24708133.773585 6972548.952381 4158982282 179093752540 2616820479 27139420.627451 163176961794 24502975017 17537717.78125 2270350.8735632 10817051081 17934850682 61346728960 10803041.137931 31097563086 28858857899 83592529.2 162848762923 244648300.71429 6922367.68 15277989.863158 1996233176 14703526.255102 1381758.9090909 13154988891 18334809240

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xylostella in Midwestern Brazil (Guilloux et al., 2003). In southeastern Brazil, the influx of migrants was suggested as the possible cause of population increase in the beginning of July (Campos et al., 2006). Zalucki, M.P., Shabbir, A., Silva, R., Adamson, D., Shu-Sheng, L., Furlong, M.J., 2012. Considering both winter and spring, a mean of 1.4 and 0.8 larvae per plant were recorded on broccoli and cauliflower, respectively. Talekar, N.S., Hu, W.J., 1996. 15, 763-789.). Includes teacher keys and student copy.Set I termsImmigration, density dependent factor, population density, birth rate, growth rate, density independent factor, death rate, population distribution, limiting factors, migration, population dispersion, emigration;Set II termsabiotic factors, community, community ecology, random distribution, demography, uniform distribution, exponential grPage 4This worksheet is best given after teaching students about the hierarchy of livings things & Earth (atoms, molecules, organelles, cells, tissues, organs, organ systems, organisms, populations, communities, ecosystems, biosphere). Development and survival of the diamond- back moth (Lepidoptera: Plutellidae) at constant and alternating temperatures. The biotic factors evaluated included crop subspecies (dummy variable C = 0 for broccoli and 1 for cauliflower), plant age (days after transplantation) and the parasitism by three species, while the abiotic factors assessed were minimum and maximum temperatures, rainfall, relative humidity and planting season (dummy variable E = 0 for spring and 1 for winter). The same population trend recorded in different regions of Brazil suggests that the migration pattern identified by Campos et al. Larval parasitoids of P. 38, 275-301. xylostella adults is the cause of population increase, one can question the reasons of population decline in the beginning of December. Similarly to found in our study, D. Moreover, under higher diversity of parasitoids, few species usually are responsible for more than 90% of larval parasitism (Mosiane et al., 2003, Ayalew and Ogol, 2006 and Guilloux et al., 2003), with the remaining species showing lower parasitism rates. 19, 60-63. The same hybrid of broccoli (BRO 68) was cultivated throughout the seasons, while the cauliflower variety "White A" was grown in spring, summer and autumn, and the hybrid "Barcelona" in winter. and de Sassi and Tylianakis, 2012de Sassi, C., Tylianakis, J.M., 2012. Additionally, the parasitism level by each parasitoid in the absence of others, here called potential parasitism (Ayalew et al., 2006Ayalew, G., Baumgärtner, J., Ogol, K.P.O.C., Löhr, B., 2006. This is important because density-dependent relationship between parasitoid and its host generally results in a more efficient regulation of the host population. J. Chin. Asman, K., Rämert, B., Ekbom, B., 2001. Among the larval parasitoids identified in the study area, D. Control 49, 259-269. Tscharntke, T., Bommarco, R., Clough, Y., Crist, T.O., Kleijn, D., Rand, T.A., Tylianakis, J.N., van Nouthuys, S., Vidal, S., 2007. Population fluctuations of the diamondback moth, Plutella xylostella (L.) on cabbages in Bacillus thuringiensis sprayed and non sprayed plots and factors affecting within -generation survival of immatures. Wade, M.R., Zalucki, M.P., Wratten, S.D., Robinson, K.A., 2008. xylostella as host (tomato, lettuce and pepper) and fragments of native vegetation, which is considered an important characteristic providing shelter and alternative hosts to natural enemies when the primary host is not available (Thomson and Hoffmann, 2009Thomson, L.J., Hoffmann, A.A., 2009. Can. Bras. Sarfraz, M., Keddie, A.B., Dosdall, L.M., 2005. Temperature- dependent development of diamondback moth, Plutella xylostella (Lepidoptera: Plutellidae) on two brassicaceous host plants. Hence, T., Baaren, J.V., Vernon, P., Boivin, G., 2007. Parasitoid diversity and impact on populations of the diamondback moth Plutella xylostella (L.) on Brassica crops in central México. Landscape structure and biological control in agroe- cosystems. 31, 221-231. Control 45, 185-199. xylostella would be able to use continuously these resources. Vegetation increases the abundance of natural enemies in vineyards. Conservation bio- logical control of arthropods using artificial sprays: current status and future challenges. 