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SOME FACTORS AFFECTING VINCA (PERIWINKLE) ROOT ROT DISEASE

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ABSTRACT: This study highlights the influence of different mineral fertilizers on the incidence and severity of vinca (Periwinkle; *Catharanthus roseus* (L.) G. Don) root rot disease. Moreover, it demonstrates the effectiveness of some chemical fungicides in reducing disease parameters. This research provides valuable insights for the development of effective fertilization strategies to enhance plant health and mitigate the impact of root rot diseases in vinca. Ammonium Sulfate ($(NH_4)_2SO_4$) completely inhibited disease parameters and consistently increased plant growth parameters. Potassium and Humate potassium have limited efficacy. Rizolex-T and Occidor fungicides demonstrated complete inhibition against all tested fungi (F3(*Fusarium solani*; Fx3(*Fusarium proliferatum*); Rh.x (*Rhizoctonia solani* L.) and Rh.w (*Rhizoctonia solani* 2) on PDA media, while Uniform and Nasrzole showed varying degrees of effectiveness depending on the tested fungi. *In vivo*, the application of fungicides has varying degrees of efficacy in preventing infection with vinca root rot pathogens. Rizolex-T, was effective against most pathogens, exhibited a partial effect against *Fusarium proliferatum*. Occidor demonstrated good efficacy against *Rhizoctonia solani* 2 but was less effective against *Fusarium solani*. Nasrzole showed overall effectiveness in preventing infection by all tested pathogens, with only partial efficacy against *Rhizoctonia solani* 2. The application of fungicides, particularly Nasrzole, positively influenced the growth parameters of vinca plants infected with root-rot pathogens.

Key words: *Catharanthus roseus*; root-rot; fertilizers; fungicides.

INTRODUCTION

Vinca (*Catharanthus roseus* (L) G. Don, commonly known as periwinkle), belongs to the family Apocynaceae and is grown as an ornamental flowering plant. It is a bedding plant widely used outdoors in flowerbeds or planters, in gardens, on balconies, or around buildings **(Gurudevan *et al*., 2022).**

Vinca is attached with damping-off, root rot, blight, canker, and leaf spot diseases. Pathogenic fungi include *Alternaria* (leaf spot), *Rhizoctonia solani* (stem, crown, and root rot), and *Phytophthora parasitica* Dast., (foliar and stems). *P. parasitica*, soil-borne pathogen, caused serious losses and death in the periwinkle with reports from India and the United States **(Nejat *et al*., 2015; Formica, 2015; Chase *et al*., 2018; Guarnaccia *et al*., 2021).** Additionally, Fusarium root rot disease was reported in Taiwan **(Chung *et al*., 1998).**

Nutrition has been registered as a component of disease control and management, the effect of mineral nutrients on disease has been based on (1) the observed effects of fertilization on a specific disease's incidence or severity, (2) the comparison of mineral concentrations in healthy or resistant tissues compared with diseased or susceptible ones, or (3) conditions influencing the availability of a specific nutrient with disease **(Meena *et al*., 2017).** As well as mineral nutrition has an important role in this system, and its management can affect not only the yield but also plant health and the environment **(Katan, 2009; Elmer and Datnoff, 2014)**. Nitrogen is the most important nutrient for plant growth

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because of its role in disease resistance **(Mur *et al*., 2017).** It has long been known that the form of nitrogen fertilizer can influence plant disease incidence, **(Gullino *et al*., 2015)**. The form of nitrogen can have striking effects on plant disease through root-mediated changes in pH, microbial profile in the rhizosphere, and alterations in the availability and function of micro-nutrients **(McGovern and Elmer, 2018).**

Phosphorus has been extensively used to prepare the formulations of fertilizers for enhancing yield of the crops and as fungicides, bactericides, and nematicides for controlling plant pathogens. It is the most effective when it is applied to control fungal diseases of seedlings, by the faster root developments which allow plants to escape from the disease **(Gupta *et al*., 2017).** Phosphorus has been shown to suppress root rot in geranium caused by *Pythium ultimum* **(Syed *et al*., 2020)** and yellows in gladiolus caused by *Fusarium oxysporum* f. sp. *gladioli* **(Prabhu *et al*., 2007)** and to control plant diseases caused by *Phytophthora* and *Pythium* **(Brunings *et al*., 2012). Yandoc *et al*. (2007)** indicated that applications of phosphonate-containing products resulted in significant disease suppression in vinca plants inoculated with *P. nicotianae* and controlled Phytophthora blight in vinca with phosphite also has been reported by **Banko and Hong (2004)**.

Potassium is a very important nutrient in plant disease prevention. It decreases the susceptibility of host plants up to the optimal level for growth **(Rawat *et al*., 2016).** Also, **Huber *et al*., (2012) and Gupta *et al*. (2017)** found that the use of K significantly decreased the incidence of fungal diseases, bacteria, viruses, insects, mites, and nematodes.

