

Table 1 Natural enemies of *Tribolium castaneum*

Type	Species	Reference
	Natural occurrence	
Bacteria	<i>Bacillus thuringiensis</i> Berliner	Saravanan and Gujar 2006
Bacteria	<i>Rickettsia</i> , <i>Spiroplasma</i>	Goodacre et al. 2015
Bacteria	<i>Wolbachia</i>	Rasool et al. 2019
Protozoa	<i>Adelina tribolii</i> Bhatia	Burges and Weiser 1973
Protozoa	<i>Adelina tribolii</i> Bhatia	Njila and Mwansat 2012
Protozoa	<i>Adelina tribolii</i> Bhatia	Purrini 1976
Protozoa	<i>Adelina tribolii</i> Bhatia	Weiser 1953
Protozoa	<i>Eliptocystis triboli</i> Sengupta, Ghosh, Haldar	Sengupta, Ghosh&Haldar91
Protozoa	<i>Farinocystis tribolii</i> Weiser	Burges and Weiser 1973
Protozoa	<i>Farinocystis tribolii</i> Weiser	Laird 1959
Protozoa	<i>Farinocystis tribolii</i> Weiser	Martin and Champ 1964
Protozoa	<i>Farinocystis tribolii</i> Weiser	Njila and Mwansat 2012
Protozoa	<i>Farinocystis tribolii</i> Weiser	Purrini 1976
Protozoa	<i>Farinocystis tribolii</i> Weiser	Rabindra and Subraman 1974
Protozoa	<i>Farinocystis tribolii</i> Weiser	Tyler 1962
Protozoa	<i>Farinocystis tribolii</i> Weiser	Weiser 1953
Protozoa	<i>Gregarina basiconstrictonea</i> Ghose, Sengupta and Haldar	Ghose et al. 1986
Protozoa	<i>Gregarina crassa</i> Ishii	Ishii 1914
Protozoa	<i>Gregarina cuneata</i> Stein	Burges and Weiser 1973
Protozoa	<i>Gregarina minuta</i> Ishii	Ishii 1914
Protozoa	<i>Hirmocystis oxecta</i> Ghose, Sengupta and Haldar	Ghose et al. 1986
Protozoa	<i>Hirmocystis triboli</i> Ghose and Haldar	Ghose and Haldar 1989
Protozoa	<i>Paranosema whitei</i> (Weiser)	Burges and Weiser 1973
Protozoa	<i>Paranosema whitei</i> (Weiser)	Njila and Mwansat 2012
Protozoa	<i>Paranosema whitei</i> (Weiser)	Purrini 1976
Protozoa	<i>Paranosema whitei</i> (Weiser)	Sokolova et al. 2005
Protozoa	<i>Paranosema whitei</i> (Weiser)	Weiser 1953
Protozoa	<i>Steinina obconica</i> Ishii	Ishii 1914
Fungi	<i>Aspergillus flavus</i> Link	Bosly and El-Banna 2015
Fungi	<i>Aspergillus fumigatus</i> Fresenius	Bosly and El-Banna 2015
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Er et al.2016
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Bosly and El-Banna 2015
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Wakil et al. 2014
Fungi	<i>Hirsutella versicolor</i> Petch	Bosly and El-Banna 2015
Fungi	<i>Lecanicillium attenuatum</i> (Zare and W. Gams)	Wakil et al. 2014
Fungi	<i>Lecanicillium lecanii</i> Zare and Gams	Bosly and El-Banna 2015
Fungi	<i>Metarhizium anisopliae</i> (Metschnikoff) Sorokin	Wakil et al. 2014
Fungi	<i>Penicillium capsulatum</i> Raper, K.B.; Fennell, D.I.	Wakil et al. 2014
Fungi	<i>Penicillium chrysogenum</i> Thom	Wakil et al. 2014
Fungi	<i>Purpureocillium lilacinum</i> (Thorn) Samson	Er et al.2016
Fungi	<i>Purpureocillium lilacinum</i> (Thorn) Samson	Wakil et al. 2014
Acari	<i>Acarophenax tribolii</i> Newstead and Duval	Allen 1967
Acari	<i>Acarophenax tribolii</i> Newstead and Duval	Champ 1966b
Acari	<i>Blattisocius keegani</i> (Fox)	Barker 1967
Coleoptera	<i>Teretrius nigrescens</i> (Lewis)	Camara et al. 2003

Hemiptera	<i>Amphibolus venator</i> (Klug)	Pingale 1954
	Laboratory efficacy	
Bacteria	<i>Bacillus cereus</i> Frankland and Frankland	Kumari and Neelgund 1985
Bacteria	<i>Bacillus subtilis</i> Cohn	Kumari and Neelgund 1985
Bacteria	<i>Bacillus thuringiensis</i> Berliner subsp <i>kurstaki</i>	Ahmedani et al. 2008
