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Research Application Summary

Plant extracts and antagonistic fungi as alternatives to synthetic pesticides in management of fungal diseases of tomato

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Abstract

Incorporation of biological pesticides in integrated pest management has lately been considered effective in production of safe food for human consumption, aesthetically valuable for the prime markets and increase in crop yields. Despite their efficacy, synthetic pesticides are generally expensive, not easily degradable and leave harmful residues on food products. The objective of this study was to evaluate the effectiveness of plant extracts in managing fungal pathogens of tomato. *In-vitro* tests were conducted between July and October 2016 to screen crude plant extracts for activity against economically important fungal pathogens. Plant samples were collected, blended to fineness and extracted in ethanol. The filtrate was concentrated by evaporating ethanol under vacuum. The poisoned food technique was used to evaluate effectiveness of the crude plant extracts against the test pathogens. Activity of the crude plant extracts was determined as inhibition of fungal colony growth. All plant extracts inhibited colony growth of the tested pathogens. Turmeric extract was the most active of these plants. *Alternaria solani* was the most susceptible pathogen while *Rhizoctonia solani* was the least. The observed potential of plant extracts in inhibiting growth of pathogens *in-vitro* is an indication of their potential to manage the diseases caused by those pathogens. Local environment should hence be explored further for more plants with antimicrobial potential and their active constituents identified and formulated. Sensitization of farmers in the use of natural products in disease management in place of synthetic pesticides should be encouraged for sustainable agriculture.

Key words: Fungal pathogens, plant extracts, synthetic pesticides

Résumé

L'incorporation de pesticides biologiques dans la lutte intégrée contre les ravageurs a récemment été considérée comme efficace dans la production d'aliments sains pour la consommation humaine, esthétiquement précieux pour les principaux marchés et l'augmentation des rendements des cultures. Malgré leur efficacité, les pesticides synthétiques sont généralement coûteux, pas facilement biodégradables et laissent des résidus nocifs sur les produits alimentaires. L'objectif de cette étude était d'évaluer l'efficacité des extraits végétaux dans la gestion des pathogènes fongiques de la tomate. Des essais in vitro ont été réalisés entre Juillet et Octobre 2016 afin de filtrer les extraits bruts de plantes en vue de lutter contre les pathogènes fongiques d'importance économique. Les échantillons de plantes ont été recueillis, mélangés et écrasés à la finesse, puis ensuite

extraits dans de l'éthanol. Un filtrat concentré a été obtenu par évaporation de l'éthanol. La technique d'aliments empoisonnés a été utilisée pour évaluer l'efficacité des extraits bruts de plantes contre les agents pathogènes d'essai. L'activité des extraits bruts de plantes a été déterminée comme l'inhibition de la croissance des colonies de champignons. Tous les extraits végétaux ont inhibé la croissance des colonies des pathogènes testés. L'extrait de Curcuma était le plus actif de ces plantes. Alternaria solani était le pathogène le plus sensible alors que Rhizoctonia solani était le moins sensible. Le potentiel des extraits bruts des plantes dans l'inhibition de la croissance de pathogènes in vitro est une indication de leur capacité à lutter contre les maladies provoquées par ces pathogènes. L'environnement local devrait donc être plus exploré avec plus de plantes ayant un potentiel antimicrobien et leurs constituants actifs identifiés et formulés. La sensibilisation des agriculteurs à l'utilisation de produits naturels pour lutter contre les maladies en lieu et la place des produits chimiques devrait être encouragée pour une agriculture durable.

Mots clés: Pathogènes fongiques, extraits végétaux, pesticides synthétiques

Background information

For the last few decades, farmers have relied on synthetic pesticides to manage crop pests and diseases. However, concerns on overreliance of these pesticides have been raised due to their cost and poor degradability which leaves residues in the food products. These concerns have been cited as some of the reasons why alternatives to these pesticides should be sought (Mizubuti *et al.,* 2012; Bhattacharjee and Dey, 2014). Use of plant extracts and other biological interventions have been considered as viable alternatives to synthetic products because of their safety and efficacy (Chethana *et al.,* 2012; Nashwa and Abo-Elyousr, 2012). The end consumers of tomatoes (*Solanum lycoperscum)* and other vegetables prefer aesthetically acceptable products. For a long time farmers have relied on synthetic pesticides to achieve this but currently use of these products have raised concerns. such as levels of residues in the vegetables, environmental pollution and degradability, thus justifying the need for alternatives to manage pests and diseases. Plant extracts and microbial antagonists are considered viable and promising options in management of economically important vegetable pests and diseases.

