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EFFECT OF FOLIAR APPLICATION OF SOME NUTRIENTS ON MAIZE EARS ROT DISEASE, SYNTHASE OF ANTI-DEFENSE COMPOUNDS, QUALITY OF MAIZE GRAINS AND BREAD

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ABSTRACT: This study was performed to investigate the effect of foliar spray by each of urea, boron, zinc, potassium alone and/or mixed of each with urea on maize ears and grains rot disease development, observe the chemical composition, phenolic compounds, antioxidant activity (DPPH), trypsin and α- amylase inhibitors activity of different treatments of maize grains. As well as, evaluate the sensory properties of balady bread prepared using different levels of corn flour and Gum Arabic as substitution of wheat flour. Moreover, the quality characteristic of dough. *In vitro* treatment of urea alone and/or its mixture with each of boron, zinc and potasium significantly reduced radial growth and sporulation of *Fusarium moniliforme* fungus on PDA medium followed by each of boron and zinc alone. While potassium was not effective in this respect compared to control. The effect of foliar nutrients applied on maize ears and grains rot disease was quantified and possible modes of action during field conditions. Twice applications at 50 and 65 days from planting by mixture of urea and boron; urea and zinc; urea and potassium were more effective than the treatment with each of urea, boron, zinc and potassium alone, provided the least disease and consistently better of yield and 100 grain weight. The effect of nutrients were really extended to reduce associated maize grains fungi infection, especially the main causal pathogen for ears and grains rot caused by *F. moniliforme* compared to control. Significantly difference between nutrients and application dates were found. Quality of maize grains treated with different nutrients were investigated. Results showed that, twice application of boron alone and mixture of urea and zinc produced maize grains contained the highest contents of crud protein (10.60 and 10.40%, respectively) while the lowest value of crud protein was 9.35% for treatment with urea and boron mixture applied twice. On the other hand, maize grains treatment with mixture of urea and zinc applied twice contain the highest content of total polyphenols extracted which was (320 mg GAE/100g) followed by mixture of urea and boron applied twice which recorded (305 mg GAE/100g), while the lowest value of total polyphenols extracted was (215 mg GAE /100g) for control maize grains. Furthermore, maize grains treated with mixture of urea and zinc applied twice contain the highest content of antioxidant activity (DPPH) (89.10%); trypsin inhibitor activity (T1A), (0.51 IU/mg) and α-amylase inhibitors (12.75 AIU/g) compared with control maize grains. Furthermore, the farinograph results indicated that, arrival time (min), developing time (min), dough stability (min) and weakening value (B.U) increased, while water absorption (%) decreased with increasing the level of adding corn flours and Gum Arabic when compared with wheat flour control.

Key words: Maize ears rot disease, nurients, total polyphenol, trypsin and α-amylase inhibitors, farinograph, bread.

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INTRODUCTION

Corn (*Zea mays* L.), or maize, is the leading cereal crop in the world followed by rice and wheat **(FAOSTAT, 2014)**. In addition, maize is generally used for animal feed. It is widely processed into various types of products such as corn meal, grits, starch, flour, tortillas, snacks, and breakfast cereals. Maize flour is used to make chapatis or flat breads which are eaten mainly in a few Northern states of India **(Rose *et al.,* 2010)**. Fungi are important and rank second as the causal of deterioration and loss of maize grains **(Ominski *et al.*, 1994)**. **Munkvold and Desjardins (1997), Desjardins *et al.* (1998) and Covarelli *et al.* (2012)** showed that, *F. moniliforme* [*F. verticillioides* (teleomorph *Gibberella moniliformis*)] was the major causal agent of symptomless, better competition and predominantly responsible for ear rot of maize which fuminisns (FBS) toxin can be present and accurately toxic to certain livestock *i.e*., horses and swine and have carcinogenic properties in rates, animals and human consumers maize grains in developing countries taken to minimize contamination of maize **(Bullerman, 1996)**. The major genera commonly encountered on maize in tropical regions are *Fusarium, Aspergillus* and *Penicillium* **(Orsi *et al.*, 2000)**. Control of plant disease by using plant nutrients has been reported by many investigators. **Reuveni *et al.* (1997)** reported that, foliar spray by boric acid inhibited powdery mildew development in cucumber plants. Mechanisms of protection was associated with stress induced by the salts or was related to an improvement nutrition status or increased photosynthesis as reported by **Walters and Murray (1992)**. **Nelson and Meinhardt (2011)** found that, foliar application of boron would increase corn yield and disease tolerance. **Cook *et al.* (1993**) showed that, foliar applied of KCl is effective against powdery mildew and *S. tritici* in the field. Moreover, **Mann *et al.* (2004) and Kettlewell *et al.* (2000)** showed that, potassium chloride foliar application may adversely affect both conidial germination and colonization of the leaf surface by means of a depression in water potential of the plant, acts as an osmoticum and may have been toxic to *Septoria tritici* and *Blumeria* (*syn. Erysiphe*) *graminis*, and spores did not subsequently germinate. Also, **Long *et al.* (2003)** reported that, K increased phenol content in maize leaf. In addition to, application of 30 and 60 kg/ha of K_2O reduced Helminthosporium leaf blight and seed infection resulted in increasing of grain yield and grain weight of wheat **(Sharma *et al.,* 2005)**. Potassium may cause reduction in severity by various modes of action, including photosynthesis, respiration and osmotic pressure regulation (**Simpson, 1986)**. Contrastly, **Nelson *et al.* (2011)** recorded that, severity of corn leaf blight increased as the nitamin (N) foliar applied rate increased (3 gal/acre), probably due to improved growth and increased greenness. **Reuveni *et al.* (2009**) reported that, foliar spray of NPK fertilizers can enhance growth of maize plants and induce systemic resistance against leaf blight disease caused by *Exserohilium turcicum,* reducing number and size of lesions of maize .**Farahat** and **Salama (2012)** mentioned that NPK combinations reduced the linear growth and sporulation of *E. turcicum*, as well as, reduced maize leaf blight disease severity by enhancing activity of peroxidase enzyme. Proteinase inhibitors (PIs) have important mechanism that plants produce to offer protection against predators or from infection by pathogens. They are widely distributed in the plant kingdom and the plant families *i.e.,* Leguminoseae, Solanaceae and Graminaceae are known to be rich in these inhibitors **(Nakahata *et al.*, 2011)**. Phenolic compounds are important plant secondary metabolites with known biological functions including antimicrobial activity and insect resistance **(Casati and Walbot, 2005).** Phenolics in maize grains had been implicated in resistance to ear rots and insects of maize **(Classen *et al.*, 1990).** Many research groups have validated the role of plant trypsin enzyme inhibitors (TI) as mean of plant defense against fungal infection **(Baker *et al.*, 2009)**. As well as **Chen *et al.* (2007)** reported that, antifungal trypsin inhibitor proteins was up regulated two fold or higher in resistant maize lines compared with susceptible ones.

