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Nota Científica / Scientific Note

Phosphate-solubilizing fungi isolated from a semiarid area cultivated with melon (*Cucumis melo* L. cv. gold mine)

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RESUMO

(Fungos solubilizadores de fosfato isolados de área semiárida cultivada com melão (*Cucumis melo* L. cv. gold mine). Considerando que pouco se conhece sobre a ocorrência de fungos solubilizadores de fosfato de áreas cultivadas com melão, foi avaliada a habilidade de solubilização desse nutriente por fungos filamentosos isolados dessas áreas. Foram avaliadas 318 amostras de fungos filamentosos pertencentes a 23 gêneros, além de Aphyllophorales e Mycelia sterilia. Dessas amostras, 52 apresentaram habilidade para solubilizar o fosfato: Aphyllophorales (2), *Aspergillus* (34), *Penicillium* (10) e *Rhizopus* (6). Esses resultados contribuem para subsidiar pesquisas que testem a capacidade desses fungos em solubilizar outras fontes fosfatadas aplicadas na cultura do melão, assim como indicam a necessidade de selecionar isolados com maior capacidade e potencial para solubilização.

Palavras-chave: adubação, fungos filamentosos, micro-organismos, Vale do São Francisco

ABSTRACT

(Phosphate-solubilizing fungi isolated from a semiarid area cultivated with melon (*Cucumis melo* L. cv. gold mine). Considering that little is known about the occurrence of phosphate-solubilizing fungi from areas cultivated with melon, the phosphate solubilization ability of filamentous fungi isolated in these areas was evaluated. Three hundred and eighteen filamentous fungal isolates belonging to 23 genera were evaluated, besides Aphyllophorales and Mycelia sterilia. From those, 52 were able to solubilize P: Aphyllophorales (2), *Aspergillus* (34), *Penicillium* (10) and *Rhizopus* (6). These results will contribute to subsidizing further research regarding the capacity of these fungi to solubilize other sources of phosphate applied to the melon crop, as well as indicate the need for a screening program to select those with higher capacity and potential for solubilization.

Key words: fertilization, filamentous fungi, microorganism, San Francisco Valley

Melon is one of the most demanding cucurbitaceous crops, usually demanding potassium, nitrogen and phosphorus fertilization (Vitti *et al.* 1994). Phosphorus stimulates growth and is essential to root formation, flowering and fructification, acting as a decisive factor in the quality and quantity of fruits (Crisóstomo *et al.* 2002).

Plant productivity is often limited by low levels of soil nutrients in absorbable forms. Phosphorus is possibly the most limiting nutrient in tropical regions, considering its high stability and, consequently, low solubility (Moreira & Siqueira 2006). Microbes have the ability to make insoluble P available by the processes of solubilization or mineralization. The solubilization process occurs through the production of organic acids that directly dissolve phosphate minerals or by a chelating action over soil cations liberating soluble phosphates (Silva Filho *et al.* 2002). Therefore, P solubilizing microorganisms play a key role in the biogeochemical cycle of phosphorus and its availability to plants (Carneiro *et al.* 2004).

With the development of organic agriculture in fruit production in the San Francisco Valley, many organic residues have been used as fertilizers. However, little is known about the effect of these residues on the soil mycobiota, especially on phosphate-solubilizing fungi. Organic residues that favor the increase of the P-solubilizing fungal population are of utmost importance for improving the nutritional condition of the crops in the region. The aim of this study was to evaluate the ability of phosphate solubilization by filamentous fungi isolated from the rhizosphere of melon plants (*Cucumis melo* L. cv. gold mine) fertilized with organic composts.

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Table 1. Filamentous fungi evaluated for the ability to solubilize phosphorus.

