Photo provided by DLF

Producing high protein content under all conditions

A CLOSER LOOK AT LUCERNE BREEDING

BY: MARCEL BRUINS

Lucerne, also known as alfalfa, is one of the most cultivated forage crops in the world with a high content of proteins, minerals and vitamins. The global market for lucerne seed is approximately 80,000 tons and it is a major forage crop in many regions of the world; this includes Central Eastern and Southern Europe, Russia, Middle East, China, South Africa, North America, South America and Australia, where lucerne is more drought tolerant than most forage grasses.

The crop is a widely used species for various climatic conditions – from Nordic to hot and dry conditions in the South. Lucerne can be cultivated alone or in mixtures with grasses for silage and hay production. In the past, lucerne was also cultivated for dehydration and pellet production.

Due to a high protein content, lucerne is often mixed with maize and cereals to make balanced protein –sugar rate feeding mixtures. Due to its deep root system (2-20m), lucerne is able to grow in extremely hot and dry conditions as it can make use of soil water in deeper soil layer. In such conditions, it is the main crop for cattle feeding.

Lucerne seed is primarily used for growing animal feed, which is generically referred to as 'forage'. Seed is planted to produce lucerne that is then used for grazing, "greenchop" (fresh lucerne cut in the field without drying), silage, baled hay, cubes or pellets as a primary food stock for the livestock industry, which includes dairy and beef cattle, horses and sheep.

It is time for *European Seed* to learn more about this crop, so we sat down with Dan Gardner and Mark Smith of S&W Seed Company and Vladimir Cernoch of DLF.

STRATEGIC IMPORTANCE

Cernoch mentions that in 2016, DLF succeeded in creating a greater platform in the lucerne seed business. Lucerne is a strategically important high-value crop for co-distribution with forage grass and clover seed in many areas, where DLF strives to develop the seed business. "While DLF has one of the most extensive plant breeding program in grasses, the goal has been to strengthen the activities in lucerne. DLF recently invested in the well-known genepool and the breeding program in lucerne from Florimond Desprez in France."

Gardner shares that his company provides expertise in agricultural breeding, production and processing for the alfalfa industry. “Each day that passes, two major issues affect the world’s population. First, the population of the world continues to increase and secondly, the availability of arable land continues to decrease. This creates a dire set of circumstances for farmers trying to feed a population increasingly wanting a diet which includes many of the foods that alfalfa hay, the “queen of forages,” supports, including milk, cheeses and beef. Our company is capitalizing on these very important trends to help farmers combat the challenges of today, while keeping an eye on providing sustainable solutions for tomorrow.”

LUCERNE ADDS VALUE TO THE FARM

Farms with a high demand for protein rich feed can become more self-sufficient by growing lucerne. Sowing a field of lucerne helps to reduce the costs for external protein sources and dependency on fluctuating world market prices, leading to improved economy. Cernoch says: “One field of lucerne will generate more than 3.000 kg protein/ha due to its high content of protein (18-20%), compared to forage grass (14%), maize (9%) or soya (1.200 kg protein/ha). In addition to high protein content and better self-sufficiency, lucerne is also an excellent mixture component with grasses and an excellent complement to maize in the feed recipes. Finally, the crop is easy to establish and saves input cost on fertilizers.”

BREEDING TARGETS

Gardner indicates that for more than 35 years, S&W Seed Company has bred lucerne varieties of the highest quality with superior genetic traits; the unique ability to grow in challenging soil conditions and to generate outstanding crop yield. “Our specialty is high-yield, non-dormant alfalfa varieties focused on maximizing profit per acre for the farmer, regardless of soil and water salinity.”

YIELD INCREASE

Cernoch mentions that similar to most other agricultural crops, dry matter (DM) yield is the main breeding goal. “Very often DM yield depends on disease resistance, which can be a limiting factor for yield. In addition to DM yield, important breeding tasks are feeding quality like protein content and cell fiber digestibility, lodging, seed production and others. “

Gardner adds that S&W are actively breeding in the US and the rest of the world for a variety of traits. “We are best known for our salt tolerant lines that are the most tolerant lines in the world. These varieties that are developed for salt tolerance are subjected to soils within the root zone with water having salinity levels of up to EC 15. This would be the equivalent of irrigating with water having an EC value of 10. Several of our alfalfa varieties are currently marketed as salt tolerant varieties, and are also very productive in soils without salt problems. United States Department of Agriculture (USDA) and University of California researchers tested one of our varieties in well drained sand tanks at the Salinity Laboratory in Riverside in 2001 using irrigation nutrient solutions with EC 15 and EC 25. With a 275 day growing period, this variety yielded 11.5 tons/acre with EC 15 solution and 6 tons/acre with EC 25 solution. So it shows that selective breeding of alfalfa varieties for salt tolerance does work! SW 9215 and SW 8421S have at least as much salt tolerance as SW 9720.”