This work aimed to provide data for the effect of foliar spray by each of urea, boron, zinc, potassium alone and/or mixed of each with urea on maize ears and grains rot disease development. Also, chemical composition, phenolic compounds, antioxidant activity (DPPH), trypsin and α- amylase inhibitors activity of different treatments of maize grain were undertaken. As well as, evaluate the sensory properties of balady bread prepared using different levels of corn flour and Gum Arabic as substitution of wheat flour. Moreover, the quality characteristics of dough were investigated.

MATERIALS AND METHODES

Effect of Plant Nutrients on *Fusarium moniliforme In vitro*

Certain plant nutrients *i.e.,* nitrogen (urea 46.5%); zinc sulphate ($ZnSO_4$, 7 H_2O, Zn 24%, S 20%); boric acid (H_3BO_3, 16.5%); potassium sulphate (K_2SO_4 , K_2O 50% and S 18%) at conc. 10 g/l, as well as, urea (10 g) plus zinc (10 g), urea plus boric acid (10 g) and urea plus potassium sulphate (10 g) were used to study their effect on mycelial growth of *F. moniliforme* fungus *in vitro,* all chemicals were produced by El Nasr Pharm. Chemicals Co. The tested nutrients concentrations were adjusted to obtain the desired concentrations on PDA medium. A mycelial discs (5 mm) diameter were taken from marginal growth of 7 days old cultures of *F. moniliforme* and transferred onto the center of Petri plates. Control treatment was *F. moniliforme* only on PDA. All treatments were incubated at 27°C and the radial growth was recorded/cm after 7 days, four replicates were used for each treatment. Sporulation was recorded 7 days post incubation. Disc of each treatment alone (5 mm diameter) of fungus growth, was suspended in 10 ml water, spores number was recorded microscopically with aid of hymacytometer. Percentage inhibition (PI) of radial growth and sporulation was calculated as follows:

PI = Control – Treatment/Control x 100

Effect of Plant Nutrients of Ears and Grains Rot Disease Under Field

The aforementioned nutrients were used to control of ears and grains rot disease under natural infection conditions in the field at the experimental farm of Sakha Agric. Res. Station during 2016 and 2017 growing seasons. Grains of maize cv. balady were used. Randomized complete block design with three replicates was used. Each plot included two ridges 4 m long at 75 cm distance and sown by 2-4 grains/hill, thinned to one plant/hill after three weeks. All cultural practices were applied at the proper time. Application of nutrients solutions were done as one spray after 50 days (flowering and beginning of infection), 65 days (milk stage) and twice at 50 and 65 days from sowing, the sowing was done on 6 and 4th of June in 2016 and 2017 seasons, respectively. Control treatment left without spraying. Ear rot disease was recorded after harvesting directly/ plot according illustrated scale of **Reid *et al.* (1996)** as follows: The severity of ear rot symptoms was evaluated using a 7 class rating scale which were 1= 0%, 2 = 1-3%, 3 = 4-10%, 4 = 11-25%, 5 = 26-50%, 6 = 51-75% and 7 = >75% of grains exhibited symptoms of infection such as rot and mycelial growth. Yield/kg/plot, weight of 100 grains (g). As well as efficiency of each treatment were recorded.

Isolation of Associated Fungi of Maize Grains

Randomized samples (3 ears) were collected from each replicate of treatments, transported to the laboratory in a separate paper bags, air dried and stored at laboratory temperature. To isolate different fungal pathogens causing ears and grains rot, standard blotter test method of **ISTA (1993)**, was used to record percentage of both germination and frequency of each isolated fungus for each treatment. Isolation procedure was done twice for each treatment during the two growing seasons.

Proximate Chemical Composition of Maize Grain

Maize grains samples treated at 50 and 65 days after sowing (applied towice) of mixture of urea and zinc; mixture of urea and boron; potassium and boron as well as mixture of urea and zinc applied at 50 days from planting were subjected for the following chemical analyses moisture, crude protein content (N x 5.95), crude fat and ash, of the samples which were determined according to the method described by **AOAC (2005)**. Total carbohydrates content was calculated by difference as follows:

Total carbohydrates (%)=100–[(crude protein (%) + ether extract (%) + ash (%)] on dry weight basis.

Extraction of Total Phenolic Compounds

Total phenolic compounds were extracted according to the method described by **QP and**

JG (2011). Flour of corn grain were subjected to phenolics extraction using methanol 95%. The extraction process was continued for 24 hr., at room temperature by stirring the flours in the solvent. The extracts were centrifuged at 4000 rpm for 15 min and filtered through filter paper (Whatman No. 41). The solvent was removed from the extracts using a rotary evaporator at 40°C under vacuum. The extracts were further dried using vacuum oven at 40°C and then kept in dry clean closed black glass bottle at 4°C for further analysis

Determination of Total Phenolic Compounds

Total phenol compounds content was determined according to **Singleton *et al.* (1999)**. The method is based on the colour reaction of Folin-Ciocalteu reagent with hydroxyl groups. Reaction absorbance was measured at 760 nm using a spectrophotometer. The results were expressed as mg gallic acid per 100g of extract.

Antioxidant activity (DPPH) assay

Antioxidant activity was measured using the (2,2-diphenyl-1- picrylhydrazyl) DPPH method described by **Soler-Rivas *et al.* (2000)**.

Trypsin inhibitor activity (T1A)

Trypsin inhibitor activity was determined using the method of **Kakade *et al.* (1969)** and expressed as the number of units inhibited per mg dry matter.

Amylase inhibitors (AIU/g)

α- Amylase inhibitors was determined using the method of **Wilson and Ingledew (1982)**.

Preparation of flour blends

One superior maize grains treatment of mixture of urea and zinc applied twice was chosen from the different samples to prepare blends then study the rheological properties of dough and organaleptic of balady bread. wheat flour (82% extract), corn flour and Gum Arabic were used, the blends were prepared according to the method described as shown in Table 1.

Rheological properties

The rheological properties of dough blends were tested by using farinograph according to **AACC (2005)**.

Organoleptical properties of balady bread

Balady bread loaves were organoleptically evaluated by 12 panelists **(Abd El-Rahim, 1992**).

Statistical Analysis

Data were analyzed statistically using the analysis of variance and the means were further tested using the least significant difference test at 0.05% (LSD) as outlined by **Steel and Torrie (1980)**.

RESULTS AND DISCUSSION

Effect of Certain Plant Nutrients on *Fusarium moniliforme In vitro*

Results in Table 2 concerned that, radial growth of *F. moniliforme* was reduced as 5.73 to 79.23 % when the fungus grown on PDA medium contained different each plant nutrients alone or mixed with urea. There was obvious correlation between all nutrients and radial growth reduction with exception of potassium, boron and zinc. Mixture of urea and zinc was the most effective one followed by mixture of urea and boron, mixture of urea and potassium and urea alone while each of boron and zinc were the least effective ones on *Fusarium* growth. All mixtures of nutrients and urea caused significantly reduction of fungus sporulation followed by each of boron and zinc alone. Potassium alone wasn't effect in reducing the sporulation. The reduction of sporulation was ranged from 51.67 to 93.54% in comparing to control.

