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Research Article
Sweetpotato Production Practices and *Cylas* species Management Options in Southern Ghana

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Abstract

Background and Objective: *Cylas* species infestation is a serious pest threat to sustainable sweetpotato production in Ghana. For integrated *Cylas* species management, exploiting the potential of entomopathogenic nematodes, noting and appreciating sweetpotato farmers' production practices is essential. Sweetpotato production practices and *Cylas* spp. management options in some major growing areas of southern Ghana were assessed. **Materials and Methods:** Farmer-level structured questionnaire was designed, pretested and used to collect information from 270 respondents employing both qualitative and quantitative techniques. **Results:** Seventy-nine percent of the farmers cultivated local sweetpotato cultivars. Eighty-six percent practiced sole cropping while 47% managed their own planting material from the previous crop. Sixty-nine percent cited *Cylas* species as the most important sweetpotato pest. Ninety-seven percent responded positively to awareness of *Cylas* spp. infestations in sweetpotato production. Major *Cylas* species management options indicated by farmers were; insecticides application, early harvesting, earthing up, crop rotation and weed control in order of significance. Seventy percent (70%) did not manage *Cylas* species infestations in sweetpotato production. **Conclusion:** *Cylas* spp. management with synthetic farm insecticides must be discouraged on grounds of human and environmental health concerns. Biological control, which involves incorporating entomopathogenic nematodes should be encouraged in an integrated pest management system for environmental friendliness.

Key words: Entomopathogenic nematodes, environmental friendliness, *Ipomoea batatas*, IPM, weevil pests, Biological control

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Sweetpotato (*Ipomoea batatas* L. (Lam) provides good ground cover and prevents soil erosion[1]. It has high β-carotene content than any other root and tuber crop[2]. It has numerous medicinal uses which include managing menstrual problems and osteoporosis[3]. Sweetpotato is also used in industrial starch production[4], microbial hydrogen[5]and ethanol fuel production[6].

However, high sweetpotato crop productivity is constrained by *Cylas* spp. infestations. *Cylas* spp. is the most serious biotic threat to sustainable sweetpotato production worldwide. Tuber losses between five and 97% have been recorded in areas where *Cylas* species infestations occur[7]. There is often a positive relationship between vine damage or weevil population density and tuber damage. Major symptom of a heavy infestation is yellowing of the vines and tuber mining by *Cylas* species larvae. Infested storage roots are often riddled with cavities, spongy in appearance and dark in storage root flesh color. This greatly reduces the food and market value of the economic harvest. The tunneling damage caused by *Cylas* species larvae predisposes the storage roots to other soil-borne pathogens. Even low levels of the larvae feeding on tubers induce a chemical reaction that imparts a bitter taste and bad odor to the storage roots[8]. The damage ultimately renders sweetpotato storage roots unwholesome for human and farm animals' consumption.

Entomopathogenic nematodes have the potential for practical biological suppression of *Cylas* spp. Strains of *Steinernema carpocapsae* (Nematoda: Steinernematidae) and *Heterorhabditis bacteriophora* (Nematoda: Heterorhabditidae) penetrate the soil and storage roots to infest and kill storage root damaging *Cylas* species larvae[7]. Entomopathogenic nematodes occur naturally in cropland soils and the infective juveniles are often persistent; remaining active for up to four months. In some cases, entomopathogenic nematodes are more effective than insecticides at reducing damage caused by *Cylas* species in sweetpotato production[9]. Integrating entomopathogenic nematodes in sustainable *Cylas* species management, noting and appreciating sweetpotato farmers' production practices is essential. In this study, sweetpotato production practices in some major growing areas of southern Ghana were assessed especially with regards to options for indigenous management against *Cylas* species.

MATERIALS AND METHODS

A farmer-level structured questionnaire was used to collect data on sweetpotato production practices from farmers employing both qualitative and quantitative techniques[10]. The questionnaire was administered in nine major sweetpotato growing districts in southern Ghana. The study areas covered three regions; Central, Volta and Eastern (Table 1). Two hundred and seventy active sweetpotato farmers were purposely selected as respondents across nine districts (30 respondents per district). Farmer selection was done in collaboration with local Agricultural Extension Agents of Ministry of Food and Agriculture in the respective districts. The survey was conducted between February and May 2017. Data collected were analyzed with SPSS and results presented in tables and graphs.