Bacteria	<i>Bacillus thuringiensis</i> Berliner	Elgizawy and Ashry 2019
Bacteria	<i>Bacillus thuringiensis</i> Berliner subsp <i>tenebrionis</i>	Mummigatti et al. 1994
Bacteria	<i>Klebsiella aerogenes</i> (Hormaeche and Edwards)	Kumari and Neelgund 1985
Bacteria	<i>Enterobacter cloacae</i> (Hormaeche and Edwards)	Kumari and Neelgund 1985
Bacteria	<i>Proteus mirabilis</i> Hauser	Kumari and Neelgund 1985
Bacteria	<i>Proteus vulgaris</i> Hauser	Kumari and Neelgund 1985
Bacteria	<i>Pseudomonas entomophila</i> Mulet et al.	Biswas et al. 2018
Protozoa	<i>Adelina tribolii</i> Bhatia	Alfazairy et al. 2020
Protozoa	<i>Adelina tribolii</i> Bhatia	Park 1948
Protozoa	<i>Adelina tribolii</i> Bhatia	Park and Frank 1950
Protozoa	<i>Farinocystis tribolii</i> Weiser	Alfazairy et al. 2020
Protozoa	<i>Farinocystis tribolii</i> Weiser	Rabindra et al 1983
Protozoa	<i>Gregarina cuneata</i> Stein	Gigliolli et al 2016
Protozoa	<i>Gregarina triboliorum</i> Watwood, Janovy, Peterson&Addison	Watwood et al. 1997
Protozoa	<i>Lymphotropha tribolii</i> Ashford	Ashford 1970
Protozoa	<i>Paranosema whitei</i> (Weiser)	Fisher and Sanborn 1962
Protozoa	<i>Paranosema whitei</i> (Weiser)	Milner 1972
Protozoa	<i>Paranosema whitei</i> (Weiser)	Milner 1973a
Protozoa	<i>Paranosema whitei</i> (Weiser)	Milner 1973b
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Akmal et al. 2020
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Golshan et al. 2013
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Hussein et al. 2013
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Khashaveh 2011
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Padin et al. 1997
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Rice and Cogburn 1999
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Wakil et al. 2014
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Zamani et al. 2013
Fungi	<i>Calvatia carniiformis</i> (Schwein.) Fr. ex De Toni	Hussein et al. 2013
Fungi	<i>Isaria farinosa</i> (Holmskjold) Fries	Sabbour 2014
Fungi	<i>Isaria fumosoroseus</i> Wise	Akmal et al. 2020
Fungi	<i>Isaria fumosoroseus</i> Wise	Ramaswamy et al. 2009
Fungi	<i>Isaria fumosoroseus</i> Wise	Sabbour 2014
Fungi	<i>Lecanicillium attenuatum</i> (Zare and W. Gams)	Wakil et al. 2014
Fungi	<i>Lecanicillium lecanii</i> Zare and Gams	Broumandnia and Ali 2020
Fungi	<i>Lecanicillium lecanii</i> Zare and Gams	Sabbour 2014
Fungi	<i>Lecanicillium muscarium</i> (Petch) Zare and Gams	Broumandnia and Ali 2020
Fungi	<i>Lecanicillium muscarium</i> (Petch) Zare and Gams	Hussein et al. 2013
Fungi	<i>Metarhizium anisopliae</i> (Metschnikoff) Sorokin	Batta and Safieh. 2005
Fungi	<i>Metarhizium anisopliae</i> (Metschnikoff) Sorokin	Khashaveh and Chelav 2013
Fungi	<i>Metarhizium anisopliae</i> (Metschnikoff) Sorokin	Wakil et al. 2014
Fungi	<i>Nomuraea rileyi</i> (Farlow) Sampson	Sabbour 2014
Fungi	<i>Penicillium</i> sp	Al-Keridis 2016
Fungi	<i>Purpureocillium lilacinum</i> (Thorn) Samson	Wakil et al. 2014
Nematodes	<i>Heterorhabditis bacteriophora</i> Poinar	Shahina and Salma 2011
Nematodes	<i>Heterorhabditis indica</i> Poinar, Karunakar and David	Shahina and Salma 2011

Nematodes	<i>Steinernema abbasi</i> Elawad, Ahmad and Reid	Shahina and Salma 2011
Nematodes	<i>Steinernema asiaticum</i> Anis, Shahina, Reid and Rowe	Shahina and Salma 2011