39, 835-838.), representing a low diversity when compared to other regions of the world (Kfir, 1997Kfir, R., 1997. Zool. Entomophaga 41, 45-52. Factors influencing abundance of P. In fact, under extreme conditions, such as climate change, these divergences may lead to a disruption of temporal and/or geographical synchronization, increasing the risks of pest outbreak (Hence et al., 2007). This study provides a valuable contribution to the knowledge about the mechanisms underlying the population regulation of the diamondback moth. Despite the continuous and abundant availability of host plants throughout the year, P. Four species of larval parasitoids were found associated with P. It is known that factors such as temperature (Wang et al., 1999Wang, X., Liu, S., Guo, S., Lin, W., 1999. The recognition of the key mortality factors of insect pests is particularly important because they can be used in the development of management strategies (Baskauf, 2003). Sarfraz, M., Dosdall, L.M., Keddie, B.A., 2006. 27, 641-650.). xylostella population and that the temperature and rainfall recorded during field experiments did not influenced pest abundance. Harcourt, D.G., 1963. Also, studies have demonstrated the importance of natural enemies' interaction with landscape, showing that both diversity and abundance of parasitoids can be linked with landscape complexity (Thies and Tscharntke, 1999Thies, C., Tscharntke, T., 1999. Minimum and maximum temperatures were recorded in July 2007(5 °C) and March 2008 (28 °C), respectively. Despite the abundant and continuous availability of food sources throughout the year, P. Effects of host stages and temperature on pop- ulation parameters of Oomyzus sokolowskii, a larval -pupal parasitoid of Plutella xylostella. was positively related to host abundance, indicating a density-dependent relationship. 2A and B, respectively. Several attributes of agroecosystems may affect parasitoids' abundance, some improving and others reducing their effectiveness, and this information can be used for the development of control strategies. Draper, N.R., Smith, H., 1981. University of Chicago Press, Chicago.), and is a practical concern with regard to species that produce economic damage (Baskauf, 2003Baskauf, S.J., 2003. 700 m2 each, with a distance of 0.50 m between plants and 0.80 m between rows. Castelo-Branco, M., França, F.H., Medeiros, M.A., Leal, J.G.T., 2001. Similar results were obtained in a study investigating the population dynamics of the diamondback moth and its larval parasitoids in Ethiopia (Ayalew et al., 2006Ayalew, G., Baumgärtner, J., Ogol, K.P.O.C., Löhr, B., 2006. 16, 607-618.) may influence the parasitism by O. Interestingly, greater diversity of larval parasitoids does not necessarily mean higher rates of parasitism. Analysis of population dynamics of diamondback moth, (Plutella xylostella (Lepidoptera: Plutellidae)) at two sites in central Ethiopia, with particular reference to parasitism. Biological conservation practices that improve parasitoid effectiveness may be sensibly adopted when larval parasitoid complex is an important mortality factor regulating an insect pest population. Thomson, L.J., Hoffmann, A.A., 2009. Bull. Meigen (Diptera: Tachinidae) were abundant, while Oomyzus sokolowskii (Kurdjumov) (Hymenoptera: Eulophidae) was rarely found. In Midwest Brazil, seven larval parasitoids and six species of hyperparasitoids were identified associated with P. Among the abiotic factors, only planting season affected the abundance the diamondback moth. Chapman, J.W., Reynolds, D.R., Smith, A.D., Riley, J.R., Pedgley, D.E., Woiwod, I.P., 2002. In addition to the biological interactions, abiotic factors, such as temperature and rainfall, and the plant used as host are known to affect insect population dynamics (Wallner, 1987Wallner, W.E., 1987. (Eds.), Insect Natural Enemies. Finally, we investigated whether factors such as host plants, temperature conditions and rainfall influence the abundance of the pest in the field. For instance, larval parasitoids of the genus Apanteles Förster and Diadegma are positively affected by intercropping (Asman et al., 2001Asman, K., Rämert, B., Ekbom, B., 2001. 25, 625-639.). Ayalew, G., Ogol, C.K.P.O., 2006. sokolowskii among regions with similar climatic conditions are probably explained by local factors influencing the parasitoid establishment. Pinheiro, F., Diniz, I.R., Coelho, D., Bandeira, P.S., 2002. 70, 488-495. We are grateful to the Meteorological Institute of Paraná State (SIMEPAR) for providing the meteorological data used in the study. John Wiley and Sons, New Delhi. Several studies have demonstrated the migratory capacity of P. Control 43, 294-309. xylostella, reducing their ability to regulate pest population. Table 1 Larval parasitoids of Plutella xylostella identified at Colombo, Paraná, Brazil. The gregarious endoparasitoid Oomyzus sokolowskii (Kurdjumov) was rarely found. Parasitism was the major factor influencing population dynamics of P. Popul. 