Appl. Ent. Phytopath.
Vol. 75, No. 2, March 2008

Some cryoprotectants of overwintering larvae of rice stem borer *Chilo suppressalis* Walker (Lep.: Pyralidae) collected from northern parts of Iran

M. ATAPOUR[1], S. MOHARRAMIPOUR[1]*, M. BARZEGAR[2] and A. KHANI[1]

1- Department of Entomology, Tarbiat Modares University

2- Department of Food Science and Technology, Tarbiat Modares University

ABSTRACT

The rice stem borer, *Chilo suppressalis* Walker overwinters as diapausing last instar larvae in which some carbohydrates were shown to be changed. To determine the presence of these compounds and their changes in diapause stage, mature overwintering larvae were collected from overwintering sites in rice fields during October 2004 to March 2005. Cryoprotectants and glycogen were measured by high-performance liquid chromatography (HPLC) and UV-Vis spectrophotometer respectively.

Glycerol was identified as the major antifreeze compound and trehalose as the main sugar that both changed significantly during the different months. The lowest and highest content of glycerol was reported on October and January (1.21±0.18 and 15.53±3.7 mg/g of larval fresh weight respectively). In contrast of glycerol, trehalose showed the highest concentration on November (7.00±0.61 mg/g) and the lowest on January (2.79±0.57 mg/g); however, its content was nearly constant from November to late winter. Despite of negative correlation between glycerol and trehalose, this was not significant. Glycogen content was decreased as glycerol content was increased and there was negative and significant correlation between them ($r = 0.964$; $P < 0.01$) showing the interconversion of glycogen to glycerol during the overwintering period. It is concluded that glycerol may be more influential in cold hardiness of *C. suppressalis* in north parts of Iran and the insect's diapause could be initiated on late November and terminated on February-March.

Key words: rice stem borer, diapause, overwintering, cryoprotectants, glycerol

* Corresponding author: moharami@modares.ac.ir

References

BAGHDADI, A., A. RABBANI, A. ABDOLLAHI and S. MOHARRAMIPOUR, 2002. Purification and characterization of antifreeze protein from sunn pest *Eurygaster integricps* Put. Applied Entomology and Phytopathology 69(2), 1-4 (In Persian with English summary).

BAGHDADI, A., S. MOHARRAMIPOUR, A. RABBANI and A. ABDOLLAHI, 2001. Coldhardiness strategies and it's seasonal variation in sunn pest *Eurygaster integricps* (Put.). Applied Entomology and Phytopathology 69(1), 51-59 (In Persian with English summary).

BALE, J. S. 2002. Insects and low temperatures: from molecular biology to distributions and abundance. Philosophical Transactions of the Royal Society of London, 357 (B): 849-862.

CHINO, H. 1958. Carbohydrate metabolism in the dipause egg of the silkworm, *Bombyx mori* and conversion of glycogen to sorbitol and glycerol during diapause. Journal of Insect Physiology, 2: 1-12.

CHO, J. R., J. S. LEE, J. J. KIM, M. LEE, H. S. KIM and K. S. BOO, 2005. Cold-hardiness of diapausing rice stem borer, *Chilo suppressalis* Walker (Lepidoptera: Pyralidae). Journal of Asia-Pacific Entomology, 8 (2): 161-166.

GOTO, M., Y. LI and T. HONMA, 2001a. Changes of diapause and cold hardiness in the shonai ecotype larvae of the rice stem borer, *Chilo suppressalis* Walker during overwintering. Applied Entomology Zoology, 36(3): 323-328.

GOTO, M., Y. SEKINE, H. OUTA, M. HUJIKURA and K. SUZUKI, 2001b. Relationship between cold hardiness and diapause, and between glycerole and free amino acid contents in overwintering larvae of the oriental corn borer, *Ostrinia furnacalis*. Journal of Insect Physiology, 47: 157-165.

JO, H. M. and Y. KIM, 2001. Relationship between cold hardiness and diapause in the smaller fruit tortrix, *Adoxophyes orana*. Journal of Asia-Pacific Entomology, 4:1-9.

JOHNSTON, S. L. and R. E. LEE, 1990. Regulation of supercooling and nucleation in a freeze intolerant beetle (*Tenebrio molitor*). Cryobiology, 27: 502-568

KOSTAL, V. 2006. Eco-physiological phases of insect diapause. Journal of Insect Physiology, 52: 113-127.

KOSTAL, V., M. SLACHTA and P. SIMEK, 2001. Cryoprotective role of polyols

independent of the increase in supercooling capacity in diapausing adults of *Pyrrhocoris apterus* (Heteroptera: Insecta). Journal of Insect Physiology, 130(B): 365-374.

