APHID POPULATION DENSITY IN POTATOES INFLUENCED BY FOLIAGE COLOUR ?

J-P. JANSEN
Walloon Agricultural research Centre,
Life Science Department, Plant Protection and Ecotoxicology Unit
Chemin de Liroux, 2, 5030 Gembloux, Belgium
Corresponding author E-mail: Labecotox@cra.wallonie.be

SUMMARY

Between 2006 and 2009, the aphid populations were compared in two groups of potato cultivar: a "light green" foliage cultivar (cv Exempla) and a "dark green" cultivar group (cv Bintje, Celina, Nicola, ...) planted side by side in the same fields and cultivated under the same conditions (date of plantation, fertilizers and pesticide treatments). The aphid population were estimated by weekly visual counts on 200 leaves between mid June to end of July.
Even if the aphid population remained below the economic threshold value during the periods of observation, the results were indicating a highly significant difference between the two cultivar groups, with 3.4x more aphids in the dark green group than in the Exempla group. In the fields with the highest aphid density, the difference was even greater, with up 10.0x more aphids in the "dark green" group than in the "light green". Significant differences were also observed for alate aphids with a mean of 2.2x more alate aphids in the "dark green" group than with Exempla.
These results suggests that a darker green foliage could be more attractive for alate aphids than lighter green foliage and therefore could explain, at least partly, why aphid populations were lower in fields of the Exempla cultivar than in the darker green cultivar planted side by side. The interest of this possible higher attractiveness of dark green foliages is discussed in terms of integrated aphid management.

Key words: aphid; foliage colour; attraction, potato, IPM.

INTRODUCTION

Aphids are considered as a serious pest in potato. In seed potato, they can transmit several virus disease and drastically reduced the marketable value of the harvest. Intensive insecticide applications are required to control alate aphids and virus transmission. In ware potato produced for the fresh market and the industry, high aphid populations can reduced yield by phloem uptake. An economic threshold value of 10 aphids per leaf was generally used for Belgium and North of France for insecticide application (Duvauchelle, 1998; Dubois and Duvauchelle, 1999; Jansen, 2002).
In Belgium, the aphid populations were highly variable from year to year and from field to field. The biological control of aphid by their natural enemies, especially parasitic hymenoptera (Aphidiidae) and predators (ladybirds, hoverflies and lacewings) can really be very efficient in ware potato and could explain in many case why aphids stayed below the economic threshold value (Jansen, 2002, 2005). To avoid the systematic and « blind » use of insecticide and try to exploit this natural control, an aphid survey system was established since 1994 and several commercial fields were monitored each year for aphid dynamic population, taking into account the importance of aphid natural enemies to predict both natural control importance and possible aphid outbreak. Since 1994, the economic threshold level was only reached in about 10% of the 250 fields followed.
In 2005, in the set of the fields followed for aphid monitoring, high aphid densities differences were observed between 4 potato cultivar planted side by side in the same field, with

large aphid population in Bintje, Annabelle and Charlotte cultivars that required insecticide treatments and far less aphids in the Exempla cultivar. The agricultural practices (plantation date, fertilisers, fungicide treatments) were similar for the 4 cultivars and no insecticides were applied before the observations. The only apparent difference between these cultivar was the foliage coloration, the foliage of Exempla being light green, the others being darker, as most of the potato cultivar were.
As the aphid population in potato started mainly with immigrant alate aphids and as attraction of specific color could be important for these insects (Klingauf, 1987), specific observations in this light green cultivar were followed in 2006-2009 and compared with a group of darker foliage cultivar planted side-by-side. The objective of these observations was to confirm or not the differences observed in 2005 and, in case of significant differences, further investigate on new possible methods for aphid control in potato.