40, 533-541.). This product contains doodle notes over the following topics: Abiotic/Biotic factors, Characteristics of Life (MRS.NERG), ecological levels of organization (biosphere, biome, ecosystem, community, population, organism), levels of organization of an organism (cell, tissue, organ, organ system, organism).Page 2From crossword puzzle, students will: (1) distinguish between biotic factor and abiotic factor; (2) describe three types of community interactions that can affect an ecosystem; (3) distinguish between primary succession and secondary succession; and (4) distinguish between habitat and niche. xylostella was more abundant in broccoli during winter. xylostella (Table 1). and Zago et al., 2013Zago, H.B., Siqueira, H.A.A., Pereira, E.J.G., Picanço, M.C., Barros, R., 2013. Griffiths, G.J.K., Holland, J.M., Bailey, A., Thomas, M.B., 2008. Thies, C., Tscharntke, T., 1999. Development and survival of the diamond- back moth, Plutella xylostella (L.) (Lepidoptera: Yponomeutidae) as a function of temperature: effects on the number of generations in tropical and subtropical regions. and Ayalew and Ogol, 2006Ayalew, G., Baumgärtner, J., Ogol, K.P.O.C., Löhr, B., 2006. and Thomson and Hoffmann, 2009Thomson, L.J., Hoffmann, A.A., 2009. PLoS ONE 7, e40557. xylostella is important not only for management purposes, but also to elucidate the factors that may be related to population collapse in the beginning of December. 16, 607-618. xylostella in southern Brazil demonstrate the feasibility of biological conservation practices to improve parasitoid effectiveness. Highly positive correlation like the observed in our study indicates parasitoid specificity and a rapid numerical response to variations in host density (Jervis and Kidd, 1996Jervis, M., Kidd, N., 1996. Multiple regression analysis showed that parasitism by D. 95, 55-66. xylostella was recorded in Southeastern and Midwestern Brazil, where the pest occurred between July and December (Guilloux et al., 2003Guilloux, T., Monnerat, R., Castelo-Branco, M., Kirk, A., Bordat, D., 2003. Temperature is another important abiotic factor known to influence the development time and survival of insects, including P. The Distribution and Abundance of Animals. 25, 625-639. This is unexpected considering that previous studies have reported rainfall as one of the most important abiotic factors causing mortality in eggs and small larvae of P. 27-36.). Neither temperature, nor rainfall significantly influenced pest abundance. Entomophaga 41, 45-52., Liu et al., 2000Liu, S.S., Wang, X.G., Guo, S.J., He, H.J., Shi, Z.H., 2000. A similar seasonal pattern in the population dynamics of P. Both temperature and rainfall may affect the abundance of the larval parasitoids associated with P. This study aimed to identify the larval parasitoids associated with P. Pest Manag. xylostella, all larvae observed during samplings were collected, taken to the laboratory and individually kept in polyethylene vials (4 cm × 7 cm) maintained in environmental chambers (FANEM(r) Ltd., model 347 CDG) regulated at 20 °C, and L12:D12 photoperiod. The negative slope of crop and the positive slope of planting season indicate higher abundance of P. We also like to thank Flavia da Silva Krechemer, from Universidade Federal de Santa Catarina and Carla Pedroso de Moraes, formerly at Universidade Federal do Paraná, for the technical support during field collection. New records of nat- ural enemies of Plutella xylostella (L.) (Lepidoptera: Plutellidae) in Pernambuco, Brazil. Natural mortality of diamondback moth in Coastal South Carolina. xylostella abundance because the analysis was performed considering the period that P. Several parasitoid species were identified associated with P. 32, 915-928.). 2 Abundance of Plutella xylostella on broccoli (A) and cauliflower crops (B) in the county of Colombo, Paraná State, Southern Brazil. 48, 151-158.). Biocontrol Sci. Entomophaga 42, 517-523., Liu et al., 2000Liu, S.S., Wang, X.G., Guo, S.J., He, H.J., Shi, Z.H., 2000. acephala D.C. An. Soc. Also, in this period both minimum and maximum temperatures recorded rarely extrapolated the lower development threshold (≅6 °C), and never reached the upper threshold (≅37 °C) (Marchioro and Foerster, 2011). 1). Meigen with 14%. Goodwin, S., 1979. 105, 1115-1129. 127, 288-292.) and other regions of the world (Goodwin, 1979Goodwin, S., 1979. 14, 949-954. 40, 533-541.), nor availability of food resources are factors that prevent the occurrence of P. Also, the larval parasitoids associated with P. High -altitude migration of the diamondback moth Plutella xylostella to the U.K.: a study using radar aerial netting and ground trapping. Science 285, 893-895. 1 Climatic variables recorded during field surveys in the county of Colombo, Paraná State, Southern Brazil. Although this study has shown that temperature and rainfall are less important that biotic interaction in the population regulation of P. Uso de inseticidas para o controle da traç a-do-tomateiro e traç a-das-crucíferas: um estudo de caso. Indeed, there are several studies demonstrating that adjacent vegetation near to crops tend to improve parasitoid effectiveness through supply of food resources and microhabitats that serve as refuge for parasitoids (Griffiths et al., 2008Griffiths, G.J.K., Holland, J.M., Bailey, A., Thomas, M.B., 2008. piceotrichosus and O. Estimating the economic cost of one of the world's major insect pests, Plutella xylostella (Lepidoptera: Plutellidae): just how long is a piece of string? Liu, S.S., Chen, F.Z., Zalucki, M.P., 2002. This is not unexpected considering that the response to abiotic factors can be sensibly different between parasitoids and their hosts (Hence et al., 2007Hence, T., Baaren, J.V., Vernon, P., Boivin, G., 2007. xylostella in surveys carried out in the county of Porto Alegre, Southern Brazil (Ferronato and Becker, 1984). Eight species were found parasitizing larvae of P. According to the Köppen-Geiger climate classification, the region is within subtropical highland climate (cfb), characterized by cold and relatively dry winters, and moderately warm and wet summers. xylostella (Campos et al., 2006). piceotrichosus (7.3%), followed by D. The most important factors were the parasitism by D. xylostella are a major cause of reduction in larval parasitoid populations (Talekar and Shelton, 1993Talekar, N.S., Shelton, A.M., 1993. Multiple linear regression analysis was conducted considering only the period of pest occurrence in the field. Neither temperature, nor rainfall and relative humidity influenced the abundance of P. However, as far as we know, this is the first report of the tachinid Siphona sp. Technol. Kfir, R., 1997. sokolowskii, respectively. Words used include: biotic factors, abiotic factors, habitat, niche, competition, competitive exclusion principle, predation, symbiosis, mutualism, commensalism, parasitism, ecological succession, primary sPage 3May be used as a way to assess student comprehension of vocabulary terms associated with Population Ecology. xylostella occurred between June and November, and the largest peaks of abundance were observed between August and September, when low temperatures and rainfall were recorded. The abundance of parasitoids was different on broccoli (χ^2 (3)=71.71 , $p < 0.001$) and cauliflower (χ^2 (3)=45.50 , $p < 0.001$). 27, 132-136. Silva-Torres, C.S.A., Pontes, V.A.F., Torres, J.B., Barros, R., 2010. Chapman and Hall, London, pp. 40, 533-541. xylostella were assessed using stepwise multiple linear regression analysis (Draper and Smith, 1981Draper, N.R., Smith, H., 1981. Population dynamics of Plutella xylostella (Lep., Yponomeutidae) and its parasitoids in the region of Brasilia. 16, 607-618.). Resistance and behavioural response of Plutella xylostella (Lepidoptera: Plutellidae) popu- lations to Bacillus thuringiensis formulations. Highest percent increment in parasitism was estimated for A. Agric. and Ayalew et al., 2006Ayalew, G., Baumgärtner, J., Ogol, K.P.O.C., Löhr, B., 2006. Keywords:Apanteles piceotrichosus; Diadegma leontiniae; Oomyzus sokolowskii; Parasitism level; Siphona sp The diamondback moth, Plutella xylostella L., 1758 (Lepidoptera: Plutellidae) is an important pest of brassicas that causes significant losses in yield in several regions of the world (Talekar and Shelton, 1993Talekar, N.S., Shelton, A.M., 1993. 30, 329-342. In conclusion, our study investigated the factors that affect the population dynamics of P. piceotrichosus and Siphona sp. Recent analysis showed that the worldwide annual cost associated with its management is estimated in US$ 4 billion (Zalucki et al., 2012). (2006) may be an isolated sample of a larger event. leontiniae and Siphona sp., with 27% and 25% of the total parasitism, respectively (Table 1). Four species of larval parasitoids were identified associated with the pest, of which Diadegma leontiniae (Brèthes) (Hymenoptera: Ichneumonidae), Apanteles piceotrichosus Blanchard (Hymenoptera: Braconidae) and Siphona sp. In each survey, 30 plants per crop were examined; and second to fourth instar larvae and pupae were collected through visual observation of all plant leaves. Entomophaga 42, 517-523. Neotrop. Efficacy and eco- nomics of shelter habitats for conservation biological control. and Kobori and Amano, 2003Kobori, Y., Amano, H., 2003. Control 45, 200-209., Wade et al., 2008Wade, M.R., Zalucki, M.P., Wratten, S.D., Robinson, K.A., 2008. xylostella. Rainfall ranged from 136 mm in the driest months (June to August) to 398 mm in the rainy months (December to February) (Fig. Several mortality factors have been proposed as possible causes of population decline, such as the reduction of host plant quality, higher temperature, migration, increase in rainfall and suppressive effect of parasitoids (Campos et al., 2006Campos, W.G., Schoereder, L.H., DeSouza, O.F., 2006. The authors are grateful to Dr. Klaus Horstmann (in memorian), Dr. Silvio Shigeo Nihei from Universidade de São Paulo, Dr. Juan José Martinez and Daniel Alejandro Aquino from Museo Argentino de Ciencias Naturalis Bernardino Rivadavia, for the identification of D. These findings indicate that competition among parasitoids is limited. 32, 317-340.). Observed and potential parasitism Slight differences were recorded between observed and potential parasitism (Table 2). In this context, understanding the key factors governing the population dynamics of the pest is important for development of management strategies. parasitizing P. 19, 1-18. Furlong, M.J., Shi, Z.H., Liu, Y.Q., Guo, S.J., Lu, Y.B., Liu, S.S., Zalucki, M.P., 2004. xylostella in Brazil (Ferronato and Becker, 1984Ferronato, E.M., Becker, M., 1984. Factors influencing population dynamics of the southwestern corn borer (Lepidoptera: Crambidae): a reassessment. 