Minufiya J. Agric. Res. Vol.39 No. 4(1): 1225-1236 (2014) "http://www.mujar.net"

PEANUT ROOT ROT AND POD-ROT CONTROL USING CALCIUM SALTS

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(Received : May 5 , 2014)

ABSTRACT: *Under artificial and natural soil infestation conditions peanut root rot and pod rot were controlled using calcium salts to avoid the hazards of fungicides under greenhouse and field conditions using the cv. Giza 6. Both diseases were determined as damping off incidence. Calcium salt applications significantly decreased the disease. However, the fungicide Rizolex-T was more effective than calcium salts on the other hand calcium salt increased the yield compounds and also the increase of protein, oil and free amino acid. Nevertheless, calcium salt reduced the formation of B1 and B2 aflatoxin on the seeds.*

Key words: *Peanut, root-and pod-rots, calcium salts, aflatoxins, protein, oil and free amino acids.*

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is an important summer field crop in Egypt for both local consumpition and exportation. Root-rot and pod-rots are the most destructive diseases attacking peanut causing great losses of yield (Mahmoud, *et al.,* 2006). They reported that *Fusarium moniliforme, Rhizoctonia solani, Sclerotium rolfsii* and *Macrophomina phaseolina* are the causal organisms of root-and pod-rots. Mabrouk-Thauria (2012) isolated *Aspergillus* sp., *Fusarium* sp., *Alternaria* sp., *Rhizoctonia* sp and *Macrophomina* sp from peanut pods. However, Satour *et al.,* (1978), adopted three categories for apparent symptoms of peanut pod-rots i.e., a) Rhizoctonia-rot, pods with dry brown lesions, b) Fusarium-rot, pods with pink discoloration and, c) Complex-rot, pods with general breakdown due to many fungi. To avoid the hazards of using fungicides for controlling such diseases, Fahim *et al.,* (2006) stated that application of microelement nutrients and their concentrations played an important role in reducing damping-off, wilt and peanut root-rot diseases caused by *Fusarium* spp. *Sclerotium rolfsii, Macrophomina phaseolina* and *Rhizoctonia solani.* However, Klopper *et al.,* (1993) and Walters *et al.,* (2007) reported that induced disease resistance can be defined as the process of active resistance dependent on the host plants physical or chemical barriers activated by biotic or abiotic agents. There are many reports demonstrating that resistance can be systemically induced in chemical substrates (Mosa, 2002, Khalifa *et al.,* 2007 and Walters *et al.,* 2007). Calcium salts play an important role in reducing peanut diseases as recorded by Mabroak-Thauria (2012). Calcium plays a central role in the cellular signaling mechanism by which plants sense and respond to endogenous and environmental stimuli (Jammes *et al.,* 2011). They mentioned that cytosolic Ca^{2+} elevation is achieved via two cellular pathways, Ca^{2+} influx through Ca^{2+} release from intracellular Ca^{2+} stores. Because of the significance of Ca^{2+} channels in cellular signaling, interaction with the environmental and developmental processes in plants could be achieved. There are many studies which confirm the efficiency of calcium nutrition as a control method to peanut root-and pod-rots, (Filonow *et al.,* 1988), Barrios-Gonzalez *et al.,* (1990), Fernandez *et al.,* (1997) and Emara *et al.,* (2004). Khalifa *et al.,* (2012, recorded that integration of calcium chloride with AM fungi was effective for controlling white rot disease of onion. Mabrouk-Thauria (2012), found that foliar applications with calcium chloride or calcium nitrate (4000-6000 ppm) decreased aflatoxins B_1 and B_2 in peanut seeds up to 50% compared to the untreated control plants.

The aim of this research work was to find out the role of calcium salts in decreasing peanut root-and pod-rot diseases, improving yield production and increasing seed contents of protein, oil and free amino acids.

MATERIALS AND METHODS

I- The causal organisms:

The fungal pathogens tested through this study were previously isolated from peanut plants and their capabilities for pathogenicity were also confirmed by (Mahmoud *et al.,* 2006).