Greenhouse studies have shown that biological agents are strictly preventive, which means they should be applied before the occurrence of disease. If the disease infection has already occurred, systemic fungicide is the best option for disease control **(Daughtrey and Buitenhuis, 2020).**

Some fungicides used in agriculture (fludioxonil, and flutolanil) as mentioned by **Mahato, (2005).** Since ornamental plants are grown for aesthetic value but not for consumption, the concern of residues on plants is not as serious as on food crops. Hence, the chemical control method is used extensively in ornamental especially when they are produced outdoors **(Lubbe and Verpoorte, 2011).** Fungicides are an effective means of soil-borne disease control and are extensively used in agriculture **(Panth *et al*., 2020).**

This study aimed to investigate the influence of different mineral fertilizers on the incidence and severity of vinca root rot disease and to examine the effectiveness of some chemical fungicides in reducing disease parameters and enhancing plant growth.

MATERIALS AND METHODS

Sample Collection, Isolation, Purification, Pathogenic Potentiality, and Identification of the Causal Pathogens

Diseased vinca plants with symptoms of damping off, root rot and crown canker were collected. Isolation of the causal organisms and the frequency percentages of the isolated fungi were calculated, and the developed colonies were identified morphologically and molecularly **(Ghannam *et al*., 2023).**

Seven isolates of *Fusarium* spp., and three isolates of *Rhizoctonia* spp., were tested for pathogenic potentiality on vinca (*Catharanthus roseus*) **(Ghannam *et al*., 2023).**

Bioassays on healthy vinca (*Catharanthus roseus*) of 6 months old were carried out with one plant as control and four replications for each fungal isolate. Totally five replications were used for every pathogen, each transplanted into 20cm pots containing sandy-clay soil (50% sand and 50% clay) after artificial infestation with the tested fungal isolates. Disease incidence was calculated one- month after transplanting.

Vinca Root Rot Disease as Affected by Mineral Fertilization, under Greenhouse Conditions

Effect of nitrogen sources on vinca root rot disease

Two variable sources of Nitrogen (N) were applied in this experiment [Ammonium Nitrate (NH_4NO_3) and Ammonium Sulfate ($(NH_4)_2SO_4$)]. These two variable sources of nitrogen (N) were used at the required usage rate stated on the packaging before planting according to **Verma *et al*. (2017)**. This experiment was carried out on seedlings (6 months old) of grown vinca which were transplanted into pots of 20 cm diameter containing infested soil (sandy-clay soil) with the tested pathogenic fungi: F3(*Fusarium solani*; Fx3(*Fusarium proliferatum*); Rh.x (*Rhizoctonia solani* 1) and Rh.w (*Rhizoctonia solani* 2). Four replicates were used for each tested pathogen for both sources of nitrogen. Four pots were left without infestation to serve as control. Two weeks after transplanting, both disease severity and incidence were calculated. Fresh and dry weights of both root and shoot were also calculated.

Effect of phosphorus sources on vinca root rot disease

Two variable sources of Phosphorus (p) were applied in this experiment, Mono Potassium Phosphate (KH_2PO_4) and Phosphoric Acid (H_3PO_4)]. These two variable sources of Phosphorus (p) were used at the required usage rate stated on the packaging before planting according to **(McGovern and Elmer, 2018)**. This experiment was carried out on seedlings 6 months old of grown vinca as follows in the case of nitrogen source concerning soil type, the tested pathogenic fungi, and the replicates, both disease severity and incidence were calculated. Fresh and dry weights of both root and shoot were also calculated.

Effect of potassium sources on vinca root rot disease

Two variable sources of Potassium (K) were applied in this experiment Humate potassium and Pure potassium. These two variable sources of Potassium (K) were used at the required usage rate stated on the packaging before planting according to **Vishwakarma *et al*. (2020)**. This experiment was conducted on seedlings (6 months old) of grown vinca as follows in the case of nitrogen source concerning soil type, the tested pathogenic fungi, the replicates, and both disease severity and incidence were calculated. However, fresh and dry weights of both root and shoot were also calculated.

Effect of NPK sources on vinca root rot disease

Two variable concentrations of NPK were determined in this experiment NPK (10:10:10 and NPK 40:40:40. These two variable concentrations of NPK were used at the required usage rate stated on the packaging before planting according to **Elmer and Datnoff (2014)**. This experiment was carried out on seedlings 6 months old of grown vinca as follows in the case of nitrogen source concerning soil type, the tested pathogenic fungi, and the replicates, both disease severity and incidence were calculated. Fresh and dry weights of both root and shoot were also calculated.

Chemical control

In vitro evaluation of fungicides against vinca root rot pathogens

The efficacy of four fungicides (Occidor 50% WP, Uniform 390 SE, Rizolex T 50% WP and Nasrzole 25% EC) for inhibiting the growth colony of pathogenic fungi was tested using the poisoned food technique **(Mahmoud *et al*., 2015)** using different concentrations *i.e.* 1000 ppm, 750 ppm, 500 ppm and 250 ppm. The growth of tested pathogens on non-poisoned PDA served as a control. Then Petri plates were incubated at 25 ± 2°C.