Nematodes	<i>Steinernema carpocapsae</i> (Weiser)	Ramos-Rodríguez et al. 2006
Nematodes	<i>Steinernema feltiae</i> (Filipjev)	Ramos-Rodríguez et al. 2006
Nematodes	<i>Steinernema feltiae</i> (Filipjev)	Shahina and Salma 2011
Nematodes	<i>Steinernema masoodi</i> Ali, Shaheen, Pervez, Hussain	Ahmad et al. 2010
Nematodes	<i>Steinernema pakistanense</i> Shahina, Anis, Reid and Maqbool	Shahina and Salma 2011
Nematodes	<i>Steinernema riobrave</i> Cabanillas, Poinar and Raulston	Ramos-Rodríguez et al. 06,07
Nematodes	<i>Steinernema siamkayai</i> Stock, Somsook and Reid	Shahina and Salma 2011
Acari	<i>Acarophenax lacunatus</i> (Cross & Krantz)	Oliveira et al. 2003a,b
Acari	<i>Acarophenax lacunatus</i> (Cross & Krantz)	Oliveira et al. 2006a,b
Acari	<i>Acarophenax lacunatus</i> (Cross & Krantz)	Oliveira et al. 2007
Acari	<i>Acarophenax tribolii</i> Newstead and Duval	Lopez et al 2005
Acari	<i>Acaropsis docta</i> (Berlese)	Somchaudhary&Mukherjee71
Acari	<i>Blattisocius tarsalis</i> (Berlese)	Haines 1981
Acari	<i>Blattisocius tarsalis</i> (Berlese)	Riudavets et al. 2002
Acari	<i>Cheyletus malaccensis</i> Oudemans	Cebolla et al. 2009
Acari	<i>Pyemotes tritici</i> (Lagreze-Fossat and Montagne)	Bruce and LeCato 1979
Hemiptera	<i>Amphibolus venator</i> (Klug)	Hussain and Aslam 1970
Hemiptera	<i>Joppeicus paradoxus</i> Puton	Miyanoshta et al, 2003
Hemiptera	<i>Lyctocoris beneficus</i> (Hiura)	Chu 1969
Hemiptera	<i>Lyctocoris campestris</i> (F.)	Parajulee et al. 1994
Hemiptera	<i>Lyctocoris campestris</i> (F.)	Parajulee and Phillips 1993
Hemiptera	<i>Peregrinator biannulipes</i> Montrouzier & Signoret	Kang et al. 1984
Hemiptera	<i>Peregrinator biannulipes</i> Montrouzier & Signoret	Kengkanpanich et al. 2006
Hemiptera	<i>Peregrinator biannulipes</i> Montrouzier & Signoret	Yao et al. 1982
Hemiptera	<i>Rhynocoris albopilosus</i> Signoret	Kwadjo et al. 2013
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Ardjoune et al, 2008
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Donnelly and Phillips 2001
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	LeCato and Davis 1973
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	LeCato and Collins 1976
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Rahman et al. 2009
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Russo et al. 2004
Hemiptera	<i>Xylocoris galactinus</i> (Fieber)	Chu 1969
Hymenoptera	<i>Anisopteromalus calandrae</i> (Howard)	Binoy 2015
Hymenoptera	<i>Cephalonomia tarsalis</i> (Ashmead)	Asl et al. 2009
Hymenoptera	<i>Holepyris sylvanidis</i> (Brèthes)	Amante et al. 2018
Hymenoptera	<i>Sclerodermus immigrans</i> Bridwell	Bridwell 1920
Hymenoptera	<i>Trichogramma chilonis</i> Ishii	Murali-Baskaran et al. 1993
Field efficacy		
Bacteria	<i>Bacillus thuringiensis</i> Berliner	Magda and Moharam 2014
Fungi	<i>Beauveria bassiana</i> (Balsamo) Vuillemin	Wakil and Schmitt 2015
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Brower and Press 1992
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	LeCato et al. 1977
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Press et al. 1975
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Press et al. 1978
Hemiptera	<i>Xylocoris flavipes</i> (Reuter)	Press et al. 1979
Hymenoptera	<i>Holepyris sylvanidis</i> (Brèthes)	Adler et al. 2012a, b
Hymenoptera	<i>Theocolax elegans</i> (Westwood)	Flinn et al. 2006