II- Greenhouse experiments:

Greenhouse experiments were carried out at Meet-Khalaf Experimental Research Station, Shebin El-Kom, Egypt in 2011 growing season:

1) Preparation of fungal inocula:

Inocula of *Fusarium moniliforme, Sclerotium rolfsii, Macrophomina phaseolina* and *Rhizoctonia solani* Kühn were individually prepared using sorghum-coarse sand-water medium (2:1:2) according to Filonow *et al.,* (1988).

2) Soil infestation:

Equal amounts of the above mentioned rot pathogens were mixed thoroughly with autoclaved soil at the rate of 2% of soil weight; and then covered with thin layer of the sterilized soil. The infested pots and those received sterilized medium only "as control (-)" were irrigated day after day for a week just before sowing. Five replicates of 50 cm diameter sterilized plastic pots assempled each treatment. Seeds of Giza 6 peanut cultivar were disinfested by 1% sodium hypochloride for 3 m and planted at the rate of 10 seeds/pot (50 plants/treatment).

3) Application of calcium salts:

The concentrations of 4000, 5000 and 6000 ppm of $CaCl_2$, Ca $(NO_3)_2$ and CaCo3 were prepared. Peanut seeds were soaked for 30 m just before sowing; as separate treatments. In the meantime, Rizolex-T (3 g/l) was used as control (+) treatment. Complete randomized block design was followed in this experiment.

4) Disease assessment under greenhouse condition:

Pre-emergence damping-off was estimated 15 days after planting and post-emergengce damping-off was determined one month after planting. However, the percentage of root-rot incidence was estimated after 120 days from planting (harvest time) as a part of the survival plants. Percentage of infection with pod-rot diseases i.e. dry brown lesions, pink discoloration and general breakdown were calculated at harvest time (120 days) according to Satour *et al.,* (1978).

III- Field Experiments:

Field experiments were carried out in naturally infested soil at Sadat City, Minufiya Governorate at 2011 and 2012 growing seasons. Three plots of 3x3.5m (1/400 feddan) served as the replicates of each treatment in complete randomized block design. The same concentrations of calcium salts (4000, 5000 and 6000 ppm) were tested as treatments to control peanut root-rot and pod-rots. However, non-treated seeds and plants assempled control (-) treatment while those treated with Rizolex-T (3 g/kg seeds) were used as control (+). Just before sowing, surface sterilized seeds were soaked in each solution for 30 minutes. Such treatments were sprayed with the same concentrations of calcium salts and/or Rizolex-T (3 g/l) after 40 and 60 days from sowing. Tap water was used for soaking and foliar application of control (-) treatment.

Seeds of the cv. Giza 6 of peanut were planted on the first week of May at 10 cm spacing between plants. Each plot included 6 rows, 3.5 meter length and 50 cm width. Cultural practices such as irrigation, fertilization and pest control were carried out as usually. At harvesting time (120 days from sowing), pods of each plant were thrushed, counted, air dried for 3 days, weighed and then examined for pod-rot diseases incidence. In the meantime, the average weight of 100 seeds of each treatment was estimated in addition to the average number and weight of pods/plant.

DISEASE ASSESSMENT under field conditions:

Beside damping-off and root-rot incidence; pod-rots were recorded at harvest time. Three categories for apparent symptoms of pod-rots and healthy ones were adopted according to Satour *et al.,* (1978): (a): Rhizoctonia-rot, pods with dry brown lesions, (b): Fusarium-rot, pods with pink discoloration and (c): Complex-rot, pods with general breakdown resulted from many fung.

IV- Statistical analysis:

All obtained data were statistically analyzed by analysis of variance (ANOVA) using the statistical analysis system (SAS Institute, inc, 1996). Means were separated by the least significant differences (LSD) test at $P \leq 0.05$ level.

V- Biochemical studies:

To study the effect of calcium salts on peanut chemical components, seed samples of each treatment were extracted according to Goldschmidt *et al.,* (1968). Another samples were digested in soxklet units using 75% ethanol for 10 h for determining free amino acids, oil contents and crude protein % as described by Snell and Snell (1953), Moore and Stein (1954) and AOAC (1998), respectively. Amino acids content were estimated as milligrams equivalent of catechol, while glucose and argenin were determined as mg/g dry weight of peanut seeds.