The inhibition percent of fungal growth due to various fungicidal effects at different concentrations was evaluated as follows:

$$PGI = (C-T)/C \times 100$$

(PGI = Percent Growth Inhibition, C = colony growth in control, T = Colony growth in treatment).

In vivo evaluation of fungicides against vinca root rots pathogens

Fungicides proved to be effective *in vitro* evaluation by poisoned food technique and were also tested in the glasshouse for control of vinca root rot disease by seedling treatment at the recommended dose of each fungicide. The soil was air dried at 2-3 percent moisture level and screened through a 2 mm sieve before use and the pots were filled and then infested. Infested soil was kept under the glasshouse conditions at 25 + 2 temperature. Seedlings were treated with fungicides by soaking them in desired aqueous fungicide concentrations for 30 minutes and then transplanted to each pot **(Mahmoud *et al*., 2015).** Four replicates of infested pots of each pathogen treatment were used for all tested fungicides. Four pots of each non-infested treatment using distilled sterilized water served as control. All pots were labeled and randomized in the glasshouse. Pots were irrigated as required. Disease incidence percent and disease severity were calculated 2weeks later according to **Wu *et al*. (2006) and Kaderabek *et al*. (2013).**

RESULTS

Isolation, Purification, Identification, and Frequency of the Causal Pathogens

Different soil-borne pathogens belonging to numerous fungal genera were isolated from the doubted diseased vinca plant root samples. The isolated soil-borne pathogens were purified as shown in Fig. 1 then morphological characters using molecular methods were identified under the Laboratory of Plant Pathology, Pl. Pathol. Dept., Fac. Agric., Zagazig Univ. The purified and identified microorganisms are of different isolates of *Fusarium* sp., and also of *Rhizoctonia solani*.

Several researchers found that vinca plants are attacked by several plant pathogenic fungi **(Nejat *et al*., 2015; Formica, 2015; Chase *et al*., 2018, Chung *et al*., 1998, Guarnaccia *et al*., 2021 and Ghannam, Ebtihal *et al*., 2023).**

Vinca Root Rot Disease as Affected by Mineral Fertilization, under Greenhouse Conditions

Data in Fig. 2 showed that *Rhizoctonia solani* 2 and *Fusarium solani* significantly exhibit disease incidence and disease severity percentages being (25%) for both when Phosphoric acid (H_3PO_4) was applied as mineral fertilizer. *Fusarium solani* recorded the highest value of disease incidence (50%) and disease severity (50%) when Humate potassium, was investigated. Data also reveal that isolate *Fusarium solani* recorded less disease incidence and severity percentages (25%, 40%) when NPK2 and Pure potassium (K_2O) were applied to the cultivated vinca soil. Mineral fertilization using Mono-Potassium phosphate (KH_2PO_4), Ammonium nitrate (NH_4NO_3), Ammonium sulfate $(NH_4)_2SO_4$, and NPK1 revealed completely healthy vinca plants without any symptoms of root rot, thus revealing the best results as seen in Fig. 2. Phosphoric acid (H_3PO_4) seemed to be the most suitable fertilizer as no incidence and severity of the disease were noticed when either *Rhizoctonia solani* 1 and or *Fusarium proliferatum*, were investigated. Humate potassium, pure potassium (K_2O), and NPK2 fertilized plants seemed to be resistant.

For *Rhizoctonia solani* 1 and *Fusarium proliferatum*, no symptoms of the disease were noticed. Application of Phosphoric acid (H_3PO_4) reveals the same results (25%) of disease severity after inoculation either with *F. solani* or *Rhizoctonia solani* isolate 2.

In consequence, high plant growth parameters including shoot fresh and dry weights, (Table 1) and root fresh and dry weights (Table 2), were determined. Data in Table 1 illustrated by Fig. 3 Reveal that the highest Shoot Fresh Weight (SFW) (g) and Shoot Dry Weight (SDW) (g) were significantly recorded when Ammonium sulfate $(NH_4)_2SO_4$, was investigated in soil inoculated with *R. solani* 1 being (27.5 g and 11.75 g). Treatment of NPK1 also reveals significant values when compared with soil inoculated with *F. proliferatum* (25.5 g and 10.6 g) followed by *F. solani* (24.25 g and 10 g). The lowest shoot fresh and dry weights were recorded when Pure potassium (K_2O) was investigated in soil inoculated with *R. solani* 2 (13 g and 5.25 g) followed by Humate potassium for *F. solani* revealing (13 g, 4.25 g), respectively.

