Activity 7. Insect resistance in wheat: Cereal aphids (RRes) Ruth Gordon-Weeks and Lesley Smart 1.10.08 – 1.4.10

Objective 1. To explore whether the differential response of hexaploid wheats to two different cereal aphid species has a genetic basis.

The major pests of UK wheat, the grain aphid, *Sitobion avenae*, and the bird-cherry oat aphid, *Rhopalosiphum padi*, vector Barley Yellow Dwarf Virus (BYDV) and intercept nitrogen assimilates necessary for developing grain. This results in significant yield losses and affects the quality of bread making wheat. These aphids can be controlled by seed treatment and application of pyrethroid insecticides, but impetus for finding alternative control methods to insecticides has come, particularly from the public perception of health and environmental issues associated with insecticide use. The development of insect resistant wheat varieties is a grower-friendly insect pest management solution and would make a substantial contribution towards reducing insecticide use.

Breeding of resistant varieties has been particularly important in the management of other species of aphids attacking wheat worldwide e.g. the greenbug, *Schizaphis graminum*, and the Russian wheat aphid, *Diuraphis noxia* (Berzonsky et al. 2003). However, despite considerable research effort, to date there are currently no commercial wheat varieties resistant to UK resident aphid species. The unique resources available through the WGIN project provide a great opportunity for targeted research on suitable traits for resistance to UK cereal aphid species.

Milestone 1. Determine the differential susceptibility to two cereal aphid species of targeted lines from the Spark x Rialto mapping population.

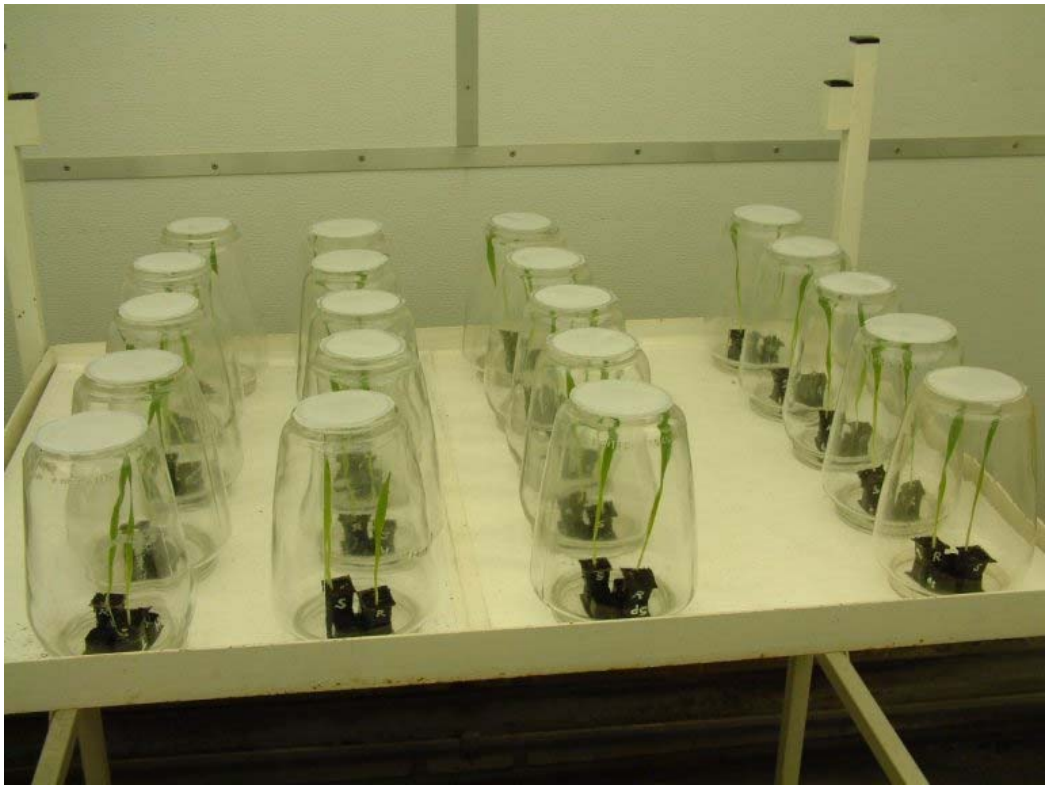
In previous studies, some lines from the mapping population, produced from the crossing of UK varieties Spark and Rialto, had showed strong resistance or susceptibility to *D*. *noxia* and *S. graminum*, but only one of these lines showed a consistent effect against both aphid species (Snape personal communication; Ricciardi et al 2010). Seventeen of these extreme lines, plus the parents, have now been tested against *R. padi* and *S. avenae* in laboratory bioassays. Since the responses of *R. padi* and *S. avenae* to these particular lines were found to be more subtle than for the other two aphid species, a choice test rather than the more stringent no-choice test method was used. Replicated groups of 10 alate aphids were given the choice between two seedlings, at the first leaf growth stage, one of a standard variety, Solstice and the other of the test variety. The number of alates settled on