VI- Determination of aflatoxins:

The aflatoxin extraction was carried out according to AOAC (1998). The methods of Singh *et al.,* (1991), were followed for aflatoxin determination using thin layer chromatographic technique. Concentration of aflatoxin was calculated following the formula:

Aflatoxin (µg/kg) = (S.Y.V)/ (X.W)

Where:

S = volume of standard aflatoxin (µl) of equivalent sample intensity.

Y = concentration of aflatoxin standard in µg/ml .

V = volume of solvent required to dilute the final extract in µl.

X = volume of sample extract (µl) that required to give fluorescence intensity comparable to S (µl).

W = weight of the original sample (in gram) contained in the final extract.

RESULTS

Under greenhouse conditions and artificial soil infestation with a mixture of *Fusarium moniliforme, Macrophomina phaseolina, Rhizoctonia solani* and *Sclerotium rolfsii* (2% of soil weight). Individual applications of calcium salts and Rizolex-T proved to be effective against peanut damping-off disease (Table 1). The obtained data cleared that Rizolex-T (3 g/l), as positive control treatment, was superior in reducing the disease which resulted 90% survival plants and only 11.33% root-rot severity.

On the other hand, calcium chloride showed better effect in disease reduction than did calcium carbonate and/or calcium nitrate. In general, increasing the salt concentration (4000, 5000, 6000 ppm) was more favourable for both damping-off and root-rot reduction. Application of the highest concentrations of $CaCl_2$, $Ca(NO_3)_2$ and CaCo3 resulted 83.34, 61.00 and 78.33% survival plants, respectively and in the same respect, root-rot incidence showed 12.33, 13.33 and 17.33%, due to the same concentrations. In comparison with the untreated control plants, (control), the survival plants were 54.67% and root-rot incidence gave 33.33%. There were clear significant variations between different tested treatments (Table 1).

Table (1): Effect of calcium salts on damping-off and root-rot diseases of peanut cv. Giza 6, grown in artificially infested soil, under greenhouse conditions.

Treat.	Conc. ppm	Disease incidence %				
		Seedling damping off		* Adult plant root-rot (120 days)	Total	Survival
		Pre-emergence 15 days	Post-emergence 30 days			
$CaCl_2$	4000	16.67	12.67	18.67	48.1	51.99
	5000	11.67	11.67	16.00	39.34	60.66
	6000	6.33	10.67	12.33	29.33	70.67
$Ca(NO_3)_2$	4000	22.33	21.00	26.67	70.0	30.0
	5000	20.33	20.33	16.33	56.99	43.01
	6000	18.67	19.33	13.33	51.33	48.67
CaCo3	4000	19.33	18.67	25.00	63.0	37.0
	5000	15.67	11.33	21.33	48.33	51.67
	6000	12.67	9.00	17.33	39.0	61.0
Rizolex-T 3 g/l (Control +)	--	4.33	5.67	11.33	21.33	78.67
Untreated plants(Control-)	--	20.00	25.33	33.33	78.66	21.34
L.S.D at 5%	--	2.4	1.59	2.67	--	

* Root-rot percentage of survived plants had root-rot symptoms (120 days age).

Results presented in Table (2) also cleared the efficiency of Rizolex-T and the tested calcium salts in reducing various pod rots of peanut. Dry brown lesions were severly decreased by Rizolex-T application (5.33%) followed by the higher concentrations of CaCo3 (9.33%), $CaCl_2$ (11.33%) and $Ca(NO_3)_2$ (15.33). Such lesions on control (-) pods were 25.33%. However, pink discolouration of pods recorded 1.33, 3.67, 2.33, 0 and 9.33%, respectively when the higher concentration (6000 ppm) of $CaCl_2$, $Ca(NO_3)_2$, CaCo3, control (+) and control (-) were tested, while general breakdown of pods gave 15.33, 12.33, 9.33, 9.33 and 22.67% respectively. So, the apparent healthy pods were 72.01, 68.67, 79.01, 85.34 and 42.67%, respectively. It could be also noticed that the higher concentrations were more effective in reducing pod rots and significant variations among the different treatments were noticed.