Data in Table 2 reveal the highest Root Fresh Weight (RFW) (g) and Root Dry Weight (RDW) (g) when soil was mineralized with Ammonium sulfate $(NH_4)_2SO_4$ and inoculated with *R. solani* 1 (5.88 g and 2.94 g) followed by treatment of NPK1 inoculated with *F. proliferatum* (5.3 g and 2.65 g) followed by NPK1 of soil inoculated with *F. solani* (5 g and 2.50 g). The least root fresh and dry weights were recorded when NPK2 of isolate *R. solani* 2 was applied (2.25 g and 1.13 g). The lowest values of both fresh and dry weights of roots were obtained when Humate potassium was investigated when the soil was inoculated with *F. solani* (2.13 g and 1.06 g).

The obtained results were agreed with those obtained by **Mur *et al*. (2017)** who found that nitrogen is the most important nutrient for plant growth because of its role in disease resistance.

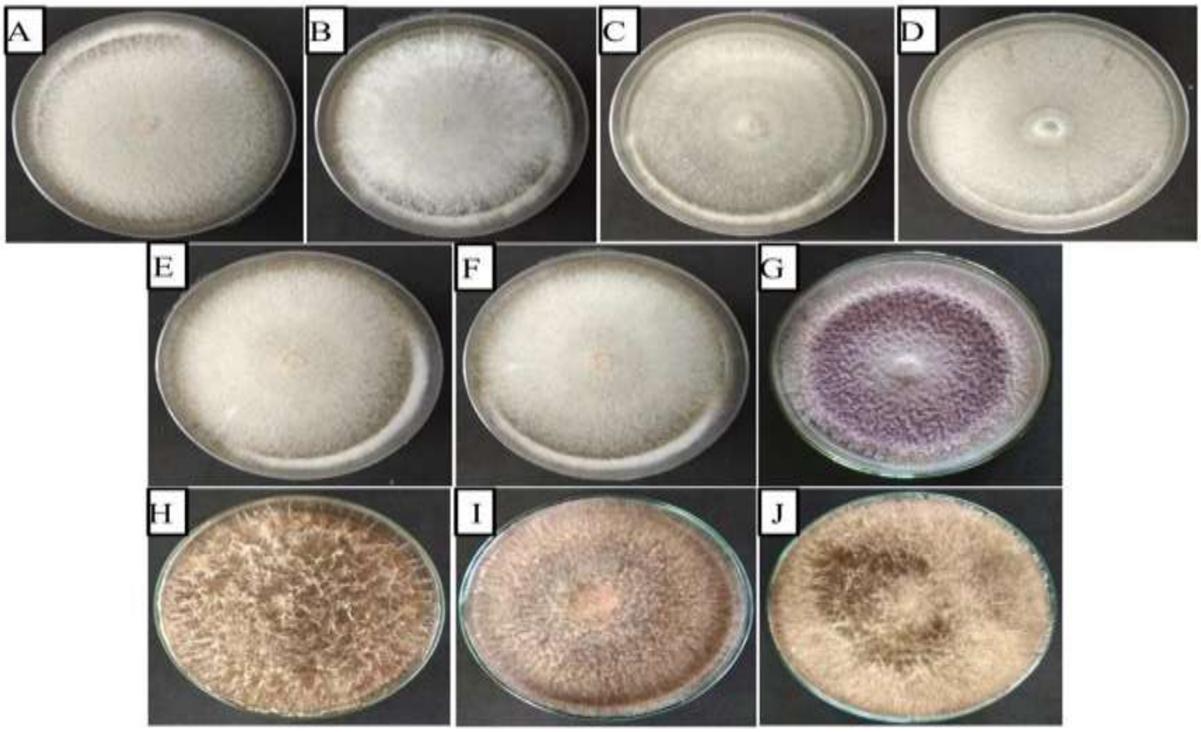

Fig. 1. Purified soil-borne pathogens isolated from diseased vinca plant root samples on PDA medium where A) *Fusarium* sp.1; B) *Fusarium* sp. 2; C) *Fusarium solani*; D) *Fusarium* sp. 4; E) *Fusarium* sp. 5;F) *Fusarium* sp. 6; G) *Fusarium proliferatum ;* H) *Rhizoctonia solani* 1 I) *Rhizoctonia solani* 2; J) *Rhizoctonia solani* 3

