

Acknowledgment

"

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

SUMMARY

/ /

/ /

Tribolium castaneum (Herbst)

(4, 8 Dimethyl decanal)

.

% , ,

%

% ,

. ()

% , ()

.

/

/

. % , ,

.



- - -

- - -

- - -

-

- - -

- - -

- - -

- - -

-

- - -

- - -

- - -

-

-

-

- - -

-

-

- - -

- - -



- -

- -

- -

-

- -

- -

- -

- -

-

-

-

-

-

-

-

-

-

-

-



-

-

-

-

-

-

-

-

-

-

-

-

-

-

-

-





(/)

/

Introduction

()

()

()

()

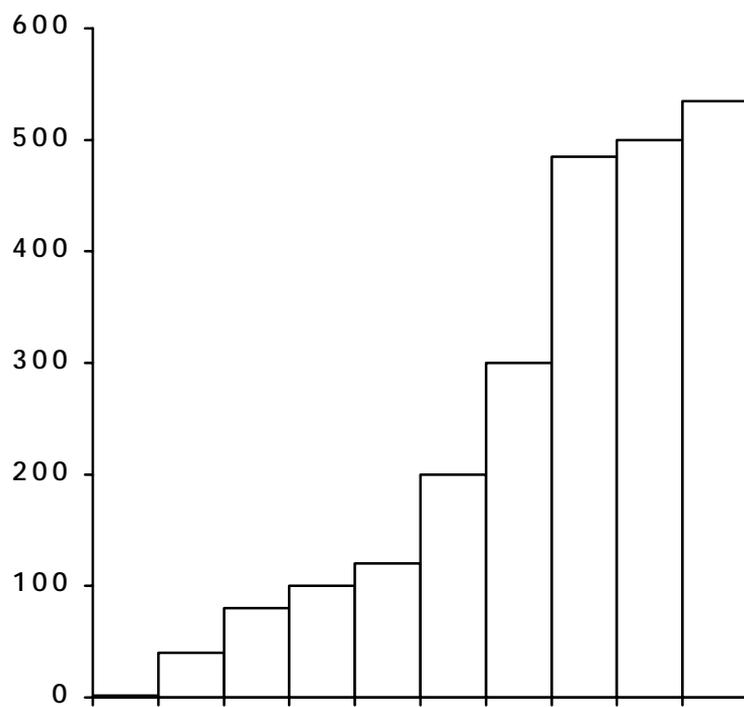
()

Davidson and Lyon (1979)

%

()

**Frederick (1976), Calvin (1972), Thomas and Brogdon (1987),
Starratt and Bond (1990)**



() (/) ()

***Tribolium castaneum* Herbst**

.

Literature Review

-

- -

Hall (1970)

Hall (1970)

Anderson and

Alcock (1954)

()

- -

()

()

Hall (1970) ()

%

Hall (1970)

Sinha and Wallace . %

% %

(1977)

(Damp grain heating)

Sinha (1963)

.(Dry grain heating)

() Hall (1970) Sinha (1963)

Oxley (1948)

% , ,

Pederson et al. (1977)

. % , % , % ,

Hall (1970)

%

-

()

·

Danald and Robert (1985) .

Davidson and Lyon .

(1979)

Hall (1970) %

. % % %

Graham (1970) . %

% ,

. %

Danald and

Robert (1985)

Cotton and Good (1937)

Danald and Robert (1985)

- :

Sitophilus oryzae L.

S. granarius L.

Sitotroga cereallella (Oliv.)

Rhizopertha dominica (F.)

Trogoderma granarium (Everts)

Callosobruchus chinensis L.

Bruchidius incarantus (Boh)

B. rufimanus (Boh)

B. lentis (Forel)

B. trifolii (Mots)

Oryzaephilus surinamensis L.
Ephestia ruehsidlla (Zello)
Plodia interpunctella (Hubn.)
Pyralis farinalis L.
Tina granella L.
Corcyra cephalonica (Staint)
Cryptolestes ferrugineus (Steph)
Tribolium castaneum (Herbst)
T. confusum Duval
Latheticus oryzae Waterch
Tenebroides mauritanicus L.
T. nades Charp
Lasioderma serricorne (F.)
Stegobium pariceum (L.)
Tenebrio molitor (L.)

Awadallah et al. (1985)

<i>T.</i>		<i>T. castaneum</i>	
<i>C.</i>	<i>E. ruehsidlla</i>		<i>confusum</i>
		Mills and White (1994)	<i>cephalonica</i>

T.

. *castaneum*

- -

()

Mostafa et al. () ()

(1981)

Rostom (1993)

%

R.

T. granarium

dominica

Mostafa et al. (1981)

. ()

*

: ()

Lepidoptera	Gelechiidae	<i>Sitotroga cerealella</i> (Oliv.)			-
		<i>Corcyra cephalonica</i> (Staint)		- -	
	Pyralidae	<i>Plodia interpunctella</i> (Hubn.)			
		<i>Anagasta kuehniella</i> (Zello)			
		<i>Ephestia cautella</i> Walker			- -
Coleoptera	Curculionidae	<i>Sitophilus oryzae</i> L.			- - -
		<i>S. granarius</i> L.		- -	- -
		<i>S. zeamais</i> (Motsch.)		- -	
	Tenebrionidae	<i>Latheticus oryzae</i> (Waterch)			- -
		<i>Tribolium castaneum</i> (Hbst.)			- -
		<i>T. confusum</i> (Duval)			-
		<i>T. destructor</i> Uyttenb.		-	
		<i>Tenebrio molitor</i> (L.)			
		<i>Alphitobius diaperinus</i> (Panz)			
		<i>A. leavigatus</i> (F.)			
	Bostrychidae	<i>Rhizopertha dominica</i>			- -
	Bruchidae	<i>Bruchus rufimanus</i> (Boh)		- -	

()

		<i>B. incarnatus</i> (Boh)			- -
		<i>Callosobruchus chinensis</i> L.			- -
		<i>C. maculatus</i> (F.)			- - -
	Trogositidae	<i>Tenebrioides mauritanicus</i> L.			
	Cleridae	<i>Necrobia rufipes</i> (De Geer)			
	Silvanidae	<i>Oryzaephilus mercator</i> (Fauv.)			-
		<i>O. surinamensis</i> (L.)			
	Dermestidae	<i>Trogoderma glabrum</i> (Hbst.)			
		<i>T. granarium</i> (Everts)			
		<i>Dermestes maculatus</i> (De Geer)			
		<i>Attagenus magatoma</i> (F.)			
	Anobiidae	<i>Lasioderma serricorne</i> (F.)			
		<i>Stegobium paniceum</i> (L.)			
	Ptinidae	<i>Mezium americanum</i> (Leporte)			

