Prevalence of fungal infections in pest insects of stored wheat in Turkey

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Abstract

In order to find stored product pest insects infected by entomopathogenic fungi, 427 wheat samples were gathered from grain stores in five cities (Adana, Mersin, Kahramanmaraş, Konya, Şanlıurfa) in Turkey between June and October in 2013. After insects in the samples were separated and identified, live insects were returned to the grains for one month of incubation. Dead insects gathered in the first examination and the ones found after the incubation period were used to isolate entomopathogenic fungi. During the study, 116 fungi were isolated from 96 insect populations in 65 wheat samples. *Beauveria* species were the most common and only additional 11 *Isaria* were isolated. The highest infection prevalence was in the populations from Adana (17.3 %) and Mersin (9.3 %), where humidity is higher than the others. Infections were greatest in *Sitophilus oryzae* (14.4%), *Cryptolestes ferrugineus* (11.3%), *Tribolium castaneum* (10.9%) and *Rhizopertha dominica* (9.5%) populations. Overall infection prevalence in the populations was highest in the samples gathered in September (14.9%) followed by those in November (10.3%). Furthermore, population levels were also found to have a significant role in the prevalence with the higher chance of finding infections in more dense populations. Four factors; location, host species, time and population level, were demonstrated to be important in the entomopathogenic fungal infection prevalence.

Keywords: entomopathogenic fungi, biological control, survey, stored product pests

1. Introduction

Stored grain loss due to pest insect infestations is a globally important concern (Subramanyam and Hagstrum, 1995). Average loss of stored products is commonly considered to be around 10%, though according to Prevett (1975) it can reach up to 50% depending on geographical position and its conditions. Half of the commonly accepted 10% loss is considered by Esin (1971) to be due to insect pests. Currently, the control of these pests in stored products is based mainly on the use of chemical insecticides. Application of these chemicals can be hazardous due to their toxicity, their residues on final products and environmental considerations (Arthur, 1996). These together with ever increasing consumers' demand for residue-free products directed more researches to investigate alternative control strategies (Inglis et al., 1997; Lomer et al., 2001). One of the most promising alternatives is the use of microbial control agents including entomopathogenic fungi as a biological control technique (Shams et al., 2011). Numerous studies established that entomopathogens provide potential for suppressing various insect pests of stored products (e.g. Adane et al., 1996; Hidalgo et al., 1998; Rice & Cogburn, 1999; Sheeba et al., 2001; Cherry et al., 2005). In this study a survey was conducted to determine extent of entomopathogenic fungi in pest populations in stored wheat in Turkey. Factors affecting prevalence were also evaluated.

2. Materials and Methods

427 wheat samples were gathered from grain stores in five cities (Adana, Mersin, Kahramanmaraş, Konya and Şanlıurfa) in Turkey between June and October in 2013. After insects in the samples were separated and identified, live insects were returned to the grains for one month of incubation at $26\pm2^{o}C$, $65\pm5\%$ r.h. in total darkness. Dead insects gathered in the first examination and the ones found after the incubation period were used to isolate entomopathogenic fungi. Dead insects were subjected to surface sterilization prior to incubation in humidity chamber at $25\pm2^{o}C$. Those populations with insects on which entomopathogeic fungi grew and sporulated (Figure 1) were used to find the prevalence of fungal infections. Effects of location, host species, time and population levels were evaluated. Pairwise chi square tests with Yates correction for continuity were used to determine differences (significance level: 0.05).

Figure 1 *Beauveria bassiana* sporulating on *Sitophilus oryzae* adults died due to fungal infection.