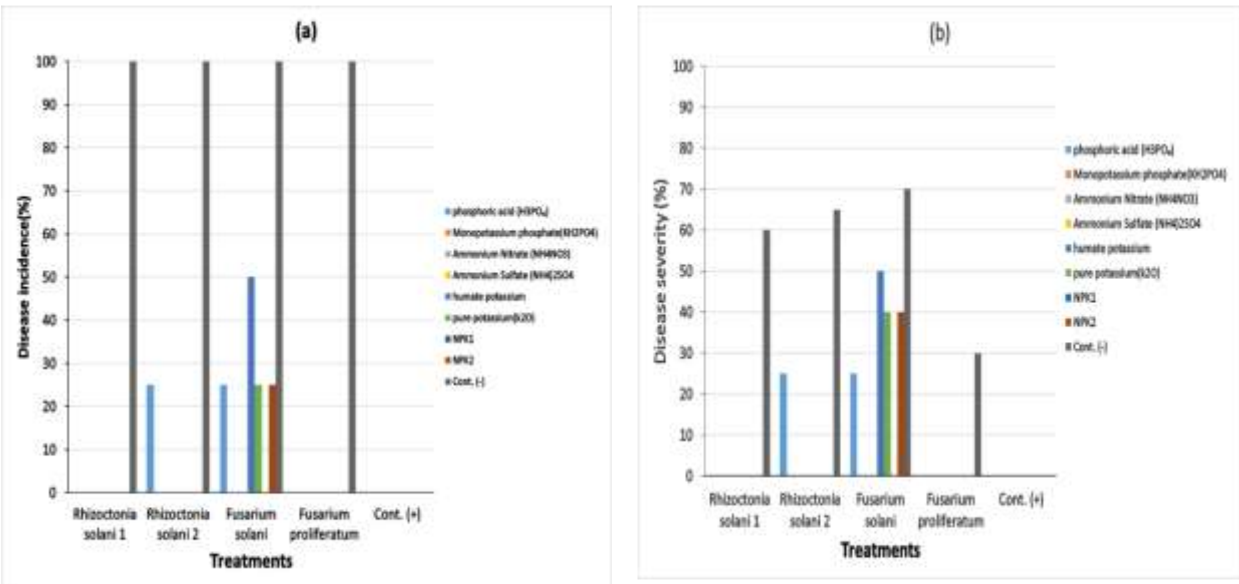

Fig. 2. Effect of soil fertilization on disease incidence (a) (DI %) and disease severity (b) (DS %) caused by root-rot disease of *Vinca rosa*

Fig. 3. **Effect of ammonium sulfate $(NH_4)_2SO_4$ on *vinca rosa* plants infected with *Rhizoctonia solani* 1 under greenhouse conditions where: 1) non-inoculated soil and non-treated with ammonium sulfate $(NH_4)_2SO_4$; 2) inoculated soil and treated; 3) inoculated soil with fungi**

Table 1. **Vinca shoot fresh and dry weights as affected by mineral fertilizers of soil inoculated with the pathogenic fungi**

	Fertilizer	Shoot fresh weight					Shoot dry weight				
		Rhizoctonia solani 1	*Rhizoctonia solani 2*	*Fusarium solani*	*Fusarium proliferatum*	Cont. (+)	*Rhizoctonia solani 1*	*Rhizoctonia solani 2*	*Fusarium solani*	*Fusarium proliferatum*	Cont. (+)
Phosphorus	Phosphoric acid (H_3PO_4)	17.50	20.25	16.5	16.75	26.75	5.75	8.25	6.25	6.45	13.10
	Monopotassium phosphate(KH_2PO_4)	17.00	21.25	16.75	18.00	26.75	8.50	9.25	6.37	7.00	13.10
Nitrogen	Ammonium Nitrate (NH_4NO_3)	16.50	15.00	16. 50	16.75	26.75	6.25	5.80	6.25	6.60	13.10
	Ammonium Sulfate $(NH_4)_2SO_4$	27.50	21.00	18.75	19.50	26.75	11.75	8.87	7.80	7.65	13.10
Potassium	Humate potassium	14.75	17.75	13.00	16.00	26.75	5.75	8.00	4.25	6.20	13.10
	Potassium(K_2O)	20.50	13.00	17.00	18.50	26.75	8.50	5.25	6.50	7.70	13.10
NPK	NPK1	20.50	18.50	24.25	25.50	26.75	7.37	8.00	10.00	10.60	13.10
	NPK2	14.75	13.00	14.50	19.00	26.75	5.50	4.50	5.37	8.10	13.10
	Cont. (-)	10.50	9.50	9.50	8.50		4.30	3.50	3.37	2.95	
LSD fungi				0.9282					0.4533		
LSD fertilizer				0.9282					0.4533		
LSD fungi* fertilizer				2.0756					1.0136		

Table 2. Vinca root fresh and dry weights as affected by mineral fertilizers of soil inoculated with the pathogenic fungi

	Fertilizer	Root fresh weight					Root dry weight				
		***Rhizoctonia solani* 1**	***Rhizoctonia solani* 2**	***Fusarium solani***	***Fusarium proliferatum***	**Cont. (+)**	***Rhizoctonia solani* 1**	***Rhizoctonia solani* 2**	***Fusarium solani***	***Fusarium proliferatum***	**Cont. (+)**
Phosphorus	**Phosphoric acid (H_3PO_4)**	2.88	4.13	3.13	3.23	6.55	1.44	2.06	1.56	1.61	3.28
	Mono Potassium phosphate (KH_2PO_4)	4.25	4.63	3.19	3.50	6.55	2.13	2.31	1.59	1.75	3.28
Nitrogen	**Ammonium Nitrate (NH_4NO_3)**	3.13	2.90	3.13	3.30	6.55	1.56	1.45	1.56	1.65	3.28
	Ammonium Sulfate $(NH_4)_2SO_4$	5.88	4.44	3.90	3.83	6.55	2.94	2.22	1.95	1.91	3.28
Potassium	**Humate potassium**	2.88	4.00	2.13	3.10	6.55	1.44	2.00	1.06	1.55	3.28
	Potassium (K_2O)	4.25	2.63	3.25	3.85	6.55	2.13	1.31	1.63	1.93	3.28
NPK	**NPK1**	3.69	4.00	5.00	5.30	6.55	1.84	2.00	2.50	2.65	3.28
	NPK2	2.75	2.25	2.69	4.05	6.55	1.38	1.13	1.34	2.03	3.28
	Cont. (-)	2.15	1.75	1.69	1.48		1.08	0.88	0.84	0.74	
LSD fungi		**0.2266**					**0.1134**				
LSD fertilizer		**0.2266**					**0.1134**				
LSD fungi* fertilizer		**0.5068**					**0.2535**				

