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SEED DRESSING AND FOLIAR SPRAY WITH DIFFERENT FUNGICIDE ALTERNATIVES FOR CONTROLLING MAIZE DISEASES UNDER NATURAL FIELD CONDITIONS

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Abstract

Evaluating different approaches for biocontrol application, *i.e.* seed dressing, foliar spraying against Maize diseases under natural field conditions were carried out during two growing seasons 2017-2018. Bio-agents, *T. harzianum, B. subtilis, P. fluorescence* and *S. cerivisae* as well as essential oils, carnation and lemongrass oils in addition to chemical inducers, ascorbic acid, potassium sorbate and sodium benzoate were used as grain dressing. Meanwhile, foliar spray was applied with *S. cerivisae,* Citric acid, Salicylic acid, Benzoic acid, Calcium chloride, Potassium bicarbonate, Potassium carbonate, Potassium monohydrogen phosphate, Potassium dihydrogen phosphate and Chitosan. The fungicides Rizolex-T50% and Topsin-M 70% were used as grain dressing or foliar spray as comparison treatments. Percentage of occurred diseases, root rot, leaf spot, gray leaf blight, late wilt and ear rots were monitored and recorded throughout the growth period from sowing up to harvest time. The highest reduction in root rot disease incidence was recorded at grains dressing with the bacterial followed by the fungal and *S. cerivisae.* meanwhile, organic salts treatments came after. Meanwhile, the lowest effect was observed with lemongrass essential oils treatments. Spraying Maize plants with salicylic acid revealed announced effect on foliar diseases incidence of leaf spot, leaf gray blight, late wilt and Ear rots. Moderate effect was observed at foliar spray with calcium chloride, citric acid and chitosan. It was observed that essential oils spray showed the lowest effect against foliar diseases. Results revealed that either grain dressing or foliar spray with various bioagents and chemical resistance inducers as well as essential oils had significant effect on different root and foliar diseases incidence. It could be suggesting that such treatments considered as protective approaches against Maize diseases.

Key words : bioagents, foliar diseases, Maize, organic salts, root rot.

Introduction

Maize (*Zea mays* L.) is one of cereal crops and represents a staple food for consumers all over the world (Anderson *et al.*, 2004). In Egypt, maize plays significant role in grain production and is considered the second most important cereal grain crop, after wheat (Anonymous, 2018). The majority of reports indicate that several soil and air borne pathogenic fungi causing maize diseases that affect roots, stalks, ears, and kernels (White, 2000). Losses in yield production seems to be a phenomenon caused by fungal diseases in all countries where maize is cultivated (Oerke, 2006), which they calculated as 4% in Northern Europe and 14% in West Africa and South Asia Balint-Kurti and Johal (2009). Manners (1993) reported that unfortunately several cultural practices were not supply satisfactory control measures against plant diseases when tried by various researchers Although agrochemicals chemicals could be considered the most effective method for controlling plant diseases, their effectiveness is threatened by the evolution of their resistant pathogens in addition to its major role in environmental pollution. Therefore, several attempts are recently used for avoiding these harmful factors. Further studies are needed to develop the utilization of fungicides alternatives to be used as applicable, cost-effective methods to control Maize diseases. The distinction of the present investigation comes from the new approach to gain superior integration management include antagonistic microorganisms as biocontrol agents and fungicides alternatives compounds, organic acids and salts as well

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as essential oils which play a significant role for stimulating self-resistance in maize plants against diseases without using any pesticides.

Materials and Methods

Evaluating different approaches, *i.e.* seed dressing, foliar spraying against Maize diseases under natural field conditions were carried out at the Experimental and Production Station, National Research Centre, Beheira Governorate, Egypt during two growing seasons 2017 and 2018.