LEE. K. Y., Y. D. CHANG and Y. G. KIM, 2002. Trehalose, a major sugar cryoprotectant of the overwintering rice water weevil, *Lissorhoptrus oryzophylus.* Journal of Asia-Pacific Entomology, 5:35-41.

LI, Y-P., M. GOTO, L. DING and H. TSUMUKI, 2002. Diapause development and acclimation regulation enzymes associated with glycerol synthsis of the shonai ecotype of the rice stem borer larva, *Chilo suppressalis* (Walker). Journal of Insect Physiology, 48: 303-310.

LI, Y-P., M. GOTO, S. ITO, Y. SATO, K. SASAKI and N. GOTO, 2001. Physiology of diapause and cold hardiness in the overwintering pupae of the fall webworm *Hyphantria cunea* in Japan. Journal of Insect Physiology, 47: 1181-1187.

MILLER, K., 1982. Cold-hardines strategies in some adult and immature insects overwintering in interior Alasca. Comp. Biochemistry Physiology, 73(A): 595-604.

MORRISEY, R and J. G. BAUST, 1976. The ontogeny of cold tolerance in the gall fly, Eurosta solidaginis. Journal of Insect Physiology, 22: 431-438.

MOUSSAVI, M. R., 1986. Rice green caterpillar in Guilan. Applied Entomology and Phytopathology 53(1-2), 39-48.(in Persian with English summary).

NAEEMULLAH, M., K. TANAKA, H. TSUMUKI and M. TAKEDA, 1999. Relationship of cold tolerance to developmental determination in the Indian meal moth, *Plodia interpunctella.* Applied Entomology Zoology, 34(2): 267-276.

PULLIN, A. S. and J. S. BALE, 1989. Effects of low temperature on diapausing *Aglais urticae* and *Inachis io* (Lepidoptera: Nymphalidae), overwintering physiology. Journal of Insect Physiology, 35:283-290.

REZWANY, N. and D. SCHAHOESEINI, 1977. Biologie und oekologie der reis stengel borer (*Chilo suppressalis* Walker). Applied Entomology and Phytopathology 43, 1-38.(in Persian with English summary).

RING, R. A. 1977. Cold-hardiness of the bark beetle *Scolytus ratzeburgy* (Col: Scolytidae). Norwegian Journal of Entomology, 24:125-136.

RING, R. A. 1981. The physiology and biochemistry of cold tolerance in arctic insects. Journal of Thermal Biology, 6: 219-229.

SOMME, L. and W. BLOCK, 1982. Cold tolerance of Colembola at Signy island. Maritime Antarctic. Oikos. 38: 168-176.

STOREY, K. B. and J. M. STOREY, 1988. Freeze tolerance in animals. Journal of

Insect Physiology, 68: 27-84 .

TSUMUKI, H. and K. KANEHISA, 1978. Carbohydrate content and oxygen uptake in larvae of rice stem borer *Chilo suppressalis* Walker. Applied Entomology Zoology, 17: 95-110.

TSUMUKI, H. and K. KANEHISA, 1979. Enzymes associated with glycogen metabolism in larvae of the rice stem borer. Applied Entomology Zoology, 14(3): 270-277.

TSUMUKI, H. and K. KANEHISA, 1980a. Changes in enzyme activities related to glycerol synthesis in hibernating larvae of the rice stem borer, *Chilo suppressalis*. Applied Entomology Zoology, 15(3): 285-292.

TSUMUKI, H. and K. KANEHISA, 1980b. Enzyme activities associated with glycogen metabolism in diapausing and developing larvae of the rice stem borer *Chilo suppressalis* (Walker). Applied Entomology Zoology, 18: 31-41.

TSUMUKI, H. and K. KANEHISA, 1980c. Metabolism of C^{14}-glucose and UDP-C^{14}-G in hibernating larvae of the rice stem borer, *Chilo suppressalis* (Walker). Applied Entomology Zoology,18: 43-53.

TSUMUKI, H. and K. KANEHISA, 1981. Effects of JH and ecdyson on glycerol and carbohydrate contents in diapausing larvae of the rice stem borer, *Chilo suppressalis* (Walker). Applied Entomology Zoology, 16(1): 7-15.

Address of the authors: Eng. M. ATAPOUR, Dr. S. MOHARRAMIPOUR and Dr. A. KHANI, Department of Entomology, College of Agriculture, Tarbiat Modares University, P. O. Box 14115-336, Tehran, Iran; Dr. M. BARZEGAR, Department of Food Science and Technology, College of Agriculture, Tarbiat Modares University, P. O. Box 14115-336, Tehran, Iran.