

Effect of Temperature on Growth of *Penicillium digitatum* and *Geotrichum candidum* on Agar and on Citrus Fruit and Chemical Control of Post-harvest Rot Caused by the Two Fungi

M.Y. Kassim and Shamsheer Khan

Department of Botany and Microbiology, College of Science,
King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia

(Received 28 November 1994; accepted for publication 13 June 1995)

Abstract. *Penicillium digitatum* and *Geotrichum candidum* were isolated from infected citrus fruits collected from cold storages of Riyadh, Saudi Arabia. Growth rates of the fungus at 5, 10, 20, 25, 30 and 35°C were compared on agar and on fruit. The rate increased with increased temperature, reaching optima at 20 and 25°C, respectively, on agar and on fruits for *P. digitatum* and 30°C for *G. candidum* on both agar and fruit. The growth rate of both fungi dropped sharply at 35°C on agar but less on fruit. To control the fruit rot of citrus caused by *P. digitatum* and *G. candidum*, bavistin, benomyl, guazatine and imazalil were used at the rate of 500 mg/liter. Fruits were inoculated with the respective fungi and after 20 hours of incubation dipped for one minute in the fungicidal solutions separately. The infected fruits were incubated in polythene bags at room temperature for two weeks. All the tested fungicides reduced the fruit infection caused either by *P. digitatum* or by *G. candidum*. Guazatine was more effective than the other fungicides and it totally inhibited the rot caused by either of the two fungi.

Key Words: Citrus fruit rot; *P. digitatum*; *G. candidum*; Temperature; Fungicides.

Introduction

The most economically feasible and expedient means to increase the world food supply is to reduce the losses in food crops that occur after harvesting. Because of their high moisture content, fresh fruit and vegetables are very susceptible to attack by pathogenic fungi during the period between harvest and consumption [1]. Post-harvest losses of perishable crops in developing countries have been estimated to be in the range 5-50% (or sometimes even more) of the harvest [2-3]. [2; 3, 1168].

Citrus is among the important fruits of the world. Post-harvest diseases of citrus caused by *Geotrichum candidum* Link ex Pers. (sour-rot) and *Penicillium digitatum* Sacc. (green mold) have been reported all over the world [1, 4-9].

The effects of temperature on the growth of pathogenic fungi and on their chemical control have been reported by various authors [8, 10-14]. The aim of the present work was to see the effect of temperature on the growth of *G. candidum* and *P. digitatum* on agar and citrus fruit and the chemical control of citrus rot caused by the two fungi.

Materials and Methods

G. candidum and *P. digitatum* were isolated from infected citrus fruits collected from the cold storage of Riyadh, Saudi Arabia. The isolates were identified in our laboratory and confirmed by the Commonwealth Mycological Institute, Kew, Surrey, England (Rept. No. H/1282/80/YS16). The two strains were maintained on PDA slants for further studies. Pathogenicity tests confirmed that the rot on the citrus was caused by the two isolated fungi. The growth rate of the two fungi on agar was compared with the increase in diameter of the rot spots on the fruit. The temperatures used were 5, 10, 15, 25, 30 and 35°C.

To see the effect of temperature on the growth of mycelium on agar, PDA plates were inoculated in the center with a 4-mm diameter disc of nonsporulating mycelium cut from the periphery of the young colonies. The plates were incubated for 10 days, after which the diameters of the colonies were measured.

To determine the effect of temperature on the development of rot, lemon fruits were inoculated by placing non-sporulating mycelium of the fungus in a circular wound 4 mm in diameter. The fruits were incubated for 10 days and then the diameters of the spots were measured. Four replicates with 4 PDA plates or 4 fruits per replicate were used.

In order to control citrus fruit rot caused by *G. candidum* and *P. digitatum*, four fungicides were tested at 500 mg/liter Bavistin (Carbendazine, BASF), Benomyl (Benlate 5% W.P. Du Pont & Co), Guazatine (Panocrine, 70% aqueous soil. Olin Corp) and Imazalil (Decozil, 69% e.c. Pennwalt Corp). Suspensions of the fungicides were prepared according to the methods prescribed by the manufacturing companies. Mature lime (*Citrus aurantifolia* var. *limetta*) fruits were punctured about 1x4 mm with a sterile pointed knife. 100 ul of spore suspension (10^8 spores/ml) of *G. candidum* or *P. digitatum* was then inserted in the punctured area. The inoculated fruits were incubated in polythene bags at room temperature (22°C) for 20 hours so that the fungus became established in the fruit. The inoculated fruits were then treated by dipping for 1 minute in the fungicide solution. Control was maintained by dipping the inoculated fruits in sterile distilled water. The fruits were then incubated at room temperature (22°C) for two weeks. The percentage rot was calculated by following Ashok and Chenulu [15] method:

$$\text{Percentage} = \frac{W - w}{W} \times 100$$

where,

W = initial weight of the fruit, and

w = weight of fruit after the removal of infected portion.

