

A fuzzy optimization model for chemical control of the soybean aphid

Silvia M. S. Carvalho, Magda S. Peixoto,
Laécio C. Barros, Rodney C. Bassanezi, and
Odair A. Fernandes

DFQM, CCTS, UFSCar, Sorocaba, SP
DMA, IMECC, UNICAMP, Campinas, SP
FCVA, UNESP, Jaboticabal, SP
{silviamcs@ufscar.br, magda@ufscar.br,
laeciocb@ime.unicamp.br, rodney@ime.unicamp.br,
oafernandes@fcav.unesp.br

Abstract. This work proposes a chemical control to soybean aphid by fuzzy linear programming. The soybean aphid, *Aphis glycines* (Hemiptera: Aphididae), is an invasive herbivore new to North America [3]. The model includes a fuzzy predator-prey system in order to describe the interaction between the prey, *Aphis glycines* (Hemiptera: Aphididae) - the soybean aphid, and its predator, *Orius insidiosus* (Hemiptera: Anthocoridae) [4] considering biotic (predator) and abiotic (temperature) factors, which affect the soybean aphid population dynamics, and a comparison between the fuzzy model and real data reported in the literature [1]. An economic threshold was developed for chemical control, i.e., when an insecticide treatment is warranted. Economic thresholds for the soybean aphid have been developed and vary from 250 to 273 aphids per plant [6]. Field studies have demonstrated that the insidious flower bug can significantly slow soybean aphid population growth, particularly during hot summer weather. We proposed in [5] a fuzzy biological control to soybean aphid, that is, the model provides how often and how much to add the predators in the plantation by fuzzy rule-based system, instead using insecticides. In this work we propose a chemical control to soybean aphid by fuzzy linear programming [2]. Subsequently, we include a comparison between the control by fuzzy system [4] and the control by fuzzy linear programming. Thus, in this paper we have propose a chemical control in the plantation when the prey population exceeds the economic damage threshold. On the one hand, the soybean aphid has still not found in Brazil. Therefore, before any eventual invasion, a predictive model to enhance control program is desirable. On the other hand, the soybean aphid has become the most devastating insect pest of soybeans in the United States. Brazil is the second largest exporter of soybean at present, after the USA and before Argentina. According to the Bureau of Agriculture of the USA, it has been estimated that Brazil will be the largest soybean exporter in 2023.

Keywords: fuzzy number, fuzzy linear programming, control

Acknowledgments. The authors acknowledge the Coordination for the Improvement of Higher Education Personnel (CAPES), PNPd/CAPES, the National Council for Scientific and Technological Development (CNPq), project numbers 305862/2013–8, and São Paulo Research Foundation (FAPESP), projects numbers 2010/06822–4 and 2013/24148–7, for the financial support.

References

1. Hunt, T.: Soybean aphid management in Nebraska. NebFacts. Nebraska Cooperativa Extension. IARN-UNL, Lincoln, NE. (NF04-599) (2005)
2. Klir, G.J., Yuan, B.: Fuzzy Sets And Fuzzy Logic: Theory and Applications, Prentice Hall, N. Jersey (1995)
3. McCornack, B.P., Ragsdale, D.W., Venette, R.C.: Demography of Soybean Aphid (Homoptera: Aphididae) at Summer Temperatures, *J. Ec. Entomology*, 97(3):854–861 (2004)
4. Peixoto, M.S., Barros, L.C., Bassanezi, R.C., Fernandes, O.A.: An approach via fuzzy systems for dynamics and control of the soybean aphid. In: 2015 Conference of the International Fuzzy Systems Association and the European Society for Fuzzy Logic and Technology (IFSAEUSFLAT15), Proceedings of the 2015 Conference of the International Fuzzy Systems Association and the European Society for Fuzzy Logic and Technology, Paris: Atlantis Press. DOI:10.2991/ifsa-eusflat-15.2015.183 (2015)
5. Peixoto, M.S., Barros, L.C., Bassanezi, R.C., Fernandes, O.A.: A study on the dynamics and control of the soybean aphid. In: 2015 Annual Conference of the North American Fuzzy Information Processing Society (NAFIPS) held jointly with 2015 5th World Conference on Soft Computing (WConSC), Fuzzy Information Processing Society (NAFIPS) held jointly with 2015 5th World Conference on Soft Computing (WConSC), Redmond, IEEE. DOI: 10.1109/NAFIPS-WConSC.2015.7284183, (2015)
6. Ragsdale, D.W., McCornack, B.P., Venette, R.C., Potter, B.D., MacRae, I.V., Hodgson, E.W., O’Neal, M.E.: Economic Threshold for Soybean Aphid (Hemiptera: Aphididae), *Journal of Economic Entomology*, 100(4):1258–1267 (2007)