MATERIALS AND METHODS

The aphid population were followed in commercial potato fields located in Florennes (2007, 2008, 2009), Thimeon (2007, 2009), Thorembais St-Trond (2006, 2007, 2008, 2009) and Wanfercee-Baulet (2006, 2008, 2009) for a total of 12 fields. Each field was planted with the cultivar Exempla on one part of the field and another cultivar (Bintje, 3x, Annabelle 2x, Nicola, 2x, Celina, Challenger, Esterling, Felsina, Franceline, 1x each) in the other part of the field. Fields were from 0.8ha to 20ha large. The cultivar Exempla has the particularity to have a light green color foliage compared to the other cultivar that show a more classical darker green coloration, grouped under the name of "dark green foliage". Differences between the two group of potatoes were easily seen when the foliage was fully developed (see photo 1) and the plants not stressed by diseases, virus, mineral or water deficiency. Each field was conducted according to the same practices for the two cultivar, in terms of plantation date, fertilisation, herbicides and fungicides treatments with sometimes only minor differences between the two cultivar.
The aphid population were estimated on a weekly basis from week 24 (10-15 June), period when aphid started to colonise the crop, to week 30 (end of July), period when aphid population had generally crashed down under normal agricultural practices. The aphids were counted on 4x25 leaves sampled in the low-mid part of the plant and 4x25 leaves of the mid-upper part of the plant, to take into account all possible aphid species, as some of them had specific preferences (Jansen, 2005). Leaves were randomly taken every 2-5 meters on a transect line. Alate and apterous aphids were counted separately. The results were analysed with the help of an Anova test (GLM) at p=0.05 (Minitab software).

Photo 1. Difference in foliage coloration between the cultivar Exempla (on the right) and a darker green foliage cultivar (on the left, Celina, Florennes 2008)

RESULTS AND DISCUSSION

The mean aphid populations counted in the 12 Exempla and "dark green foliage" group of cultivar are illustrated in figure 1 (mean of all fields, alate and apterous aphids). The aphid population followed a classical evolution for the potato crop in Belgium, with an arrival mid of June (week 23-24), a 2-3 week increase of the population, a peak beginning of July (week 26-27), sometimes delayed in several fields to mid of July (week 28) and then a decline due to the increased activity of aphid natural enemies and changes in the plant metabolism.

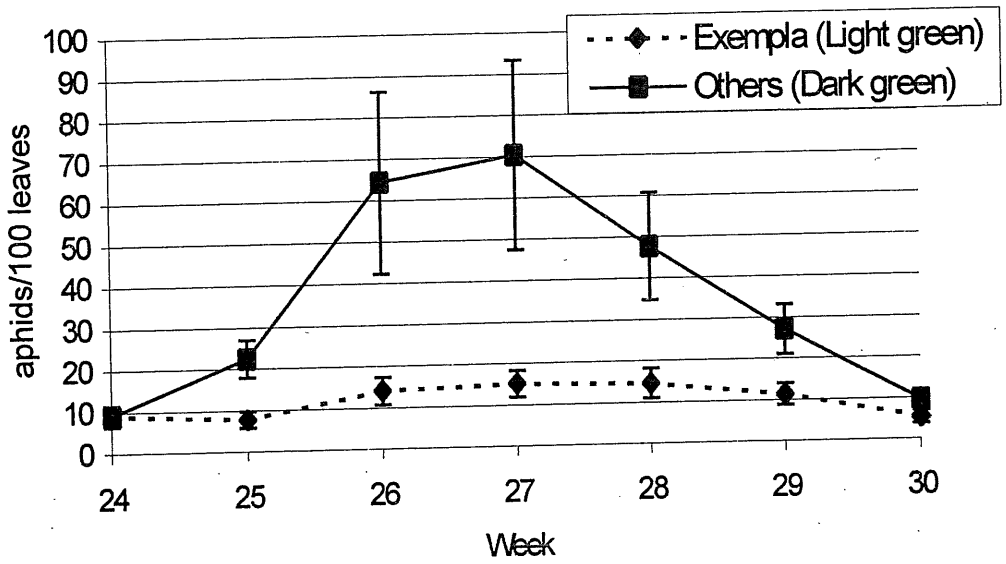

Figure 1. Evolution of the total aphid population in potato on a light green foliage cultivar (cv Exempla) and dark green foliage cultivar cultivated side by side on the same fields (mean of 12 fields, 2006-2009).