Under *in vitro*, radial growth and sporulation of *F. moniliforme* fungus were significantly reduced when plant nutrients were added to PDA medium. Urea alone and their mixture with each of zinc, boron and potassium alone were more effective and had strong retarding of radial growth and sporulation of *F. moniliforme* than zinc and boron alone wherever, its reduced only the sporulation. The above nutrients can be retarding and caused precocious effects against *F. moniliforme* fungus under *in vitro* condition. The inhibition was up to 79.23 of radial growth and 93.54% of sporulation. Potassium alone had not effect in this characters **Ziv and Zitter (1992)** found that ammonium bicarbonate proved to be the effective salt in suppressing the

Table 1. Wheat flour (82% extract) and its blends (corn flour and Gum Arabic) for balady bread making

Sample blends number	Wheat flour (82% extraction)	Corn flour	Gum Arabic
1	100	-	-
2	89	10	1
3	84	15	1
4	79	20	1

Table 2. Effect of some nutrients of radial growth, and sporulation of *Fusarium moniliforme*

Treatment	Conc/g/L.	Radial growth/cm	Inhibition (%)	Sporulation 10^6	Inhibition (%)
Urea	10	2.63c	64.07	0.63c	83.72
Boron	10	6.86b	6.28	1.63b	57.88
Zinc	10	6.90b	5.73	1.87b	51.67
Potassium	10	7.86a	-	4.12a	-
Urea+ Boron	10+10	2.20cd	69.94	0.50c	87.08
Urea+ Zinc	10+10	1.52d	79.23	0.38c	90.18
Urea+ Potassium	10+10	2.25cd	69.26	0.25c	93.54
Control	-	7.32ab	-	3.87a	-

In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT.

growth of *Didyamella bryoniae, Ulocladdium cucurbitae*, *A. cucumerina* and *Colletotrichum orbicularia in vitro*. While the reverse was true with potassium chloride with the certain four fungi. 0.1 M of KOH(K) and N $(NH4)_2SO_4)$ were significantly reduced of linear growth and sporulation of *H. turcicum* and NP and NPK treatments led to stop of spores formation, **Farahat and Salama (2012)**. As well as, **Farahat and Salama (2013)** added that, *Cercospora beticola* fungus radial growth and cercosporin toxin were decreased with application each of urea, zinc, mixture of urea and zinc, mixture of urea and boron and potassium was not effective. Aflatoxin biosynthesis in *A. flavus* and penicillin were inhibited and controlled by high nitrate and nitrogen metabolite repression. **Change *et al.* (1996), Giordano *et al.* (1999)** and **Abro *et al.* (2013)** documented that, nitrogen nutrition (NO_3) at 15-30mM decreased secondary infection and sporulation was significantly influenced by the nutrition status, the lowest secondary infection by *B. cinerea* was observed with moderate level of N.

Effect of Plant Nutrients of Ears and Grains Rot Disease in Field

Results in Tables 3 and 4 show that, ear rot disease percentage was affected by application once (50 days) and by twice applications (50 and 65 days) after planting. This treatments led to significant decrease of the disease infection percentage and recorded the most effective ones during the two tested seasons, recording efficiency ranged from 35.71 to 64.62%. Boron applied 65 days after planting showed enhancement in reducing of the disease and recorded efficiency ranged from 30.00 to 45.23%. Zinc, sprained once (after 65 days) followed by spraied twice reduced the disease

Table 3. Effect of spraying urea, boron, zinc and potassium alone on ear rot percentage, yield and grains weight of maize cv. balady under field nature infection in 2016 season

Treatment	Application date	Ear rot (%)		Yield weight/kg	Efficiency (%)	100 grains	
		Infection	Efficiency			Weight (g)	Efficiency
Urea	**50**	22.67ef	47. 46	4.06defg	8.84	34.34de	5.59
	65	30.33cd	30.00	40.05efg	8.58	34.17def	9.48
	50+65	32.50bc	24.99	4.08defg	9.38	35.42bcd	9.25
Boron	**50**	15.33h	64.62	4.96a	32.73	36.32ab	12.03
	65	30.33cd	30.00	3.87fgh	3.75	32.88fgh	1.42
	50+65	20.33fg	53.08	4.13def	10.72	35.71bc	10.15
Zinc	**50**	26.00de	39.99	4.37bcd	21.14	33.91efg	4.59
	65	17.67gh	59.22	4.95a	32.71	36.72ab	13.26
	50+65	22.00efg	53.84	4.45bc	19.30	37.58a	15.92
Potassium	**50**	25.00e	42.30	4.57b	22.52	32.72gh	0.9
	65	35.00b	19.22	3.32gh	-	32.78gh	1.11
	50+65	22.50ef	48.07	4.21cde	12.87	34.87cde	7.57
Control	**-**	43.33a	-	3.73h		32.42h	-

In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT ear rot percentage as disease severity rating as scale adopted by **Reid *et al.* (1996)**.

Table 4. Effect of spraying urea, boron, zinc and potassium alone on ear rot percentage, yield and grains weight of maize cv. balady under field nature infection in 2017 season

Treatment	Application date	Ear rot (%)		Yield weight/kg	Efficiency (%)	100 grains	
		Infection	Efficiency			Weight (g)	Efficiency (%)
Urea	**50**	30.83abc	11.94	3.83de	3.51	36.69bcd	3.64
	65	25.00de	28.57	3.92cde	5.95	37.27b	5.28
	50+65	27.50cde	21.43	4.17ab	12.70	37.51b	5.96
Boron	**50**	22.50ef	35.71	4.01abcd	8.11	37.29b	5.34
	65	19.17f	45.23	4.25a	14.86	36.88bc	4.18
	50+65	18.83f	46.20	4.14abc	11.89	40.69a	14.94
Zinc	**50**	33.33ab	1.67	4.03abcd	8.92	37.69b	6.46
	65	25.83cde	26.20	4.09abc	10.54	39.41a	11.32
	50+65	27.16cde	22.40	4.25a	14.86	40.34a	13.95
Potassium	**50**	23.33def	34.29	3.99bcd	7.84	37.44b	5.76
	65	28.33bcd	19.06	4.07abcd	10.00	35.78cd	1.07
	50+65	25.33de	27.63	4.09abc	10.54	37.40b	4.80
Control	**-**	35.01a	-	3.70e	-	35.40d	-

+In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT.

from 17.67 to 27.16% and efficiency from 59.22 to 22.40 %, while application at 50 days after sowing recorded positive results only in the first season. Foliar application of urea recorded ear rot from 22.67 to 32.50% and efficiency from 11.94 to 47.46%, recording positive effect against the disease with exception application at 50 days in the second season. Spraying potassium showed retarding the disease when applied twice followed by spray at 50 day while spraying at 65 days was the lowest one. The infection recorded 22.50 to 35.00% and efficiency recorded 48.07 to 19.06% in the two tested seasons. Control treatment recorded the highest disease percentage during the two seasons.

In most cases yield/kg showed enhancement with the tested treatments of maize plants with exception of boron and potassium applied at 65 days in the first season and urea only at 50 and 65 days at the second season. Other treatments recorded yield ranged from 4.95 to 4.05 kg and efficiency from 8.58 to 32.71% at the first season and 4.25 to 3.90 kg and efficiency 14.86 to 7.86% at the second season compared to 3.73 and 3.70 kg yield of control treatment.

