

Changes in Pests, Weeds and Diseases in Scotland over the last 20 years

SUMMARY

- **Many factors combine to influence pest, weed and disease infestations, including changes in husbandry, varieties, pesticides and climate**
- **Crops advance faster in the spring and summer compared to 20 years ago**
- **Winter cropping weeds have become more important, including grass weeds**
- **Rhynchosporium and Septoria tritici remain the key cereal disease threats**
- **Ramularia disease threat has increased, but variety and fungicide changes have a greater influence than climate change**
- **Pest problems such as wheat bulb fly and cabbage stem flea beetle are taking advantage of the reduction in use of broad-spectrum insecticides**
- **The unpredictability of seasonal weather as a consequence of climate change requires better pest, weed and disease monitoring and forecasting to predict the main threats in a season**

Introduction

The populations of pests, weeds and diseases in Scotland changes over time in response to cropping patterns, varieties, husbandry, rotation, cultivation, pesticide use and, probably, also climatic changes. This technical note examines the changes over recent years and discusses what factor may have caused such changes. A further Technical Note in this series looks forward to possible future developments with particular reference to available climatic change theories.

Weeds

There are over 80 common weed species in Scotland. The population

of these species vary according to many factors including local climate, soil type and characteristics, historical cropping patterns, rotations, husbandry practice, cultivation and long-term patterns of herbicide use. Distinguishing climatic factors from these other factors is difficult, and currently the only general approach is to examine whether local weed populations and behaviour increasingly compare with regions of the UK which have currently clear climatic differences; for example, a comparison of winter cropping rotations now in SE Scotland with those of East Anglia in the recent past. However, factors such as soil type and characteristics differences can confound such comparison, so care has to be taken.

Pests

The threat from specific pests is often driven by climate. For example slugs are less of a threat after hot, dry summers as this increases mortality so there are fewer slugs to attack autumn sown crops such as winter oilseed rape and wheat. However, there are trends that can be seen over several years that suggest that some pests are becoming more prevalent and damaging compared to how they were 20 or so years ago. For example winter oilseed rape growers now have to contend with 'new' pests such as cabbage stem flea beetle and rape winter stem weevil which were virtually unknown a decade ago in Scottish crops.

As with weeds and diseases, various factors can influence the rise and fall of pest problems, and these include loss of some insecticides which may well have kept some pest problems down, as well as changes in cropping patterns, new crop varieties and the climate.

Diseases

The type and severity of crop disease is influenced by changes in varietal resistance, the environment, crop rotation and types of cultivation. The introduction of new fungicides and fungicide resistance can also influence which diseases dominate in a season. Most crop diseases can survive and develop to an epidemic in a wide range of climatic conditions. As such, seasonal variations have a big impact on whether a particular disease will reach epidemic proportions. Recent changes in seasonal weather patterns include settled weather in the autumn followed by mild and wet winters. This has led to earlier sowing of winter-sown cereals and increased survival of diseases over the winter.

Changes over the last 20 years

In this section we look at the changes in serious disease, pest and weed problems in Scotland over the past 20 years by using data collected by SAC. This data consists of crop monitoring (Adopt A Crop), annual surveys and enquiries to the Crop Clinic Specialists. Adopt A Crop is a routine survey of crops throughout Scotland whilst the Crop Clinic generally targets issues that growers found difficult to control for a variety of reasons, rather than being a true indication of the overall situation in Scotland. Nevertheless, the changes over time do reflect changes in farming and provide a useful base from which to consider future changes.

Winter Cereals

A comparison of crop development between 1986 and twenty years later in 2006 shows winter wheat and winter barley are now more advanced in their development in the main part of the cropping season compared to 1986 (Table 1).