Matt Grewal of S&W Seed Company in an alfalfa field.

REGIONAL DIFFERENCES

Lucerne is produced under various climatic conditions. One of the most important traits for lucerne varieties is fall dormancy, i.e. the ability to stop growth before winter. Varieties with strong fall dormancy are mainly suited in the Nordic conditions, where it is necessary to stop growth before winter in order to survive. At the other extreme, in Southern conditions, varieties with strong winter growth are asked for, as these lucerne cultivars have a higher yield productivity in mild winters compared to dry and hot summer. The US fall dormancy scale has a range from 1 -11:

- FD 1-2 covers varieties with very strong fall dormancy used mainly in Nordic and continental conditions
- FD 3-5 are varieties used for example in West & Central Europe and the European part of Russia
- FD 6-8 are semi dormant varieties mostly for the Southern part of Europe
- FD 9-11 are non-dormant varieties suited for the Mediterranean region, North Africa, and other areas in the Southern hemisphere.

Cernoch indicates that DLF is conducting a range of national variety trials in many countries across Europe. “In the current research program, the main germplasm comes from varieties with a dormancy score in the range four to five. This is the most common type used across much of Central, Eastern and Northern Europe.”

Gardner: “The climate in the western U.S., where a majority of our company’s production is located, is ideally suited for high-quality alfalfa seed production.”

A field of lucerne. (Photo provided by RAGT)

DOES EACH REGION REQUIRE ITS OWN VARIETIES?

Cernoch underlines that apart from climatic conditions, the development of new varieties is under influence by farmers requests for quality. "For example, in Central, Eastern and Southern Europe, farmer's priority is DM yield and lodging resistance (standability), as the first cut is carried out just before flowering. DM yield and lodging resistance here are the main traits for variety registration." He adds "Western European farmers are also looking for DM yield and lodging, but feeding quality issues like protein content and fiber digestibility are important too. US and Canadian farmers prefer high cell wall digestibility with low lignin content, and therefore North American varieties are less lodging resistant. That is one of the main reasons, why overseas varieties often have registration-problems in Europe."

Photo provided by DLF

PESTS AND DISEASES AFFECTING LUCERNE

Pests and diseases can drastically affect DM yield and persistency of lucerne. Cernoch says that diseases that have a different importance in various regions. "The most important diseases and pests are *Verticillium, Colletotrichum* (anthracnose) and stem nematodes. Breeding for resistance to these problems are important tasks for all plant breeders. "

CREATING A NEW LUCERNE VARIETY

Plant breeders need to combine a variety of traits. "We need fall dormancy, DM yield, feeding quality, disease resistance and seed yield. In our global breeding and testing network, DLF is developing, screening and selecting lucerne germplasm derived from different sources across the world to develop the most suitable varieties according to climatic and management demands for the single regions" says Cernoch. "DLF's lucerne breeding program operates across Europe and around the world. We are looking to develop varieties that offer higher yields, better disease resistance and stronger winter hardiness," he adds.

Smith states "I am happy to say that S&W Seed has full capabilities in all facets of alfalfa breeding. We have two greenhouse complexes screening and characterizing 20-plus pests of alfalfa, which includes diseases, insects, and nematodes. Also we have an NIR lab characterizing forage quality and a molecular lab working on markers and new trait development. In addition, our company has research facilities in Australia and the US with

collaborations and partnerships in Europe and other areas of the globe allowing us to move quickly to address grower concerns and needs for all dormancies."

WHAT'S IN THE PIPELINE?

"We also have an ETS approved transgenic program, a gene editing / NBT program, as well as a broad conventional breeding program." says Gardner. "Our European program focuses on lodging tolerance and forage quality. And we are currently using marker assisted selection and utilizing advance statistical designs on a regular basis."

Cernoch mentions that their new breeding program offers commercial varieties that are recommended for both forage and dehydration on the official GEVES list in France. "The varieties provide top yield, high protein, good lodging resistance and improved pest and disease tolerance. DLF also offers specialised lucerne varieties with good features in yield and establishment under sub-optimal conditions, allowing growth of lucerne on soils where it usually does not belong".