Regarding to 100 grain weight, one application at 65 days and twice applications by zinc followed by one application at 50 days and two applications of boron recorded the highest enhancement of weight in the two seasons. Other treatments of zinc and boron showed slight enhancement with exception of spraying boron at 65 days in the first season.

Urea treatments showed positive effect in this respect especially when applied twice but spraying at 50 days in the second season recorded negative effect. Potassium treatment with twice application recorded the most effective one, while the reverse was true with one application at either 50 and or 65 days in the first season. In general, most of treatments showed enhancement of 100 grain weight in the two tested seasons in comparison with control, so application of this treatments were useful in this respect.

Effect of Plant Nutrients of Associated Fungi on Maize Grains

Infection of maize grains were recorded in Tables 5 and 6, wherein, isolated fungi were *F. moniliforme*, which was the most recorded one with all applied nutrients, followed by *Fusarium* sp., *A. flavus, A. niger* and *Penicillium* sp. during the two tested seasons. Early application of nutrients at 50 days after sowing especially boron, reduced infection by *F. moniliforme* compared with other treatments, which reduced isolation percentage in comparison to the control in the two tested seasons, with exception of potassium in the first season. *F. moniliforme* recorded isolation percentage ranged from 15.33 to 37.13 compared to 32.00 and 42.11% with control in the two seasons. In the most cases, other isolated fungi, *i.e., Fusarium* sp., *A. flavus, A. niger* and *Penicillium* sp. recorded low percentages and were reduced with the most used nutrients in comparing with control. On the other hand, germination percentage was enhanced with treatments which caused reduction of infection ranged from 82.10 to 94.12 comparing to 78.18 and 75.11 in the control. Boron was the most effective one in increasing germination (%) in the two seasons, which valued 91.16 and 89.10, but zinc application recorded the highest value (94.12) only in the first season.

The importance of mineral nutrition for plant growth and vigor is obvious, the role of nutrients in plant disease resistance is less well known but is gaing increasing recognition. Many of the micronutrients are required for polyphenol formations and other aspects of phenolic metabolism, and hence they are crucial for plant defense capability (**Huber and Withelm, 1988; Graham and Webb, 1991**). In the present study, application of boron providing inhibitory factors for ears and grains rot disease and the last. Yield and 100 grains were consistently better than other *i.e.,* zinc, potassium, urea and control. Application nutrients were possible to reduce the disease in the field and enhancement of yield and 100 grain weight. Two application of nutrients were more effective than one time in reducing of and in infection by *F. moniliforme*, which is the main causal of grains rot disease. Early nutrients application at anthesise (at 50 days) was more useful than late one (at 65 days) in disease reduction. In the most cases, *F. moniliforme* was the most isolated one while *A. flavus, A. niger* and *Peniciilium* sp. fungi recorded with low percentages in isolation test as recorded by **Desjardins *et al.* (1998) and**

Table 5. Effect of spraying urea, boron, zinc and potassium alone on isolated fungi and germination percentages from maize grains cv. balady under field nature infection in 2016 season

Treatment	Application date	Isolated fungi (%)					Germination (%)
		Fm	F.sp	A.f	A.n	P.sp	
Urea	50	26.00c	1.03d	2.03d	2.03e	0.96d	87.13d
	65	20.00e	1.01d	1.96d	4.96b	1.00d	87.16d
	50+65	19.66ef	0.96d	1.30e	2.05e	1.01d	84.15e
Boron	50	15.33h	2.01c	2.96c	2.01e	2.03c	82.16f
	65	18.33fg	2.05c	2.97c	1.03f	3.02a	91.16b
	50+65	19.66ef	0.33e	2.03d	3.97c	1.96c	89.15c
Zinc	50	18.00g	1.03d	3.02c	2.00e	1.96c	94.12a
	65	30.00b	1.96c	4.02b	2.97d	1.96c	82.13f
	50+65	20.00e	2.01c	1.96d	0.97f	2.96a	86.16d
Potassium	50	32.66a	2.03c	3.97b	2.96d	0.96d	87.16d
	65	23.00d	3.03b	2.03d	0.97f	2.33b	91.15b
	50+65	21.00e	3.01b	1.04f	1.97e	2.36b	89.13c
Control	-	32.00a	3.96a	4.92a	5.98a	3.09a	78.18g

+In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT.

F.m = *F. moniliforme*, F.sp: *Fusarium* sp., A.f: *A. flavus*, A.n: *A. niger*, Psp: *Penicillium* sp.

Table 6. Effect of spraying urea, boron, zinc and potassium alone on isolated fungi and germination percentages from maize grains cv. balady under field nature infection in 2017season

Treatment	Application date	Isolated fungi (%)					Germination (%)
		F.m	F.sp	A.f	A.n	P.sp	
Urea	50	27.06i	1.96c	2.02c	1.99c	2.02c	86.10d
	65	25.06j	2.02c	3.95a	0.43e	3.93a	85.11e
	50+65	23.05k	0.96d	3.03b	0.96d	0.96d	86.12d
Boron	50	23.10k	2.00c	2.96b	0.33e	1.03d	88.09b
	65	27.96h	2.03c	1.03d	0.96d	0.97d	89.10a
	50+65	29.96f	1.96c	0.97d	0.33e	1.96c	86.05d
Zinc	50	28.10g	2.03c	2.96b	3.01b	2.02c	82.10g
	65	37.13b	1.04d	1.94c	1.97c	0.96d	87.10c
	50+65	33.10c	1.01d	3.96a	1.98c	0.96d	84.10f
Potassium	50	32.10d	2.03c	3.97a	2.96b	2.01c	88.10b
	65	25.10j	2.96c	3.96a	3.01b	2.97b	88.23b
	50+65	30.10e	3.01b	1.04d	2.01c	1.01d	86.10d
Control	-	42.11a	4.10a	3.97a	4.97a	3.92a	75.11h

+ In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT.

F.m = *F. moniliforme*, F.sp: *Fusarium* sp., A.f: *A. flavus*, A.n: *A. niger*, Psp: *Penicillium* sp.

Covarelli *et al.* (2012). Mechanisms of protection was associated with stress induced by the salts or was related to improvement nutrition status or increase photosynthesis as reported by **Walters and Murry (1992)**. Other authors have shown boron to effective against certain plant diseases *i.e*., **Reuveni *et al.* (1997)** tested the inhibitory effect of boron (boric acid) against powdery mildew disease in cucumber and recorded the providing inhibitory development of the disease. **Nelson and Meinhardt (2011)** reported that foliar application of boron would increase yield and disease tolerance. The results of which suggested the effective reduction of ears and grains rot can be achieved by boron application in the field with supporting by **SMBSC (2011)** they found that, boron has been identified as a key component in disease defense mechanisms of sugar beet plants.