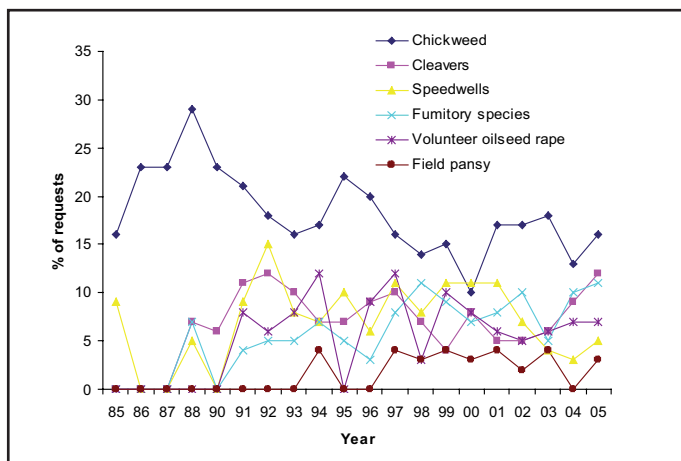
Weeds

Figure 1 gives the trend in requests regarding those broad-leaved weeds that appeared most often in requests, as a percentage of all requests. In most cases, since the mid-1990s there has been little indication of any new trends in requests. However in the early 1990s there were clear increases in speedwells, field pansy, fumitory species, and volunteer oilseed rape (Figure 1). The latter was a response to the advent of increased acreages of rape, both spring and winter varieties, with the former a particularly weedy form. Speedwell, pansy and fumitory appeared as common weeds as the acreage of winter cereals increased, as did their frequency in the rotation. Similarly, cleavers did not appear as a frequent request until the late 1980's. This was also a weed that was particularly associated with winter cropping in other parts of the UK where winter cropping was already well established by that time. As a proportion of requests it has not changed greatly, although the number of cleaver requests, as with all winter weed species, has increased over the time period.

Table 1. Comparison of growth stages of winter wheat and barley (1986 and 2006)

| Winter wheat | April | May | June | July |
|---------------|-----------------------|-----------------------|-------------------|-------------|
| 1986 | Two main tillers | First node detectable | Booting | Flowering |
| 2006 | First node detectable | Third node detectable | Ear fully emerged | Late milk |
| Winter barley | April | May | June | July |
| 1986 | Six main tillers | Flag leaf emerged | Flowering | Early dough |
| 2006 | First node detectable | Booting | Early milk | Hard dough |

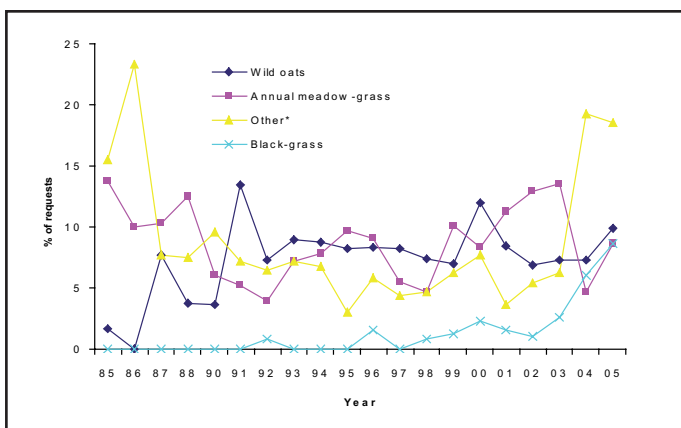
Figure 1. Main broad-leaved weed requests in winter cereals from 1985-2005 as a percentage of total requests



The one species that appears to have reduced as a proportion of requests since the 1980's is chickweed, but requests still outnumber those for other species as it is the most common weed of winter crops in Scotland.

Figure 2 shows the trend in requests for grass weed management. Couch-grass appeared as a frequent request in the 1980's but disappeared as glyphosate pre-harvest treatment had its full controlling effect. The increase in other weeds since 2002 largely reflects brome species, with meadow-brome recently appearing in the Borders. The bromes are indicators of winter cropping and reduced tillage, but meadow-brome may also be an indicator of warmer conditions.

Figure 2. Main grass weed requests in winter cereals from 1985-2005 as a percentage of total requests. Other* includes sterile brome, meadow brome, rough meadow-grass, onion-couch and couch-grass.



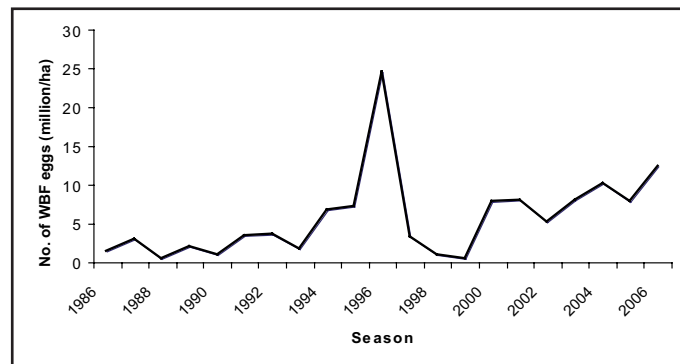
Equally, the one or two cases of black-grass in the 1990's has increased in the early 2000's, and this may also reflect an increase in reduced tillage and winter cropping, but may also reflect milder and wetter winter conditions. Tests for herbicide resistances in Scottish black-grass populations indicate, through lack of such resistances being found, that they may be local populations that are responding to climatic changes as well as increased winter cropping and reduced tillage. The initial response by farmers and the trade was that the problem was due to the ingress of English cereal seed, but most black-grass from England would be expected to have some clear herbicide resistance.