RESULTS

Across the districts, 71% of the respondents were males (Fig. 1). In the Fanteakwa and Ketu North Districts, 54 and 10% of the farmers respectively, had no formal education (Table 2). In the Ketu North district, 35% of the respondents had cultivated sweetpotato for over 20 years whilst 20% in the Upper Manya Krobo and Upper West Akyem districts had the same wealth of experience in sweetpotato cultivation (Table 3). Sixty-three percent respondents were cultivating

Table 1: Some identifiable characteristics of the surveyed districts

District	Region	Agro ecology	District location
Ketu South	Volta	Coastal Savanna	N6° 08.041' E1° 11.011'
Ketu North	Volta	Coastal Savanna	N6° 08.303' E0° 53.716'
Akatsi South	Volta	Coastal Savanna	N6° 10.721' E0° 52.228'
Abura Asebu Kwamankese	Central	Coastal	N5° 11.152' W1° 15.333'
Twifo Heman Lower Denkyira	Central	Coastal Savanna	N5° 15.281' W1° 21.430'
Komenda Edina Eguafo Abirem	Central	Coastal Savanna	N5° 04.514' W1° 29.465'
Fanteakwa	Eastern	Transitional Forest	N6° 20.466' W0° 21.074'
Upper Manya Krobo	Eastern	Transitional Forest	N6° 22.986' W0° 01.889'
Upper West Akyem	Eastern	Transitional Forest	N5° 47.551' W0° 25.405'

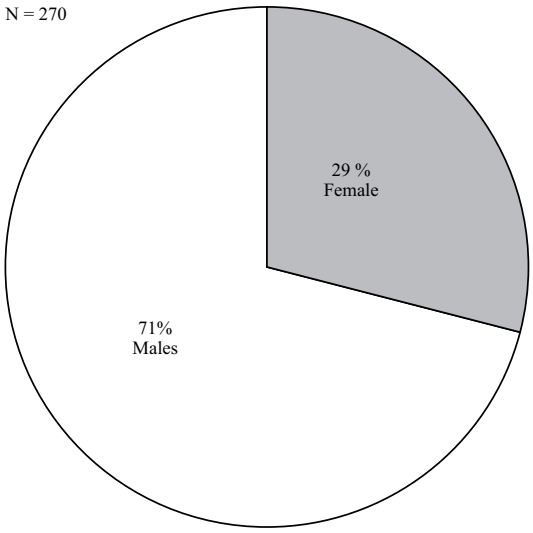

Fig. 1: Distribution of sweetpotato farmers by sex in nine districts of southern Ghana

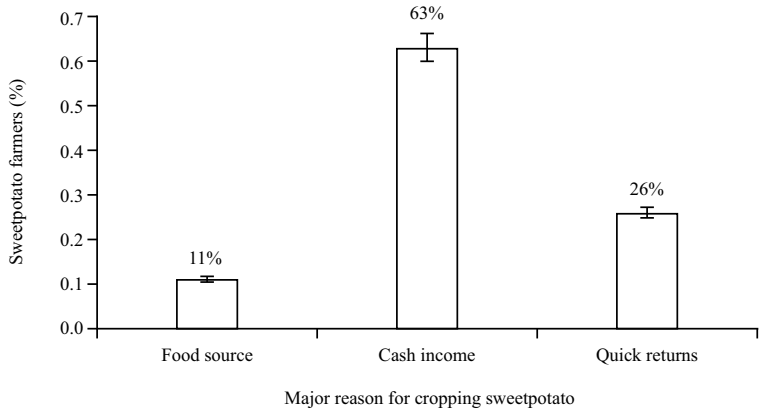

Fig. 2: Reasons why farmers cultivate sweetpotato in nine districts of southern Ghana, N = 270

Table 2: Sweetpotato farmer's formal education levels in nine districts of southern Ghana

	Formal education level (%)			
District	None	Basic	Secondary	Tertiary
Ketu South	7	77	16	0
Ketu North	10	77	13	0
Akatsi South	26	60	10	3
Abura Asebu Kwamankese	33	61	6	0
Twifo Heman Lower Denkyira	33	57	10	0
Komenda Edina Egufo Abirem	13	74	13	0
Fanteakwa	54	43	3	0
Upper Manya Krobo	40	47	7	6
Upper West Akyem	20	60	20	0
Mean	26	62	10	1

N: 30 respondents per district

sweetpotato primarily for cash income whilst, 26% cited "quick returns'' or "early maturing" as the most important reason for growing the crop (Fig. 2).