In the field, applying urea reduced the ears and grains rot disease especially with two applications and in infection by *F. moniliforme*, *A. flavus, A. niger* and *Peniciilium.* **Reuveni *et al*. (2009)** and **Farahat and Salama (2012)** found that NPK nutrients can be reduce leaf blight disease severity of maize by enhance of growth with increase of chlorophyll content and activation of systemic resistance, wherever defense enzymes of PO and PPO were recorded in high activity. **Nelson *et al*. (2011)** recorded growth improvement with corn nitamin spraying (nitrogen source). Moreover, **Locke *et al*. (2004**) reported that, nitrogen are considered major essential element to plant growth and luxuriant plant growth that resulted is alleged to predispose plant to disease. **Otto-Hanson *et al.* (2013)** found that, adding urea to antagonist led to increase of effectiveness against potato scab disease control. **Shim and Woloshuk (1999)** found that, addition of nitrogen (ammonium sulphate) to corn drastically inhibit FB1 toxin production by *F. moniliforme.*

In the field, potassium sulphate applying twice was more effective than one application in retarding of ears and grains rot disease severity and in fungi associated with corn grains in comparing with control and caused yield enhancement. Potassium may cause reduction in severity of ear and grains rot disease followed by reduction of corn grains associated fungi of *F. moniliforme, A. flavus, A. niger* and *Peniciilium* by various modes of action including photosynthesis, respiration, osmotic pressure regulation as reported by **Simpson (1986).** Means of a depression in water potential of the plant and may have been toxic to spores and subsequently did not germinate of *S. tritici* and *Blumeria* **(Mann *et al.,* 2004; Kettlewell *et al.,* 2000)**. **Long *et al.* (2003)** added that, K increased the production of diseases inhibitory compounds such as phenols, phytoalexins and auxins around the infection sites of resistance plants. **Sharma *et al.* (2005)** added that, K_2O reduced leaf blight and seed infection resulted in increasing of grain yield and grain weight of wheat.

Zinc reduced reduction ears and grains rot disease when applied twice more than application one time, as well as, enhancement of yield, grains weight and caused increase of grains size (quality) in comparing with control and other treatments. Fungi associated with maize grains were reduced, resulted are in zinc application especially *F. moniliforme*. The results are in same line of **Farahat and Salama (2013)**, they found that foliar spray by zinc led to decrease of cercospora leaf spot disease severity of sugar beet with high activity of PO and PPO enzymes.

Effect of Nutrients Mixture of Ears and Grains Rot Disease in Field

From the data in Tables 7 and 8, mixture of urea and boron applied twice at (50+ 65 days) of maize cv. balady led to significantly decrease of ears and grains rot disease in the field during the two tested seasons, *i.e*., 18.33 and 18.35, recording efficiency 58.02 and 47.62%, respectively. This treatment was the most effective one in comparing control, which recorded 43.66 and 35.02% infection of rot, in the two seasons. On the other hand, this treatment was not effective with applying at 50 days in the first season and 65 days in the second season in reducing the disease. Treatments of mixture of urea and zinc and urea and potassium recorded positive results in reducing the disease at the first season in comparison with control followed by mixture of urea and boron treatment applied twice only. The most nutrients tested reduced, ears rot percentage with the most cases and the efficiency against the disease ranged from 16.28 to 59.55% in the two tested seasons.

Table 7. Effect of spraying urea combined with each of boron, zinc and potassium on ear rot percentage, yield and grains weight under field nature infection in 2016 season

Treatment	Application date	Ear rot (%)		Yield weight/kg	Efficiency	100 grains	
		Infection	Efficiency			Weight (g)	Efficiency
Urea+ Boron	**50**	41.00a	6.09	3.51c	7.66	35.14ab	8.45
	65	30.66cde	29.77	3.70c	13.49	33.61bcde	3.73
	50+65	18.33f	58.02	3.75c	15.03	34.66b	6.97
Urea+ Zinc	**50**	17.66f	59.55	4.98a	52.76	36.78a	13.51
	65	33.16bcd	24.05	4.80a	47.23	34.19bc	5.52
	50+65	27.66e	36.64	4.25b	30.36	34.00bcd	4.93
Urea+ Potassium	**50**	35.83b	17.93	4.73b	30.43	34.30bc	5.86
	65	35.00bc	19.85	3.51c	7.66	32.75cde	1.08
	50+65	30.33de	30.33	3.75c	15.03	32.30e	-
Control	**-**	43.66a	-	3.26c	-	32.40de	-

In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 8. Effect of spraying urea combined with each of boron, zinc and potassium on ear rot percentage, yield and grains weight under field nature infection in 2017 season

Treatment	Application date	Ear rot (%)		Yield weight/kg	Efficiency	100 grains	
		Infection	Efficiency			Weight (g)	Efficiency
Urea+ Boron	**50**	29.30bc	16.28	3.80cd	2.70	37.87abc	7.06
	65	31.00ab	11.42	3.75d	1.35	37.34bcd	5.56
	50+65	18.35e	47.62	4.43a	19.72	37.28cd	5.40
Urea+ Zinc	**50**	25.00cd	28.57	4.36a	17.83	39.24a	10.94
	65	24.16cd	30.97	3.90bcd	5.41	36.05de	1.95
	50+65	22.50de	35.71	4.15ab	12.16	38.96ab	10.14
Urea+ Potassium	**50**	23.33de	33.34	4.13abc	11.62	39.05a	10.40
	65	23.34de	33.34	3.93bcd	6.21	37.89abc	7.12
	50+65	26.00bcd	25.71	3.83bcd	3.51	36.80cde	4.04
Control	**-**	35.02a	-	3.71d	-	35.37e	-

+ In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT.

Yield weight/kg was enhancened and provided the highest with mixture of urea and zinc which applied at 50 days in the two seasons and recorded the most effective one *i.e*., 4.98 and 4.36 kg, efficiency recorded 52.26 and 17.53% followed by mixture of urea and boron applied twice. Also, mixture of urea and zinc showed enhancement of yield with all applied dates with exception of at 65 days after planting in the second season. Mixture of urea and potassium applied 50 days after planting led to increase yield in the two tested seasons, which ranged from 4.13 to 4.73 kg and efficiency ranged from 11.62 to 45.09%. Other treatments showed slight increase of yield and efficiency in the two tested seasons in compared to control. Application of mixtures of urea and boron and urea and zinc at 50 days provided the highest increase of 100 grain weight during the two tested seasons and recorded the highest efficiency followed by mixture of urea and potassium (applied at 50 days) and mixture of urea and boron (applied twice). Other mixtures of nutrients showed enhancement and/or non during one season only in comparing of control.