Annual meadow-grass requests have remained constantly high over the whole period (Figure 2). Wild-oat requests were originally at a low level in the 1980's, and this may reflect an adaptation in populations from largely spring emergers to autumn and spring emergers as winter cereals became more popular, but may also reflect movement of winter cereal acreages onto land infested with wild-oats which had previously been used for spring barley. Earlier sowing of winter cereals would also encourage wild-oats to emerge in the autumn.

Pests

Pest numbers naturally fluctuate from season to season as a consequence of a range of factors influencing survival, successful breeding, and natural control through predation and disease. Wheat bulb fly is a case in point. The egg numbers in September on one farm in East Lothian have been monitored over the last 20 years (Figure 3). There is a fluctuation in egg numbers from one year to the next with a big leap in numbers in 1996 (Figure 3). When you consider that the egg numbers we use to determine risk to a winter wheat crop are 2.5 million eggs/ha for an early sown wheat, and 1 million eggs/ha for late (October) sown wheat, then the risk in 1996 was particularly high. However, if you ignore the 1996 season when looking at the egg populations over the last 20 years, there is a gradual increase in egg numbers over time, with the last 6 seasons having populations consistently above the 2.5 million eggs/ha treatment threshold (Figure 3).

Figure 3. Wheat bulb fly egg counts (millions/ha) on a farm in East Lothian over the last 20 years.



The large increase in wheat bulb fly eggs in 1996 can be explained in part by the weather over the previous year. The winter of 1995/1996 had been relatively mild and with less rain than usual, which will have reduced winter kill due to drowning of the already relatively high population of 7.2 million eggs/ha population. The warm, humid summer led to problems with moulds on the heads of cereals, which is what adult wheat bulb flies feed on during the summer months to provide resources for egg laying. Consequently the weather conspired to provide near perfect conditions for wheat bulb fly which led to the large increase in egg numbers in 1996.

The gradual increase in wheat bulb fly over the last 20 years can be partially explained by the changes in climate helping to promote winter survival and subsequent egg laying. But other factors such as the withdrawal of many soil applied insecticides and restrictions on the use of systemic insecticides such as dimethoate to just one application a season for wheat bulb fly control, will have aided winter survival of the eggs and larvae.

Another pest that has become more noticeable on winter (and spring) cereals are cereal leaf beetle grubs. Their occasional slimy presence on the leaves a few years ago has altered from being simply an unpleasant nuisance when crop walking to now causing a fair bit of damage to the crop, and in particular, damage to the flag leaf can affect yield and grain quality. Again their increase may well be a consequence of changes in insecticide use in the spring where specific aphicides are now used rather than broad-spectrum insecticides, and by changes in the climate to warmer, wetter springs and summers which favour the grubs and the beetles.

Diseases

Disease levels in commercial crops in 1986 and 2006 are likely to be different since there are always seasonal differences from year to year. Changes in varieties and fungicides can also impact on the type of disease likely to develop. Table 2 compares disease levels in winter wheat between 1986 and 2006. All three diseases appeared in both years, but septoria nodorum has now become a minority disease. Septoria tritici and powdery mildew are present at similar levels in both years. Yellow rust is a problem in susceptible varieties both now and in 1986. The main factor influencing a yellow rust epidemic is the growing of a susceptible variety (Slejpner in 1986 and Robigus in 2006). Early sowing and mild winters will also increase the risk of an early epidemic.

Brown rust has historically been a rare disease in Scotland, despite the use of susceptible varieties. Riband, for example is susceptible to the disease. Brown rust has only started to become a more important disease in recent years. A change to warmer spring and summer temperatures will lead to an increase in the disease.

In winter barley, net blotch and powdery mildew have declined since 1986, but rhynchosporium remains a common disease (Table 3). As in wheat, changes may be due to variety and fungicide changes and not only changes in climate. The introduction of the strobilurin fungicides in the 1990's helped reduced the importance of net blotch. Fungicide resistance to this group may now lead to a swing back in the importance of this disease. Warmer summers will also increase the risk. Powdery mildew has also been effectively controlled by fungicides and in 2006 there were more superior mildew protectant fungicides available compared to 1986.

