Do we need to be worried about the potential threat of invasive species to crops as the climate changes?

Evans, KA

Published in:
Dundee Conference on Crop Protection in Northern Britain 2012

Print publication: 01/01/2012

Document Version
Publisher's PDF, also known as Version of record

DO WE NEED TO BE WORRIED ABOUT THE POTENTIAL THREAT OF INVASIVE SPECIES TO CROPS AS THE CLIMATE CHANGES?

KA Evans
Crop & Soil Systems, SAC, West Mains Road, Edinburgh EH9 3JG

Summary: There are pests that have the potential to invade the UK and cause problems to a wide range of crops. These include invertebrates, fungi and plant species. With climate change ongoing, the conditions within UK crops will become favourable for the spread of pests currently within the UK, and establishment of several invasive species, which will provide significant issues for their management.
This paper will summarise the potential for several current and potential invasive pest species to spread and establish under current and future climates, and discuss the likely impacts they will have on specific UK crops.

INTRODUCTION

Climate change is now an accepted phenomenon and its impact on Scottish agriculture will become more noticeable over the next 50 years (Davies *et al*, 2007). Over the last half century temperatures have increased in every season in all parts of Scotland, and in some areas in Scotland, particularly northern and western areas, winter rainfall has increased on average by 60%. Climate change scenarios produced by the UK Climate Projections Programme (UKCP09) and the Intergovernmental Panel on Climate Change (IPCC) suggest Scotland is to get warmer winters and summers, with an increase in winter rainfall, but a decrease in summer rainfall, and with more extreme weather events (see Table 1). These changes in temperature and rainfall coupled with increases in carbon dioxide concentration will affect crops as well as the pests, weeds and diseases that live on or in them.
The climate will also become more favourable for species that have yet to establish in the UK, as increase in temperatures will directly affect pest physiological processes, such as the rate of growth and development. The growth period of most temperate species occurs during the warmer summer period of the year. A rise in summer temperatures may be expected to increase the speed of development, allowing for more generations to develop within a season in multivoltine species (Bale *et al*, 2002).
This paper summarises how climate change is likely to affect the pests we currently see on crops in Scotland, and identify potential 'new' threats that could take advantage of the changes in climate over the next half century or so.

Table 1. The likely changes in Scottish climate by 2050

Climatic variable	Likely change
Temperature	Warming of between 1-2°C, with greatest warming during the autumn except for the extreme north of the country. There will be more extremes of temperature in the summer and autumn, with fewer very cold days, especially in the winter.
Rainfall	Winter rainfall will increase by 15-20%. Summer rainfall will decrease by 15-30%.
Humidity	Relative humidity will decrease slightly.
Soil moisture	There will be a reduction in soil moisture in the summer and autumn of between 10-30% except in the Highlands. Winter soil moisture will increase up to 10% from current levels.
Thermal growing season	This will increase in all areas allowing earlier sowing of crops to occur along with earlier harvests and potential for novel crops to be grown.

METHODS

Climatic modelling can be used as a tool in pest risk assessment, and has a major role in determining the effects of global change on ecosystems (Baker *et al*., 2000). CLIMEX is a software package that contains two distinct functions: the 'Match Climates' function in CLIMEX uses an inductive approach, as it compares meteorological data from different areas directly (Sutherst *et al*, 2000). This function calculates a 'Match Index', which is a measure of the overall similarity of climatic variables at different locations. CLIMEX also contains a 'Compare Locations' function, which is based on a deductive approach as using species-specific climate response models (Sutherst, 2003). This function generates an 'Ecoclimatic Index' representing a measure of the overall climatic suitability of a location for a specific species (Baker *et al*, 2000; Sutherst *et al*, 2000). The ability to predict the risk of establishment plays an important role in the management of invasive species, particularly in determining priority species for control and regions most vulnerable. CLIMEX is now used for quarantine, biological control, pest management and conservation worldwide, and is applicable for a diverse range of species, pests and diseases. Within this paper, CLIMEX has been used to determine the suitability of the projected Scottish climate for 2050-2099 (based on the A1B medium emissions scenarios produced in UKCP09 and the IPCC) for the establishment and spread of a range of current and invasive crop pest species.

CLIMATE CHANGE AND CURRENT PESTS

The impact of climate change on pests of crops is driven by the response of invertebrates to temperature, moisture and carbon dioxide. Some pests such as cereal aphids will reproduce more rapidly at the elevated carbon dioxide levels forecast for 2050, and temperature increases will accelerate the rate of multiplication even further, allowing more generations per season (up from 18 to 23 for some aphid species). This inevitably has consequences for the crops that aphids infest, particularly for crops such as seed potatoes where virus transmission by aphids is a potential threat.

We are already seeing 'new' pest problems arising in Scottish crops which are, in part, in response to climatic changes: cabbage stem flea beetle and rape winter stem weevil in winter oilseed rape and orange wheat blossom midge in cereals for example.

