrose and fixed concentrations of bread yeast solutions (2, 3 and 4% sucrose and 2% yeast) and the average percentages reduction of nematode. In other words, the highest average percentage nematode reduction (87.4) was achieved by using the highest concentration of sucrose + fixed concentration of yeast solution (4% sucrose and 2% yeast) followed by 82.1% reduction using 2% sucrose and 2% yeast, then 80.2% reduction obtained by applying 3% sucrose and 2% yeast.

Effect of sucrose-activated bread yeast on plant growth parameters

Table 3 illustrates growth parameters of eggplant as affected by the different concentrations of yeast and fixed concentration of sucrose solutions (1, 2 and 3% yeast and 2% sucrose). On the basis of plant growth index, the best treatment was achieved by 2% yeast and 2% sucrose as plant growth index was 15.4 followed by 15.0 by adding 1% yeast and 2% sucrose. However, there was no increase in plant growth index by adding 3% yeast and 2% sucrose solution compared to untreated control. Table 4 illustrates growth parameters of eggplant as affected by sucrose and yeast solutions at different concentrations (2, 3 and 4% sucrose and 2% yeast). The best result was achieved by adding 2% sucrose and 2% yeast as plant growth index was 15.4 followed by 14.9 which was attained by 3% sucrose and 2% yeast, but there was no increase in plant growth index by using the treatment of the highest concentration of sucrose +fixed concentration of yeast solution (4% sucrose + 2% yeast).

Discussion

Suppressive effects of bread yeast containing *S. cerevisiae* for controlling nematodes and improving plant growth criteria were reported by other investigators (Youssef & Soliman, 1997; Ismail *et al.*, 2005; Youssef & El-Nagdi, 2011). The bread yeast was more effective in reducing root-knot nematode, *M. javanica* on cucumber (Karajeh, 2013) and on squash (Noweer & Hasabo, 2005) when applied at 10g than rate of 5g/l. The bread yeast containing *S. cerevisiae* was as effective as the nematicide, oxamyl when applied as soil drench for controlling *M. javanica* on tomato cv. Asala under field conditions (Karajeh, 2014). An explanation for the mentioned suppressive effects on root-knot nematode may be due to the carbohydrates in yeast are converted to CO_2 and ethyl alcohol toxic to nematodes as suggested by Noweer & Hasabo, 2005 and Mostafa, 2004.

The positive effect of active dry yeast in improving plant growth may be explained on the basis that active bread yeast is considered as a bio-stimulator containing different nutrients, proteins, vitamins, nucleic acid and various minerals (Wareing & Philips, 1973). In the present study, it was observed that eggplant growth decreased at the highest sucrose concentration. This may be attributed to that when a plant was treated by sucrose solution in soil, it will usually cause injury to plant making soil water less available to the plant, which lowers the soil water potential. Therefore, as water flows from higher to lower water potential, sucrose prevent water to flow from the soil (lower potential) into the plant (higher potential). The results correspond to Hershey, 2001, who mentioned that plant roots are not designed to absorb sucrose from soil.

Table 1. Population density of *Meloidogyne incognita* on eggplant as affected by yeast (*Saccharomyces cerevisiae*) at different concentrations and sucrose at a fixed concentration.

Treatments	J_2 /pot	Red. %	J_2 in roots	Red. %	Galls/ plant	Red. %	Egg-masses/ plant	Red. %	Nematode reduction %	R
Yeast 5g+sucrose 10g solution (1%yeast+2%sucrose)	593b	78.1	260 b	66.4	30 b	70.6	17 b	77.0	73.0	0.97
Yeast 10g+sucrose 10g solution (2%yeast+2% sucrose)	260d	90.4	167 c	78.4	22 c	78.4	14 bc	81.1	82.1	
Yeast 15g+suscrose 10g solution (3%yeast+2%sucrose)	343c	87.3	117 d	84.9	15 d	85.3	10 c	86.5	86.0	
Untreated control	2710a	-	773 a	-	102 a	-	74 a	-	-	

Values are averages of 5 replicates. Dissimilar letter(s) in a column indicates significant ($P \leq 0.05$) differences among the treatments according to DMRT. R= Coefficient Correlation (Treatment/Average nematode reduction %)

Table 2. Population density of *Meloidogyne incognita* on eggplant as affected by sucrose at different concentrations and yeast (*Saccharomyces cerevisiae*) at a fixed concentration.