Bio-agents, *T. harzianum*, *B. subtilis*, *P. fluorescence* and *S. cerivisae* as well as essential oils, carnation and lemongrass oils in addition to chemical inducers, ascorbic acid, potassium sorbate and sodium benzoate were used as grain dressing. Meanwhile, foliar spray was applied with *S. cerivisae*, Citric acid, Salicylic acid, Benzoic acid, Calcium chloride, Potassium bicarbonate, Potassium carbonate, Potassium monohydrogen phosphate, Potassium dihydrogen phosphate and Chitosan. Grain dressing applied before sowing, meanwhile foliar spray was applied three times with 15 days intervals starting at 30 days of sowing. Bioagents suspensions were used at concentration of 10^8/ cfu, while essential oils and chemical inducers applied at concentration of 2%. As for fungicides treatments, Rizolex T50% used as grain dressing (3g/Kg grains), meanwhile, Topsin-M 70% used as foliar spray (2g/L). Maize grains (*cv*. boushy) were surface disinfected by immersing in sodium hypochlorite (2%) for 2 min, and washed several times with sterilized water, then air dried. Sterilized grains (at the ratio of 500 g/L) were imbibed in each of the prepared solutions of either bioagents, essential oils or chemical inducers for 16 h (Jensen *et al.,* 2004). The treated grains were then air-dried and packed into plastic bags and transferred to the field for sowing. Grain dressing was carried out by applying the tested materials to the gum moistened grains in polyethylene bags and shaking well to ensure even distribution of the added materials. The treated seeds were then left on a plastic tray to air dried. The fungicide Rizolex-T 50 WP at the recommended dose (3 g/kg) was applied as the grain dressing as stated before. In addition, disinfected, untreated Maize grains were sown as a comparison treatment. A field experiment was established which consisted of (3.5x6.0 m) plots, composed of 12 rows and a 25 cm spacing between plants within a row. Three replicates (plots) per each relevant treatment were used in a completely randomized block design. Two maize grains per hole were used in all the treatments. Plots received the usual agricultural practices, *i.e.* NPK fertilizer and irrigation *etc*. Percentage of occurred diseases, *i.e.* root rot, leaf spot, gray leaf blight, late wilt and ear rots were monitored and recorded throughout the growth period from sowing up to harvest time.

Statistical analysis

The obtained data were subjected to IBM SPSS software version 14.0. Analysis of variance was determined and the mean values were compared by Duncan's multiple range test at P <0.05.

Results

Evaluating different approaches for biocontrol application, *i.e.* Grain dressing and foliar spraying with

Table 1: Average suppression of some maize root and foliar diseases using bioagents, essential oils and chemical inducers as grain dressing during two growing seasons under field conditions.

Treatment	Maize root and foliar diseases (%)				
	Root rot	Leaf spot	Leaf gray blight	Late wilt	Ear rots
T. harzianum	2.8 ±0.2 f	20.0 ±2.0 cd	15.7 ±2.1 e	17.1 ±1.0	22.8 ±1.9 c
B. subtilis	1.4 ±0.2 g	21.4 ±1.0 cd	14.2 ±1.9 e	22.8 ±1.1 d	22.8 ±1.0 c
P. fluorescence	1.4 ±0.2 g	18.5 ±2.0 e	17.1 ±1.1 cd	24.2 ±2.2 c	24.2 ±1.6 b
S. cerivisae	5.7 ±0.3 d	22.8 ±2.0 c	18.2 ±2.0 c	17.1 ±1.5 f	22.8 ±0.9 c
Ascorbic acid	8.5 ±0.3 c	17.1 ±1.0 f	20.0 ±1.5b	18.5 ±1.0 f	20.0 ±2.0 d
Potassium sorbate	4.2 ±0.2 e	24.2 ±1.0 c	17.1 ±1.0 cd	17.1 ±0.9 f	21.4 ±0.9 d
Sodium benzoate	7.1 ±0.3 cd	18.5 ±1.0 e	21.4 ±1.3 b	22.8 ±2.1 d	24.2 ±1.2 b
Carnation oil	8.5 ±0.7 c	25.7 ±2.0 b	18.5 ±1.8 c	21.4 ±1.1 de	18.5 ±1.0 e
Lemongrass oil	8.5 ±0.8 c	17.1 ±2.0 f	17.1 ±2.0 cd	25.7 ±2.1 c	18.5 ±1.2 e
Rizolex-T 50 WT	11.4 ±0.8 b	27.1 ±2.0 b	22.8 ±2.1 b	28.5 ±1.1 b	25.7 ±2.1 b
Control	16.4 ±2.1 a	31.4 ±1.2 a	28.8 ±0.9 a	32.2 ±1.9 a	30.3 ±2.2 a

Means ± standard deviations within each column followed by the same letter are not significantly different by Duncan multiple range test at P < 0.05.

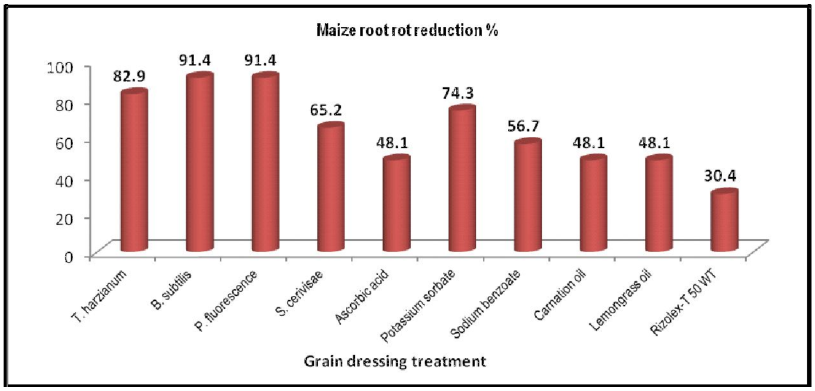

Fig. 1: Average effectivity of grain dressing with bioagents, chemical resistance inducers on Maize root rot disease reduction during two growing seasons under field conditions.