Mostafa et al. (1981) *

-

- -

Tribolium

. **Coleoptera**

Tenebrionidae

()

Good (1936)

Freeman (1962)

Howe (1956)

Dyte (1961 and 1965)

()

Mostafa *et al.* (1981)

Aldryhim and Alyousif (1992)

- -

()

()

()

-

Park (1933)

Good (1936)

Hinton

(1948)

()

()

()

Gray (1948) Howe (1956)

-

- -

() ()

-
.
-
.Howe (1956)

%

Holdaway (1932)

. %

Good Gray (1948) Lyall (1968) Mickel and Standish (1946)

Park and Frank (1948) Miller (1944) (1936)

Al-Khalifa (1981)

Al-Khalifa (1987 and 1988)

Howe (1956) Mickel and Standish (1946)

%

Khalifa and Badawy (1955) Park and Frank (1948) Good (1936)

Park and Noskin (1947)

. % - ,
% %
Young (1970) . %

Dawson (1964)

. %
()

()

White (1982)

Mickel and Standish (1946) Abdel Samad et al. (1988)

Birch (1947)

Kim *et al.* (1988)

White

(1988)

Desmarchelier Amos *et al.* (1986)

Sinha *et al.* (1988) (1988)

- -

Weidner (1984)

Hall (1970)

Page and Bubatti (1963)

(Residual

. effect)

Samson and Parker (1989)

%

/

“Fenitrothion”

/

“Pirimiphos methyl”

.

Chlorpirifos-methyl

Daglish *et al.* (1992)

Methacrifos

Deltamethrin

Malathion

Pirimiphos-methyl

/

%

(Deltamethrin)

(Malathion)

Elliott and Janes (1973)

(Pyrethroids)

Barlow *et al.* (1971)

Hadaway (1972)

Anon (1973)

Champ and Campbell (1970)

Shakoori *et al.* (1988)

.

Hole *et al.* (1976)

(Phosphine)

Bond and Morse (1982)

Bond (1980)

Price and Mills (1988)

Chang and Dyte (1976) Howe (1968)

Bond (1980)

Bond (1978)

Rajendran and Muthu (1989)

(Ethylene

(Methyl iodide)

dibromide)

Bell *et al.* (1988)

%

(Aerosol) Arthur (1993)
% , % (Parllethrin aerosol)
% ,
/ ,
%
/ ,
Oryzaephilus surinamensis
%

Anon .

Graham (1970) (1973)
Boon and Ho (1988) .

. (Methyl Bromide)

-
- -

Noling and Becker (1994)

- -

Noling and Becker Grahl (1992)

Majewski *et al.* (1995) Taylor (1994) (1994)

Taylor (1994) Grahl (1992)

Yagi *et al.* (1995)

%

Majewski *et al.* (1995)

Yagi *et al.* (1995)

%

Gan *et al.* (1994)

Buffin (1992)

/

%

Weare (1995)

Mano and

Andreae (1994)

. / -

%

- -

Noling and Becker

Silver (1994) Buffin (1992) (1994)

Buffin (1992)

- - -

Barry (1994) Ebeling (1971)

Aldryhim (1990)

Shawir et Le Patourel and Singh (1984)

al. (1988)

Edwin *et al.* (1992) Saxena *et al.* (1992)

Saim and Jilani and Su. (1983) Malik and Mujtaba (1984)

Meloan (1986)

Hafez *et al.* (1988)

***Blattisocius* sp.**

Mohsin (1979) O'Brien and Wolfe (1964)

Raghavan *et al.* Mitlin and Wiygul (1970) Mayer *et al.* (1975)

Buscarlet *et al.* (1986) Richardson and Myser (1973) (1976)