However, under field and natural soil infestation conditions, at 2011 and 2012 growing seasons, the tested compounds showed conciderable effects in reducing peanut damping-off and root-rot diseases (Table 3). At the first season, control (-) treatment recorded 25.66% damping-off and consequently 74.34% surviral plants. While control (+) treatment resulted 1.67% damping-off and 98.33% survivals. In the meantime application of $CaCl_2$, $Ca(NO_3)_2$, and/or CaCo3, (at 6000 ppm) recorded 2.67, 3.67 and 1.67% damping-off respectively. Consequently, the survival plants were 98.33, 96.33 and 98.33% respectively with the above mentioned compounds. As for root-rot diseases at 2011 growing season, it was 13.33 and 3.33%, respectively for control (-) and control (+). While it was 3.0, 3.33 and 2.0% when $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, (6000 ppm) were individually applied, respectively.

Nearly similar results were achieved at the second season. In both seasons, there were significant variations between the treatments and as salts concentration increases which the diseases reduction was noticed.

Under field and natural soil infestation conditions, Rizolex-T (3 g/l) and different concentrations of calcium salts (4000-6000 ppm) significantly reduced pod-rots and general breakdown of peanut pod yield both at 2011 and 2012 seasons in comparison with the nontreated control plants (Table 4). The tested fungicide was more effective than calcium salts which in their higher concentration gave good results. Foliar applications with 6000 ppm of $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, resulted dry brown lesions *R. solani* in the average of 8.33, 10.33 and 6.0% respectively. While positive and negative control treatments showed 4.33 and 18.33% dry brown lesions respectively.Pink discolouration due to *F. moniliforme* 0, 0.67, 0, 0 and 3.33% when $CaCl_2$, $Ca(NO_3)_2$, CaCo3, Rizolex-T and control (-) were respectively tested, at 2011 growing season. General breakdown of pods was 9.33, 12.0 and 9.0% when 6000 ppm of $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, were individually applied to peanut foliage respectively. These were 8.33 and 17.33% respectively when control (+) and control (-) were examined. Apparent healthy pods were 87.34 and 61.1% as a result of control (+) and control (-) treatments. Such healthy pods recorded 82.34, 74.0 and 85.0% when $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, solutions were applied respectively.

Table (2): Effect of calcium salts on peanut pod-rot disease under greenhouse and artificial soil infestation conditions 2011.

Treat.	Conc. Ppm	Pod rot incidence %				Apparent healthy %
		Infection %			Total	
		Dry brown lesions	Pink discoloration	General break down		
$CaCl_2$	4000	13.33	3.76	19.33	36.33	63.67
	5000	11.67	1.67	17.67	31.01	68.99
	6000	11.33	1.33	15.33	27.99	72.01
$Ca(NO_3)_2$	4000	19.33	8.67	20.67	48.67	51.33
	5000	16.67	5.33	18.67	40.67	59.33
	6000	15.33	3.67	12.33	31.33	68.67
CaCo3	4000	12.76	4.67	13.33	30.67	69.33
	5000	11.67	3.33	11.67	26.67	73.33
	6000	9.33	2.33	9.33	21.99	79.01
Rizolex-T 3 g/l (Control +)	--	5.33	0.00	9.33	14.66	85.34
Untreated plants(Control -)	--	25.67	9.33	22.67		42.33
L.S.D at 5%	--	1.79	0.80	1.83		3.89

Table 3

Table 4

Nearly similar results were achieved at the second growing season, which indicate the efficiency of calcium salts in controlling pod-rots of peanut.

Peanut yield was also responded to the applications of calcium salts both at 2011 and 2012 growing seasons (Table 5). In comparison with control (-) all tested salt concentrations and Rizolex-T showed significant increase of the average number of pods/plant, weight of pods/plant and 100 seeds weight. Calsium carbonate showed more efficiency in increasing the number and weight of produced pods, which were 23.1 and 68.7 g when the concentration of 6000 ppm was applied. Generally, increasing salts concentration led to increase of the average seeds weight. These were 65.5, 70.0 and 68.7g when 6000 ppm of each $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, were applied, respectively at 2011. The average hundred seeds weight of control (+) and (-) recorded 56.0 and 53.2 g respectively. Similar results were obtained at the second growing season (2012) and significant differences could be noticed between different treatments of both seasons.