31, 221-231., Golizadeh et al., 2007Golizadeh, A., Kamali, K., Fathipour, Y., Abbasipour, H., 2007. However, the role they play in regulating pest population was not investigated, despite the importance of this information for bioprospection of parasitoid species to be used as biocontrol agents against P. piceotrichosus, accounting for 47% of the overall parasitism, followed by D. There was no pesticide application during field surveys. Applied Regression Analysis. 38, 275-301.), and therefore should be used with caution in order to avoid reductions in parasitoids population. Although the diversity of larval parasitoids found in different regions of Southern Brazil is similar, it is lower when compared to those found in Midwestern Brazil (Guilloux et al., 2003Guilloux, T., Monnerat, R., Castelo-Branco, M., Kirk, A., Bordat, D., 2003. Fig. Kobori, Y., Amano, H., 2003. Practical Approaches to their Study and Evaluation. In this context, the identification of key mortality factors related to variation in the abundance of P. and Silva-Torres et al., 2010Silva-Torres, C.S.A., Pontes, V.A.F., Torres, J.B., Barros, R., 2010. 32, 915-928. Parasitism was consistently higher in the absence of other parasitoid species, but the difference between observed and potential parasitism was quite subtle. xylostella, and these findings were attributed to host plant morphology conferring less exposure of small larvae and pupae to rain (Muckenfuss et al., 1992Muckenfuss, A.E., Shepard, B.M., Ferrer, E.R., 1992. Table 2 Probabilities of Plutella xylostella parasitism by its larval parasitoids in the presence (observed parasitism in bold) and in the absence of other parasitoid species (potential parasitism in regular font) in broccoli and cauliflower crops during winter and spring season. The percentage of parasitism was determined based on the total number of larvae collected and the number of parasitized larvae. Shi, Z.H., Liu, S.S., 2003. xylostella occurred in the field, when large variations in temperature were not recorded. xylostella, these parameters may indirectly affect pest abundance. The latter situation can be easily detected when comparing the abundance of an insect species over time in regions where temperature varies widely throughout the year. Initially, we investigated the population dynamics of the pest in commercial crops located in Southern Brazil. xylostella in the study area was restricted between June and November. PLoS ONE 7, e40557.). Asian Vegetable Research and Development Center, Taiwan, pp. Rev. 30, 288-294. These data comprise daily minimum and maximum temperature (°C), daily rainfall (mm) and daily relative humidity (%). Biol. Host plant leaves provided to the larvae were previously washed in 0.5% solution of sodium hypochlorite to avoid larval contamination with entomopathogens. piceotrichosus were previously recorded as the most abundant parasitoids of P. Financial support was provided by the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES). xylostella, and three of these parasitoids play a major role on pest population regulation. was positively related to host abundance, indicating the existence of a density-dependent relationship. Parasitoids of Plutella xylostella (Lep. Several factors are responsible for this situation in different regions of the world, such as the diversity and availability of host plants, lack of effective natural enemies, high tolerance to a wide range of temperatures, and high reproductive potential and genetic plasticity, which combined favors the rapid evolution of resistance to insecticides (Talekar and Shelton, 1993 and Mohan and Gujar, 2003Mohan, M., Gujar, G.T., 2003. University of Chicago Press, Chicago. 38, 249-253. Among the abiotic factors evaluated, only plant season influenced pest abundance. Then it asks them to underline which part of the statement led them to the answer. The influence of post -flowering pests on cowpea seed yield with particular reference to damage by Heteroptera in southern Benin. Statistical analysis The role biotic and abiotic factors on the abundance of P. Characteristics of parasitism of Plutella xylostella (Lep., Plutellidae) by Oomyzus sokolowskii (Hym., Eulophidae). Population dynamics of P. This scenario is not much different in some regions of Brazil, where insecticide resistant populations cause serious economic damage (Castelo-Branco et al., 2001Castelo-Branco, M., França, F.H., Medeiros, M.A., Leal, J.G.T., 2001. Econ. Exper- imental analysis of the influence of pest management practice on the efficacy of an endemic arthropod natural enemy complex of the diamondback moth. Average temperatures recorded during field surveys ranged from 13 °C in the colder months of winter to 20 °C in summer. This condition has prompted a demand for alternative management strategies, particularly those