Invasive species management summary

Spodoptera frugiperda

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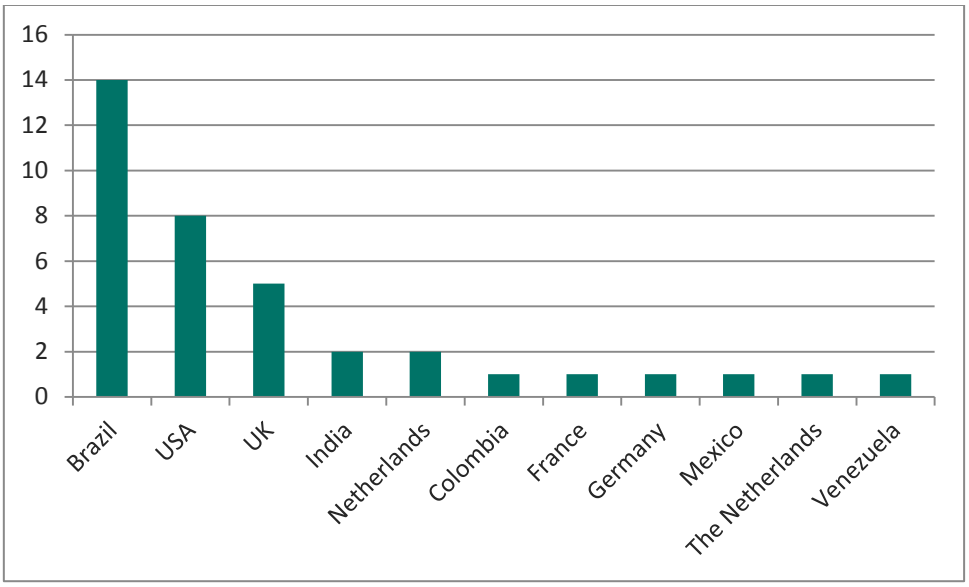
Spodoptera frugiperda management summary

Spodoptera frugiperda (fall armyworm)

Relevant Invasives Programme countries: Ghana

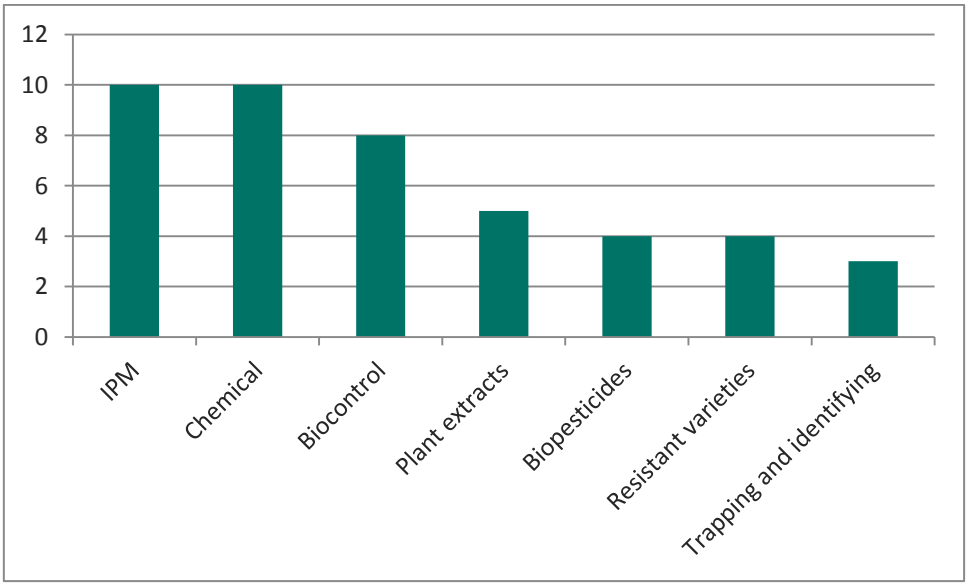
35 records were inspected from the 46 available for the CAB Direct search terms "Spodoptera frugiperda" and "IPM". 11 records were discounted because their summary type was not directly related to management controls.