TAXA	Nº of samples	PSF	TAXA	Nº of samples	PSF
Alternaria tenuissima (Kunze) Wiltshire	01	-	*Humicola fuscoatra* Traaen	07	-
Aspergillus flavipes (Bainier & R. Sartory) Thom & Church	02	-	*Monodictys castaneae* (Wallr.) S. Hughes	02	-
A. flavus Link	02	+	*Myrothecium indicum* P.Rama Rao	03	-
A. fumigatus Fresenius	18	-	*M. roridum* Tode	03	-
A. japonicus var. *aculeatus* (Iizuka) Al-Musallam	03	+	*M. verrucaria* (Alb. & Schwein.) Ditmar	03	-
A. japonicus var. *japonicus* Saito	08	+	*Neocosmospora vasinfecta* var. *africana* (Arx) P.F. Cannon & D. Hawksw.	11	-
A. nidulans (Eidam) G. Winter	03	-	*Paecilomyces carneus* (Duché & R. Heim) A.H.S. Br. & G. Sm.	01	-
A. niger Tieghem	16	+	*P. lilacinus* (Thom) Samson	02	-
A. niger var. *niger* Tieghem	02	+	*P. variotii* Bainier	01	-
A. sydowii (Bainier & Sartory) Thom & Church	01	-	*Penicillium citreonigrum* Dierckx	01	+
A. tamarii Kita	03	+	*P. citrinum* Thom	04	-
A. terreus Thom	17	-	*P. corylophilum* Dierckx	02	-
A. terreus var. *aureus* Thom & Raper	09	-	*P. crustosum* Thom	01	+
A. ungüis (Weill & L. Gaudin) Thom & Raper	05	-	*P. decumbens* Thom	04	+
A. ustus (Bainier) Thom & Church	02	-	*P. fellutanum* Biourge	03	-
A. viridinutans Ducker & Thrower	05	-	*P. griseofulvum* Dierckx	03	-
Chaetomium convolutum Chivers	03	-	*P. janthinellum* Biourge	04	+
C. cupreum L.M. Ames	01	-	*P. pinophilum* Thom	02	-
C. leucophora L.M. Ames	01	-	*P. restrictum* J.C. Gilman & E.V.Abbott	05	-
C. nigricolor L.M. Ames	02	-	*P. spinulosum* Thom	01	-
C. ochraceum Tschudy	03	-	*P. vinaceum* J.C. Gilman & E.V. Abbott	07	-
C. trigonosporum (Marchal & É.J. Marchal) Chivers	05	-	*P. waksmanii* K.M. Zalessky	01	-
Cladosporium sphaerospermum Penz.	02	-	*Rhizopus microsporus* var. *chinensis* (Saito) Schipper & Stalpers	06	+
C. tenuissimum Cooke	02	-	*R. microsporus* var. *microsporus* Tieghem	07	-
Curvularia eragrostidis (Henn.) J.A. Mey.	01	-	*Scopulariopsis brumptii* Salv.-Duval	01	-
Emericella nidulans (Eidam) Vuill.	15	-	*S. croci* J.F.H. Beyma	01	-
E. nidulans var. *acristata* Subramaniam	17	-	*S. sphaerospora* Zach	04	-
E. nidulans var. *echinulata* Godeas	09	-	*Scytalidium lignicola* Pesante	01	-
E. rugulosa (Thom & Raper) C.R. Benj.	01	-	*Sordaria fimicola* (Roberge ex Desm.) Ces. & De Not.	02	-
E. variecolor Berk. & Broome	01	-	*Talaromyces trachyspermus* (Shear) Stolk & Samson	02	-
Eupenicillium brefeldianum (B.O. Dodge) Stolk & D.B. Scott	01	-	*Thielavia fragilis* (Natarajan) Arx	04	-
E. crustaceum F. Ludw.	01	-	*T. microspora* Mouch.	03	-
Eurotium chevalieri L. Mangin	04	-	*T. terrestris* (Apinis) Malloch & Cain	01	-
E. rubrum W. Bremer	01	-	*T. terricola* (J.C. Gilman & E.V. Abbott) C.W. Emmons	17	-
Fusarium equiseti (Corda) Sacc.	01	-	*Torula caligans* (Bat. & H.P. Upadhyay) M.B. Ellis	07	-
F. merismoides Corda	02	-	*Trichoderma pseudokoningii* Rifai	01	-
F. oxysporum E.F. Sm. & Swingle	03	-	*T. virens* (J.H. Mill., Giddens & A.A. Foster) Arx	01	-
F. redolens Wollenw.	01	-	*T. viride* Pers.	01	-
F. solani (Mart.) Saccardo	09	-	Aphyllophorales	02	+
Fusarium stilboides Wollenw.	02	-	Black Mycelia sterilia	01	-
TOTAL	185			133	

PSF = Phosphate-solubilizing fungi.