As the Scottish climate changes over the next 50 years, many of these pests will become serious problems (see Table 2).

Table 2. Likely increase or decrease in severity of specific crop pests by 2050

Common name	Crops affected	Increase/decrease in severity
Turnip sawfly	Oilseed rape, vegetable brassicas	Increase
Gout fly	Cereals	Increase
Wheat stem sawfly	Wheat	Increase
Wheat bulb fly	Wheat and spring barley	Decrease
Aphids	All crops	Increase
Cereal leaf beetle	Cereals	Increase
Wireworm	Cereals, potatoes	Increase
Cabbage root fly	Vegetable brassicas, oilseed rape	Increase
Pea moth	Peas	Decrease
Potato cyst nematode	Potatoes, tomatoes	Increase
Diamondback moth	Brassica vegetables	Increase
Carrot fly	Carrots, parsnips	Decrease
Cutworm	Field vegetables, potatoes	Increase
Slugs	All crops	Decrease, except in the northwest

Some pests that are sensitive to moisture will decrease to some extent. Slugs for example could decrease in severity due to lower rainfall in the summer months in most areas (Willis *et al*, 2006), however, any increase in summer irrigation will negate this benefit. Conversely, wheat bulb fly will become less of an issue in future years due to egg mortality increasing due of the projected increase in winter rainfall, as survival is low if annual rainfall exceeds 840mm (Thomas, 1948).

Many pests that are already present could increase in importance (see Table 1), with cabbage root fly for example becoming a significant pest of winter oilseed rape as in Germany, where it is now considered to be one of the most important pests of this crop.

INVASIVE PESTS

Several pest species invade Scotland annually as they are unable to overwinter under the current climate. One example is the Silver Y moth (*Autographa gamma*), which is widespread across Europe. In spring variable numbers migrate north reaching as far as Iceland Greenland, and Finland. In Scotland adults are present in significant numbers from May onwards with numbers dwindling in late autumn as they are killed off by frosts. Numbers of moths caught in pheromone traps in East Lothian since 2001 are summarised in Table 3.

Table 3. Peak No. of Silver Y moth caught in pheromone traps in East Lothian 2001-2011

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Peak No.	58	101	200	92	119	219	145	435	221	728	114

Populations of silver Y moth vary from year to year (Table 3), with some years such as 2010 having a significant invasion, which subsequently caused problems on several crops. The projected increase in winter temperatures, and reduction in frosts has the potential to allow Silver Y moth to survive in Scotland and become a significant pest by the middle of the century, especially as it can attack a range of crops such as potatoes, brassicas, peas, carrot, lettuce, wheat and maize.

Several potato pests have the potential to be introduced (or re-introduced) into the UK. Breeding colonies of Colorado potato beetle (*Leptinotarsa decemlineata*) have occasionally been present in the UK, but the last was eradicated in 1977. Colorado potato beetle (CPB) is a notifiable quarantine pest, whose introduction is prohibited under the EC Single Market Protected Zone arrangements for Plant Health.
Using a CPB climate response model in CLIMEX (Kocmánková *et al*, 2010), the current climate is suitable for establishment of the beetle in south east England (Fig. 1a), and by 2050 (Fig. 1b) areas in East Lothian, Fife and Angus will be suitable for establishment, with most of the UK suitable by 2080 (Fig. 1c), with 3 generations of CPB possible in south east England, and 2 generations in Scotland.

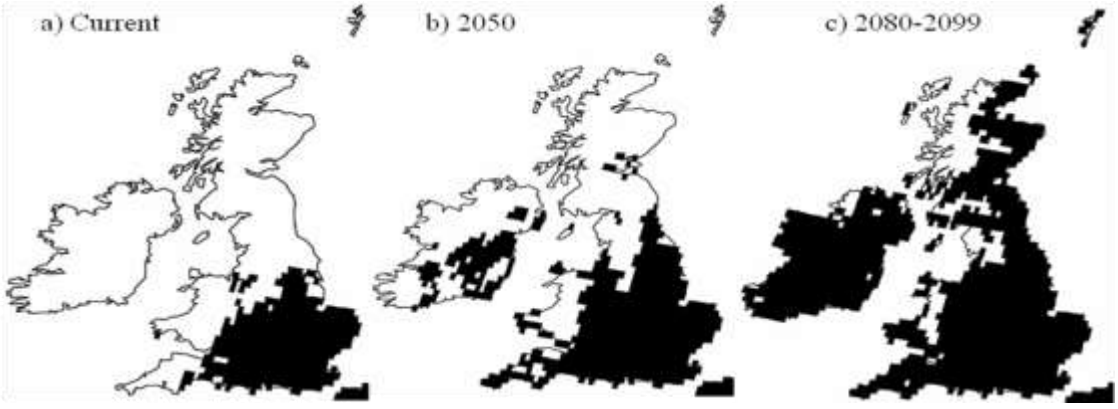

Figure 1. The potential distribution of CPB (shaded black) in the UK under the current climate (a), climate projected for 2050 (b) and climate for 2080-2099 (c).