Chemical analysis of peanut seeds proved that the application of calcium salts increased protein, oil and free amino acid contents in peanut Gizo 6 cultivar seeds (Table 6). In general, increasing the salts concentration showed better amounts of such compounds. Percentage of protein contents were 16.25 and 21.13% in the cases of control (-) and control (+) treatments respectively. Protein percentages in peanut seeds reached 20.56, 19.81 and 20.44, respectively when 6000 ppm of $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, were individually applied to the plants. Oil contents in peanut seeds recoded 55.0 and 50.7% in control (+) and control (-) treatments respectively. These were 55.0, 54.3 and 57.0%, respectively when $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, were separately applied at 6000 ppm. Free amino acids were also increased in response to the different calcium salts application. They gave 1.04 mg/g dry weight in the untreated control plants. While they were 1.78, 1.41 and 1.76 mg/g.d.w when $CaCl_2$, $Ca(NO_3)_2$, and CaCo3, were individually tested, respectively.

Table (5): Effect of calcium salts on yield components of peanut plant of cv. Giza 6.

Treat.	Conc. ppm	Yield components 2011			Yield components 2012		
		No. of pods/ plant	Wt. of pods/ plant	100 Seeds wt.(g)	No. of pods/plant	Wt. of pods/plant	100 Seeds wt.(g)
$CaCl_2$	4000	18.7	57.9	53.2	17.1	56.9	55.0
	5000	19.3	58.0	62.0	18.4	58.1	63.5
	6000	22.00	60.5	65.5	23.3	62.3	68.7
Ca $(NO_3)_2$	4000	17.7	57.3	55.0	17.3	57.3	58.7
	5000	19.7	58.2	65.2	19.4	58.2	66.9
	6000	21.8	60.7	70.0	22.3	61.5	72.9
CaCo3	4000	19.3	58.2	58.0	19.0	58.3	53.0
	5000	21.7	60.7	60.5	20.1	60.0	61.2
	6000	23.1	62.5	68.7	23.1	62.1	69.5
Rizolex-T 3 g/l (Control +)	--	22.1	61.5	56.0	23.3	63.3	55.9
Untreated plants(Control -)	--	17.3	57.3	53.2	18.2	58.3	51.0
L.S.D at 5%	--	3.3	6.01	3.04	3.8	6.08	3.01

Table (6): Effect of calcium salts on protein, oil and free amino acids in the seeds of peanut cv. Giza-6 of 2012 season.

Treat.	Conc. ppm	Protein content (%)	Oil content (%)	Free amino acids mg/g dry weight
$CaCl_2$	4000	19.8	54.2	1.23
	5000	20.3	54.5	1.67
	6000	20.6	55.0	1.78
Ca $(NO_3)_2$	4000	18.3	52.5	0.90
	5000	18.6	53.7	1.06
	6000	19.8	54.3	1.41
CaCo3	4000	18.9	55.5	1.06
	5000	20.1	56.5	1.43
	6000	20.4	57.0	1.76
Rizolex-T 3 g/l (Control +)	--	21.1	55.0	1.67
Untreated plants (Control -)	--	16.3	50.7	1.04
L.S.D at 5%	--	--	--	--

Results shown in Table (7) indicate that the application of calcium salts to Giza 6 peanut cultivar severly decreased the formation of B_1 and B_2 aflatoxins in the seeds compared to control (-) plants both at 2011 and 2012 seasons. Such effects were noticed at all tested concentrations but increasing the salts concentration led to more reduction of aflatoxin which was nil at 6000 ppm of all tested salts. However, CaCo3 was the best effecitive used salt in reducing aflatixin production followed by $CaCl_2$. In the meantime, Rizolex-T (3 g/l) gave completely free seeds from aflatoxin (B).