Averagely, 79% of respondents cultivated local sweetpotato cultivars (Fig. 3). None from Twifo Heman Lower Denkyira district cultivated sweet potato crop above

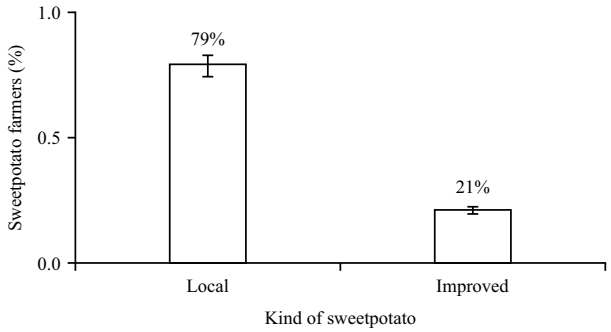

Fig. 3: Kind of sweetpotato grown by farmers in nine districts of southern Ghana, N = 270

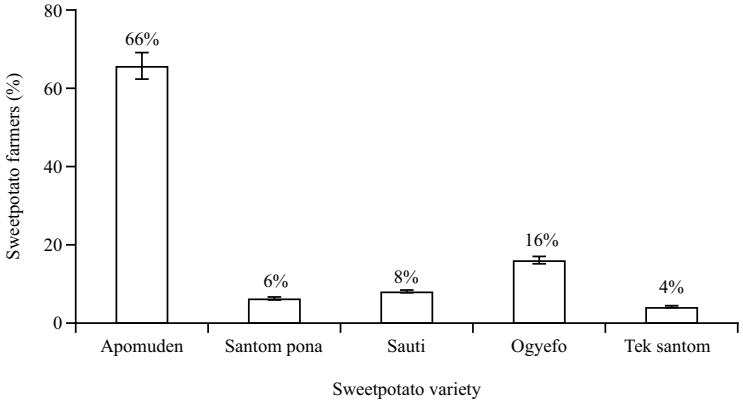

Fig. 4: Adoption of improved sweetpotato cultivars by farmers in nine districts of southern Ghana

Table 3: Percentage of respondents to sweetpotato cultivation experience in nine districts of southern Ghana

	Experience in sweetpotato cultivation (years)				
District	1-5	6-10	11-15	16-20	>20
Ketu South	40	20	13	3	24
Ketu North	17	19	13	16	35
Akatsi South	39	13	22	7	19
Abura Asebu Kwamankese	30	17	13	10	30
Twifo Heman Lower Denkyira	36	23	16	13	12
Komenda Edina Eguafo Abirem	23	33	6	13	25
Fanteakwa	23	23	17	10	27
Upper Manya Krobo	13	17	17	33	20
Upper West Akyem	27	40	10	3	20
Mean	28	23	14	12	24

N: 30 respondents per district

Table 4: Sweetpotato farm size and mode of land preparation across the study area

	Sweetpotato farm size (acres)				Land preparation method		
District	≤0.5	0.6-1	2-4	≥5	Flat plough	Mounds	Ridges
Ketu South	27	30	27	16	3	63	34
Ketu North	7	13	70	10	6	67	27
Akatsi South	40	33	20	7	0	67	33
Abura Asebu Kwamankese	37	30	26	7	6	41	53
Twifo Heman Lower Denkyira	16	37	47	0	3	73	24
Komenda Edina Eguafo Abirem	20	47	20	13	0	53	47
Fanteakwa	13	7	57	23	20	77	3
Upper Manya Krobo	7	40	37	13	3	97	0
Upper West Akyem	17	46	33	4	0	100	0
Mean	20	26	37	10	6	71	25

N: 30 respondents per district, ≤: less than or equal to, ≥: Greater than or equal to