Spring Cereals

A comparison of crop development between 1986 and 2006 shows spring barley is now more advanced in development in the main part of the cropping season compared to 1986 (Table 4). This pattern was also seen in the winter cereals (Table 1).

Table 2. Comparison of diseases in winter wheat (1986 and 2006)

| | % Crops in each disease severity category | | | | | |
|-------------------------|---|------|------|-------|--------|------|
| Septoria tritici | 0% | 0.1% | 1-5% | 6-10% | 11-25% | 25+% |
| 1986 | 50 | 24 | 24 | 0 | 2 | 0 |
| 2006 | 47 | 11 | 35 | 7 | 0 | 0 |
| Powdery mildew | | | | 0 | 4 | 0 |
| 1986 | 68 | 14 | 14 | 4 | 0 | 0 |
| 2006 | 67 | 20 | 11 | 2 | 0 | 0 |
| Septoria nodorum | | | | | | |
| 1986 | 76 | 4 | 20 | 0 | 0 | 0 |
| 2006 | 96 | 2 | 2 | 0 | 0 | 0 |

Table 3. Comparison of diseases in winter barley (1986 and 2006)

| | % Crops in each disease severity category | | | | | |
|-----------------------|---|------|------|-------|--------|------|
| Rhynchosporium | 0% | 0.1% | 1-5% | 6-10% | 11-25% | 25+% |
| 1986 | 33 | 0 | 60 | 7 | 0 | 0 |
| 2006 | 67 | 16 | 15 | 2 | 0 | 0 |
| Powdery mildew | | | | | | |
| 1986 | 66 | 14 | 20 | 0 | 0 | 0 |
| 2006 | 85 | 9 | 4 | 2 | 0 | 0 |
| Net blotch | | | | | | |
| 1986 | 66 | 14 | 20 | 0 | 0 | 0 |
| 2006 | 98 | 2 | 0 | 0 | 0 | 0 |

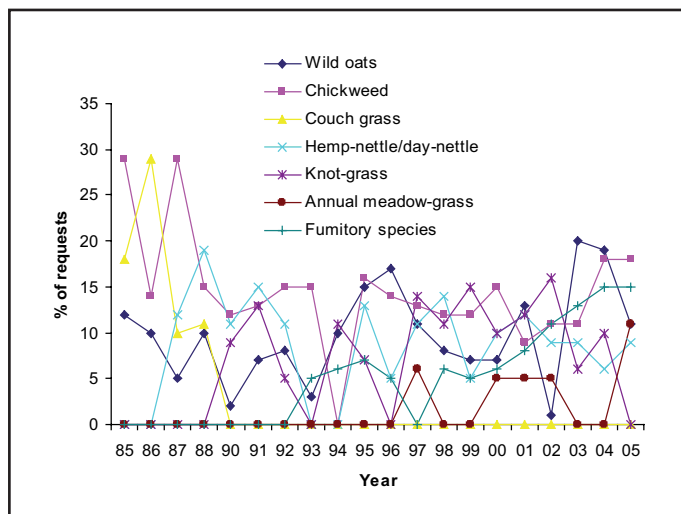
Table 4. Comparison of growth stages of spring barley (1986 and 2006)

| Spring barley | April | May | June | July |
|----------------------|--------------------|-----------------|-------------------|-------------|
| 1986 | Coleoptile emerged | Leaf emergence | Flag leaf emerged | Late flower |
| 2006 | First leaf emerged | One main tiller | Booting | Early milk |

Weeds

Spring broad-leaved weed populations tend to be more complex than winter crop populations (Figure 4). However, most noticeable is the decrease in couch-grass in the 1980's as pre-harvest glyphosate treatments controlled this previously severe weed problem. Chickweed appears to have been at higher levels in the 1980's, but it remains as a very high contribution to spring weed problems up to the present. Wild-oat has been at a consistently high request level over the whole period, as have hemp-nettle/day-nettle species and knot-grass, although requests were low in the mid-1980's (Figure 4).