based on biological and cultural control (Sarfraz et al., 2005 and Sarfraz et al., 2006). leontiniae (5.8%) and Siphona sp. Effect of rainfall on a population of the diamond- back moth, Plutella xylostella (Lepidoptera, Plutellidae). and Marchioro and Foerster, 2011Marchioro, C.A., Foerster, L.A., 2011. Afr. Ayalew, G., Baumgärtner, J., Ogol, K.P.O.C., Löhr, B., 2006. In: Talekar, N.S. (Ed.), Diamondback Moth and Other Crucifers Pests: Proceedings of the Second International Workshop. xylostella was selected as the dependent variable and the biotic and abiotic factors as independent variables. Liu, S.S., Wang, X.G., Guo, S.J., He, H.J., Shi, Z.H., 2000. Sci. sokolowskii was rarely found in the study area, it was the most abundant larval parasitoid of P. de Sassi, C., Tylianakis, J.M., 2012. 39, 835-838.). leontinae (partial r^2 = 0.38) and A. Additionally, fertilization during planting was made with chicken manure. and Pinheiro et al., 2002Pinheiro, F., Diniz, I.R., Coelho, D., Bandeira, P.S., 2002. 105, 1115-1129.). On the other hand, other studies have shown that rainfall did not affect the population dynamics of P. Material and methods The study was conducted on organic commercial crops located in the county of Colombo, Paraná State, Southern Brazil (S 25°17', W 49°13', 950 m altitude) between June 2007 and June 2008. Major mortality factors in the population dynamics of the dia- mondback moth, Plutella maculipennis (Curt.) (Lepidoptera: Plutellidae). 27, 981-989. Its occurrence was restricted to June-November, coinciding with the periods of lower temperature and rainfall (Fig. xylostella (Liu et al., 2002Liu, S.S., Chen, F.Z., Zalucki, M.P., 2002. Austral Ecol. Hortic. and Campos et al., 2006Campos, W.G., Schoereder, L.H., DeSouza, O.F., 2006. Together these variables explained 60.2% of the variation in the pest abundance (Table 3). Talekar, N.S., Shelton, A.M., 1993. Seedlings of broccoli and cauliflower were transplanted to plots of ca. xylostella on broccoli during winter. Wallner, W.E., 1987. Factors affecting insect population dynamics: differences between outbreak and non-outbreak species. It has statements of examples describing various parts of the hierarchy, & asks students to state which part it best describes. The mean number of larvae sampled in winter was slightly lower than in spring on both broccoli (winter: 49.2 ± 15.7; spring: 36.3 ± 6.4 immatures/30 plants) and cauliflower (winter: 24.3 ± 4.4; spring: 23.5 ± 6.6 immatures/30 plants). 232-292. Its influence on insect abundance is easily noticed when temperature extrapolates lower and upper development thresholds causing insect mortality; and/or when higher temperatures accelerate development resulting in an increase in the number of generations of the species. Ann. xylostella has made the economical production of brassicas impracticable in certain regions of the world (Talekar and Shelton, 1993 and Sarfraz et al., 2006Sarfraz, M., Dosdall, L.M., Keddie, B.A., 2006. The contribution of each variable was determined by the coefficient of determination (r^2) and the p value. xylostella in the study area. 27, 641-650. After harvesting, the area passed through a fallow period, when wild radish and remains of previous crops were incorporated into the soil as green manure. If climatic conditions are not a limiting factor, and environmental resources are available throughout the year, it is expected that a highly flexible species like P. 95, 55-66., Annamalai et al., 1988Annamalai, S., Itô, Y., Saito, T., 1988. Here, data obtained in field surveys carried out in different host plants were used to answer a series of questions involving the ecology of P. Seasonal abundance of the diamondback moth was evaluated on broccoli (Brassica oleraceae var. xylostella throughout the year in Southern Brazil. leontinae, A. 14, 309-316. oleraceae car. Mosiane, S.M., Kfir, R., Villet, M.H., 2003. Insect Sci. xylostella worldwide, and some of which are considered important for the regulation of pest population (Sarfraz et al., 2005Sarfraz, M., Keddie, A.B., Dosdall, L.M., 2005. 22, 495-504.). xylostella among regions are explained as a result of variations in rainfall (Martínez-Castillo et al., 2002Martínez-Castillo, M., Leyva, J.L., Cibrián-Tovar, J., Bujanos Muníz, R., 2002. Martínez-Castillo, M., Leyva, J.L., Cibrián-Tovar, J., Bujanos Muníz, R., 2002. var. Diadegma leontiniae (Brèthes) was the most abundant parasitoid on broccoli, accounting for 58% of the overall parasitism recorded, followed by Apanteles piceotrichosus (Blanchard) with 26% and Siphona sp. Also included are hundreds of unit PowerPoint slides, the bundled homework package, unit notes, Isopod lab report information, and much more from my Abiotic Factors Unit on TpT. xylostella and their role in regulating the abundance of the pest was assessed. and Tscharntke et al., 2007). 