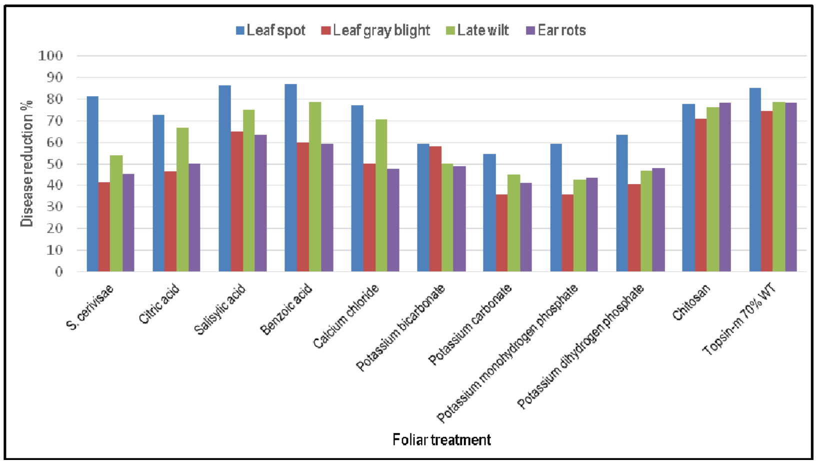

Fig. 2: Average reduction in Maize foliar diseases in response to plant spray with bioagents and chemical resistance inducers during two growing seasons under field conditions.

various fungicide alternatives against Maize diseases under natural field conditions were performed twice during summer cultivating seasons 2017-2018. Data presented in table 1 and Fig.1 showed that all applied treatments could reduce both root and foliar diseases of Maize plants compared with untreated check control. Also, foliar spray application had superior effect on the incidence of foliar diseases compared with grain dressing treatment (Table 2 and Fig. 2). Concerning root rot, the lowest disease incidence was recorded as 1.4% with reduction of 91.4% at grains dressing with the bacterial *B. subtilis* and *P. fluorescence* followed by 2.8% with reduction of 82.9% at the fungal *T. harzianum* treatment. Meanwhile, *S. cerivisae* recorded 5.7% disease incidence with reduction of 65.2%. On the other hand, grains dressed with potassium sorbate, sodium benzoate and ascorbic acid recoded disease incidence as 4.2, 7.1 and 8.5%, with disease reduction of 74.3 and 56.7, respectively. Carnation and lemongrass essential oils treatments recorded 8.5% disease incidence with reduction of 48.1% when used as grains dressing. Grains dressed with the fungicide revealed 11.4% root rot incidence compared with untreated control which was 16.4%

Table 2: Average efficacy yeast and chemical inducers as foliar spray against Maize diseases incidence during two growing seasons under field conditions.

Treatment	Maize root and foliar diseases (%)			
	Leaf spot	Leaf gray blight	Late wilt	Ear rots
S. cerivisae	5.7±1.0 g	16.8±2.2 c	15.7±1.2 de	17.1±1.9 bc
Citric acid	8.5±1.2 e	15.4±2.2 cd	16.4±1.6 d	15.7±0.9 de
Salicylic acid	4.2±0.8 g	10.0±1.5 ef	8.5±1.3 f	11.4±0.9 e
Benzoic acid	4.1±1.0 g	11.5±1.0 e	6.9 ± 1.1 g	12.3 ± 1.0 e
Calcium chloride	7.1±1.0 f	14.4±1.9 d	17.0±0.5 bc	16.4±1.1 d
Potassium bicarbonate	12.8±1.4 c	12.0±1.5 e	17.1±1.0 bc	16.0±1.5 d
Potassium carbonate	14.2±2.0 b	18.5±1.0 b	18.8±1.3 b	18.5±1.5 b
Potassium monohydrogen phosphate	12.8±2.2 c	18.5±3.0 b	18.5±3.0 b	17.1±2.0 bc
Potassium dihydrogen phosphate	11.4±1.2 cd	17.1±2.0 c	17.1±2.0 bc	15.7±0.8 de
Chitosan	6.9±1.2 fg	8.4±0.8 g	7.6 ± 1.0 g	8.4±1.1 f
Topsin M70%	4.6±1.3 g	7.4±7.4 g	6.8±0.2 g	6.6±1.1 g
Control	31.4±1.2 a	28.8±0.9 a	32.2±1.9 a	30.3±2.2 a

Means ± standard deviations within each column followed by the same letter are not significantly different by Duncan multiple range test at $P < 0.05$.

and caused disease reduction as 30.4% over the check treatment.