Geography



Brazil, where *S. frugiperda* is an established pest, is the largest single source of papers. The only other two countries to generate significant papers were the USA, where *S. frugiperda* is also a pest, and the UK. There were no papers from Africa, potentially the primary area of concern for this pest in the coming years.

Most commonly studied approaches



Both IPM and chemical control were the most commonly studied approaches. IPM strategies typically incorporated limited chemical control with biocontrol. *Doru luteipes*, *Telenomus remus* and *T. pretiosum* emerged as commonly-studied biocontrol agents. The use of plant extracts such as *Trichilia pallida*, biopesticides such as *Bt* and resistant varieties, particularly GM crops, were also discussed several times.

Details of techniques

IPM

- IPM strategies against *S. frugiperda* have been discussed since at least the 1980s (Wiseman, 1985), and often since then (e.g. Wyckhuys et al., 2007; Wyckhuys and O'Neil, 2010; Blanco et al., 2014). In the following techniques listed, those where the authors have mentioned its relevance to IPM have been labelled 'IPM relevant'

Biocontrol

- IPM relevant: Egg parasitism with *Telenomus* sp., combined with commercial products containing the fungus *Nomuraea rileyi* and bacteria *Bacillus thuringiensis* provided control of *S. frugiperda* (García et al., 2002)
- IPM relevant: The entomopathogenic nematodes *Heterorhabditis indica*, *Steinernema carpocapsae* and *Steinernema glaseri* may be used to control *S. frugiperda*, and were compatible with 12 (out of 18) class 1 insecticides tested (Negrisoli Júnior et al., 2010)
- In Nicaragua, naturally-occurring ants were found to significantly reduce *S. frugiperda* abundance (Perfecto, 1991)
- IPM relevant: The egg parasitoids *Trochogramma atopovirilia* and *T. preiosum* gave 30% and 60% control of *S. frugiperda*, respectively. *T. exiguum* did not show the same potential (Díaz et al. 2012)
- IPM relevant: The combination of *Telenomus remus* and *Trichogramma pretiosum* gave promising control of *S. frugiperda* as part of IPM (Goulart et al., 2011)
- Naturally occurring *Diabrotica speciosa* (Coleoptera, Chrysomelidae), *Leptoglossus zonatus* (Hemiptera, Coreidae), *Monocrepidius* aff. *posticus* and *Monocrepidius fuscofasciatus* (Coleoptera, Elateridae) were all found to eat *S. frugiperda* egg masses in maize fields in Brazil (Menezes-Netto et al., 2012)
- The parasitoid *Telenomus remus* shows promise against *S. frugiperda*, although there was no parasitism at 35°C (Bueno et al., 2010)
- Redoan et al. (2013) consider *Doru luteipes* to be one of the best natural enemies against *S. frugiperda.* Triflumuron was harmless against it

Plant extracts

- Biopesticides from *Calceolaria integrifolia* (Céspedes et al., 2014), Asteraceae (Tavares et al., 2009), *Trchilia pallida* twigs and *T. pallens* leaves (Bogorni and Vendramim, 2005), and plants containing the flavonoid rutin (Silva et al., 2016; IPM relevant), have all shown some degree of insecticidal activity against *S. frugiperda*

Biopesticides

- IPM relevant: Camacho et al. (2016) suggested the nucleopolyhedrovirus SfMNPV 003, a biopesticide, could be incorporated into IPM programs

Resistant varieties

- Combination of *Bt* maize and spinosad provided control of *S. frugiperda* and other lepidopterans better than or equal to lambda-cyhalothrin (Musser and Shelton, 2003)