Also, the form of nitrogen fertilizer can influence plant disease incidence **(Gullino *et al*., 2015).** The form of nitrogen can have striking effects on plant disease through root-mediated changes in pH, microbial profile in the rhizosphere, and alterations in the availability and function of micro-nutrients **(McGovern and Elmer, 2018).** As well as the presence of ammonium ions in the fertilizer promotes nitrogen uptake and enhances plant growth **(Li *et al*, 2013)**.

Phosphorus has been shown to suppress root rot in geranium caused by *Pythium ultimum* **(Syed *et al*., 2020)** and yellows in gladiolus caused by *Fusarium oxysporum* f. sp. *gladioli* **(Prabhu *et al*., 2007)** and to control plant diseases caused by *Phytophthora* and *Pythium* **(Brunings *et al*., 2012). Yandoc *et al*., (2007)** indicated that applications of phosphonate products significantly suppressed *P. nicotianae* root rot on vinca plants. Phosphorus fertilizers enhanced yield of the crops, and controlled several plant diseases **(Gupta *et al*., 2017). Huber *et al*., (2012) and Gupta *et al*., 2017)** found that the use of K significantly decreased the incidence of fungal diseases, bacteria, viruses, insects, mites, and nematodes. Potassium decreases the susceptibility of host plants up to the optimal level for growth **(Rawat *et al*., 2016).**

Chemical Control

In vitro evaluation of fungicides against vinca root rot pathogens

Data presented in Table 3 show the effect of different fungicides on the linear growth of the tested vinca plant pathogenic fungi *R. solani* 1, *R. solani* 2, *Fusarium solani,* and *F. proliferatum.*

Table 3. Linear growth reduction percentage of vinca root-rot pathogens as affected by different fungicides

Fungicide	Concentrations (ppm)	*Fusarium solani*	*Fusarium proliferatum*	*Rhizoctonia solani* 1	*Rhizoctonia solani* 2
Rizolex-T 50% wp	250	37.70	68.10	100.00	100.00
	500	51.80	71.10	100.00	100.00
	750	54.40	66.30	100.00	100.00
	1000	62.20	74.40	100.00	100.00
Occidor 50% wp	250	100.00	100.00	100.00	100.00
	500	100.00	100.00	100.00	100.00
	750	100.00	100.00	100.00	100.00
	1000	100.00	100.00	100.00	100.00
Uniform 390 SE	250	27.70	66.60	0.00	0.00
	500	38.80	66.60	0.00	0.00
	750	46.30	69.20	0.00	0.00
	1000	53.60	67.70	0.00	0.00
Nasrzol e 25% EC	250	63.30	100.00	83.30	78.80
	500	71.10	100.00	78.80	91.10
	750	73.30	100.00	81.10	88.80
	1000	**76.60**	**100.00**	**80.00**	**90.00**

LSD fungi :0.6277

LSD fungicides :0.5614

LSD fungi* fungicides: 1.2554

Occidor 50% wp completely inhibited linear growth of all the investigated pathogenic fungi at all tested concentrations where it recorded a reduction percentage of 100%. Rizolex-T 50% wp completely reduced linear growth of both isolates *Rhizoctonia solani* 1 and *Rhizoctonia solani* 2 at all tested concentrations as the reduction percentage indicates 100%.

The higher the concentration, the higher the inhibition percentage of Rizolex- T 50% wp when both pathogens *Fusarium solani* and *Fusarium proliferatum*, were examined. However, it completely reduced *R. solani* 1 and/ or *R. solani* 2 growth.

F. solani and *F. proliferatum* treated with fungicide Uniform 390 SE indicate that the higher the concentration, the higher of inhibition percentage. However, such fungicides reveal no effect on the growth of both *R. solani* 1 and/ or *R. solani* 2.

A complete reduction percentage of *F. proliferatum* was obtained when the fungicide Nasrzole 25% EC was investigated at all its investigated concentrations. It recorded high growth inhibition percentage when *F. solani*, *R. solani* 1 and *R. solani* 2, were examined. However, it caused a complete reduction percentage at all its concentrations when *F. proliferatum*, was investigated.