Also, data in table 1 and Fig. 1 revealed that grain dressing with various bioagents and chemical resistance inducers as well as essential oils had extended effect on different foliar diseases incidence which significantly differed than untreated control treatment. In general, the recorded range for diseases incidence of leaf spot, leaf gray blight, late wilt and ear rots was between 17.1-25.7%, 15.7-21.4%, 17.1-25.7%,18.5-24.2% compared with 27.1, 22.8, 28.5, 25.7% at fungicide treatment and 31.4, 28.8, 32.12, 30.3% at control treatment, in relevant respective order.

Regarding foliar approaches, data in table 2 and Fig. 2 showed that spraying Maize plants with chitosan revealed announced effect on foliar diseases incidence of leaf spot, leaf gray blight, late wilt and ear rots which recorded as 6.9, 8.4, 7.6 and 8.4% with diseases reduction by 78.0, 70.8, 76.3 and 78.2%, respectively. High suppressing effect was observed at salicylic treatment on foliar diseases incidence of leaf spot, leaf gray blight, late wilt and ear rots recorded as 4.2, 10.0, 8.5 and 11.4% with reduction of 86.8, 65.2, 75.1 and 63.6%, followed by treatment of benzoic acid that leaf spot, leaf gray blight, late wilt and ear rots incidence was recorded as 4.1, 11.5, 6.9 and 12.3% with calculated diseases reduction by 87.1, 60.0, 78.5 and 59.4%, in respective order over control treatment.

Moderate effect was observed at the other foliar spray treatments of *S. cerivisae*, Calcium chloride, Potassium bicarbonate, Potassium monohydrogen phosphate and Potassium dihydrogen phosphate. Topsin-M 70%, the fungicide treatment could reduce the disease incidence of leaf spot, leaf gray blight, late wilt and ear rots by 85.3, 74.3, 78.8 and 78.2% relatively to control treatment, respectively.

Discussion

Present investigation was designed to get agro-chemical alternative control approaches characterized with environmentally safely application, such as plant resistance inducers and biocontrol agents which may supply control measures against various soilborne and foliar pathogens. Therefore, the target of the present work was evaluating some fungicide alternatives against root rot, leaf spots, late wilt and ear rots incidence of Maize when used as grain treatment and foliar spray under natural field conditions. Root and foliar diseases cause fundamental harm to the maize crop where ever it grown.

Since there are no resistant cultivars to soil and air-borne plant pathogens as well as the fungicides which cannot active enough protection to the crop from attacking by these pathogens, therefore, developing another alternative control measures are considered important to minimize the incidence of these diseases. Many investigators reported similar results in agreement with the present study outcome. In this regard, Da Silva and Pascholati (1990) studied the effect of previous simultaneous application of cell suspension or filtrates of the commercial baker's yeast *Saccharomyces cerevisiae* for protecting maize against anthracnose leaf disease caused by *Colletotricum graminicola* under greenhouse conditions. Also, Shalaby and El-Nady (2008) indicated strong potentiality of *S. cerevisiae* which act as plant growth promoters and as biocontrol agents against damping-off of sugar beet seedlings caused by *F. oxysporum*. Control of maize seedling blight, root rots and stalk rots caused by *Fusarium graminearum* was achieved when *Bacillus* sp. used as grains dressing (Pal *et al*., 2009). Moreover, the bioagents, *T. viride* and *Pseudomonas* spp. had cabability for controlling stalk rots of maize (Chen *et al*., 1999). Seed coating with *Pseudomonas cepacia* could reduce the *Fusarium moniliforme* infected maize root with by 23–80% (Hebbar *et al*., 1992). They added that a range of soil-borne fungal pathogens including *Fusarium graminearum*, *Fusarium moniliforme* and *Macrophomina phaseolina* were also found to be suppressed as a result of plant roots associated with *Pseudomonas cepacia*. On the other hand, recently essential oils and their constituents are obtaining growing interest due to their safely use broad acceptability by consumers, and their multi-purpose utilization (Akin *et al*., 2010). A set of treatments, such as antimicrobial bioagents, mild heat and salt compounds integrated with essential oils have been successfully used (Abdel-Kader *et al*., 2011). Moreover, application of calcium salts, hydrogen peroxide and chitosan as pre- or postharvest approaches are suggested strategies against fruit decay (Conway *et al*., 1992; El-Mougy *et al*., 2008). Furthermore, chemical stimulants (inducers) seem to influence the native defense system in plants against diseases or create some new compounds supporting it. Many others (Ziadi *et al*., 2001; Achuo *et al*., 2004; Abdel-Kader et al. 2015) used several compounds recognized to stimulate the defense mechanism tools in plants such as salicylic, benzoic, citric and oxalic acids. All previous reports confirmed the obtained results in the present investigation. Therefore, it could suggest that using bioagents, chemical inducers, organic acids and salts as well as essential oils considered a successful approach for controlling root and foliar diseases of such crops.

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