14, 949-954.) and management practices (Furlong et al., 2004Furlong, M.J., Shi, Z.H., Liu, Y.Q., Guo, S.J., Lu, Y.B., Liu, S.S., Zalucki, M.P., 2004. In the stepwise multiple regression the abundance of P. 70, 488-495.). Effect of intercropping on oviposition and emigration behavior of the leek moth (Lepidoptera, Acrolepiidae) and the dia- mondback moth (Lepidoptera, Plutellidae). Areas of Focus within this PowerPoint What are Abiotic (non-living) Factors that affect plants and ani BIOLOGICAL CONTROL AND CROP PROTECTION • • copy Cesar Augusto Marchioro Luís Amilton Foerster About the authors The serious economic loss caused Plutella xylostella L., 1758 in several regions of the world has prompted a demand for alternative management strategies. 32, 317-340. Chi-square test was used to compare the frequency of occurrence of larval parasitoids ($p < 0.05$). Publication in this collectionOct-Dec 2016 Received31 Aug 2015 Accepted01 June 2016 xylostella Samplings were taken weekly, allowing the record of the abundance of P. Biocontrol 44, 391-402.), interspecific competition (Talekar and Hu, 1996Talekar, N.S., Hu, W.J., 1996. Annamalai, S., Itô, Y., Saito, T., 1988. xylostella in all plant phenological stages. Frequent failure in the control of P. leontiniae and A. The most abundant parasitoid on cauliflower was A. Ecol. 39, 835-838. Biological control of the dia- mondback moth, Plutella xylostella: a review. Biology, ecology, and management of the dia- mondback moth. xylostella in the field. Crop Prot. leontinae, Siphona sp., A. Climate change disproportionately increases her- bivore over plant or parasitoid biomass. 11, 277-285. The key role that the larval parasitoids complex showed as a mortality factor of P. Meteorological data were obtained from weather stations of the Meteorological Institute of Paraná State during the sampling period. Wang, X., Liu, S., Guo, S., Lin, W., 1999. The meteorological factors evaluated did not affect the abundance of P. In this context, it is reasonable to suppose that migration is the possible cause of seasonality in the neotropical populations of P. In: Jervis, M., Kidd, N. Biocontrol 44, 391-402. Control 45, 200-209. sokolowskii were previously recorded in other regions of Brazil (Ferronato and Becker, 1984Ferronato, E.M., Becker, M., 1984. First instar larvae were not collected because at this stage they are leaf-mining, which makes their observation and sampling difficult. 90, 221-231. Occurrence of the diamondback moth (Plutella xylostella L.) and its parasitoids in Ethiopia: influence of geographical region and agronomic traits. Furthermore, both rainfall duration and intensity are important factors causing egg and larval mortality (Kobori and Amano, 2003). xylostella, but the average parasitism rate (23%) was similar to the one recorded in our study (Guilloux et al., 2003). 38, 249-253.), and often differences in the abundance of P. According to the stepwise regression analysis, P. 53, 137-149. Seasonal phenology of the diamondback moth, Plutella xylostella (L.), (Lepidoptera: Plutellidae), and its parasitoids on canola, Brassilca napus (L.), in Gauteng province, South Africa. Nevertheless, our study demonstrates a clear seasonal variation in the abundance of the insect pest. Appl. Dreyer, H., Baumgärtner, J., 1995. Results Seasonal abundance of the diamondback moth on broccoli and cauliflower is shown in Fig. This analysis allows the ranking of the biotic and abiotic variables based on their explanatory importance. In addition to parasitism, crop subspecies was another biotic factor that influenced pest population dynamics. Insect seasonality: why? Diamondback moth-host plant inter- actions: implications for pest management. 52, 107-126. leontiniae, A. Plutellidae) in South Africa: an annotated list. 130, 343-348. 53, 137-149.). 27, 981-989., Kfir, 1997Kfir, R., 1997. Differences in the abundance of O. Res. The cropping system followed the protocol recommended for organic farming. In spring, summer, autumn and winter 8, 10, 9 and 13 samples were respectively carried out on broccoli and 9, 9, 10 and 10 on cauliflower. 13, 261-278. 90, 221-231., Mosiane et al., 2003Mosiane, S.M., Kfir, R., Villet, M.H., 2003. Emerged parasitoids were properly preserved in alcohol 95% and sent to taxonomists for identification. Baskauf, S.J., 2003. Changes in numbers in the parasitoid complex associated with the diamondback moth, Plutella xylostella (L.) (Lepidoptera) in Victoria. sokolowskii. 16, 607-618.), was estimated following Dreyer and Baumgärtner (1995Dreyer, H., Baumgärtner, J., 1995. Control 49, 259-269.). 48, 151-158. F-values higher than 1.0 were used as a criterion for a variable to enter in the final model. Although O. Larvae were fed on fresh leaves of the crop on which they were collected until the emergence of adult moths or parasitoids. Campos, W.G., Schoereder, L.H., DeSouza, O.F., 2006. Ferronato, E.M., Becker, M., 1984. xylostella, in some cases for distances longer than 3000 km using air currents (Talekar and Shelton, 1993Talekar, N.S., Shelton, A.M., 1993. Andrewartha, H.G., Birch, L.C., 1954. These results show the importance of larval parasitoids complex in regulating P. BioControl 47, 23-31. 