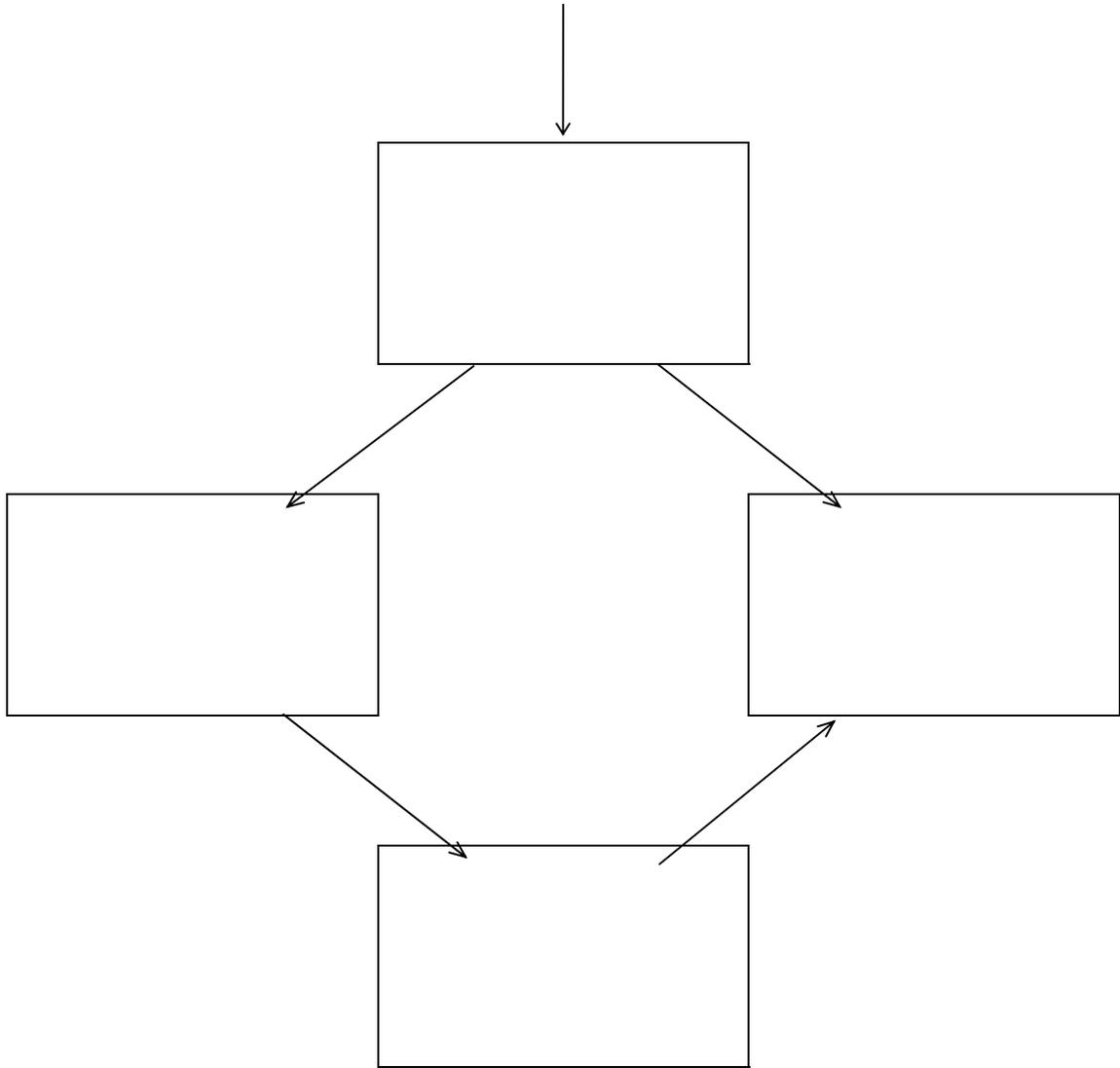
-

- -

Wilson (1963)

Wilson (1963)

()



()

(Wilson 1963)

Karlson and Butenandt (1959)

. (Hormon)

(Pheroin)

.

Shorey and Mc Kelvey (1977)

(Allomone)

-: (Kairomone)

: _____

.

: _____

.

: _____

.

- -

Michael (1980)

- -

Sex Pheromone

-

Brich and Haynes (1982)

Rangaswamy and Sasikala (1991)

Maissa *et al.* (1987)

-

Maissa et al. (1987)

-

Maissa et al.

(1987)

Aggregation Pheromone

-

Brich and Haynes (1982)

Faustini et al. Suzuki (1980) Suzuki and Sugawara (1977)

(1981)

Obeng-Ofori and Coaker (1990a)

- - - ,

-

%

Rangaswamy *et al.* (1988)

(Ethyl decanoate)

(Methyl decanoate)

(Decanoic acid)

(Decanol)

% % %

% %

Obeng-Ofori and Coaker (1990a)

%

4-

Javer *et al.* (1990)

8-dimethyl decanal

Mondal

(1986)

(Methyl Quinone)

Mondal (1987, 90, 93)

(Methyl Quinone)

4-8-dimethyl decanal

Mondal

(1988)

(Methyl Quinone)

(Primiphos methyl)

(Primiphos methyl)

(Methyl Quinone)

Burkholder (1979)

Burkholder (1979)

Trogoderma granarium

Shapas *et al.* ()

Qayyum (1979) Khorramshahi and Burkholder (1980) (1977)

-

-

-

-

-

-

-

Materials and Methodology

-

/ /

/ /

Materials

-

- -

,

,

. ()

.

,

.

,

.

.

()

-

-

-

- -

(4, 8 Dimethyl decanal) *T. castaneum*

. () **Zoecon**

- -

,

. () .

- -

(Hard Wheat)

() ()

. /

()

-

-

()

- -

T. castaneum

Sitophilus granarius

. %

±

. % ±

.

-

- -

()

()

()

()

			//	
			//	
			//	
			//	
x			//	
(±)			//	
	() ()		//	
--			//	
	% % %		//	

()

C2 A1 B1 C1

A3 B2 C3 A2

B4 C4 A4 B3

()

B4 A1 B1 A3

A2 B3 A4 B2

()

()

-

-

- -

)

(

/

/ / /

.

/ /

.

.

.

.

- -

LSD

. SAS

P ≤ 0.5

- -

RESULTS

-

-

()

.

- -)

()

(-

% , %

.% ,

(%)

% ,

% , , ,

.

.% ,

()

	-	-	-	
, ± A a	, ± , A b	, ± , A b	, ± , A b	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	
, ± , A a	, ± , A a	, ± , A a	, ± , A a	

()

%

%

-

-

% , % ,

% ,

()

% , % , % ,

(% ,)

(% ,)

% , % , % ,

. (% ,)

()

	-	-	-	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	
, ± , A a	, ± , A c	, ± , A b	, ± , A b	
, ± , A a	, ± , A b	, ± , A bc	, ± , B ab	

()

%

%

-
-

.

-

()

.

% , % , % ,

/

.

% , /

. /

.(% ,)

()

	-	-	-	
, ± , A a	, ± , A a	, ± , A a	, ± , A a	
, ± , A a	, ± , A ab	, ± , A b	, ± , A b	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	

()

(% ,)

%

%

% ,

-
-

()

% ,
. % ,

% , % ,

. % , % ,

. % ,

()

	-	-	-	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	
, ± , A a	, ± , A b	, ± , A b	, ± , A c	

()

%

%

-

-

% , % , % ,

% ,

% , % ,

()

()

% , % ,

. (% ,)

(% ,)

(% ,)

. (% ,)

()

	-	-	-	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	

()

.%

%

-

-

. % ,
() % , %
% , % % ,

()

% , % ,

% , % ,

% , % , % , % ,

()

	-	-	-	
, ± , B a	, ± , B bc	, ± , B b	, ± , A c	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	

()

%

%

-
-

. (% ,)

(% ,)

(% ,)

(% ,)

(% ,)

.

-

()

. ()

()

% , ,

()

.

()

% , ()

.

%

()

% ,

()

	-	-	-	
, ± , B a	, ± , A c	, ± , A bc	, ± , B b	()
, ± , A a	, ± , A c	, ± , A c	, ± , A b	()

()

%

%

-

-

% , % , % ,
.

()

% , % , % ,
.
(%)
(% ,) (% ,)

-
()

% , % , % ,
.

()

	-	-	-	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	
, ± , A a	, ± , A b	, ± , A ab	, ± , A b	
, ± , A a	, ± , A c	, ± , A b	, ± , A bc	

()

%

%

-
-

% , % ,
% , % , % ,
% ,
% ,
. (% ,)

% ,
% , % ,

% ,
% , % ,

% ,
% , % ,

()

()

	-	-	-	
, ± , A a	, ± , A b	, ± , A b	, ± , A b	%
, ± , B a	, ± , B c	, ± , AB bc	, ± , AB b	%
, ± , C a	, ± , B b	, ± , B b	, ± , B b	%

()

%

%

-
-

% , % , % , %

.

%

. % %

%

.