Effect of Plant Mixture of Nutrients of Associated Fungi Maize Grains

Results in Tables 9 and 10 confirmed that, *F. moniliforme* was the most important isolated fungus which recorded the highest percentage of isolation procedure according to **ISTA (1993)**. The frequency of the fungus was affected by application date and by the used mixture of nutrients especially by twice application followed by application at 50 and 65 days after planting compared to control treatment. Mixture of nutrients with twice applications of urea and zinc in the first season and urea and potassium in the second season were the most effective in reducing *F. moniliforme* frequency percentage in comparing with control and other treatments in the two tested seasons. Other associated fungi were *Fusarium* sp., *A. flavus, A. niger* and *Penicillium* sp. isolated in low frequencies. *A. flavus* fungus frequency was not reduced with late applied (65 days) by mixture of nutrients of urea and zinc as well as urea and potassium compared to the control in the second season. Also, late application of mixture of urea and boron as well as urea and zinc recorded negative results with *Penicillium* sp. Generally, twice application of mixture of nutrients was more effective than one time with the last associated fungi group. Reduction of isolated fungi led to increase of germination percentage in the two tested seasons in comparing with control. Results recorded that, reduction of the disease can be done by application of this mixtures with two times, causing yield and 100 grain weight increase and subsequently less isolated fungi especially the main pathogen *i.e., F. moniliforme* and others *i.e*., *A. flavus, A. niger* and *Penicilium* sp., than one time application. The present results supported by the finding of **Farahat** and **Salama (2013)**, they reported that mixture of urea and zinc, urea and boron in field application on sugar beet plants reduced cercospora leaf spot disease severity with enhancement of total soluble, sucrose and chlorophyll content. **Reuveni *et al*. (2009)** and **Farahat and Salama (2012)** found that NPK and NK nutrients can be reduced leaf blight disease severity of maize in the field by enhance of growth with increase of chlorophyll content and activation of defense enzyme of PO and which recorded in high activity.

Our finding are consistently with the hypothesis that, the beneficial effect of mixture of nutrients are related to reduce or prevent infection by ear and grains rot fungi by means of disease inhibitory compounds such as phenols, phytoalexins and auxins around the infection sites (**Long *et al.,* 2003**). **Abbasi *et al.* (2002)** concluded that, ammonium lignosulfonate (N) plus potassium phosphate foliar application indicated that future integrated disease management for bacterial spot of the two products, while mixture of potassium phosphate and micronutrients solution did not improve protection over that obtained with each one alone of powdery mildew on cucumber **(Reuveni *et al*., 1998)**. The mechanism of protection is associated with stress induced by salts, or is related an improved nutrition status or increased photosynthesis as reported by **Walters and Murray (1992)**.

Proximate Chemical Composition of Corn Grain

The chemical composition of different treatments of maize grain were determined and the results are recorded in Table 11. The moisture content of sex maize grain treatments were ranged from 9.95 to 10.64%. However,

Table 9. Effect of spraying urea combined with each of boron, zinc and potassium isolated fungi and germination from maize grains cv. balady under field nature infection in 2016 season

Treatment	Application date	Isolated fungi (%)					Germination (%)
		F.m	F.sp	A.f	A.n	P.sp	
Urea+ Boron	**50**	24.10c	1.01d	1.03d	2.03d	1.06c	86.10e
	65	25.13b	1.03d	1.96c	4.66b	1.01d	87.10d
	50+65	22.11e	1.06d	1.03d	2.03d	1.05cd	88.11c
Urea+ Zinc	**50**	23.10d	1.96c	2.03c	1.03e	2.01b	92.10a
	65	24.13c	0.33e	2.00c	3.00c	2.03b	88.16c
	50+65	17.16g	2.03c	0.71d	1.03e	1.03cd	92.23a
Urea+ Potassium	**50**	25.13b	2.00c	3.03b	1.04e	1.06c	88.10c
	65	21.06f	2.96b	1.01d	2.03d	2.00b	89.13b
	50+65	21.13f	3.01b	2.04c	1.03e	2.03b	89.16b
Control	**-**	32.10a	3.96a	3.83a	5.75a	3.05a	78.10f

+ In the same colum , means followed by a common letter are not significantly different at the 5% level by DMRT.
F.m = *F. moniliforme*, F.sp: *Fusarium* sp., A.f: *A. flavus*, A.n: *A. niger*, Psp: *Penicillium* sp.

Table 10. Effect of spraying at 50, 65 as well as 50 + 65 days after sowing by urea combined with each of boron, zinc and potassium on isolated fungi and germination from maize grains cv. balady in 2017 season

Treatment	Application date	Isolated fungi (%)					Germination (%)
		F.m	F.sp	A.f	A.n	P.sp	
Urea+ Boron	**50**	25.13f	2.00c	2.01c	1.06d	2.03c	92.03a
	65	32.10c	1.00d	1.04d	2.97b	3.80a	91.10b
	50+65	28.20e	1.01d	1.33d	1.03d	1.06d	92.10a
Urea+ Zinc	**50**	32.13c	2.97b	3.01b	3.04b	1.03d	89.06d
	65	37.10b	1.01d	4.00a	2.03c	2.98a	87.06f
	50+65	30.10d	2.97b	2.02c	1.10d	1.03d	88.10e
Urea+ Potassium	**50**	28.16e	2.01c	2.03c	1.03d	1.06d	86.11g
	65	28.16e	2.03c	4.00a	2.96b	2.06c	91.10b
	50+65	22.10g	1.03d	1.10d	1.08d	2.03c	90.132c
Control	**-**	42.10a	3.90a	4.06a	4.95a	3.66a	75.11h

+ In the same colum, means followed by a common letter are not significantly different at the 5% level by DMRT.
F.m= *F. moniliforme*, F.sp: *Fusarium* sp., A.f: *A. flavus*, A.n: *A. niger*, Psp: *Penicillium* sp.

Table 11. Gross chemical composition (%) of different treatments of maize grains (on dry weight basis)

Treatment		Moisture	Crud protein	Crud fat	Ash	Total carbohydrates (%)**
Control		*10.64 a	*10.10 b	*4.10 a	*1.31a	*84.49b
Urea+ Zinc	**Applied twice**	9.95 b	10.40 a	4.30 a	1.28a	84. 02c
Urea+ Boron	**Applied twice**	10.21 b	9.35 c	4.21 a	1.22a	85. 22a
Potassium	**Applied twice**	9.97b	9.96 b	3.98 a	1.41a	84.65 b
Boron	**Applied twice**	10.20 b	10.60 a	4.40 a	1.33a	83.67d
Urea+ Zinc	**One spray (50 days)**	10.64a	10.21ab	4.14a	1.25a	84.40b

* Each value is an average of three determinations.
+ Values followed by the same letter in colum are not significantly different at $P \leq 0.05$
**Total carbohydrates were calculated by difference.

maize grain treated with boron applied twice contain the highest content of crud protein (10.60%) followed by maize grain treated with mixture of urea and zinc applied twice (10.40%) while the lowest value of crud protein was 9.35% for maize grain treatment with mixture of urea and boron applied twice. These results are in line with those of **Ujabadeniyi and Adebolu (2005) and Sule Enyisi *et al.* (2014)**. They reported that, protein content can range from 8.7 to 10.70 (g/100 g) depending on corn cultivar and soil or climate characteristics. Apparent also from the same table that, maize grain treatments contain crud fat from 3.98 to 4.40%, 1.22 to 1.41% ash content, and 83. 67 to 85.22% total carbohydrate. These results are in line with those of **Mlay *et al.* (2005); Ujabadeniyi and Adebolu (2005); Paucean and Man (2013) and Sule Enyisi *et al.* (2014).** Furthermore, chemical composition of maize and maize products are generally affected by environmental and genetic factors (**Ikram *et al.*, 2010**).