each seedling was recorded at 2, 5 and 24h and the number of nymphs produced on each seedling was recorded at 24h. These data were then

compared in a paired Students t test and the number of nymphs produced was expressed as a proportion of the nymphs produced on Solstice in the same assay, thus providing a "preference index" for both aphid species (Figures 1 & 2). Those lines that were much more or much less preferred than Solstice were retested to confirm the results. As for *D*. *noxia* and *S. graminum,* the most and least preferred lines were not the same for *R. padi* and *S. avenae*. However, there were a few lines where the responses coincided and one in particular that was very susceptible to 3 of the 4 aphid species.

Since SR120 was most preferred by both aphids and Spark preferred to Rialto by both species, we looked at leaf morphology of all three lines and Solstice under UV high powered stereo microscope. Spark had very few leaf hairs on both abaxial and adaxial leaf surfaces and, in contrast, Rialto and Solstice had lots of leaf hairs on both surfaces. However, SR120 also had extensive leaf hairs on both surfaces, which ruled out that particular aspect of leaf morphology from affecting aphid settlement.

Settlement assay



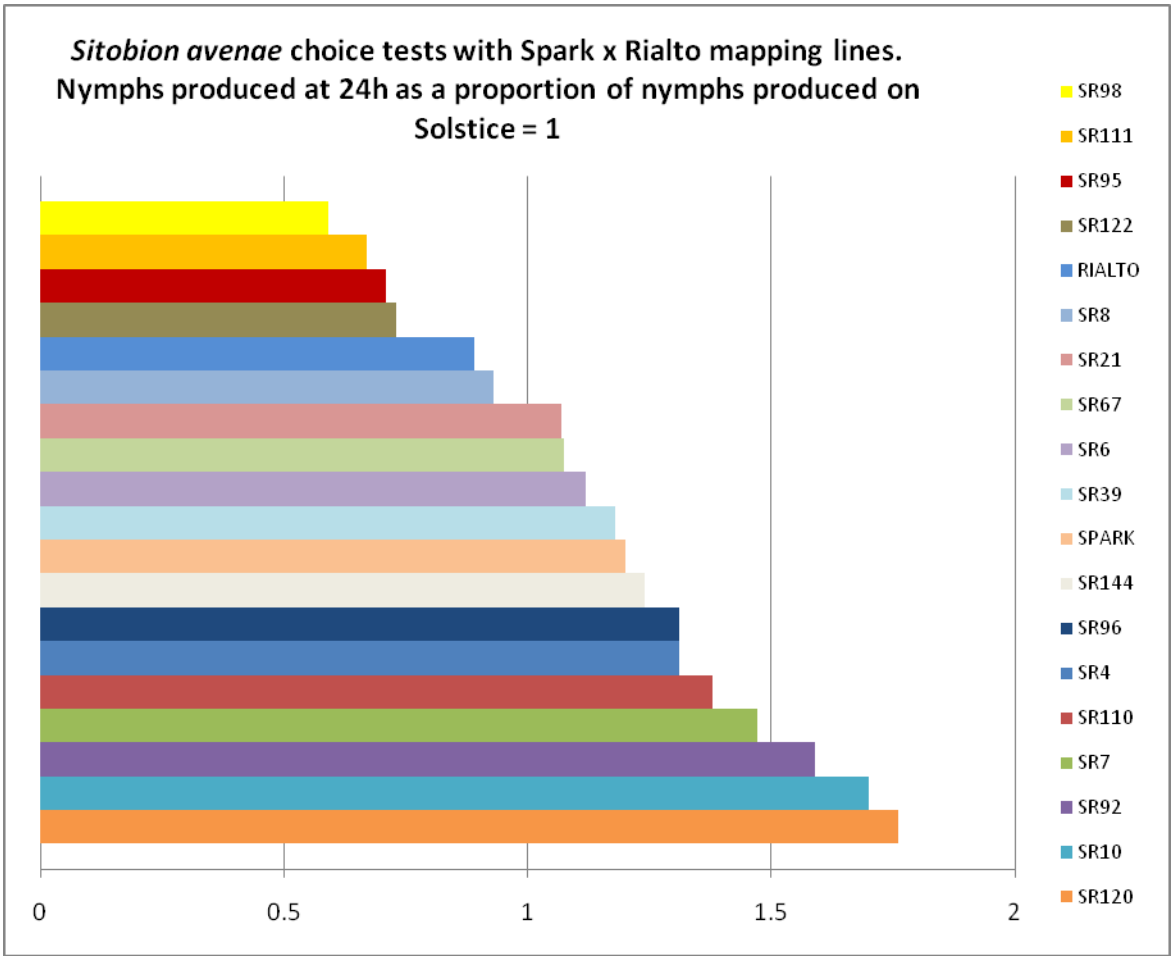


Figure 1. Preference of *Sitobion avenae* for nymph production on lines from the Spark x Rialto mapping population compared to Solstice.