. % (%)

%

. % , % , % ,

% , % , %

%

% ,

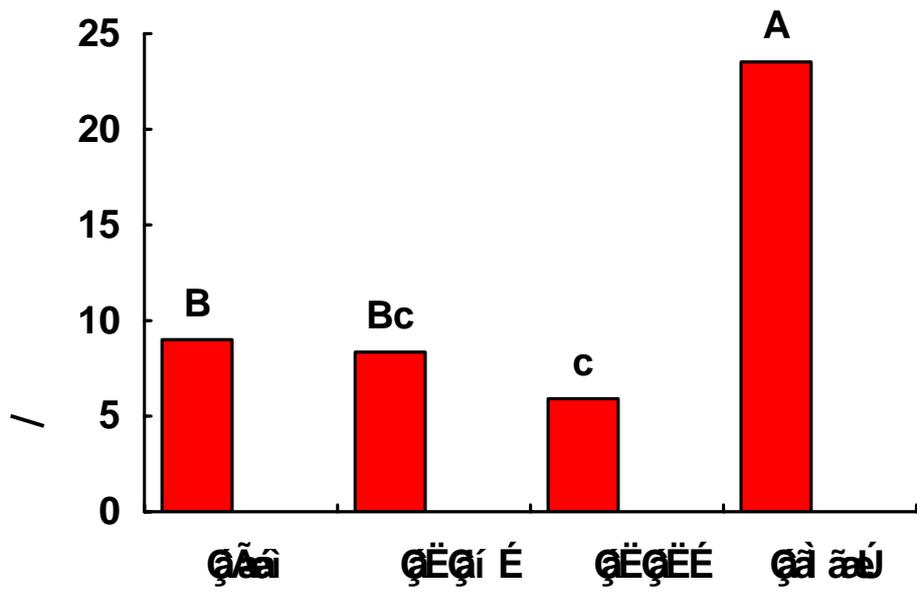
(% ,) (% ,)

. (% ,)

-

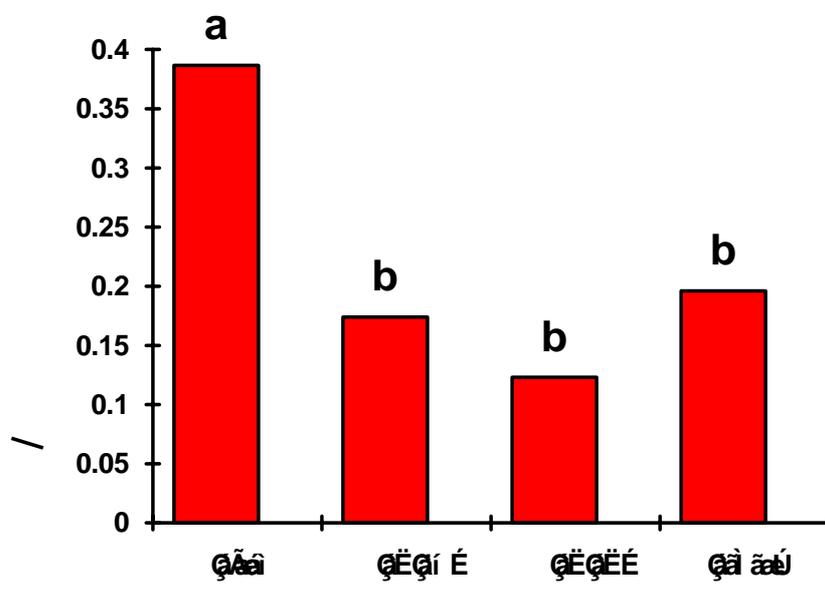
()

. ()



()

()



/

()

DISCUSSION

-

-

Starrat and Bond (1990) Calvin (1972)

Taylor (1994) Fredrick (1976) Thomas and Brogdon (1987)

()

Grahl (1992)

Suzuki Wilson (1963)

Faustini *et al.* (1981) Longstaff (1994) (1980)

Burkholder (1979)

Obeng-Ofori and Coaker (1990a)

Bartelt *et al.* (1994)

Burkholder (1984)

Bartelt *et al.* (1994)

Sinclair *et al.* (1984)

Trematerra (1993)

Phillips *et al.* (1993)

(Vanillin)

(Maltol)

Maissa, *et al.*

(1987)

Mc Gregor (1964)

/

/

()

Faustini et Suzuki (1980)

***al.* (1981)**

Takahashi and Yamamoto (1972)

%

()

-

()

White (1982)

Mickel and Standish (1946)

Abdel Samad *et al.* (1988)

Mc Grogan (1964)

⋮

-

.

-

.

-

.

-

.

English summary

This study has been carried out between April 1994 and April 1996 at the laboratories of the Entomology and plant protection Department of the Faculty of Agriculture, King Saud University. The main objective of the study was to investigate the efficiency of the pheromone traps against the flour beetles: *Tribolium castaneum* Herbst., as influenced by several factors. These factors were depth of traps, age of pheromone, density of insects, temperature, presence of food attractants, wheat variety, age of insects, presence of other stored-grain insects and finally percentage of dockage.

Cylindrical polyethylene containers filled with 23 kg of wheat (1 m high) were used. In each container 30 adult flour beetles were released. After 24 hours perforated grain probe insect traps accommodating rubber septa treated with the aggregation pheromone (4, 8-Dimethyl decanal) of the flour beetle (*T. castaneum*) were inserted 10 cm deep from the upper surface of the stored wheat grains. Traps were removed from grains after three intervals; 24, 72 and 120 hours. Trapped insects were counted.

From these results, no significant differences were observed in the sum of percentages of total trapped insects when the pheromone traps were placed at 10 or 20 cm depth. Increasing the depth of traps to 30 cm, decreased the percentages of insects trapped.

Similarly, increasing the age of pheromone didn't show any significant differences in the percentages of the trapped beetles. However, increasing the pheromone age to 4 weeks decreased the percentages of trapped insects but insignificantly.

Studying the effect of wheat variety on pheromone trap performance showed significant differences in the percentages of insects attracted to the traps present in the durum wheat. It has also been observed that, increasing the dockage content decreased the percentages of insects attracted to traps.

Increasing beetle density from 30 to 60 insects/container had no affect on the rate of capture. However, decreasing beetle density from 30 to 10 insects/container increased the percentages of capture from 10.82 to 17.50%, respectively. Presence of *Sitophilus granarius* with *T. castaneum* had no influence on the pheromone trap efficiency.

The study also showed that, raising the temperature from 20 to 30 c° significantly increased the percentages of the insects attracted to the pheromone traps. Contrarily, presence of food lures didn't show any significant differences between the percentages of the attracted beetles.

References

.()

.

.

.()

.

.