Total Phenolics, Antioxidant Activity, Trypsin and α-amylase Inhibitors of Corn Grains

Whole grain foods, such as maize, contain a variety of natural antioxidants, such as polyphenols. The search for sources of natural antioxidants has led to the study of antioxidants in cereals and agro-wastes **(Buranov and Mazza, 2008).** Total polyphenols extracted from different treatments of maize grains were determined and the results are recorded in Table 12. Mixture of urea and zinc applied twice contain the highest content of total polyphenols extracted which was (320 mg GAE/100 g) followed by mixture of urea and boron applied twice which recorded (305 mg GAE/100g), while the lowest value of total polyphenols extracted as (215 mg GAE/ 100g) for control maize. The difference might be attributed to the genotype of maize. **Gembeh *et al.* (2001) and Shery *et al.* (2007)** reported that, phenolic-like coumpounds and phenolic coumpounds had function in natural resistance of plant pathogens of maize and inhibited the growth of *A. flavus.* Micronutrients are required for polyphenol formations and phenolic metabolism, and crucial for plant defense **(Huber and Withelm, 1988; Graham and Webb, 1991)**. The antioxidant capacities of the maize samples were measured by the radical scavenging activities of the DPPH radical (Table 12). All extracts possessed good DPPH radical scavenging activity. Mixture of urea and zinc applied twice presented highest DPPH scavenging activity (89.10%), followed by mixture of urea and boron applied twice (87.75%), mixture of urea and zinc applied at 50 days (85.22%), boron applied twice (81.65%), potassium applied twice (72.22%). and finally by control (75.11%). Results are in agreement with those of **Zhao *et al.* (2005), Ramos-Escudero *et al.* (2012) and Bacchetti *et al.* (2013)**. In addition, **Zilic *et al.* (2012)** reported that, Total Antioxidant Capacity (TAC) of corn cob are affected by many factors such as cultivars as well as growing conditions. Results in the same Table indicate that, trypsin

Table 12. Total phenolics content, DPPH (%) radical scavenging activity, trypsin inhibitor and α-amylase inhibitors of different treatments of maize grains (on dry weight basis)

Treatment		TPC (mg GAE /100 g)	DPPH (%)	Trypsin inhibitor (IU/mg)	α- amylase inhibitors (AIU/g)
Control		215.64 e	75.11 d	0.27 b	6.10 f
Urea+ Zinc	**Applied twice**	320.64 a	89.10 a	0.51 a	12.75 a
Urea+ Boron	**Applied twice**	305.21 b	87.75 ab	0.49 a	11.62 b
Potassium	**Applied twice**	220.97e	77.22 d	0.30 b	6.90 e
Boron	**Applied twice**	250.20 d	81.65 c	0.31 b	8.30 d
Urea+ Zinc	**One Spray (50days)**	280.64 c	85.22 b	0.48 a	10.65 c

* Each value is an average of three determinations.
+ Values followed by the same letter in colum are not significantly different at $P \leq 0.05$.
Antioxidant activity (DPPH%).

inhibitor activity of different treatments of maize was possessed in high with twice application of mixture of urea and zinc, mixture of urea and boron and one spray of urea and zinc (50 days) while α- amylase inhibitor recorded in high conc. with all used treatments especially mixture of urea and zinc applied twice. Many research groups have validated the role of plant trypsin inhibitor (TI) as mean of plant defense against fungal infection **(Baker *et al.*, 2009)**. **Chen *et al.* (2007) and Farahat *et al.* (2010)** detected that, antifungal trypsin inhibitor proteins was higher in resistant maize lines compared with susceptible ones and caused decreasing of infection by ear rot and associated fungi especially *F. moniliforme*. TI demonstrated antifunal activity against fungal growth and conidial germination of eight phytopathogenic fungi including *F. moniliforme*, may be partially due to its inhibition of fungal α-amylase activity and production **(Chen *et al.*, 1999)**, limiting the avialibility of simple sugars needed for fungal growth and aflatoxin production **(Woloshuk *et al.*, 1997)**. All of these earlier studies indicated an impotant role for maize grains protiens in disease resistance. Further investigation found that both constitutive (delay fungal invation) and inducible (induced antifugal synthesing) proteins are required for maize grain resistance to *A. flavus* infection and aflatoxin production **(Chen *et al.*, 2001).**

A corn α-amylase inhibitor inhibited *F. moniliforme* amylase **(Figueira *et al.*, 2003)** and play important roles as part of plant defence mechanisms against fungal protease, these inhibitors are part of the natural resistance in corn for the control of specific phytopathogens (**Blanco-Labra *et al.,* 1995)**.

Rheological Properties of Dough

The farinogram established the flour behavior during the bread making process. Results presented in Table 13 show the effect of replacement of wheat flour (82% extraction) by levels of 10, 15 and 20% maize flour and Gum Arabic 1% (Blend 2, Blend 3 and Blend 4) on farinograph parameters. From the obtained results it could be noticed that, water absorption percentage decreased from 58.70% for Blend 1 (control sample 100% wheat flour 82% extraction) to 56.10, 55.60 and 54.90% at (Blend 2, Blend 3 and Blend 4) 10, 15 and 20% maize flour and Gum Arabic 1% replacement respectively. The present results are in accordance with those of **Whistler *et al.* (1984)** who found that, water absorption decreased with the addition of corn flour to wheat flour, this reduction in water absorption could be attributed to the ability of wheat starch to absorb water 2.47 times more than corn starch. Concerning dough development time (mixing time), arrival time and weakening dough increased with increasing the addition amount of corn flours. These results are in the same trend with **Hegazy (2002), Rizk (2004) and Farahat *et al.* (2010)**, they found that, the wheat/maize doughs containing either 15 or 20% maize flour showed lower water absorption, mixing time and dough stability as compared to control dough. Dough weakening degrees increased from 100 for control to 110 and 120 BU. for test doughs.

Table 13. Effect of corn flour and Gum Arabic addition as partial substitute to wheat flour (82% extraction) on farinograph parameters of the dough

Parameter	Replacement levels of corn flour			
	Blend 1	Blend 2	Blend 3	Blend 4
Water absorption (%)	58.70a	56.10c	55.60b	54.90d
Arrival time (min)	1.0d	1.5c	2.5a	2.0b
Developing time (min)	1c	1.5b	2.5a	2.5a
Dough stability (min)	4.5a	4.5a	4.0b	3.5c
Weakening value (B.U)	70c	80b	80b	90a

Blend 1 : 100% wheat flour (82%).
Blend 2 : Wheat flour 89% +10% corn flour+1% Gum Arabic.
Blend 3 : Wheat flour 84% +15% corn flour+1% Gum Arabic.
Blend4: Wheat flour 79% +20% corn flour+1% Gum Arabic.
* Each value is an average of three determinations.
+ Values followed by the same letter in row are not significantly different at $P \leq 0.05$.

