An integrated SNP, SSR, DArT map in the wheat population 'Kenyon/86ISMN 2137'.

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Single nucleotide polymorphism (SNP) markers are a powerful new tool for wheat genetics. Most current SNP markers are gene-based markers, which facilitates comparative mapping with *Brachypodium* and rice. This feature enables development of additional markers from the publicly available genome sequences of these related species for map-based cloning projects. A recombinant inbred line (RIL) population developed from the cross 'Kenyon/86ISMN 2137' was tested with the 9,000 SNP Infinium iSelect BeadChip panel developed by researchers in the U.S. and Australia. An integrated map of SNP, SSR, and DArT markers has been developed. The 'Kenyon/86ISMN 2137' RIL population segregates for reaction to multiple wheat pathogens, including *Puccinia triticina*, *Phaeosphaeria nodorum*, *Mycosphaerella graminicola*, *Tilletia* spp., and *Fusarium graminearum*. Efforts to map resistance to these pathogens are in various stages of completion.

SESSION VIII: HIGH-THROUGHPUT PHENOTYPING

State of the art and future developments in phenotyping: half a century of expertise in ARVALIS Institut du végétal.

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Arvalis is a technical institute created by the will of cereal-growing French farmers. For more than 50 years, Arvalis employees have conducted research experiments with the primary goal of increasing the competitiveness of farmers. Other applied research institutes exist in France, but Arvalis is the largest one in terms of employees and studied crops (cereals, maize, potatoes, protein-rich crops, flax, forage). Various fields of research are undergone by Arvalis (innovation for agricultural equipment, innovation in plant protection, cultivation practices). However the main task for Arvalis is to evaluate crop varieties.

Agriculture in France faces many challenges as in the rest of the developed countries. Main concerns are global warming and its consequences, increasing costs of nitrogen fertilizers, and the legislation changes towards reduced use of pesticides. In order to address the concerns of farmers, Arvalis has deeply modified the way it evaluates varieties by adapting phenotyping methods to address new challenges. We perform the evaluation of genotypes in a national network of experiments under optimal plant protection and fertilization in order to approximate the highest potential of each new released variety. In addition, we evaluate also the same varieties under stressful environments (e.g., drought, frost, fungal attacks, and nitrogen depletion).

Global yield is not a sufficient indicator to monitor the potential of a variety under stress. We try to follow the elaboration of yield throughout the successive phenological phases. This allows us to better understand the interactions between genotype and the various limiting factors. The use of high-throughput phenotyping tools and crop models are now unavoidable. Twenty years ago our institute first proposed the use of shading facilities to control rainfall, and we are now developing more innovative techniques to better control the environment (the PHENOME project). Recent advances in the field of robotics and miniaturisation of devices have opened the door for innovative phenotyping techniques under field conditions. Arvalis plays a major role in France in the developing and testing of new phenotyping tools (e.g., Phenoblé, Racine, and Phenomobi). We progressively integrate those facilities into the phenotyping platforms and we hope to achieve major breakthroughs in that field.