Treatments	J_2/pot	Red. %	J_2 in roots	Red. %	Galls/ plant	Red. %	Egg-masses/ plant	Red. %	Nematode reduction%	R
Sucrose 10g+Yeast 10g solution (2%sucrose+2% yeast)	260d	90.4	167 c	78.4	22 b	78.4	14 b	81.1	82.1	0.90
Sucrose15g+Yeast 10g solution (3%sucrose+2%yeast)	687b	74.6	220 b	71.5	12 c	88.2	10 bc	86.5	80.2	
Sucrose 20g+Yeast 10g solution (4%sucrose+2%yeast)	413c	84.8	112 d	85.5	10 c	90.2	8 c	89.2	87.4	
Untreated control	2710 a	-	773 a	-	102 a	-	74 a	-	-	

Values are averages of 5 replicates. Dissimilar letter(s) in a column indicates significant ($P \leq 0.05$) differences among the treatments according to DMRT. R= Coefficient Correlation (Treatment/Average nematode reduction %).

Table 3. Plant growth parameters of eggplant infected by *Meloidogyne incognita* as affected by yeast (*Saccharomyces cerevisiae*) at different concentrations and sucrose at a fixed concentration.

Treatments	Shoot			Root		Plant growth index
	Length (cm)	Fresh Weight (g)	Dry weight (g)	Fresh weight (g)	Dry weight (g)	
Yeast 5g + sucrose 10 g Solution (1% yeast+2% sucrose)	38.8 a	18.1 a	4.1 a	11.6 bc	2.2 a	15.0 a
Yeast 10g + sucrose 10g Solution (2% yeast+2% sucrose)	39.4 a	18.7 a	3.7 b	13.4 a	1.9 a	15.4 a
Yeast 15g + sucrose10 g Solution (3% yeast+2% sucrose)	37.2 b	16.0 b	4.0 ab	10.9 c	1.4 b	13.9 a
Untreated control	39.2 a	17.5 ab	2.6 c	12.1 b	2.0 a	14.7 a

Values are averages of 5 replicates. Dissimilar letter (s) in a column indicates significant ($P \leq 0.05$) differences among the treatments according to DMRT; Plant growth index= average plant growth parameters.

Table 4. Plant growth parameters of eggplant infected by *Meloidogyne incognita* as affected by sucrose at different concentrations and yeast (*Saccharomyces cerevisiae*) at a fixed concentration.

Treatments	Shoot			Root		Plant growth index
	Length (cm)	Fresh Weight (g)	Dry weight (g)	Fresh weight (g)	Dry weight (g)	
Sucrose 10g + Yeast 10 g Solution (2% sucrose+2% yeast)	39.4 a	18.7 a	3.7 b	13.4 a	1.9 a	15.4 a
Sucrose15g + Yeast 10 g Solution (3% sucrose+2% yeast)	39.8 a	17.9 b	4.4 a	10.8 d	1.5 b	14.9 b
Sucrose 20g + Yeast 10g Solution (4% sucrose+2% yeast)	36.2 b	16.0 c	3.4 b	11.4 c	1.4 b	13.7 c
Untreated control	39.2 a	17.5 b	2.6 c	12.1 b	2.0 a	14.7 b

Values are averages of 5 replicates. Dissimilar letter(s) in a column indicates significant ($P \leq 0.05$) differences among the treatments according to DMRT; Plant growth index= average plant growth parameters.

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