There are several potato flea beetle species (*Epitrix* spp.) that are currently at risk of establishment within Europe (EPPO, 2010). Two species; *E. cucumeris* and *E. similaris* have been found in Portugal, with *E. similaris* also being found in Spain. The beetles feed on the leaves, but the larvae feeding on the tuber can cause holes up to 1 cm into the tuber flesh significantly affecting tuber quality. Matching the climate of Porto, Portugal where *Epitrix* spp. are present in potato crops with the current and forecast UK climates indicates that over the next 40-90 years the UK and Scottish climate will become suitable for the establishment of this pest.

SUMMARY

As the climate slowly changes, and we see seasons vary from year to year, pest problems gradually become more common and noticeable. When wheat bulb fly egg counts exceed 35 million/ha (as in 2010), and Silver Y moth trap catches exceed 700 in a week (also in 2010), outbreaks of pest problems are likely to increase in frequency and significantly affect crops. Whilst several pests will be 'forced out' by the changes in climate making the country unsuitable for establishment, other pests are waiting for the opportunity to get into the country and take advantage of the climate becoming suitable for their establishment and survival.

Measures are in place at UK and EU levels to try to prevent many of these invasive species such as *Epitrix* spp., CPB, Zebra chip disease vectored by psyllids, western corn rootworm (already present), European corn borer (already present) and others spreading in the UK or getting into the country. However, growers, agronomists and researchers need to be vigilant to spot pest infestations at an early stage to allow management, and where possible, eradication, to take place.

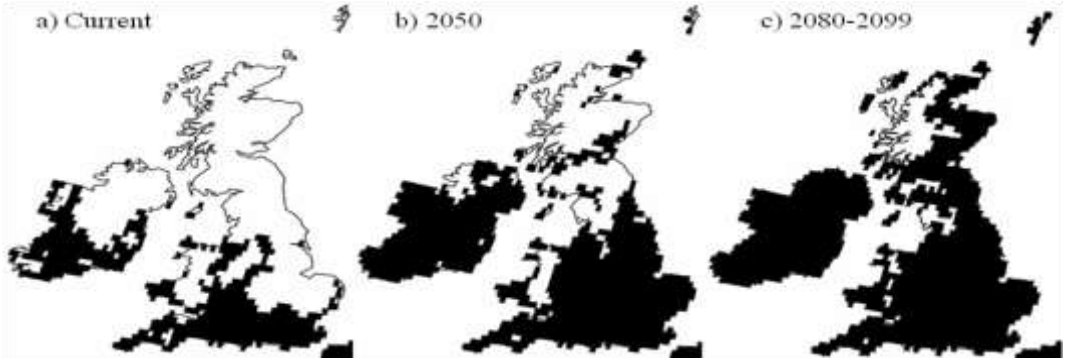

Figure 2. Climate matches for the UK with Porto, Portugal (shaded black) where *Epitrix* spp. are found in potato crops: current climate (a), climate projected for 2050 (b) and climate for 2080-2099 (c).

REFERENCES

Baker R, Sansford C, Jarvis C, Cannon R, MacLeod A, Walters K, 2000. The role of climatic mapping in predicting the potential geographical distribution of non-indigenous pests under current and future climates. Agriculture, Ecosystems and Environment 82, 57-71.

Bale J, Masters G, Hodkinson I, Awmack C, Bezemer T, Brown V, Butterfield J, Buse A, Coulson J, Farrar J, Good J, Harrington R, Hartley S, Jones T, Lindroth R, Press M, Symrnioudis I, Watt A, Whittaker J, 2002. Herbivory in global climate change research: direct effects of rising temperatures on insect herbivores. Global Change Biology 8, 1-16.

Davies K, Evans A, Oxley S, 2007. Impact of Climate Change in Scotland on Crop Pests, Weeds and Disease. SAC Technical Note TN605.

EPPO, 2010. Report of a Pest Risk Analysis for *Epitrix* species damaging potato tubers. [http://fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/praEpitrix.pdf]

Kocmánková E, Trnka M, Eitzinger J, Formayer H, Dubrovský M, Semerádová D, Žalud Z, Juroch J, Možný, M, 2010. Estimating the impact of climate change on the occurrence of selected pests in the Central European region. Climate Research 44, 95–105.

Sutherst R, Maywald G, Russell B, 2000. Estimating vulnerability under global change modular modelling of pests. Agriculture, Ecosystems and Environment 82, 303-319.

Sutherst R, 2003. Prediction of species geographical ranges. Journal of Biogeography 30, 805-816.

Willis JC, Bohan DA, Choi, YH, Conrad KF, Semenov MA, 2006. Use of an individual-based model to forecast the effect of climate change on the dynamics, abundance and geographical range of the pest slug *Deroceras reticulatum* in the UK. Global Change Biology 12, 1643–1657.

Thomas I, 1948. Insect damage assessment. Agriculture, Lond. 55, 125-129.