Fifty-four rhizosphere soil samples were collected at random from an irrigated semiarid area cultivated with melon (*C. melo* cv. gold mine) in the San Francisco Valley, Petrolina, Brazil (09º32´09´´S, 40º55´28´´W). Aliquots (1 mL) of serial dilutions (1:1000) of the soil samples were plated on Sabouraud Agar medium with chloranphenicol (500 mg l^{-1}), and incubated at 28 ºC for up to 96 h. The fungal colonies were transferred and maintained on Potato Dextrose Agar (PDA). Fungal species were identified based on colony morphology on different media (Czapeck, malt extract agar and PDA) and micromorphological characteristics. The evaluation of the ability of these fungi to solubilize phosphorus was carried out by removing a 5 mm diameter disc from the edge of the colony and transferring it to a Petri dish containing GAGES solid medium (glucose, arabinosis, glycerol, soil extract, $CaCl_2$, $MgSO_4$, NaCl and agar) supplemented with 10% K_2HPO_4 (50 ml) and 10% $CaCl_2$ (50 ml), to produce inorganic phosphate precipitate, $CaHPO_4$ (Souchie *et al.* 2006). The plates were kept at room temperature (28 ºC) for 12 days and the colonies that formed a clear zone around them, due to solubilization of $CaHPO_4$, were considered P-solubilizing fungi.

From the soil samples, 318 filamentous fungi (Tab. 1) were isolated, belonging to 23 genera and 78 species, besides Aphyllophorales and Mycelia sterilia. Fifty-two of them were able to solubilize P, as follows: *Aspergillus flavus* (2), *A. japonicus* var. *aculeatus** (3), *A. japonicus* var. *japonicus** (8), *A. niger* (16), *A. niger* var. *niger** (2), *A. tamarii** (3), *Penicillium citreonigrum** (1), *P. crustosum** (1), *P. decumbens** (4), *P. janthinellum** (4), *Rhizopus microsporus* var. *chinensis** (6) and Aphyllophorales (2). Those marked (*) are reported for the first time as P-solubilizers.

Among the identified species, 15% are P-solubilizers, which agrees with values usually found soil (8 to 58% of all fungi), as reported by Nahas *et al.* (1994). *Aspergillus* and *Penicillium* species stood out as phosphorus solubilizers, and these two genera are the most cited in the literature with this capability (Silva Filho *et al.* 2002; Wakelin *et al.* 2004; Souchie *et al.* 2006). However, most works have not identified the species, making comparisons only possible at the genus level. All 16 samples of *A. niger* were able to solubilize phosphate. This species has been isolated from soils cultivated with a wide variety of plants, such as coconut, beets, olive, wheat, chickpea, soybean, broad bean, rice, sugar cane, *Pinus*, *Eucalyptus* and *Avicennia germinans* (Wahid & Mehana 2000; Abd-Alla & Omar 2001; Rashid *et al.* 2004; Zayed & Abdel-Motaal 2005). Two samples of *Aspergillus flavus* solubilized P, which has been reported for the species (Abd-Alla & Omar 2001; Sapatnekar *et al.* 2003; Rashid *et al.* 2004). *Aspergillus fumigatus, A. nidulans, A. terreus, Emericella nidulans, Fusarium oxysporum, Sordaria fimicola* and *Thielavia terricola* were not able to solubilize P, but other isolates of the same species from Indian soils were reported as phosphorus solubilizers (Sapatnekar *et al.* 2003). Similarly, *Penicillium citrinum* and *Trichoderma viride* did not show the capacity to solubilize P in this study, although *P. citrinum*, isolated from wheat, soybean and broad bean rhizospheres (Abd-Alla & Omar 2001), and *T. viride*, isolated from black soil of Maharashtra, India, and sugar cane plantations (Sapatnekar *et al.* 2003; Zayed & Abdel-Motaal 2005), have been reported as solubilizers. A screening program to select those isolates with high capacity and potential for solubilization is planned, with the further goal of a program for controlled inoculation.

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