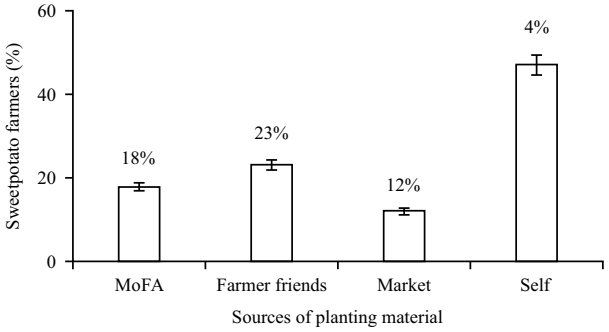

Fig. 5: Sources of farmers' sweetpotato planting material, N = 270

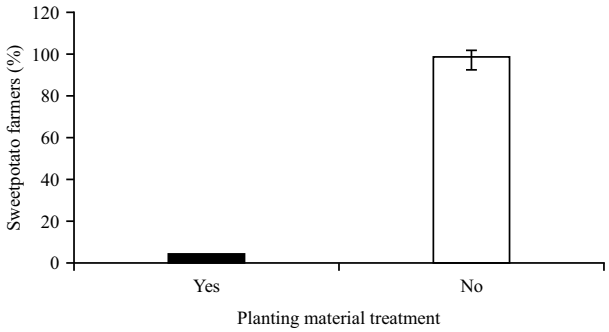

Fig. 6: Farmers responses to sweetpotato planting material chemical treatment prior to planting, N = 270

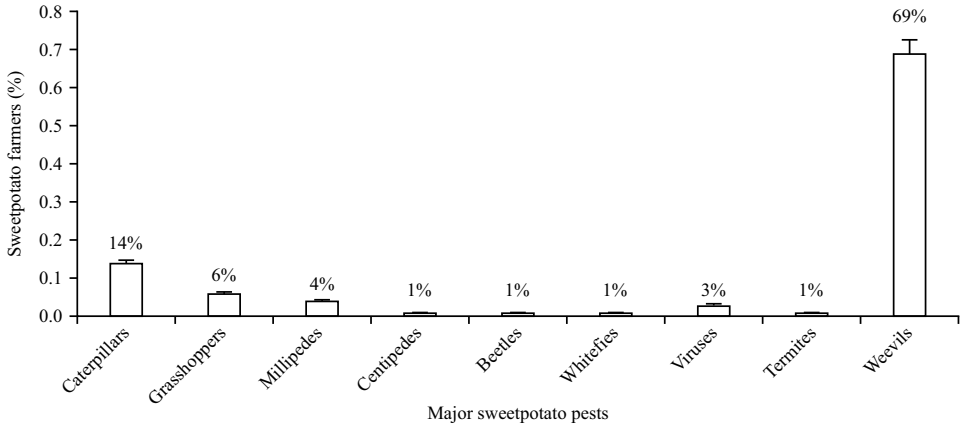

Fig. 7: Farmers responses to major sweetpotato crop pests, N = 270

five acres (Table 4). Land preparation methods employed for growing sweetpotato were flat ploughed, mounds and ridges. In the Akatsi South, Komenda Edina Eguafo Abirem and Upper West Akyem districts, none used flat ploughed to cultivate sweet potato. In the Upper West Akyem district, all the farmers used mounds to cultivate the crop, whilst none used ridging in the Upper Manya Krobo district (Table 4). Six, 8, 16 and 4% were growing Santom Pona, Sauti, Ogyefo and Tek Santom improved sweetpotato varieties, respectively (Fig. 4).

In the Ketu South and Fanteakwa districts, all the farmers practiced sole cropping whilst 93%, 93% and 94% farmers in the Ketu South, Ketu North and Upper West Akyem districts respectively, practiced same (Table 5).

Averagely, 47% of respondents managed their own sweetpotato planting material from the previous crop. Almost 18%, 23% and 12% got their supply from the Ministry of Food and Agriculture, friends and open market, respectively (Fig. 5).