. ()

.

.()

.

.()

.

.

.

.()

.():

.

.()

.()

.

.():

. ()

.

.

.

. ()

()

.

. ()

.

. ()

. ()

)

-

:

(

.

- Abdelsamad, R. M., Elhag, E. A. and El Tayeb, Y. M.(1988). Studies on the phenology of *Tribolium castaneum* (Herbst.) (Coleoptera : Tenebrionidae) in the Sudan-Gezira. *J. stored prod. Res.*, 24 (2): 101-105.
- Aldryhim, Y. N. (1990). Efficacy of the amorphous silica dust, dry acid, against *Tribolium confusum* (Duv.) and *Sitophilus granarius* (L.) *J. stored prod. Res.*, 26 (4): 207-210.
- Aldryhim, Y. N. and Alyousif, A. (1992). Inspection of Wheat grain samples delivered to the grain silos and flour mills Organization in 1988 -1989 with emphasis on insect infestation. *Arab Gulf Journal of Scientific Research*, 10: 65-75.
- Al-khalifa, M. S. (1981). The Spermathecal structure of the flour beetle *Tribolium castaneum* (Herbst.) (Col., Tenebrionidae) Ind. *J. Zool.*, 9 (1) : 1-6.
- Al-khalifa, M. S. (1987). The Ultrastructure and Histochemistry of Fat body cells of the adult female red flour beetle, *Tribolium castaneum* (Herbst.) *J. Coll. of Agri. K. S. Univ.*, 9: (2) 307-315.
- Al-khalifa, M. S. (1988) The structure and possible functions of the Oviducts in the flour beetle *Tribolium castaneum* (Herbst.) *J. of the Coll. of Sci. K. S. Univ.*, 19 (1) 49-57.

- Amos, T. G., Semple, R. L. and Williams, P. (1986). Multiplication of some stored grain insects on varieties of wheat. *General and app. Entomology*, 18: 48-52.
- Anderson, J. A. and Alcock, A. W. (1954). *Storage of cereal grain and their products*. American Association of Cereal Chemists.
- Anon, (1973). *Report of the 9th Session of FAO working party of Experts on pest resistance of pesticides*, P. 17 Rome.
- Arthur, F. H. (1993). Evaluation of parllethrin aerosol to control stored product insect pests. *J. stored prod. Res*, 29 (3) :253-257.
- Awadallah, K.T., Tawfik, M. F. S. and Abdella, M. M. H. (1985). Population studies on flour insect pests and their natural enemies at four localities of Egypt. *Bulletin de la Societe Entomologique d' Egypte*. 64: 95-109.
- Barlow, F., Elbott, M., Farmam, A.W, Hadaway, A. B., Janes N. F., Needham, P. H. and Wickhman, J. C. (1971). Insecticidal activity of the pyrethrine and related compounds. IV. Essential features of the Insecticidal activity in Chrysanthemates and related cyclopropane esters. *Pestic. Sci.* 2: 115-118.
- Bartelt, R. J., Vetter. R. S., Carlson, D. G. and Baker, T. C. (1994). Influence of pheromone dose, trap height and septa age on effectiveness of pheromones for *Carpophilus mutilatus* and *C. hemipterus* in a California date garden. *J. Eco. Ent.* 87: 667-675.

- Bell, C. H., Hole, B. D. and Clifton, A. L. (1988). The toxicity of mixtures of methyl bromide and methyl chloroform to stored product insects. *J. stored prod. Res*, 24 (2) :115-122.
- Birch, L. C. (1947). Ability of flour beetles to breed in wheat. *Ecology*, 28: 322-324.
- Brich, M. C. and Haynes, K. F. (1982). *Insect pheromones*. Edward Arnold, 58. Pp.
- Bond, E. J. (1978). Toxicity of mixtures of methyl bromide and phosphine to insects. *J. Econ. Ent.*, 71: 341-342.
- Bond, E. J. (1980). Sorption of tritiated phosphine by various stages of *Tribolium castaneum* (Herbst.). *J. stored prod. Res*, 16 : 27-31.
- Bond, E. J. and Morse, P. M. (1982). Joint action of methyl bromide and phosphine on *Tribolium castaneum* (Herbst.) (Coleoptera : Tenebrionidae) *J. stored prod. Res*, 18 : 83-94.
- Boon, K. S. and Ho, S. H. (1988). Factors influencing the post-fumigation reinfestation of *Tribolium castaneum* (Herbst.) (Coleoptera : Tenebrionidae) in a rice warehouse. *J. stored prod. Res*, 24 (2) :87-90.
- Buffin, D. (1992). Calls to phase-out methyl bromide. *Pesticides - News*, 18 : 5-6.
- Burkholder, W. E. (1979). Application of pheromones and behavior modifying techniques in detection and control of stored

product insects. Proceedings of the 2nd intern. working confer. on stored product. *Ent. Ibadan, Nigeria, Sep. 1978*, p 56-65.

Burkholder, W. E. (1984). Stored product insect behavior and pheromone studies: keys to successful monitoring and trapping. Proc. 3rd Int. working Conf. on *stored product Ent.* Manhattan, K. S., 20-33.

Buscarlet, L. A., Ravenel, J. L. and Guitton, A. (1986). Effects of fasting and irradiation on the free amino acid content of *Tribolium confusum*. J. Du. Val. (Coleoptera: Tenebrionidae). *J. stored prod. Res.*, 22 (4) : 217-225.

Calvin, M. M. (1972). Fate of pesticides in the environment. *Ann. Rev. Ent.* 17 : 199-223.

Champ, B. R. and Champbell - B., M. J. (1970). Insecticide resistance in an Australian *Tribolium castaneum* (Herbst.) 1-A test method for detecting insecticides resistance. *J. stored prod. Res.*, 6 : 53-70.

Chang, B. R. and Dyte, C. E. (1976). *Report of the FAO global survey of pesticides susceptibility of stored grain pests.* ix - 297 : FAO, ROME.

Cotton, R. T. and Good, N. E. (1937). Annotated list of the insects and mites associated with stored grain and cereal products, and of their arthropod parasites and predators. *U.S. Dept. Agr. Misc. Pub.* 258 : 1-81.