Significant differences were observed between Exempla and the dark foliage cultivar group from week 24 to week 28, with a mean of 3.4x more aphids in the dark group than in Exempla ($F_{1,126}$=18.07, p<0.001), taking into account all aphids counts. If only the counts corresponding to the aphid peak were analysed separately, these differences reached 4.6x at week 26 ($F_{1,22}$=4.70, p=0.046) and 4.7x at week 27 ($F_{1,22}$=4.67, p=0.046). These means included several fields with a low aphid populations and the biggest difference observed reached up to 10.0x more aphid in a dark green cultivar planted side by side with Exempla. At any count with sufficient number of aphid (> 0.5 aphid/leaf), aphid were more numerous in Exempla than in a dark green cultivar.

Results of the specific alate aphid counts are illustrated in figure 2 (mean of 8 fields). Four fields with very low alate aphid populations were not retained for the analysis to limit variability of the data. The alate aphid populations showed a similar pattern than the total aphid population, even if these aphids only accounted for a few percent of the population. For all the aphid counts, a mean of 2.2x more alate aphid was found in dark green potato cultivar group than in Exempla and this difference was significant (F1,100=10.27, p=0.002). The biggest individual difference observed reached up to 5.0x more aphid in a dark green cultivar planted side by side with Exempla.

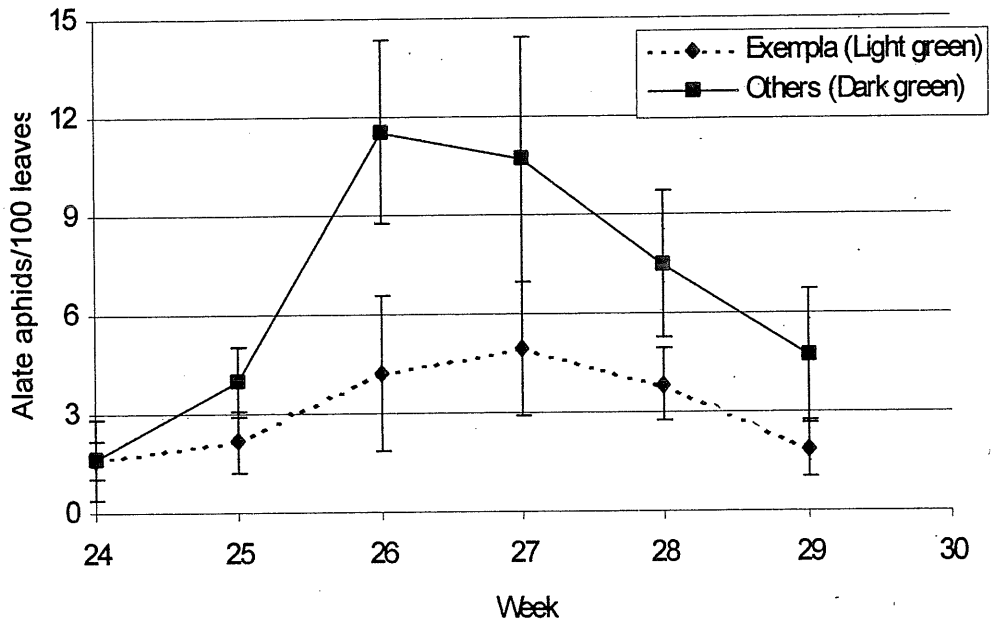

Figure 2. Evolution of the alate aphid population in potato on a light green foliage cultivar (cv Exempla) and dark green foliage cultivar group grown side by side on the same fields (mean of 8 fields, 2006-2009).

The maximum mean differences was observed at week 26, with 2.75x more alate aphids on dark green potato cultivar group than on Exempla ($F_{1,18}$=7.87, p=0.016). About 2x more alate aphids were also observed in the dark group compared to exempla the other weeks except at week 24 and 30, but the differences were only significant at week 28 ($F_{1,16}$=5.34, p=0.043). However, as the variability of the results was high, especially in relation to the low alate aphid populations, significant differences would probably be obtained if the number of fields followed, the sampling effort and/or the number of replicates was increased. It must be noted that alate aphid results are more difficult to interpret because there was a mix of