Ninety-seven percent (respondents) did not subject their sweet potato planting material to any form of chemical

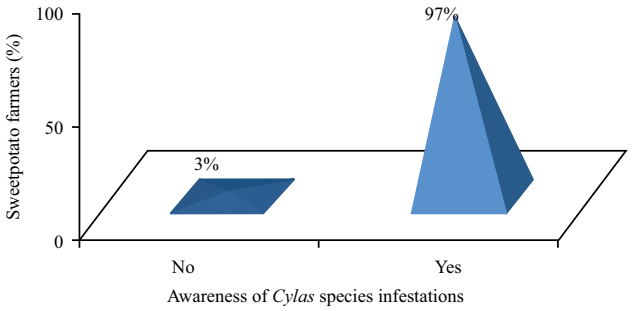

Fig. 8: Farmers awareness of sweetpotato *Cylas* species infestations, N = 270

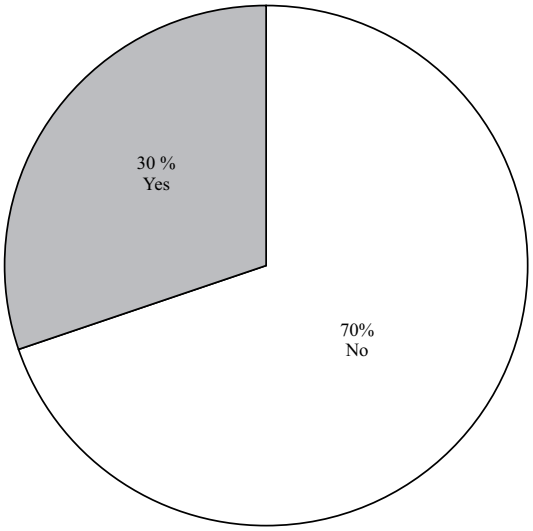

Fig. 9: Farmers responses to *Cylas* species management, N = 270

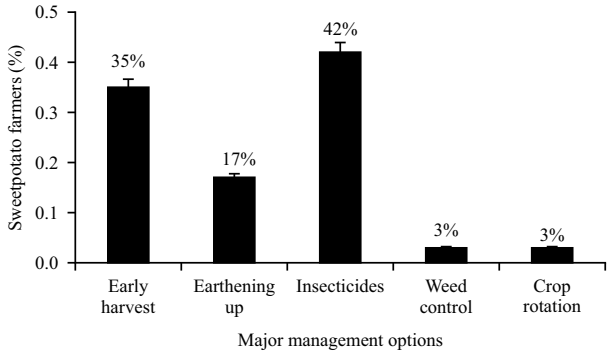

Fig. 10: Farmers responses to major management options against *Cylas* species infestations, N = 81

treatment prior to planting to ward off pre-existing pests and pathogens (Fig. 6).

Farmers responses to major sweetpotato pests across the districts were; weevils (69%), caterpillars (14%), grasshoppers (6%), millipedes (4%), viruses (3%), centipedes (1%), beetles (1%), whiteflies (1%) and termites (1%) (Fig. 7). Ninety-seven percent of the farmers responded positively to awareness of sweetpotato *Cylas* species infestations (Fig. 8).

Table 5: Responses of sweetpotato farmers to various questions by the district in percentage

	Cropping system	rotational cropping		
District	Sole	Mixed	Yes	No
Ketu South	100	0	93	7
Ketu North	83	7	93	7
Akatsi South	77	23	72	28
Abura Asebu Kwamankese	50	50	43	57
Twifo Heman Lower Denkyira	73	27	73	27
Komenda Edina Eguafo Abirem	97	3	33	63
Fanteakwa	100	0	27	73
Upper Manya Krobo	93	7	27	73
Upper West Akyem	97	3	94	6
Mean	86	13	62	17

N: 30 respondents per district

Seventy percent of the respondents never managed *Cylas* species infestations in sweetpotato production (Fig. 9).

DISCUSSION

Majority (71%) of the respondents across the study area were males. Illiteracy rate found among the sweetpotato farmers was below the 46% Ghanaian adult illiteracy rate as cited by Ghana Education Service in 2012. Sixty-six percent of farmers who had adopted improved sweetpotato cultivars were growing Apomuden variety (Orange Fleshed Sweetpotato, a precursor for pro-vitamin A). This may be due to cultural norms that designate sweetpotato as men's crop in the study areas or the drudgery nature of land preparation which may be unbearable for prospective sweetpotato women farmers. In a similar study involving 120 sweetpotato farmers in four districts of Ghana, 69% of the respondents were males[11]. Adoption of improved agricultural practices is positively correlated with education, whether formal or informal[12]. Sweetpotato farming was found to be a lucrative venture as 63% of respondents were cultivating the crop primarily for cash income. However, the profit margin for sweetpotato traders far outweighed that of the farmers due to lack of storage and processing facilities which compelled the farmers to sell off their produce quickly at the farm gate[11]. Land preparation methods recorded agreed with the study of others who posited that sweetpotato in southern Ghana was planted mainly on constructed mounds[13]. Sweetpotato farmers used other land preparation methods but said that planting was easier on mounds than on ridges. Mounding was