DISCUSSION:

Peanut is a very important crop in Egypt where its seeds contain high values of protein and oil. Positive geotropism of peanut flowers led to the formation of pods into the soil which make them in direct contact with soil born pathogens. Such case make difficulty in management of pod-rots and root-rot diseases. Healthy plants only can express chemical, physiological and/or morphological resistance and escape from infection (Ammar, 2003). To achieve this situation, biotic or abiotic methods were followed to induce plant resistance instade of using fungicides. In this work, calcium salts were tested to control root-and pod-rots of peanut cultivar Giza-6, both under greenhouse and field conditions.

Calcium chloride, Ca $(NO_3)_2$ and CaCo3 (4000, 5000 and 6000 ppm) proved to be effective in reducing damping-off, root-rot and pod-rot diseases. It is of logic that increasing the concentration of the tested salt will be more effective for diseases reduction which was also observed in this work. Such results were also recorded by Filonow *et al.,* (1988), Barrios-Gonzales *et al.,* (1990), Fernandez *et al.,* (1997), Mosa (2002), Emara *et al.,* (2004), Khalifa *et al.,* (2007), Walters *et al.,* (2007), Khalifa *et al.,* (2012) and Mabrouk-Thauria (2012). However, Klopper *et al.,* (1993) and Walters *et al.,* (2007), mentioned that induced disease resistance is a process of active resistance dependent on the host physical or chemical barriers activated by biotic or abiotic agents. Calcium as abiotic agent plays a central role in the cellular signaling mechanism by which plant sense and respond to endogenous and environmental stimuli (Jammes *et al.,* 2011).

Results of this research also cleared that seed yield and their contents of protein, oil and free amino acids were increased than those of control (-) plants in response to the application of different calcium salts. This could be due to the activation of plants chemical and physical barriers as mentioned by Klopper *et al.,* (1993) and Walters et al., (2007). Application of calcium salts significantly decreased B1 and B2 aflatoxins in peanut seeds which recorded 0 when 6000 ppm of any tested calcium salt and/or Rizolex-T were used. This result could be explained either by weak synthation or degradation of produced B aflatoxin because of treatments. Such results were also recorded by Barrios-Gonzalez *et al.,* (1990), Fernandez *et al.,* (1997) and Mabrouk-Thauria (2012).

Table (7): Effect of calcium salts on aflatoxins formation in peanut seeds (Cultivar Giza 6) under field and natural soil infestation condition during 2011, 2012 seasons.

Treat.	Conc. ppm	Ug aflatoxins/ kg seeds					
		2011 season		Total ug/L	2012 season		Total ug/L
		B_1	B_2		B_1	B_2	
$CaCl_2$	4000	20.0	12.0	32.0	20.0	10.0	30.0
	5000	17.0	7.00	24.0	12.0	8.00	20.0
	6000	00.0	00.0	00.0	00.0	00.0	00.0
$Ca(NO_3)_2$	4000	36.0	15.0	51.0	42.0	20.0	62.0
	5000	30.0	12.0	42.0	33.0	15.0	48.0
	6000	00.0	00.0	00.0	00.0	00.0	00.0
CaCo3	4000	20.0	7.00	27.0	12.0	8.00	20.0
	5000	00.0	00.0	00.0	8.00	00.0	8.00
	6000	00.0	00.0	00.0	00.0	00.0	00.0
Rizolex-T 3 g/l (Control +)	--	00.0	00.0	00.0	00.0	00.0	00.0
Untreated plants (Control -)	--	40.0	27.0	67.0	42.0	27.5	69.5

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مقاومة عفن جذور وقرون الفول السودانى باستخدام أملاح الكالسيوم

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الملخص العربى

تحت ظروف العدوى الصناعية والطبيعية تم مقاومة عفن الجذور وعفن قرون الفول السودانى باستخدام أملاح الكالسيوم لتفادى مخاطر استخدام المبيدات تحت ظروف الصوبة والحقل على الصنف جيزة ٦ وقد تم تقدير كلا المراضين على أساس حدوث سقوط البادرات وقد أدى تطبيق استخدام أملاح الكالسيوم إلى نقص المرض معنويا ورغم ذلك لقد كان تأثير المبيد الفطرى ريزوليكس-ت أكثر كفاءة من أملاح الكالسيوم ومن وجهة أخرى قد أدى استخدام أملاح الكالسيوم لزيادة مكونات المحصول وكذلك زيادة البروتين والأحماض الأمينية وكذلك الزيوت ومع ذلك أدى استخدام أملاح الكالسيوم إلى نقص أفلاتوكسين B1 و B2 فى البذور.