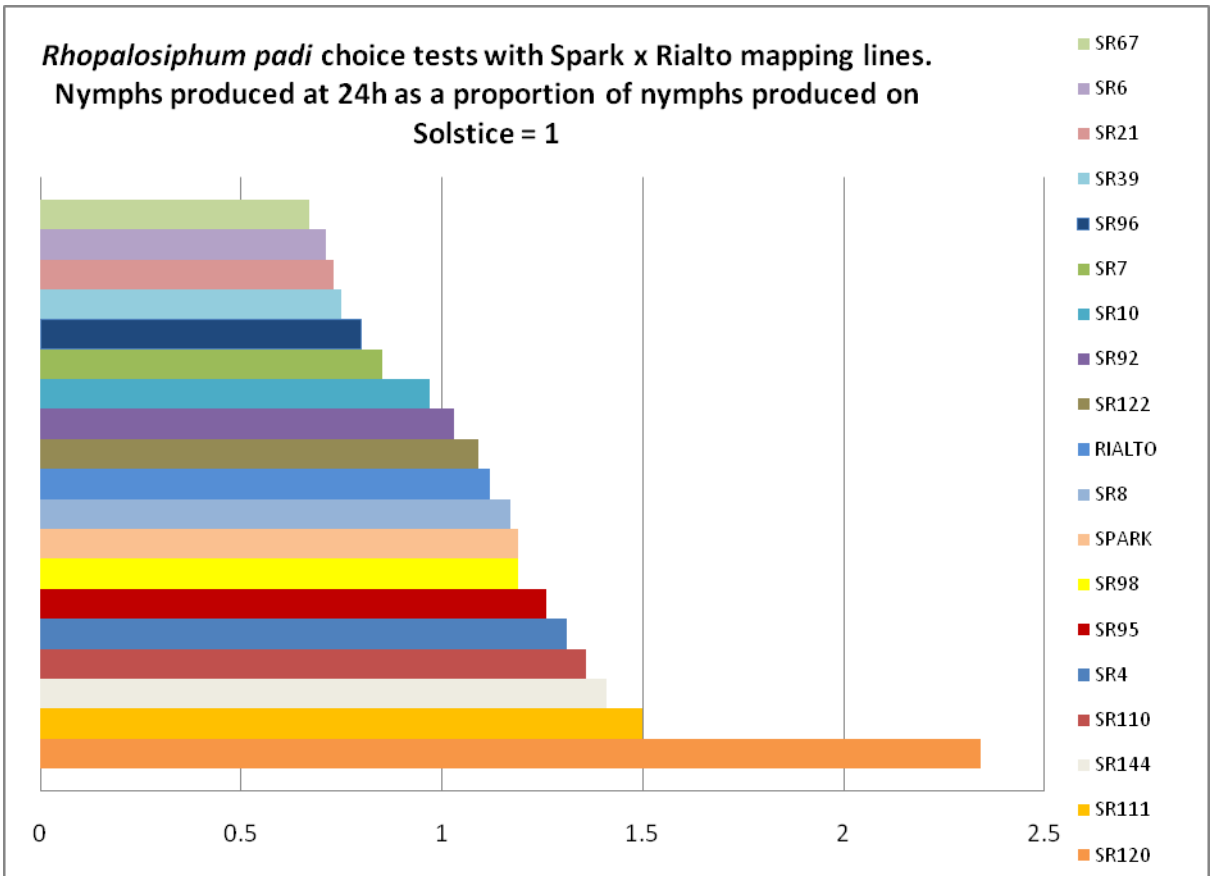


Figure 2. Preference of *Rhopalosiphum padi* for nymph production on lines from the Spark x Rialto mapping population compared to Solstice.

No choice development assays to determine Mean Relative Growth Rate (MRGR)

More detailed developmental assays were performed for eight of the lines from the mapping population, chosen from the most and least preferred lines for each aphid species, and the

two parental lines. Fifteen replicated groups of five or six adult alatae were placed in clip cages, attached to leaves of test wheat seedlings and left overnight to larviposit. Neonate nymphs, collected the following morning, were weighed in batches of five in a 0.2ml Eppendorf tube on a microbalance (Cahn C33, Scientific and Medical Products Ltd, Manchester, UK) and then transferred to the first leaf of 7-8 day old seedlings of Solstice, as the standard variety, or of the test line. At least 12 batches of nymphs were set up on each plant line and each batch was enclosed in a clip cage. The seedlings were kept in a controlled temperature room (20 +/- 2°C, 16:8 h L:D, 40% RH). Surviving nymphs were re-weighed in their batches after 6 or 7 days and the Mean Relative Growth Rate (MRGR) was calculated as:

MRGR = (ln 6/7day weight – ln birth weight) / number of days

All data were subjected to ANOVA to determine any significant differences. The MRGR of the aphids on each line is presented as a proportion of the MRGR on Solstice in the same trial in Figures 3 (*S. avenae*) and 4 (*R. padi*). The graph colours are consistent with those of Figures 1 & 2.

There were no significant differences between MRGR on the lines compared to Solstice for either aphid except for *R. padi* on line SR67 (Fig. 4). From the limited data obtained so far, except for line SR67, settlement preference of alatae does not relate to development rate of nymphs. This observation has been supported by work done in the Crop Science Initiative project on the importance of Hydroxamic acids in aphid resistance.

Clip cage

These data are now being checked to determine whether there is any genetic basis to the effects with the possibility of creating a new mapping population between SR120 and SR67.