- Daglish, G. J., Zorzetto, N. J., Lambkin, T. M., Erbacher, J. M. and Eelkema, M. (1992). control of *T. castaneum* (Herbst.) in stored peanuts using residual insecticides. *J. stored prod. Res*, 28 (3) :157-160.
- Danald, A. W. and Robert, B. M. (1985). *Fundamental of applied Entomology*.
- Davidson, R. and Lyon, W. (1979). *Insect pest of farm, garden and archard*. John Wiley and Sons, 596 Pp.
- Dawson, P. S. (1964). Age at sexual maturity in female flour beetles *Tribolium castaneum* and *T. confusum*. *Ann. Ent. Soc. Am.*, 57:1-3.
- Desmarchelier, J. M. (1988). The relationship between wet-bulb temperature and the intrinsic rate of increase of eight species of stored product Coleoptera. *J. stored prod. Res*, 24:(2) :107-113
- Dyte, C. E. (1961). A study of the development of beetle infestations in flour milling machinery. *App1. Biol. Annals*. 49 : 378-382.
- Dyte, C. E. (1965). Studies on insect infestation in the machinery of three English flour mills in relation to seasonal temperature changes. *J. stored prod. Res*, 1 : 129-144.
- Ebeling, W. (1971). Sorptive dusts for pest control. *Ann. Rev. Ent.* 16 : 123-158.
- Edwin, L. S. David, G. B. and Bruce, M. (1992). High temperature combined with carbon dioxide enriched or reduced oxygen

atmospheres for control of *Tribolium castaneum* (Herbst.) *J. stored prod. Res*, 28 (4) :235-238.

Elliott, M. and Janes, N. F. (1973). Chemistry of the natural pyrethrins : The natural insecticide. *Casida J. Ent.* P56-114.

Faustini, D., Burkholder, W. and Laub, R. (1981). Sexually dimorphic setiferous sex patch in the male red flour beetle, *Tribolium castaneum* (Herbst.). *J. Chem. Ecol.*, 7 : 467-482.

Frederick, W. P. (1976). Biochemical genetics of insecticide resistance *Ann. App. Biol.*, (21) : 179-197.

Freeman, J. A. (1962). The influence of climate on insect populations of flour mills. *Trans. 11th cong. Ent.*, 2 : 301-308.

Gan, J., Yates, S. R., Anderson, M. A., Spencer, W. F., Ernst, F. F. and Yates, M. V. (1994). Effect of soil properties on degradation and sorption of methyl bromide in soil. *Chemosphere*, 29 (12) : 2685-2700.

Good, N. E. (1936). The flour beetles of the genus *Tribolium*. *U. S. Dept. of Agri. Tech. Bull.* 498 : 1-58.

Graham, W. M. (1970). Warehouse ecology studies of bagged maize in kenya. IV. Reinfestation following fumigation with methyl bromide gas. *J. stored prod. Res*, 6 :177-180.

Grahl, C. (1992) Methyl bromide under siege. *pest control*, 6 (4): 34-39.

Gray, H. E. (1948). *The Biology of flour beetles*. N. West Miller, 236, 3a, 14a, 18a.

- Hadaway, A. B (1972). Toxicity of insecticides to tsetse flies. *Bull. Wild Hlth. Org.* 46 : 353-362.
- Hafez, S. M., Mallawani, M. A. and Taher, S. H. (1988). Biological studies on *Blattisocius tarsalis* keegan, a predacious mite inhabiting stored food in Egypt. *Ann. of Agric. Sci. Cairo*, 33 : (2) : 1387-1393.
- Hall, D. W. (1970). Handling and storage of food grains in Tropical and Subtropical areas. FAO, Agric. develop, paper No. 90, U. N. Rome.
- Hinton, H. E. (1948). A Synopsis of the genus *Tribolium* Macleay with some remarks on the evolution of its species. *Bull. Ent. Res.*, 39 : 13-55.
- Holdaway, F. G. (1932). An experimental study of the growth of populations of the flour beetle, *Tribolium confusum* (Duv.) as affected by atmospheric moisture. *Ecol. Monogr.*, 2 : 261-304.
- Hole, B. D., Bell, C. H., Mills, K. A. and Goodship, G. (1976). The toxicity of phosphine to all developmental stages of thirteen species of stored product beetles. *J. stored prod. Res*, 12 :235-244.
- Howe, R. W. (1956). The effects of temperature and humidity on the rate of development and mortality of *Tribolium castaneum* (Herbst.), *Ann. Appl. Biol.*, 44 : 356-368.

- Howe, R. W. (1968). A further consideration of the heterogeneity of the developmental period of *Tribolium Castaneum* (Herbst.) in constant environmental conditions. *J. stored prod. Res*, 4 :221-231.
- Javer, A., Borden, J. H. and Pierce, H. D. (1990). Evaluation of pheromone baited traps for monitoring of Cucujid and Tenebrionid beetles in stored grain. *J. Econ. Ent.* 83 (1) : 268-272.
- Jilani, G. and Su, H. C. F. (1983). Laboratory studies on several plant materials as insects repellents for protection of cereal grains. *J. Econ. Ent.* 76 : 154-157.
- Karlson, P. and Butenandt, A. (1959). Pheromones (Ectohormones) in insects. *Ann. Rev. Ent.*, 4 : 39-42.
- Khalifa, A. and Badawy, A. (1955). Biological studies on *Tribolium confusum* (duv.), *Tribolium castaneum* (Herbst.) and *Latheticus oryzae waterh.* (Coleoptera, Tenebrionidae). *Bull. Soc. Ent. Egypt*, 39 : 351-373.
- Khorramshahi, A. and Burkholder, W. E. (1980). Behavior of the Lesser grain borer *Rhyzopertha dominica* (Coleopetera : Bostrichidae) : male-produced aggregation pheromone attacks both sexes. *J. Chem. Ecol.* 7: 33-38.
- Kim, K. C., Kim S. G. and Choi, H. S. (1988). An investigation of insect pests and the period of maximum occurrence of key insect pests in stored rice grain. *Korean J. of App. Ent.* , 27 (2) : 117-124.

- Le Patourel, G. N. J. and Singh, J. (1984). Toxicity of amorphous silicas and silica-pyrethroid mixtures to *Tribolium castaneum* (Herbst.). *J. stored prod. Res.*, 20 : 183-190.
- Longstaff, B. C. (1994). The Management of stored product pests by non-chemical means: an Australian perspective. *J. stored prod. Res*, vol 30 (3) : 179-185.
- Lyll, R. P. D. (1968). Resume Of A Ph.D. dissertation (1965) entitled "studies on the Morphology and biology of a stored grain pest, *Tribolium castaneum* (Herbst.). *Tribolium Inf, Bull.*, 11 :82-83.
- Maissa, M. A., Abdu, R. M. and Hussein, M. A. (1987) Effect of time of day and temperature on sex pheromone production and perception by the rust-red flour beetle, *Tribolium castaneum* (Herbst.). *Arab Gulf Journal of Scientific Research*, 5 (1): 147-156.
- Majewski, M. S., Mc Chesney, M. M., Woodrow, J. E., Prueger, J. H. and Seiber, J. N. (1995). Aerodynamic measurements of methyl bromide volatilization from trapped and nontrapped fields. *J.of Env. quality*, 24 (4) : 742-752.
- Malik, M. M. and Mujtaba, N. S. H. (1984). Screening of some indigenous plants as repellents and antifeedants for stored grain insects. *J. stored Prod. Res.*, 20 : 41-44.
- Mano, S. and Andreae, M. O. (1994). Emission of methyl bromide from biomass burnings. *Science, Washington*, 263 : 1255-1257.