Literature summary

Farmers of horticultural crops incur heavy losses due to pests and diseases. Overreliance on synthetic pesticides to manage pests and diseases normally results in rejection of their produce in prime markets due to non-compliance with set standards especially high residue levels (Bhattacharjee and Dey, 2014). Therefore, to close the gap between healthy products, safe environment and high yields, alternatives to synthetic pesticides are being sort (Mizubuti *et al.,* 2012). Plant extracts and antagonistic microorganisms have been successfully used in some regions and these could form part of the alternatives for farmers in the management of economically important pests and diseases (Al-Samarrai *et al.*, 2012; Chethana *et al.,* 2012).

Study description

Crude extracts from different plant species were screened between July and October 2016 for *in-vitro* activity against four plant pathogenic fungi using the poisoned food technique (Al-Samarrai *et al.,* 2012). The test phytopathogens included *Alternaria solani, Pythium ultimum, Fusarium oxysporum* fsp. *lycopersici* and *Rhizoctonia solani*. Fresh plant materials were finely blended and extracted with 95% ethanol. The ethanol extract was concentrated by vacuum evaporation and 1 ml of the concentrate incorporated into 50ml of molten Potato Dextrose Agar (PDA) media. Five millimetres of seven-day old fungal pathogen agar discs were inoculated at the centre of each agar plate. Growth inhibition was determined as the reduction in fungal colony radial growth as compared to cultures without plant extract. The extracts with the highest activity were further evaluated for their inhibitory activity against the four test pathogens.

Research application

The crude plant extracts evaluated inhibited radial growth of the four tomato pathogens *in- vitro*. Turmeric (*Curcuma longa*) was the most active plant against all the pathogens while mint (*Mentha piperita*) was the least active. Turmeric extracts specifically inhibited the colony growth of *Alternaria solan*i by up to 70%. *Alternaria solani* was the most susceptible pathogen while *Rhizoctonia solani* was the least sensitive (Table 1).

Table 1. Percentage colony diameter inhibition of different tomato plant pathogens as affected by various crude plant extracts incorporated in culture media

Source of extracts	*Pythium*	*Alternaria*	*Rhizoctonia*	*Fusarium*	Mean
Turmeric	55.3a	72.6a	33.2a	8.2d	44.1a
Garlic	20.2de	43.2b	24.4b	8.4d	24.9b
Lemon	49.0a	34.7c	14.2c	2.0g	21.1c
Pepper	29.0d	15.6de	35.3a	6.7de	14.3d
Ginger	34.8cd	37.6bc	0.0d	36.4a	24.2bc
Rosemary	44.4bc	22.1de	0.0d	10.7c	14.1d
Neem	13.7ab	7.8f	0.0d	4.4f	4.4g
Aloe	20.0e	9.0ef	0.0d	27.2b	9.6e
Mint	20.6de	9.5ef	0.0d	4.5ef	5.5fg
Marigold	45.2de	11.3ef	0.0d	4.6ef	8.8ef
Control	0.0f	0.0g	0.0d	0.0g	0.0h
LSD ($p \leq 0.05$)	11.6	6.7	5.5	2.1	3.4
CV (%)	26.9	19.5	38.9	14.2	30.4

Means followed by the same letter(s) within each column do not differ significantly at $P \leq 0.05$

Discussion

Crude plant extracts were found to inhibit colony growth of all the test tomato fungal pathogens with turmeric (*Curcuma longa*) being the most active. *Alternaria solani* was the most susceptible. Wongkaew and Sinsiri (2014) reported antimicrobial activity of turmeric and cassia extracts against *Alternaria alternata, Fusarium oxysporum f.sp. lycopersici, Pythium* sp. and *Phytophthora infestans*. This activity is attributed to the aromatic oil turmerones and curcuminoids. However, extracts from marigold had limited activity against the test pathogens in contrast to reports by Rodino *et al.* (2012) who reported that marigold extracts were effective against *Rhizoctonia solani*. The extracts used in this study were extracted in ethanol which may explain their effectiveness. Similar results have been reported by Wongkaew and Sinsiri (2014) that ethanolic extracts were effective in reducing colony growth of pathogenic fungi *in-vitro*. Contrary to results herein, Dabur *et al.* (2007) reported that water extracts were also effective in reducing fungal growth. This is further contrasted by Bandor *et al.* (2013) who reported that using water in extraction increases impurities which could compromise the quality of the resultant extracts. The difference in results of these studies could be due to the solvent system (Bandor *et al.,* 2013), sensitivity of the test pathogen (Agbenin and Marley, 2012) as well as difference in active compounds found in the plants used (Nashwa and Abo-Elyousr, 2012).

Conclusion and recommendation

From this study it is apparent that the local environment has plants with antimicrobial properties. Comprehensive explorations should be made and more plants with such properties identified. Their active compounds should then be identified and formulated and made available for farmers to use as pesticides. This will reduce the harmful effects of continuously using synthetic pesticides.

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