Figure 4. Main weed requests in spring cereals from 1985-2005 as a percentage of total requests



Of more interest is the appearance of fumitory species in the early 1990's (Figure 4). Fumitory is now one of the most common control requests and its increase probably reflects its encouragement in winter crops as well as the use of herbicides that are particularly ineffective against this group of species. Although not assessed in a formal basis, there is anecdotal and observational evidence from SAC specialists and consultants that, although common fumitory (*Fumaria officinalis*) has increased, other fumitory species, once uncommon or rare, have appeared much more frequently. For example, wall fumitory or common ramping fumitory (*Fumaria muralis*) may be as least as common as common fumitory and purple ramping fumitory (*Fumaria purpureum*), which is considered rare, and white ramping fumitory (*Fumaria capreolata*) becoming more common. There are other species that may also be appearing. This may also reflect poorer control of fumitory by once routine herbicide treatments for control of this weed, such as mecoprop-p. The 'new' fumitory species appear more naturally resistant. It is also possible that herbicide resistance has developed in this group of species, but there has been no research on this species, although resistance in Scottish common chickweed populations to sulfonyl-urea herbicides has been demonstrated.

The increase in annual meadow-grass requests may reflect the increase in grass weeds due to increased winter cropping in rotations. It may also reflect damper soil conditions in early spring and summer, and its erratic appearance over the years (Figure 4) may reflect drier and wetter spring periods.

Pests

Over the last few seasons in particular, free-living nematodes in the soil have been causing problems in spring cereals and also in some winter cereals as well. These nematodes feed on the roots of plants which leads to 'stubby-roots', and a proliferation of side roots. A reduced or thickened root system due to nematode damage makes plants more susceptible to drought stress and mineral deficiencies and is expressed in the field as patches of stunted plants. In Scottish soils populations of some nematode species (e.g. *Pratylenchus* and *Trichodorus*) have increased by 300% over the last 12 years. One cereal crop that was showing severe nematode damage symptoms had nematode counts of over 12,500 in a kg of soil, which is pretty high when you consider that we have seen effects on roots at populations as low as 200 nematodes/kg of soil. One explanation for the large increase in nematode populations is the withdrawal of a large group of soil applied insecticides that were routinely used in field vegetable and cereal production for control of soil pests such as wireworm, leatherjackets, cabbage root fly and carrot fly. These will have had a secondary impact on free-living nematodes in the soil, and subsequent to their restriction of use and withdrawal nematode populations increased. Climatic changes such as generally warmer and wetter winters will have also contributed to the increase in nematode populations.

Leatherjackets have also become more prevalent (see below under Grassland, Figure 6) and damage to spring barley in particular has become more common over the last 15 years.

Diseases

Changes in diseases has been more noticeable in spring barley. In 1986, ramularia was not deemed of sufficient importance to be recorded as a major disease, however in 2006, it has become one of the major diseases present (Table 5). Rhynchosporium remains a major threat in both years, while powdery mildew has declined in importance. The decline in powdery mildew is a consequence of changes in varietal resistance. Although some popular varieties are susceptible (e.g. Optic, Oxbridge), most spring barley varieties show good resistance due to the mlo gene resistance. There are also superior mildew protectant fungicides available today compared to 1986.

The increase in ramularia is not necessarily due to climate change. Effective fungicides to control powdery mildew and rhynchosporium, which have little impact on ramularia would have enabled this pathogen to develop. Ramularia also became important at the same time mildew resistant varieties became popular, and there may be a trade off between controlling mildew and the development of ramularia. Now it has become an established disease, it will continue to increase in importance if wet spring and summer weather continues.

Table 5. Comparison of diseases in spring barley (1986 and 2006)

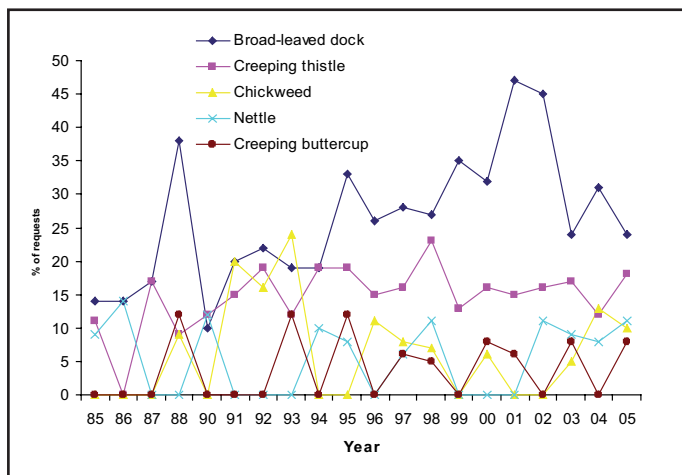
| | % Crops in each disease severity category | | | | | |
|-----------------------|---|------|------|-------|--------|------|
| | 0% | 0.1% | 1-5% | 6-10% | 11-25% | 25+% |
| Rhynchosporium | | | | | | |
| 1986 | 51 | 23 | 23 | 3 | 0 | 0 |
| 2006 | 71 | 14 | 14 | 1 | 0 | 0 |
| Powdery mildew | | | | | | |
| 1986 | 56 | 15 | 22 | 3 | 2 | 2 |
| 2006 | 79 | 9 | 11 | 1 | 0 | 0 |
| Ramularia | | | | | | |
| 1986 | 100 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 92 | 6 | 2 | 0 | 0 | 0 |