- Mayer, R. T., Cooper, J., Farr, F. M. and Singer, R. H. (1975), Some effects of ionizing radiation on adult horn flies; *Haematobia irritans*. *Insect Biochem.*, 5 : 35-42.
- Mc Gregor, H. E. (1964). Preference of *Tribolium castaneum* for wheat containing various percentage of dockage. *J. Eco. Ent.* 57: 511-513.
- Michael, D. A. (1980). *Introduction to insect behavior*. Macmillan publishing Co., Inc. New York., 12-98.
- Mickel, C. E. and Standish, J. (1946). Susceptibility of processed soy flour and soy grits in storage to attack by *Triboilum castaneum* (Herbst.). Univ. of Minn. *Agric. Exp. Stn. Tech. Bull.*, 178 : 1-20.
- Miller, L. W. (1944). Investigations of the flour beetles of genus *Tribolium*. 1 - The influence of *Tribolium castaneum* (Herbst.) and *T. confusum* (Duv) in wheat and flour in Victoria. *J. Dep. Agric. Victoria*, 42 : 217-221.
- Mills, J. T. and White, N. D. G. (1994). Seasonal occurrence of insects and mites in a Manitoba feed mill. *Proceedings of the Entomological Society of Manitoba*, 49 (1) : 1-15.
- Mitlin, M. and Wiygul, G. (1970). Effect of Gamma irradiation on utilization of glycine carbons in biosynthesis of RNA and amino acids in the Boll Weevil *J. insect. Physiol.*, 16 : 2271-2279.

- Mohsin, A. (1979). Changes in free amino acid level due to physical and chemical agents in aging. *Drosophila Experientia*, 35:1072-1073.
- Mondal, K. (1986). Effects of methylquinone, aggregation pheromone and pirimiphos methyl on Larval growth of *Tribolium castaneum* (Herbst.), *Bangladesh J. of Zoology*, 14 (2) : 123-128.
- Mondal, K. (1987). Primiphos-methyl on sex ratios in *Tribolium castaneum*. *Ento. Experi. et applicata*, 44 (2) : 201-203.
- Mondal, K. (1988). Effect of synthetic methylquinone, aggregation pheromone and primiphos-methyl on adult mortality in *Tribolium castaneum* (Herbst.). *Pakistan J. of Zoology*, 20 (1): 41-46.
- Mondal, K. (1990). Combined action of methyl quinone, aggregation pheromone and primiphos-methyl on *Tribolium castaneum* larval mortality, *Pakistan J. of Zoology*, 22 (3) : 249-255.
- Mondal K. (1993). Effect of synthetic quinone and pheromone on *Tribolium castaneum*. *Annals- of Entomology*, 8 (2) : 19-21.
- Mostafa, S. A. S., Dabbour, A. I. M. A. Nassif and Aziz, M. I. A. (1981). Insect pests encountered in stored products in Saudi Arabia. *Anz. Schadling*, 54 : 184-187.
- Noling, J. W. and Becker, J. O. (1994). The challenge of research and extension to define and implement alternatives to methyl bromide. *J. of Hematology*, 26 (4) : 573-586).

- Obeng-Ofori, D. (1991). Analysis of orientation behavior of *Tribolium Castaneum* and *T. confusum* to synthetic aggregation pheromone. *Entomologia-Experimentalis et applicata*, 60 (2) 125-133.
- Obeng-Ofori, D. and Coaker, T. H. (1990a). Some factors affecting responses of flour stored product beetles (Coleopetera, Tenebrionidae and Bostrichidae) to pheromones. *Bull. Entom. Res.*, 80 (4) : 433-441.
- Obeng-Ofori, D. and Coaker, T. H. (1990b). *Tribolium* aggregation pheromone: monitoring, range of attraction and orientation behavior of *T. castaneum*. *Bull. of Entom. Res.*, 80 (4) : 443-451.
- O'Brien, R. D. and Wolfe, L. S. (1964). *Radiation, Radioactivity and insects*. Academic press. New York. 23-34 Pp.
- Oxley, T. A. (1948). *The scientific principles of grain storage*. Liverpool, Northern publ. Co. 103 Pp.
- Page, A. B. P. and Bubatti, O. F. (1963). Fumigation of insects. *A. Rev. Entom.*, 8 : 239-264.
- Park, T. (1933). Studies in Population Physiology. II: Factors regulating initial growth of *Tribolium confusum* populations. *J. Exp. Zool.*, 65 : 17-42.
- Park, T. and Frank, M. B. (1948). The fecundity and development of the flour beetles, *Tribolium confusum* and *T. castenum* at three constant temperatures, *Ecology*, 29 : 368-374.

- Park, O. and Noskin, V. (1947). Studies in nocturnal ecology. XIV. Activity of the flour beetle *Tribolium confusum* as a test of a theory of activity. *Anat. Res.*, 99 :89-112.
- Pederson, J. R., Mills, R. B. and Wibur, D. A. (1977). *Manual of grain and cereal products insects and their control*, Kansas State Univ., Manhattan, Kansas., 27-117.
- Phillips, T. W., Jiang, X. L., Burkholder, W. E., Phillips, J. K. and Tran, H. Q. (1993). Behavioral responses to food volatiles by two species of stored product Coleoptera, *Sitophilus oryzae* and *Tribolium castaneum*. *J. Chem. Eco.* 19: 4, 723-734.
- Price, L. A. and Mills, K. A. (1988). The toxicity of phosphine to the immature stages of resistant and susceptible strains of some common stored product beetles and implications for their control. *J. stored prod. Res.*, 24 (1) : 51-59.
- Qayyum, H. A. (1979). Insect pests on stored cereal grains and their control in Pakistan. Res. report, April 30, 1979, Dept. of Entom., Univ. of Agric., Faisalabad, P. 40.
- Raghavan, K. G., Ramakrishnan, V. and Nadkarni, G. B. (1976), Tyrosine metabolism in gamma- irradiated rice moth *Corcyra cephalonica* *Radiat. Res.*, 67 : 46-55.
- Rajendran, S. and Muthu, M. (1989). The toxic action of phosphine in combination with some alkyl Halide fumigants and carbon dioxide against the eggs of *Tribolium castaneum* beetles (Coleopetera : Tenebrionidae) (Herbst.). *J. stored prod. Res.*, 25 (4) : 225-230.