22, 495-504. Annu. Population dynamics. Guilloux, T., Monnerat, R., Castelo-Branco, M., Kirk, A., Bordat, D., 2003. Local variation in susceptibility of the diamondback moth, Plutella xylostella (Linneaus) to insecticides and detoxification enzymes. In light of these findings, it is possible that precipitation recorded during the period of pest occurrence in the field may not have been intense enough to cause significant mortality on the immatures. and Chapman et al., 2002Chapman, J.W., Reynolds, D.R., Smith, A.D., Riley, J.R., Pedgley, D.E., Woiwod, I.P., 2002. (5.0%). Syst. Seasonal abundance of the parasitoid complex associated with the diamondback moth, Plutella xylostella (Lepidoptera: Plutellidae) in Hangzhou, China. One peak of abundance was recorded in August on broccoli, while on cauliflower two peaks were recorded, one in September and another in October. Conservation biological control and enemy diversity on a landscape scale. and Zalucki et al., 2012Zalucki, M.P., Shabbir, A., Silva, R., Adamson, D., Shu-Sheng, L., Furlong, M.J., 2012. Mem. These findings indicate that conservation practices may be adopted to improve parasitoid effectiveness and reduce pest population. piceotrichosus and Siphona sp., crop and planting season affected the abundance of P. Parasitism was the major factor influencing the abundance of P. Wolda, H., 1988. 27-36. 127, 288-292. 13, 261-278., Guilloux et al., 2003Guilloux, T., Monnerat, R., Castelo-Branco, M., Kirk, A., Bordat, D., 2003. Surveys initiated always two weeks after seedling transplant, but the number of samples varied due to differences in plant cycle length. On the other hand, it is well known that pesticides used against P. Aust. Golizadeh, A., Kamali, K., Fathipour, Y., Abbasipour, H., 2007. piceotrichosus (partial r^2 = 0.06) and crop subspecies (partial r^2 = 0.05) (Table 3). Environ. 97, 1814-1827. Zago, H.B., Siqueira, H.A.A., Pereira, E.J.G., Picanço, M.C., Barros, R., 2013. Impact of extreme temperatures on parasitoids in a climate change perspective. According to the multiple regression analysis, parasitism by D. If influx of P. 15, 763-789. Climate data shown are: rainfall (column), mean temperature (solid line), minimum temperature (dashed line) and maximum temperature (dotted line). Abundância e complexo de parasitóides de Plutella xylostella (Linnaeus, 1758) (Lepidoptera: Plutellidae) em Brassica oleracea L. xylostella showed a clear seasonality. Some statements could describe more than one, so thPage 5This is a 300 slide PowerPoint presentation with built-in class notes (red slides), challenge questions, exciting visuals, built-in lab activity, homework or classwork sheet, lesson notes, video links, and much more. Jervis, M., Kidd, N., 1996. Table 3 Regression statistics for abundance of Plutella xylostella. The experimental site was surrounded by other vegetable crops that are not used by P. Ecosyst. Discussion Seasonal cycles in insect communities are often attributed to variations in quality and availability of resources according to climatic conditions (Wolda, 1988Wolda, H., 1988. xylostella Four species of larval parasitoids comprising two orders and four families were identified associated with P. Despite the availability of food resources throughout the year, the occurrence of P. Mohan, M., Gujar, G.T., 2003. xylostella, contributing to 48% of the variation in pest abundance. 232-292.), two desired attributes for biocontrol agents. xylostella (Harcourt, 1963Harcourt, D.G., 1963. italica) and cauliflower (B. Neither temperature (Marchioro and Foerster, 2011Marchioro, C.A., Foerster, L.A., 2011. Although this climate condition is found in the study area, we probably did not detect the influence of temperature on P. Together, this information can be used for management purposes, particularly those involving biological control. Abundance of larval parasitoids In order to identify the larval parasitoids associated with P. Seasonal pattern of insect abundance in the Brazilian cerrado. 27, 132-136.). Soc. Interspecific competition between Cotesia plutellae Kur- djumov (Hymenoptera: Braconidae) and Oomyzus sokolowskii Kurdjumov (Hymenoptera: Eulophidae), two major parasitoids of Plutella xylostella (L.) (Lep- idoptera: Plutellidae). xylostella and investigate the biotic (crop subspecies, plant age and parasitism) and abiotic factors (minimum and maximum temperatures, rainfall, relative humidity and planting season) affecting the population dynamics of the pest in organic crops located in Southern Paraná State, Brazil. Seasonality in neotropical populations of Plutella xylostella (Lepidoptera): resource availability and migra- tion. xylostella Multiple regression analysis showed that parasitism by D. Entomol. botrytis) crops. Understanding the factors governing the population dynamics of insects is an important issue of insect ecology (Andrewartha and Birch, 1954Andrewartha, H.G., Birch, L.C., 1954. Muckenfuss, A.E., Shepard, B.M., Ferrer, E.R., 1992. John Wiley and Sons, New Delhi.). and Shi and Liu, 2003Shi, Z.H., Liu, S.S., 2003. Marchioro, C.A., Foerster, L.A., 2011.

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