Grassland

Weeds

Most of the important weed species of grassland form a consistent proportion of the direct requests on grassland weed control (Figure 5): common chickweed in newer swards, creeping buttercup, creeping thistle and nettle in both established and newer swards.

Figure 5. Main weed requests in grassland from 1985-2005 as a percentage of total requests



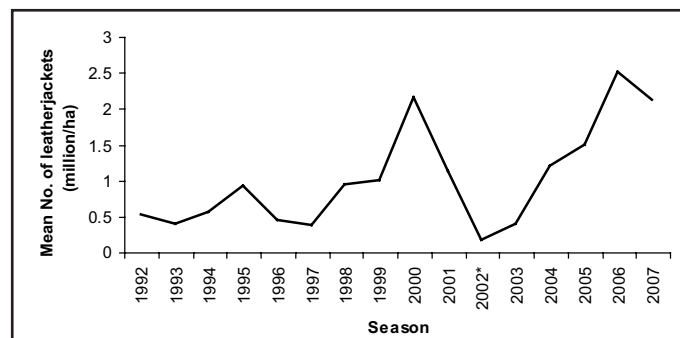
Broad-leaved dock has always been an important portion of the requests, but since the mid-1990's it has dominated the requests (Figure 5). Docks are responsive to wet, mild conditions of high fertility, and may be responding to milder/wetter winters that have become characteristic since the early 1990's.

Pests

Leatherjacket populations have been monitored for the last 15 years in an annual survey of grassland, and there has been a fluctuation of mean populations every 5 years or so, however the peak of leatherjacket populations for each cycle has been higher as the years progress (Figure 6). The decline in 2002 may not have been as steep as it looks as monitoring was restricted due to the restrictions for farm visits imposed due to the foot and mouth disease outbreak that season, but there is a distinct 5-6 year cycle in leatherjacket populations. This cycle will be driven by climate, particularly rainfall but also by predators and parasites of leatherjackets responding to the increase in food. However, when the leatherjacket population declines, its next peak is higher than the previous peak. The consequence of this cycle is that leatherjackets are becoming a much more serious problem in grassland and spring sown crops such as barley, oilseed rape and vegetables sown after grass, as the damage threshold for grassland is only 1 million leatherjackets/ha and for spring crops after grass 0.6 million/ha. For the

last two seasons over 63% of fields assessed had populations over the 1 million/ha damage threshold (77% over the 0.6 million/ha threshold for spring crops).

Figure 6. Mean numbers of leatherjackets in grassland from 1992 to 2007. * Sampling was restricted in 2002 due to the foot and mouth disease outbreak, so numbers may well be an underestimate of the true population of leatherjackets in that season.



Summary

Fluctuations in pest, weed and disease levels happen naturally as a consequence of various environmental factors such as predation, disease, rainfall patterns, crop rotations etc., however, if one looks at these changes over the last 20 years, then some trends can be seen. For example the increase in levels of leatherjackets, ramularia, and certain grass and broad-leaved weeds.

What drives these trends cannot be simply put down to climate change, but it does play a role along with other factors such as changes in pesticide use, new varieties, and timing of sowing.

Over the next decade and beyond as climate change is predicted to accelerate, these changes in pests, weeds and disease will become more noticeable and potentially create new problems for Scottish growers to combat. Problems with pesticide resistance will need addressing, as well as the appearance of 'new' problems to cope with as the Scottish climate changes to favour what are currently minor or even non-existent problems. Discussion of the potential impact of climate change on Scottish pest, weed and disease problems is outlined in another Technical Note titled "Impact of Climate Change in Scotland on Crop Pests, Weeds and Disease".

The monitoring and forecasting of pests, weeds and diseases needs to be maintained, and in some cases improved, so that the impacts of climate change as well as changes in pesticide availability, agronomy and new varieties on crop protection can be managed and communicated effectively to Scottish farmers.

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