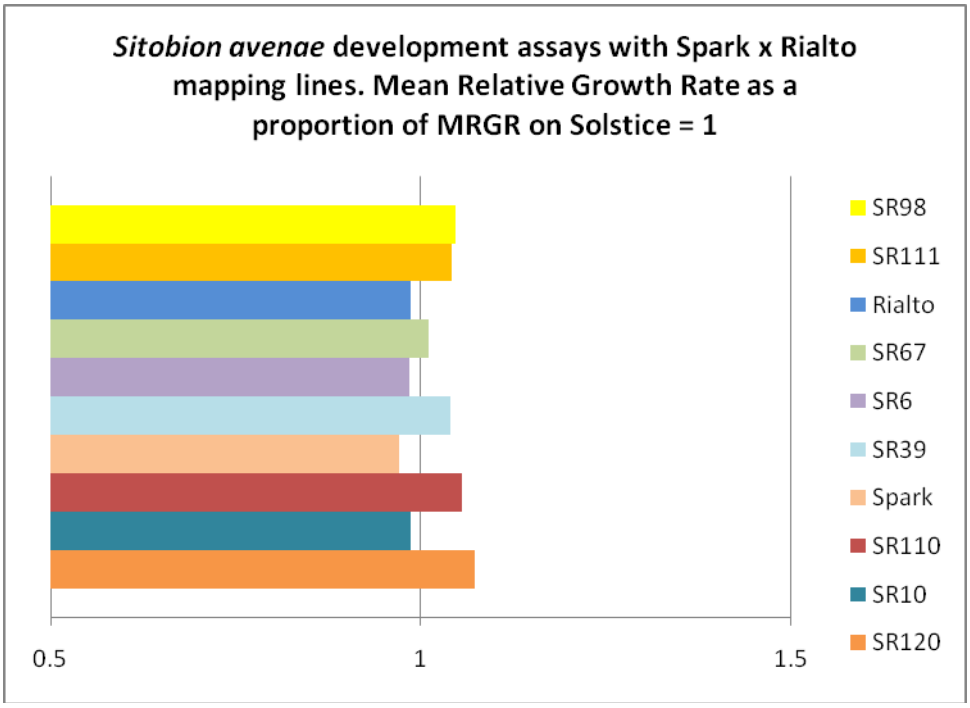


Figure 3. MRGR of *S. avenae* on selected lines from the Spark x Rialto mapping population compared to MRGR on Solstice.

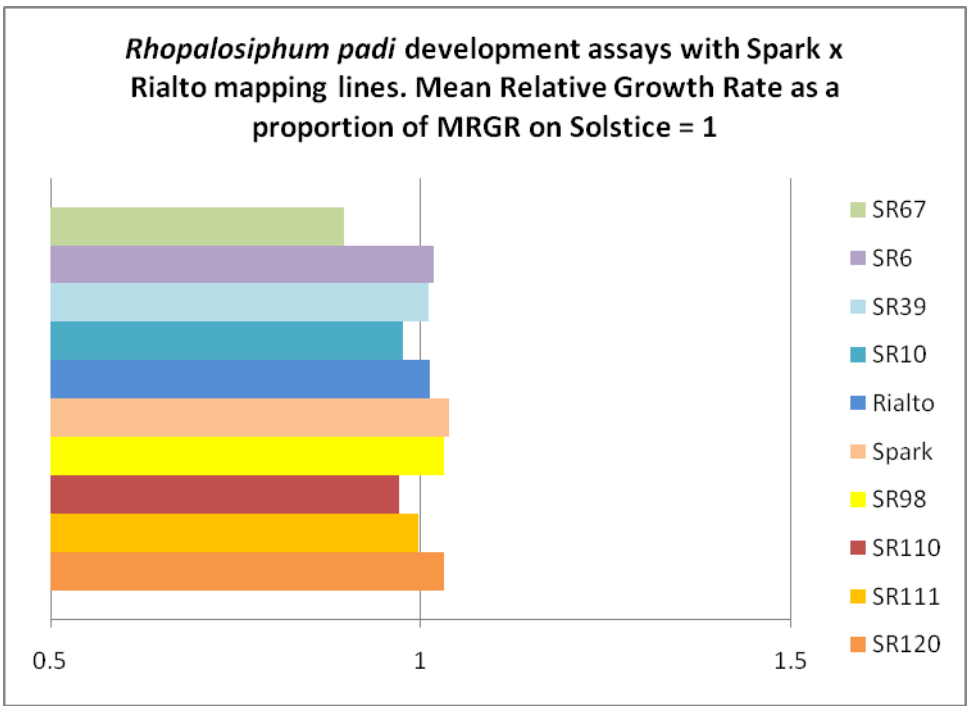


Figure 4. MRGR of *R. padi* on selected lines from the Spark x Rialto mapping population compared to MRGR on Solstice. (Line SR67 significantly different to Solstice $P<0.05$)

References

Berzonsky, W.A., Ding, H., Haley, S.D., Lamb, R.J., McKenzie, R.I.H., Ohm, H.W., Patterson, F.L., Peairs, F.B., Porter, D.R., Ratcliffe, R.H., and Shanower, T.G. (2003) Breeding wheat for resistance to insects. *Plant Breeding Reviews*, 22: 221–296.

Ricciardi M, Tocho B, Tacaliti MS, Vasicek A, Giménez DO, Paglione A, Simmonds J, Snape JW, Cakir M and Castro AM (2010) Mapping quantitative trait loci for resistance against Russian wheat aphid (*Diuraphis noxia*) in wheat (*Triticum aestivum* L.) *Crop & Pasture Science*, 61: 970–977