- Survival of S. frugiperda fed on Bt cotton was 74.1% compared to 96.7% for those fed on non-Bt cotton (Ramalho et al., 2007)
- Maize plants with a synthetic cry gene for the production of a *Btk*-insecticidal protein showed resistance to *S. frugiperda* (Lynch et al., 1999); however, Fonseca and Polanía (1998) warned that *S. frugiperda* has the potential to become resistant to *Btk*
- Cry1A.105/Cry2Ab2 and Vip3Aa20 *Bt* corn reduced *S. frugiperda* performance to less than 5% and 0%, respectively (Waquil et al., 2016)
- IPM relevant: Davis et al. (1998) suggested *S. frugiperda*-resistant maize could be used as part of an IPM strategy
- The transgenic genotypes NS90 PRO2, Maximus VIP 3, Feroz VIP 3 and Maximus VIP 3 elicited an aversion and/or an antibiosis reaction from *S. frugiperda*. The transgenic genotypes HX 20A55, 30A91 PW, LG 6036 PRO, 20A78 HX and BR 9004 PRO showed a moderate resistance to *S. frudiperda* (Paiva et al., 2016)

Trapping and ID

- Pheromone traps can be used for *S. frugiperda* (Weber and Ferro, 1991), and can be a useful tool in IPM in maize in Brazil (Cruz et al., 2010; IPM relevant)
- Elliott et al. (2014) devised an improved method for sampling *S. frugiperda* (and *Helicoverpa zea*) in sorghum in USA

Chemical control

- The use of pesticides alone to control *S. frugiperda* has been looked at by Hurksa and Gladstone (1988), Ebbinghaus et al. (2007), Soares et al. (1999) and Hardke et al. (2007). Soares et al. (1999) reported that six insecticidal sprays were needed to control *S. frugiperda* (and *Aphis gossypii*) on cotton in Brazil
- IPM relevant: Indoxacarb, spinosad, novaluron, emamectin benzoate and methoxyfenozide all provide reasonable control of lepidopteran pests on collards, and, since they are relatively less toxic to natural enemies, the authors suggest they can be incorporated into IPM strategies (Cordero et al., 2006)

Other

- Rain kills small *S. frugiperda* larvae (García et al., 2002)

Current in-country activity

Ghana

No information could be found on any activities against *S. frugiperda* in Ghana, probably due to its recent arrival in the country.

Smallholder farming applicability

Smallholders in the Americas continue to rely primarily on chemical control to control *S. frugiperda*, despite limited results: for instance, approximately 3,000 tons of active ingredient per year are used to tackle it in Mexico, yet the average maize yield remains 38% below the world average (Blanco et al., 2014). IPM is not commonly practiced or known of among farmers unless they have attended outreach session about it or belong to social groups that are aware of it (Blanco et al., 2014; Wyckhuys and O'Neil, 2007). In order to avoid West African smallholders relying solely on chemical control for this new pest, it is essential that CABI and partners inform farmers about IPM strategies to tackle *S. frugiperda*, which can provide greater control than chemicals alone, with reduced environmental impact.
The most successful IPM strategies will almost certainly include biocontrol (e.g. Díaz et al. 2012; Goulart et al., 2011), but potential biocontrol agents for *S. frugiperda* are still being studied in the Americas, and are unheard of in West Africa, the region likely to be hit by an

invasion. It may therefore take several years to identify a successful biocontrol agent for *S. frugiperda* in West Africa. In the meantime, farmers must be encouraged to use other aspects of IPM.

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Conclusion

If *S. frugiperda* is set to invade West Africa, and perhaps beyond, it is critical that CABI and partners first communicate IPM strategies to smallholders and discourage a reliance on chemical control. In the meantime, work should be done to test the several potential biocontrol agents discussed in the literature, to see if they can be used in Africa. No silver bullet biocontrol for *S. frugiperda* has yet been found, as they all provide only partial control, so it may be that biocontrol cannot be relied on fully to manage *S. frugiperda*, and instead must be used as part of other IPM strategies.

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