- Rangaswamy, J. R., Sasikala, V. B. and Pereira, J. (1988). Synthetic C10-compounds as aggregation pheromone mimics to flour beetle, *Tribolium castaneum* (Herbst.). *Indian J. of Exper. Biology*, 26 (4) : 297-303.
- Rangaswamy, J. R. and Sasikala, V. B. (1991). Sex pheromone of Z-2, nonenyl propionate isolated from virgin females of red flour beetle *Tribolium castaneum*. *Indian J. of Exper. Biology*, 29 (3) : 263-266.
- Richardson, B. L. and Myser, W. C. (1973). Radiation effects on the hemolymph free amino acid pool of the honeybee prepupa (*Apis mellifera*) and the waxmoth larva (*Galleria mellonella*). *Radiat. Res.*, 54 : 274-283.
- Rostom, Z. M. F. (1993). Survey of some granivorous and non granivorous insects and mites of stores in Saudi Arabia. *J. stored prod. Res.*, 29 : (1) : 27-31.
- Saim, N. and Meloan, C. E. (1986). Compounds from leaves of Bay (*Laurus Nobilis* L.) as repellents for *Tribolium castaneum* (Herbst.) when added to wheat flour. *J. stored Prod. Res.*, 22 (3) : 141-144.
- Samson, P. R. and Parker, R. J.(1989). Laboratory studies on protectants for control of Coleoptera in maize, *J. stored prod. Res.*, 25 (1) : 49-55.
- Saxena, B. P., Sharma, P. R., Thappa, R. K. and Tikku, K. (1992). Temperature induced sterilization for control of three stored grain beetles, *J. stored prod. Res.*, 28 (1) : 67-70.

- Shakoori, A. R., Fayyaz, M. And Saleem, M. A. (1988). Biochemical changes induced by Fenprothrin in the sixth instar larvae of *Tribolium castaneum* (Herbst.). *J. stored prod. Res.*, 24 (4) : 215-220.
- Shapas, T. J., Burkholder, W. E. and Boush, G. M. (1977) Population suppression of *Trogoderma glabrum* by using pheromone luring for protozoan pathogen dissemination. *J. Econ. Entomol.*, 70 : 469.
- Shawir, M., Le Patourel, G. N. J. and Moustafa, F. I. (1988). Amorphous silica as an additive to dust formulations of insecticides for stored grain pest control. *J. stored prod. Res.*, 24 (3) : 123-130.
- Shorey, H. H. and Mc Kelvey, J. J. (1977). *Chemical control of insect behavior*. Inter Science, John Wiley and sons Inc. New York and London.
- Sinclair, E. R., Howitt, C., Bailey, P. and Swincer, D. (1984). Test of phermones for monitoring infestation of stored product insects. Proc. of the 4th Australian Applied Ent. Res. Conf., Adelaide, Australia, 24-28 sep. 1984
- Sinha, R. N. (1963) Suitability of climatic areas of Canada for infestation of some major stored grain insects on farms. *Proc. Ent. Soc. Manitoba*, 19 : 31-39.
- Sinha, R. N., Demianyk, C. J. and Mc Kenzie R. I. H. (1988). Vulnerability of common wheat cultivars to major stored - product - beetles. *Canadian J. of Plant Sci.*, 68 (2) : 337-343.

- Sinha, R. N. and Wallace, H. A. H. (1977). Storage stability of farm-stored rapeseed and barley. *Canadian J. of plant Sci.*, 57: 351-365.
- Silver, P. (1994). Alternatives to methyl bromide sought. *Pesticides News*, 24 (5): 12-27.
- Starratt, A. N. and Bond, E. J. (1990). Recovery of glutathione levels in susceptible and resistant strains of *Sitophilus granarius* (L.) (Coleoptera : Curculionidae) following methyl bromide treatment. *J. stored prod. Res.*, 26 (1) : 39-41.
- Suzuki, T. (1980). 4-8-Dimethyl decanal : The aggregation pheromone of flour beetles, *Tribolium castaneum* and *T. confusum*. *Appl. Ent. Agric. Biol. Chem.* 44 :2519-2520.
- Suzuki, T. and Sugawara, R. (1977). Isolation of an aggregation pheromone for the flour beetles, *Tribolium castaneum* and *T. confusum*. *Appl. Ent. Zool.* 14: 228-230.
- Takahashi, F. and Yamamoto, Y. (1972). Upper limit of the population growth of *Tribolium confusum* Duval. *Kontyu* 40: 55-64.
- Taylor, R. W. D. (1994). Methyl bromide : is there any future for this fumigant? *J. stored prod. Res.*, 30 : (4) : 253-260.
- Thomas, M. B. and Brogdon, W. G. (1987). Improved detection of insecticide resistance through conventional and molecular techniques. *Ann. Review of Entom.*, 32 : 145-162.
- Trematerra, P. (1993). Attractive stimuli and trapping of *Colydium castaneum* (Herbst.) *Tecnica-Molitoria*, 44 : (10) : 857-868.

- Weare, B. C. (1995). Efforts to reduce stratospheric ozone loss affect agriculture. *California Agric.*, 49 (3) : 24-27.
- Weidner, H. (1984). Recent Literature on stored - product protection : seed beetles and cereal pests. *Zeitsch. -fur-pflan-und-pflanz.*, 91 (3) : 305-324.
- White, G. G. (1982). The effect of grain damage on development in wheat of *Tribolium castaneum* (Herbst.). *J. stored prod. Res.*, 18 : 115-119.
- White, G. G. (1988). Temperature changes in bulk stored wheat in sub-tropical Australia, *J. stored prod. Res.*, 24 : 5-11.
- Wilson, E. O. (1963) *The insects*. Scientific American, Inc. San Francisco., 54-130.
- Yagi, K., Williams, J., Wang, N. Y. and Cicerone, R. J. (1995). Atmospheric methyl bromide from agricultural soil fumigations, *Science*, Washington, 267 5206, 1979-1981.
- Young, A. M. (1970). Predation and abundance in populations of flour beetles. *Ecology*, 51 : 602-619.