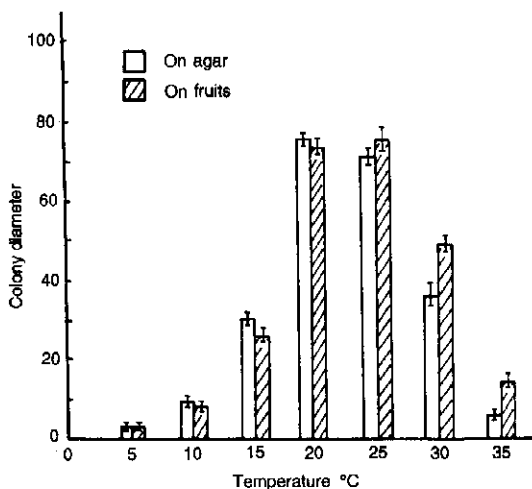


Fig. 1. Effect of temperature on the growth of *P. digitatum* on agar and fruits. (Values are colony diameters after 10 days and are means of 4 replicates. Vertical lines show \pm SE).

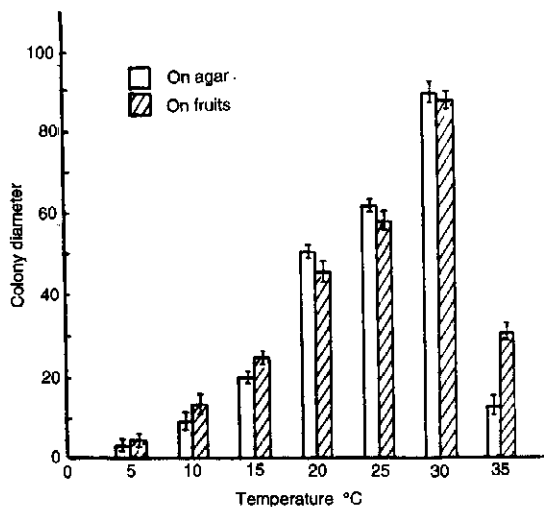


Fig. 2. Effect of temperature on the growth of *G. candidum* on agar and fruits. (Values are colony diameters after 10 days and are means of 4 replicates. Vertical lines show \pm SE).

Results and Discussion

The results of temperature experiments on agar and fruits are shown in Figs. 1 and 2. The two isolates of fungi (*P. digitatum* and *G. candidum*) did not show any significant difference between their growth rate. However, the growth rates of *P. digitatum* and *G. candidum* were slow at 50°C on both agar and citrus fruits. The growth increased with increasing temperature, reaching optima at 20 and 25°C, respectively, on agar and fruit for *P. digitatum* and 30°C for *G. candidum* on both agar and fruit. The growth rate of both fungi dropped sharply at 35°C on agar but only slightly on fruit. The fungi were apparently more sensitive to high temperature on agar than on fruit. Pierson [10] has reported the same type of results for *Rhizopus stolonifer*. It is possible that in fruits the fungi are protected from the direct effect of high temperature.

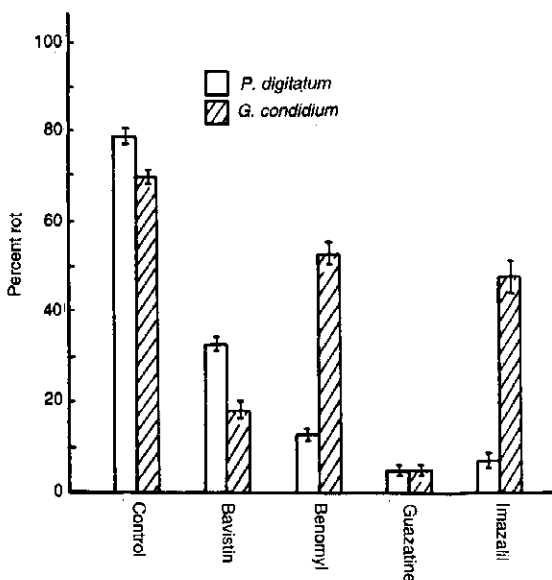


Fig. 3. Effect of different fungicides on citrus fruit rot caused by *P. digitatum* and *G. candidum*. (Values are the means of 4 replicates show \pm SE).

The results of chemical control are shown in Fig. 3. It was observed that all the tested fungicides except bavistin gave significant protection to the citrus fruits against *P. digitatum* when treated with 500 mg/liter Guazatine and Imazalil were more effective than benomyl. Echert *et al.* [1; 11] have also reported that these fungicides are effective against *P. digitatum*. Bavistin and guazatine inhibited the growth of *G. candidum*, but benomyl and imazalil were essentially inactive against this fungus. Guazatine was the most effective fungicide against *P. digitatum* and *G. candidum*. These results confirm the reports of other investigators [1, 11, 14, 16].