***In vivo* evaluation of fungicides against vinca root rot pathogens**

Data in Fig. 4 indicate that all the investigated fungicides completely prevent the infection with root rot pathogens of vinca plants except for *Fusarium proliferatum* when Rizolex-T 50% wp was examined where disease incidence (DI%) and disease severity (DS%) recorded (25% and 40%), respectively. On the other hand, Occidor 50% wp recorded disease incidence (DI %) and disease severity of (25%, 40%, and 25%, 60%) for both *R. solani* 2 and *F. solani*, respectively. Application of Nasrzole 25% EC indicates complete inhibition of disease parameters when all the pathogens were examined except for those of *Rhizoctonia solani* 2 where both DI and DS only recorded 25% and 60%, respectively. However, Uniform 390 EC indicates a complete reduction of both disease incidence and severity when applied to all pots inoculated with any of the investigated pathogens.

Such results were consequently followed by high plant growth parameters including (SFW g) and (SDW g) (Table 4) and (RFW g) and (RDW g) (Table 5). Data in Table 4 illustrated by Fig. (5) show that the highest SFW g and SDW g were obtained in the treatment of *R solani* 1 when Nasrzole 25% EC was investigated being (20.5g and 9.33g), respectively. However, the least SFW g and SDW g were recorded in the treatment of *Fusarium solani* when Rizolex-T 50% WP was investigated (10.25 g and 4.75 g), respectively.

The same general trend was obtained in (Table 5) when root fresh and dry weights were determined as affected by the same different pathogenic fungi genera by applying the same different fungicides while Nasrzole 25% EC exhibited the best values when *Rhizoctonia solani* 1 and *Fusarium solani* treatments, were investigated.

These results are in agreement with **Mahato (2005)** who found that fungicides used in agriculture production. Ornamental plants are grown for aesthetic value only; the concern of residues on plants is not as serious as on food crops. Hence, the chemical control method is used extensively in ornamentals especially when they are produced outdoors **(Lubbe and Verpoorte, 2011).** Fungicides are an effective means of soil-borne disease control and are extensively used in agriculture **(Panth *et al*., 2020).**

Greenhouse and field studies have shown that biological agents are strictly preventive, which means that they should be applied before the occurrence of disease. If the disease infection has already occurred, systemic fungicides are the best option for disease control **(Daughtrey and Buitenhuis, 2020).**

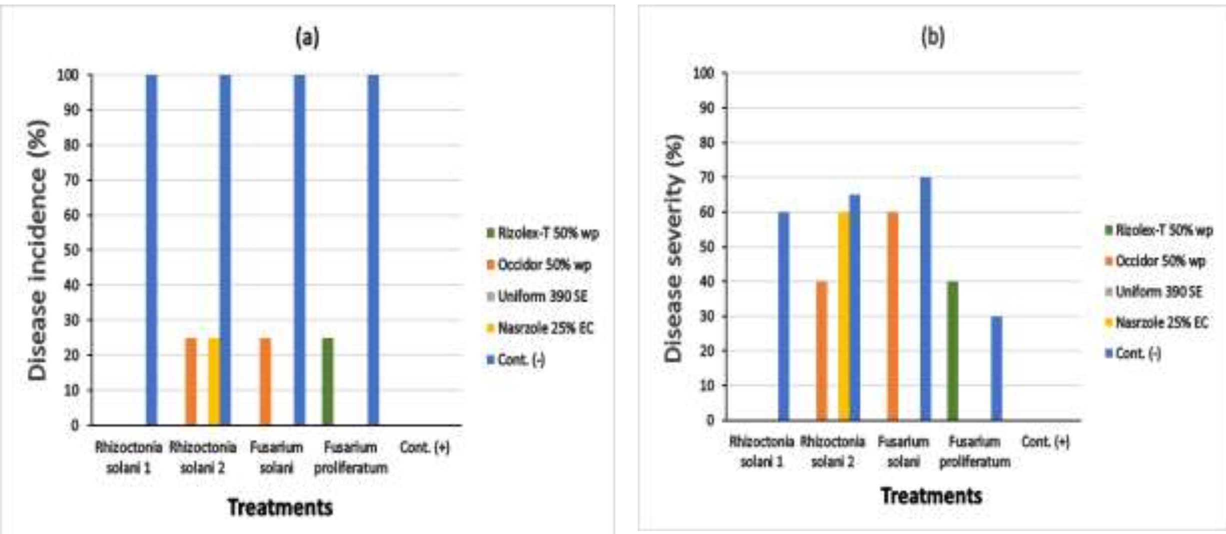

Fig. 4. Effect of fungicides on disease incidence (a) (DI %) and disease severity (b) (DS %) of root-rot disease on *vinca rosa*

Fig. 5. **Effect of Nasrzole 25% EC fungicide against vinca plants infected with *Rhizoctonia solani* 1 under greenhouse conditions Where: 1) control; 2) inoculated soil and treated with Uniform 390 SE; 3) inoculated soil with fungi**