3. Results and Discussion

During the study, 116 fungi were isolated from 96 insect populations in 65 wheat samples. *Beauveria* species were the most common and only additional 11 *Isaria* were isolated. The highest infection prevalence was in the populations from Adana (17.3%) and Mersin (9.3%), where humidity is high (Table 1). These two cities are located at the Mediterranean Sea while the others are inland. The only city with statistically higher prevalence was Adana (x^2= 5.52 - 16.01). Prevalence was highest in *Sitophilus oryzae* (14.4%), *Cryptolestes ferrugineus* (11.3 %), *Tribolium castaneum* (10.9%) and *Rhizopertha dominica* (9.5%) populations (Tables 1-2). The only statistically significant difference was between *O. surinamensis* and *S. oryzae* populations (x^2= 5.74). Overall infection prevalence in the populations was highest in the samples gathered in September (14.9%) followed by those in November (10.3%) (Table 2). Prevalence in samples collected in September was significantly higher than those in June (x^2= 5.01), July (x^2= 4.56) and October (x^2= 4.34). Furthermore, population levels were also found to have a role in the prevalence with the higher chance of finding infections in more dense populations. Those samples with less than 100 insects in each showed 3.55 % infection prevalence while the samples with 100-1000 insects and those with more than 1000 insects resulted with 12.99% and 33.33% infection prevalences respectively.

Table 1   Prevalence of fungal infections in insect populations according to sampling locations in June-November, 2013.

Insect species	Prevalence according to locations (%)						TNE*
	Adana	K. Maraş	Konya	Mersin	Şanlıurfa	Overall	
Cryptolestes ferrugineus	18.5	0.0	12.5	7.7	16.7	11.3	159
Latheticus oryzae	16.7	0.0	0.0	0.0	7.7	5.3	38
Oryzaephilus surinamensis	13.6	2.4	0.0	3.6	0.0	5.1	156
Rhyzopertha dominica	13.5	10.2	6.7	5.9	8.6	9.5	200
Sitophilus granarius	-	20.0	0.0	0.0	0.0	3.6	28
Sitophilus oryzae	23.7	6.9	0.0	16.1	0.0	14.4	111
Sitophilus sp.	13.3	0.0	0.0	15.4	0.0	7.0	57
Tribolium castaneum	20.5	6.5	4.7	15.0	7.1	10.9	201
Tribolium confusum	0.0	6.3	0.0	0.0	0.0	4.2	24
Tribolium sp.	16.7	0.0	0.0	0.0	0.0	5.3	19
Trogoderma granarium	0.0	0.0	12.5	0.0	12.5	8.7	23
Trogoderma sp.	0.0	-	16.7	0.0	-	9.1	11
Cryptophagidae	50.0	0.0	0.0	0.0	-	16.7	6
Overall	17.3	5.4	5.0	9.3	6.3	9.3	1033

*TNE: Total number of populations examined.

4. Conclusions

Fungal infections were not found to be common in the populations examined in this study. Although a gradual increase in prevalence was observed in time, only in September was it statistically higher than those of other three months. The higher prevalence in cities with higher humidity level was both due to the requirement of high humidity for fungal infections to occur, and the abundance of insects in these cities in comparison to the others. In this study, four factors; location, host species, time and population level, were demonstrated to be important in the entomopathogenic fungal infection prevalence in insect pest populations in stored wheat.

Table 2 Prevalence of fungal infections in insect populations according to sampling time in 2013.

Insect species	Prevalence according to sampling time (%)						
	June	July	August	September	October	November	Overall
Cryptolestes ferrugineus	0.0	9.1	6.7	23.3	9.1	12.5	11.3
Latheticus oryzae	0.0	0.0	0.0	12.5	0.0	20.0	5.3
Oryzaephilus surinamensis	0.0	5.9	6.5	6.9	3.0	5.7	5.1
Rhyzopertha dominica	5.9	4.0	11.8	17.9	2.4	11.4	9.5
Sitophilus granarius	0.0	0.0	0.0	14.3	0.0	0.0	3.6
Sitophilus oryzae	10.0	0.0	21.7	15.4	16.7	20.0	14.4
Sitophilus sp.	-	-	-	13.3	4.8	4.8	7.0
Tribolium castaneum	11.8	10.0	5.4	12.8	15.4	10.2	10.9
Tribolium confusum	0.0	10.0	0.0	0.0	0.0	0.0	4.2
Tribolium sp.	0.0	0.0	0.0	-	100.0	0.0	5.3
Trogoderma granarium	0.0	25.0	0.0	0.0	0.0	14.3	8.7
Trogoderma sp.	-	50.0	0.0	0.0	0.0	0.0	9.1
Cryptophagidae	-	0.0	0.0	100.0	0.0	-	16.7
Overall	5.2	6.6	8.2	14.9	7.8	10.3	9.3

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