References

- [1] Eckert, J.W. "The Chemical Control of Post-harvest Diseases: Subtropical and Tropical Fruits." *Ann. Rev. Phytopath.*, 23, No. 4 (1985), 421-454.
- [2] Harvery, J.M. "Reduction of Losses in Fresh Market Fruits and Vegetables." *Ann. Rev. Phytopath.*, 61, No. 3 (1978), 321-341.
- [3] Salunkhe, D.K. and Desai, B.B. *Post-harvest Biotechnology of Fruits*. Vol. I. Florida: CRC Press, Inc Roca Raton, 1984.
- [4] Butler, F.E.; Webster, R.K., and Eckert, J.W. "Taxonomy, Pathogenicity and Physiological Properties of the Fungus Causing Sour Rot of Citrus." *Phytopathology*, 55, No. 11 (1965), 1262-1268.
- [5] Kaul, J.L. and Lall, B.S. "Post-harvest Fungal Diseases of Citrus in Himachal Pradesh." *Indian Phytopath.*, 28, No. 1 (1975), 119-122.
- [6] Gutter, Y. "Interrelationship of *Penicillium digitatum* and *P. italicum* in thiabendazole-treated Oranges." *Phytopathology*, 65, No. 4 (1975), 498-499.
- [7] Spalding, D.H. "Control of *Alternaria* Rot of Tomatoes by Post-harvest Application of Imazalil." *Plant Dis.*, 64, No. 1 (1980), 169-171.
- [8] Brown, G.E.; Nagy, S., and Maraulja, M. "Residues from Post-harvest Non-recovery Spray Applications of Imazalil to Oranges and Effects on Green Mold Caused by *Penicillium digitatum*." *Plant Dis.*, 67, No. 9 (1983), 954-957.
- [9] Abou-Heilah, A.N. "Post-harvest Diseases of Some Vegetables in the Two Main Markets of Riyadh (Saudi Arabia)." *J. Univ. Kuwait*, 12, No. 1 (1985), 103-112.
- [10] Pierson, C.F. "Effect of Temperature on the Growth of *Rhizopus stolonifer* on Peaches and on Agar." *Phytopathology*, 56, No. 3 (1966), 276-278.
- [11] Eckert, J.W.; Bretschneider, B.F., and Ramayake, M. "Investigation on New Post-Harvest Fungicides for Citrus Fruits in California." *Proc. Int. Soc. Citriculture*, 10, No. 1 (1981), 804-810.
- [12] Cutter, Y. *et al.* "Chemical Control in Citrus of Green and Blue Molds Resistant to Benzimidazoles." *Phytopath. Z.*, 102, No. 1 (1981), 127-138.
- [13] Kassim, M.Y.; Sheir, H.M., and Shamsher, K. "Some New Storage and Market Diseases in Saudi Arabia. II. Fruit Diseases." *J. Coll. Sci. King Saud Univ.*, 16, No. 1 (1985), 31-39.
- [14] Kassim, M.Y. "Chemical Control of Post-harvest Diseases of Potato and Tomato." *Indian Phytopath.*, 39, No. 2 (1986), 243-244.
- [15] Ashok, G. and Chenulu, V.V. "Chemical Control of Post-harvest Diseases of Citrus Reticulate and *Solanum tuberosum*" *Indian Phytopath.*, 35, No. 4 (1982), 628-632.
- [16] Brown, G.E. "Biology and Control of *Geotrichum candidum*, the Cause of Citrus Sour Rot." *Proc. Fla. State Hort. Soc.*, 92, No. 1 (1979), 186-189.

تأثير درجة الحرارة على نمو كل من فطرّة البنسليام ديجيتاتم والجيوترىكم كانديدم على الأجار وثار الليمون ومقاومة العفن المتسبب عن كل منها

محمد يحيى أحمد آل قاسم و شمشير جولاب الدين خان

قسم النبات والأحياء الدقيقة، كلية العلوم، جامعة الملك سعود، ص.ب ٢٤٥٥،

الرياض ١١٤٥١، المملكة العربية السعودية

(سُلم في ٢٥ جمادى الآخرة ١٤١٥هـ؛ وقبل للنشر في ١٥ محرم ١٤١٦هـ)

ملخص البحث. عزلت فطرتي البنسليام ديجيتاتم والجيوترىكم كانديدم من ثار الليمون المصابة والتي جمعت من مخازن التبريد في الرياض، وقد قورن معدّل النمو على الأجار وعلى الثار فوجد أن الدرجة المثلى للنمو كانت ٢٠° و ٢٥°م على التوالي بالنسبة لفطرّة البنسليام و ٣٠°م بالنسبة للجيوترىكم سواءً على الأجار أو على الثمرة وقد انخفض معدّل النمو بصورة شديدة عند ٣٥°م على الأجار وبصورة أقل على الثمرة. لاختبار فعالية المبيدات استعملت كل المبيدات التالية: البافستين، البنوميل، الجوزاتين والأمازاليل بمعدّل ٥٠٠مجم/لتر حيث نفعت بها الثار بعد ٢٠ ساعة من تلقيحها بالفطرتين المذكورتين ثم حضنت الثار وهي موضوعة في أكياس البولي ايثيلين عند درجة حرارة الغرفة ولمدة أسبوعين، وقد وجد أن جميع المبيدات المستخدمة قد اختزلت إصابة الثار ولكن مبيد الجوزاتين كان أكثرهم تأثيراً حيث نبط ظهور العفن تماماً في كل من الفطرتين.