Table (3): Effect of calcium salts on damping of and root-rot diseases of peanut cv. Giza 6 under field and natural soil infestation conditions during 2011 and 2012 seasons.

Treat.	Conc. ppm	Damping-off 2011 (%)					Damping-off 2012 (%)				
		Pre-emergence	Post-emergence	*Adult plant (Root-rot)	Total	Survival	Pre-emergence	Post-emergence	*Adult plant (Root-rot)	Total	Survival
$CaCl_2$	4000	6.00	1.67	6.67	14.34	85.66	2.00	3.33	6.33	11.66	88.34
	5000	3.00	0.67	5.00	8.67	91.33	1.67	0.67	5.00	7.34	92.66
	6000	2.67	0.00	3.00	5.67	94.33	0.00	0.33	3.33	3.66	96.34
$Ca(NO_3)_2$	4000	7.33	2.33	7.33	16.99	83.01	3.67	3.33	9.33	16.33	83.67
	5000	5.67	1.67	6.00	13.34	86.66	3.00	3.00	6.33	12.33	87.67
	6000	2.67	1.00	3.33	7.00	93.00	2.00	2.67	5.33	10.00	90.00
CaCo3	4000	5.00	1.33	4.67	11.00	89.00	1.33	2.67	5.00	9.00	91.00
	5000	2.33	.67	3.33	6.33	93.67	0.67	2.00	4.00	6.67	93.33
	6000	1.67	0.00	2.00	3.67	96.33	0.33	1.33	3.00	4.66	95.34
Rizolex-T 3 g/l (Control +)	--	1.67	0.00	2.00	3.67	96.33	1.00	0.67	1.67	3.34	96.66
Untreated plants(Control-)	--	13.33	12.33	13.33	38.99	61.01	12.33	9.67	14.33	36.33	63.67
L.S.D at 5%	--	2.4	1.1	1.2			2.3	1.6	1.06		

* Root-rot: Percentage of survived plants had root-rot symptoms (120 days age).

Table (4): Effect of calcium salts on peanut pod-rot diseases under field conditions during 2011 and 2012 seasons.

Treat.	Conc. Ppm	Pod rot incidence % (2011)				Pod rot incidence % (2012)			
		Dry brown lesions	Pink discoloration	General break down	Apparent healthy %	Dry brown lesions	Pink discoloration	General break down	Apparent healthy %
$CaCl_2$	4000	13.67	1.33	12.33	72.67	12.00	2.00	9.33	76.67
	5000	9.33	1.00	11.00	78.67	8.67	1.67	7.67	81.99
	6000	8.33	0.00	9.33	82.34	6.33	0.00	6.33	87.34
$Ca(NO_3)_2$	4000	17.67	1.67	18.67	63.28	14.67	2.67	18.33	64.33
	5000	14.33	1.33	12.33	72.01	13.33	1.33	15.67	69.67
	6000	10.33	0.67	12.00	74.00	11.00	0.67	12.67	75.66
CaCo3	4000	12.33	1.00	13.33	73.34	11.33	1.33	10.67	76.67
	5000	7.33	0.00	12.00	80.67	8.00	0.33	9.00	82.67
	6000	6.00	0.00	9.00	85.00	5.67	0.00	8.33	86.00
Rizolex-T 3g/l (Control +)	--	4.33	0.00	8.33	87.34	3.33	0.00	7.67	89.00
Untreated plants(Control-)	--	18.33	3.33	17.33	61.01	14.00	5.33	16.33	64.34
L.S.D at 5%	--	2.97	1.59	2.44	4.13	1.55	0.33	2.67	3.97