prominent in sweetpotato production[11] and most preferable because of the easier harvesting of the produce. Land preparation for sweetpotato cultivation in the southern and middle belt of Ghana consisted of bush burning or tractor ploughing after which hoes and or mattocks were used to prepare mounds[14,15].

Seventy percent of the 120 sweetpotato farmers were aware of improved sweetpotato cultivars out of which 21% cultivated one or more of the improved cultivars[11]. However, earlier findings by others reported non-availability of improved sweetpotato cultivars in the southern and middle belt of Ghana[14]. In the current study, the use of local sweetpotato cultivars for cultivation was common. Similarly, most sweetpotato farmers didn't have access to improved planting materials in southern Benin[16]. All the improved sweetpotato planting materials encountered in the current study were developed by CSIR-Crops Research Institute of Ghana, except Tek Santom which was developed by Kwame Nkrumah University of Science and Technology (KNUST), Ghana. Similarly, Santompona, Sauti, Faara, Okumkom and Apomuden were recorded as improved sweetpotato cultivars being cultivated by farmers in four districts of Ghana[11]. Sole cropping was the most popular sweetpotato cropping system practiced among the 120 sweetpotato farmers[11]. As was found in the current study, *Cylas* species and caterpillars were reported as major insect pests that damaged sweetpotato in Dangbo and Bonou townships of southern Benin[16]. *Cylas* species was also found to be a common pest infesting sweetpotato in Ghana[11].

Significantly, farmers reported of six major sweetpotato production practices with no mention of *Cylas* species management[11]. There is reported lack of adequate methods for managing pests and diseases in sweetpotato production in Benin[16]. In the current study, 70% of the respondents did not practice any management options against *Cylas* species infestations. On the contrary, insecticides were used to control insect pests in sweetpotato production in southern Benin[16]. Actellic 50EC insecticide was reported to be commonly used to manage *Cylas* species in the Twifo-Ati Mokwa district of Ghana[11].

Subsequently, similar studies must be conducted in other major sweetpotato growing areas in other regions of Ghana to give a broader picture of cultivation practices especially with regards to *Cylas* species management. This study would guide Agricultural Extension Workers and other relevant stakeholders on the dissemination of improved sweetpotato production practices to promote integrated management of *Cylas* species in sweetpotato production, highlighting the potential of entomopathogenic nematodes as biological control agents. Hence, it is recommended that sweetpotato farmers should contact their Agricultural Extension Workers in their communities on improved sweetpotato production practices to increase the productivity of the crop. Some of the sweetpotato farmers were highly illiterate across the study areas. This made analyzing some of their responses tedious. Also, some of the respondents were reluctant to respond to the questions asked for fear that nothing would come out of the study just like other earlier research works.

CONCLUSION

For sustainable high sweetpotato crop productivity, *Cylas* species must be managed effectively. *Cylas* species management with synthetic farm chemicals must be discouraged on grounds of human and environmental health concerns. Biological control, especially employing entomopathogenic nematodes should be encouraged in an integrated pest management system for environmental friendliness. Agricultural Extension Agents, Crop Scientists and relevant NGOs should informally educate sweetpotato farmers on improved production practices that would promote biological control of *Cylas* species to minimize reliance on synthetic farm chemicals.

SIGNIFICANCE STATEMENT

This study discovered that *Cylas* species management that can be beneficial for increased sweetpotato crop productivity is regrettably unpopular in sweetpotato production in Ghana. This study will help researchers to uncover the critical areas of exploring entomopathogenic nematodes in an integrated management system against *Cylas* species in sweetpotato production that many researchers were not able to explore. Thus, a new theory on applying entomopathogenic nematodes in *Cylas* species management may be arrived at.

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