Dough stability is an important index for the strength based on the quantity and quality of dough gluten. It could be showed that, the stability was decreased (4.5, 4.0 and 3.5 min for Blend 2, Blend 3 and Blend 4 replacement, respectively) compared to control (4.5 min). These results are in agreement with **Abd El-Rahman and Abd El-Hady (2008)**. They reported that, dough stability had been attributed to protein poor in sulfhydryl groups, which normally caused a softening or degradation action of the dough.

Sensory Evaluation of Bread

Organoleptic characteristics of balady bread produced from different blends of wheat flour 82%, corn flour and gum arabic at different levels (10, 15 and 20%) are shown in Table 14. There is a significantly ($p<0.05$) difference in score values of appearance, crust colour, crumb colour, distribution of crumb, homo crumb, odor, taste and total score between control and all levels of replacement. The results showed that, balady bread made without adding corn flour and gum arabic (control) gave the highest scores for all characteristics. The balady bread prepared using corn flour and gum arabic at level 20% gave approximately the lowest scores for all characteristics. The results in Table 14 show that, the scores for all characteristics of balady bread were decreased with increasing the percent of corn flour replacement. These results are in agreement with those of **Rizk (2004) and Hussein *et al.* (2013)** who found that, addition of corn flour at 10% level caused almost slightly effect on the produced bread. Furthermore, **Ward and Andon (2002)** found that, addition of Gum Arabic at levels (1%) to wheat flour and wheat flour with 20% corn meal or barley meal increased the values total score for the organoleptic characteristics of bread loaves.

Conclusion

Given these observation, it was hypothesized that foliar applied each one may be suppress infection of maize ears and grains rot disease by *F. moniliforme* and other fungi by activation of anti-defense compounds (total polyphenol, trypsin and alpha amylase inhibitors) as well as, addition of Arabic gum enhancement of bread quality. It may be possible to use its in an alternate approach.

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Table 14. Sensory evaluation of balady bread containing different levels of corn flour and Gum Arabic as substitution of wheat flour 82%

Property	Appearance	Crust colour	Crumb colour	Distribution of crumb	Homo crumb	Odor	Taste	Total score
Source	20	10	10	20	10	10	20	100
Blend 1	18.35a	9.0a	9.20a	18.65a	9.20a	8.9oa	18.30a	91.60a
Blend 2	18.50a	9.10a	8.4b	17.71b	8.85a	8.15c	17.30b	88.01b
Blend 3	18.35a	9.15a	8.1b	17.70b	7.95b	8.22c	16.40c	85.87c
Blend 4	17.95a	8.10b	7.50c	17.50b	7.51b	8.50b	16.10c	83.16d

Values followed by the same letter in column are not significantly different $P \leq 0.05$

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تأثير رش المجموع الخضري للذرة الشامية ببعض المغذيات على مرض عفن الكيزان وتنشيط تخليق مركبات الدفاع وجودة الحبوب ورغيف الخبز

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أجريت هذه الدراسة لمعرفة تأثير الرش الورقي بواسطة كل من اليوريا، البورون، الزنك، البوتاسيوم منفرداً و/أو مختلط مع كل من اليوريا على عفن كيزان الذرة وتطور مرض عفن الحبوب، ومراقبة التركيب الكيميائي، والمركبات الفينولية، والنشاط المضاد للأكسدة، مثبطات التربسين والالفا اميليزللمعاملات المختلفة من حبوب الذرة، وكذلك تقييم الخصائص الحسية للخبز البلدي المحضر باستخدام مستويات مختلفة من دقيق الذرة والصمغ العربى كبديل لدقيق القمح وكذلك خصائص العجين، وتتلخص النتائج المتحصل إليها في الآتي: معمليا كل مخاليط المغذيات و اليوريا منفردة المختبرة سببت خفضا معنويا فى نمو وتجرثم فطر فيوزاريم مونيليفورم على بيئة البطاطس تبعها كل من البورون والزنك منفردا، تأثير رش المجموع الخضري بالمغذيات تحت ظروف الحقل على مرض العفن الظاهرى لكيزان وحبوب الذرة الشامية يمكن أن يكون احد الطرق المؤثرة، الرش مرتان عند ٥٠ و٦٥ يوم من الزراعة بمخلوط اليوريا والبورون واليوريا والزنك واليوريا والبوتاسيوم أكثر كفاءة عن اليوريا و البورون والبوتاسيوم كل بمفردة وحققت أقل ظهور للمرض وحسنت من المحصول ووزن ١٠٠ حبة، التأثير امتد وأدى إلى خفض الفطريات المصاحبة لحبوب الذرة الشامية (الإصابة الكامنة) خصوصا فطر فيوزاريم مونيليفورم المسبب الرئيسى لعفن الكيزان والحبوب بالمقارنة بالكنترول، تم دراسة جودة حبوب الذرة وتنشيط تخليق مركبات الدفاع لحبوب الذرة التي تم معاملتها بمواد مغذية مختلفة وأوضحت النتائج أن حبوب الذرة المنتجة من الرش مرتين للبورون وحده وخليط من اليوريا والزنك قد احتوت على أعلى نسبة من البروتين وكانت (١٠,٦٠ و١٠,٤٠% على التوالى)، بينما كانت أقل قيمة للبروتين كان لخليط اليوريا والبورون وكانت ٩,٣٥%، وجد أن حبوب الذرة المعاملة بخليط من اليوريا والزنك مرتان تحتوى على اعلى كمية من المركبات الفينولية (٣٢٠ ملليجرام كل ١٠٠ جرام) ويليها حبوب الذرة المعاملة مرتان بخليط من اليوريا والبورون وكانت (٣٠٥ ملليجرام لكل١٠٠ جرام) بينما كانت اقل كمية من المركبات الفينولية (٢١٥ ملليجرام لكل ١٠٠ جرام) لحبوب الذرة غير المعاملة، حبوب الذرة المعاملة بخليط من اليوريا والزنك مرتان تحتوى على أكبر كمية من النشاط المضاد للأكسدة (٨٩,١٠%) ومثبط انزيم التربسين (٠,٥١ وحدة دولية/ملليجرام) ومثبط انزيم الالفا اميليز (١٢,٧٥ وحدة/جرام) بالمقارنة بالحبوب غير المعاملة، تم إجراء مقارنة بين أنواع الخبز البلدي الناتج عن إضافة دقيق الذرة الشامية المعاملة بخليط من اليوريا والزنك مرتان إلى دقيق القمح البلدي بنسبة (١٠و١٥و٢٠%) والصمغ العربى بنسبة ١% وتمت دراسة الخلطات الناتجة على الصفات الطبيعية للدقيق الناتج على جهاز الفارينوجراف، وجد أن إضافة دقيق الذرة الشامية والصمغ العربى إلى دقيق القمح يؤدى إلى زيادة كلا من زمن الخلط وزمن الوصول وضعف العجينة بينما أدت لتناقص الماء الممتص عند مقارنتها بالكنترول من دقيق القمح، كما اتضح من الاختبارات الحسية أن جميع أنواع الخبز الناتجة من الخلطات عالية الجودة.

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