immigrating aphids that colonise the crop and alate aphids originating from the aphid population established in potato that were leaving the crop to colonise other fields. However, the population found at week 24 to 26 can be considered as immigrating aphids in majority and those of week 28 to 30 at the end of the aphid season as alate aphids leaving the crop.
The selective attraction of alate aphids by specific colour and/or contrast between different colours is not fully understand but it is known that several wave-length comprised between 500-580nm (yellow to green) caused an active reaction of aphids and are used for trapping system as Yellow Moericke water traps and Yellow sticky cardboard (Klingauf, 1987). Observations on aphid population in different lettuce cultivars were also indicating that aphids preferred green to red-green lettuce cultivars (Muller, 1964). These information suggested that the colour could play a role in the selection of host plant by alate aphids for alighting, when climatic conditions allowed this selection.
Our results showed that the alate aphids were more attracted by dark green foliage potato cultivars than by greener foliage cultivar as Exempla, when the two cultivar were planted side-by-side. This specific attraction could also explained why bigger aphid population were found later in these dark green cultivar, with aphid colony up to 5-10x more important. However, it is not known if the colour only was important or if it was the colour contrast between the two area, as the two cultivar group were at each occasion compared when they were planted side-by side.
There was no specific cases in the different fields followed where the aphid economic threshold value was exceeded in the dark cultivar and not in Exempla, but the aphid population remained low between 2006 and 2009. This situation could occurred in the future in case of higher aphid pressure, as it was already observed in the past (e.g. 1994 and 1996, with more than 30-40 aphids/leaf), and specific insecticide applications required in dark green potato cultivars while aphid stay below the economic threshold value in light green cultivar as Exempla could be expected. However, the main important cultivars in terms of potato production (Bintje, Innovator, Asterix, etc...) have a classical dark green foliage coloration. Thus, the interest to have less aphids in light green cultivar will be limited in terms of insecticide use.
The apparent selective attraction of the darker green foliage potatoes could be used for the seed potato production, that required regular insecticides treatments to control alate aphids acting as virus vector. A darker green group or strip of potatoes can be used as trap plants to try concentrate aphids and virus on these plants and limit the problems on adjacent seed potato plants with a lighter green foliage. The trap plants could be another cultivar selected for its specific darker color and/or potato conducted according to specific conditions (e.g. nitrogen fertilisation in excess) to obtain a contrast with the cultivated part of the field for seed production. However, the mechanisms that are responsible for the particular behaviour of the alate aphids in plant selection according to its color and/or contrast with adjacent plants are unknown and fundamental researches need to be carried out before the possible application of this behaviour in aphid control.

LITERATURE

DUBOIS L. and DUVAUCHELLE S. 1999 - Evolution des pucerons en cultures de pommes de terre. *Phytoma*, **512**: 31-33.

DUVAUCHELLE S. 1998- Lutte raisonnée contre les pucerons de la pomme de terre, détermination d'un seuil d'intervention. 1er Colloque transnational sur les luttes biologique, intégrée et raisonnée, Lille, 21-23 Janvier 1998, communications orales, pp 367-374

KLINGAUF F.A. 1987. Host plant finding and acceptance. In "Aphids, their biology, natural enemies and control", World Crop Pests Vol 2A, pp 209-223. A.K. Minks, A. K. and Harrewijn, P. eds, Elsevier, Amsterdam, The Netherlands,

JANSEN J-P. 2002 - Pucerons et auxiliaires de lutte en pomme de terre de consommation: synthèse des observations réalisées entre 1994 et 2001 en Belgique. 2ème Conférence internationale sur les moyens alternatids de lutte contre les organismses nuisibles aux végétaux. Lille, 4-7 Mars 2002, communications orales.

JANSEN J-P. 2005 – Pucerons en pomme de terre de consommation: bilan de 12 années d'observation. Journée d'étude Pomme de terre Edition 2005, Gembloux, 23 Novembre 2005, pp 41-50. CRA-W eds, Gembloux, Belgique.

MULLER H.J. 1964. Uber die anflugdichte von aphiden auf farbige salatpflanzen. Ent. Exp. Appl. 7:85-104