Table 4. Vinca plant growth parameters (shoot fresh and dry weights) as affected by different fungicides of soil inoculated with the pathogenic fungi

Fungicides	Shoot fresh weight					Shoot dry weight				
	***Rhizoctonia solani* 1**	***Rhizoctonia solani* 2**	***Fusarium solani***	***Fusarium proliferatum***	**Cont. (+)**	***Rhizoctonia solani* 1**	***Rhizoctonia solani* 2**	***Fusarium solani***	***Fusarium proliferatum***	**Cont. (+)**
Rizolex-T 50% wp	11.50	10.75	10.25	11.50	26.75	5.38	4.88	4.75	6.25	13.10
Occidor 50% wp	15.25	17.50	16.50	17.75	26.75	6.23	8.75	8.25	8.88	13.10
Uniform 390 SE	14.75	14.00	15.75	10.50	26.75	6.10	6.75	7.88	5.13	13.10
Nasrzole 25% EC	20.50	18.00	15.25	17.75	26.75	9.33	9.00	7.50	8.88	13.10
Cont. (-)	10.50	9.50	9.50	8.50		4.30		3.37	2.95	
LSD fungi			**1.1761**					**0.5777**		
LSD Fungicides			**1.1761**					**0.5777**		
LSD fungi*Fungicides			**2.6298**					**1.2917**		

Table 5. Vinca plant growth parameters (root fresh and dry weights) as affected by different fungicides of soil inoculated with the pathogenic fungi

Fungicides	Root fresh weight					Root dry weight				
	Rhizoctonia solani 1	*Rhizoctonia solani* 2	*Fusarium solani*	*Fusarium proliferatum*	Cont. (+)	*Rhizoctonia solani* 1	*Rhizoctonia solani* 2	*Fusarium solani*	*Fusarium proliferatum*	Cont. (+)
Rizolex-T 50% wp	2.69	2.44	2.38	3.13	6.94	1.34	1.22	1.19	1.56	3.47
Occidor 50% wp	3.11	4.38	4.13	4.44	6.94	1.56	2.19	2.06	2.22	3.47
Uniform 390 SE	3.05	3.38	3.94	2.56	6.94	1.53	1.69	1.97	1.28	3.47
Nasrzole 25% EC	4.66	4.50	3.75	4.44	6.94	2.33	2.25	1.88	2.22	3.47
Cont. (-)	2.16	1.75	1.69	1.48		1.08	0.88	0.84	0.74	
LSD fungi			**0.2888**					**0.1441**		
LSD Fungicides			**0.2888**					**0.1441**		
LSD fungi*Fungicides			**0.6458**					**0.3222**		

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بعض العــوامــــــل المـــــؤثـــــــرة علـــــى مـــــــرض عفــن جــــــذور الــونكـــا

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خلال هذه الدراسة تم التركيز على تأثير الأسمدة المعدنية المختلفة على نسبة وشدة الإصابة بمرض عفن جذور الوينكا. وكذا دراسة فعالية المبيدات الفطرية ضد الإصابة بالمرض. تم اظهار استراتيجيات التسميد الفعالة لدعم صحة النبات ودورها في مكافحة مرض عفن الجذور في الوينكا. وقد أدي التسميد بكبريتات الامونيوم الى تأثيرات إيجابية على نمو النبات وتقليل معدلات الإصابة بالمرض. في حين أظهر اكسيد البوتاسيوم وهيومات البوتاسيوم فعالية محدودة في مكافحة المرض. وقد أظهر كلاً من المبيد الفطري ريزولكس-تي وأوكسيدور تثبيطا كاملا ضد جميع الفطريات المختبرة على البيئة معملياً. في حين أظهر المبيد يونيفورم ونصر-زول درجات مختلفة من الفعالية طبقا لطبيعة العزلة الفطرية. وقد اثر استخدام المبيدات الفطرية بدرجات مختلفة من الفعالية في الوقاية من العدوى بمسببات مرض عفن جذر الوينكا تحت ظروف الصوبة. وقد أظهر المبيد الفطري ريزولكس-تي تأثيرا جزئيًا علي الفطر *Fusarium proliferatum* تحت ظروف الصوبة على الرغم من فعاليته القوية معمليا، وقد أعطى المبيد الفطرى أوكسيدور فعالية جيدة ضد الفطر *Rhizoctonia solani* العزلة 2 ولكنه كان أقل فعالية ضد الفطر *Fusarium solani* 1 عزلة رقم 1. كما كان للمبيد نصر-زول فعالية كاملة ضد العدوى بمعظم المسببات الممرضه التي تم اختبارها، مع فعالية جزئية فقط ضد *Fusarium solani* العزلة 2. كما ان استخدام المبيدات الفطرية، وخاصة نصر-زول أثر بشكل معنوي على معدلات نمو نباتات الوينكا المصابة بمسببات مرض عفن الجذور المختلفة.

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