As a legume, alfalfa can satisfy its nitrogen needs through a naturally occurring symbiotic relationship with bacteria called rhizobia in the soil. This invaluable trait removes the need to use additional nitrogen fertilizer inputs to support plant growth. Recent research is trying to unlock this species' genome. Understanding the genome sequence could lead to alfalfa plants with increased ability to survive in stressful environments such as drought and animal grazing. It could also produce higher biomass yields when baled as hay, extend its growing season, and adapt better to different soil types and nutrient levels.

WHERE ON THE WEB

Background information on the initial Medicago truncatula research is available at http://www.noble.org/Global/news/annualreport/2011/annualreport.pdf

Salt Tolerance - WATER QUALITY FOR IRRIGATION OF ALFALFA HAY

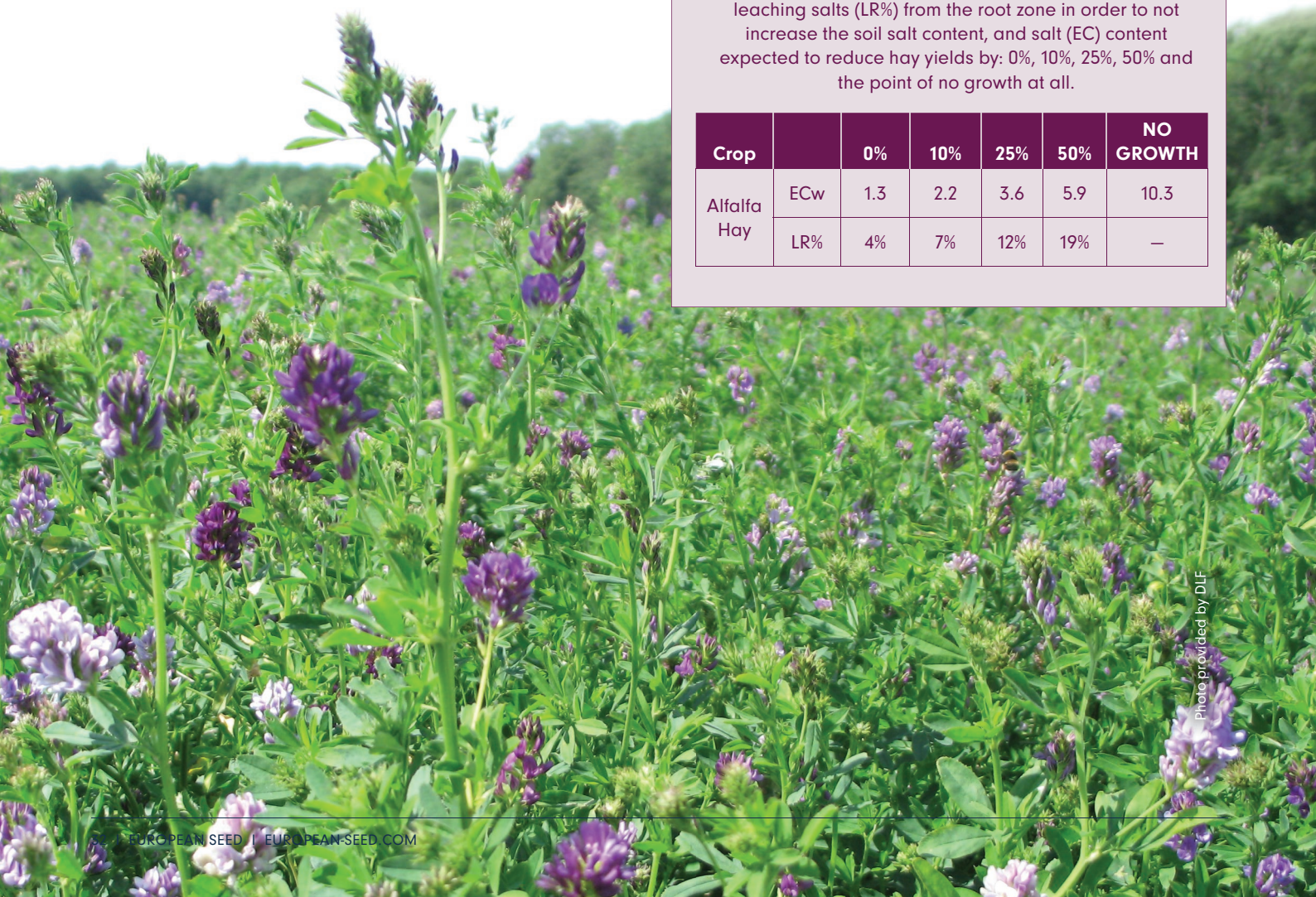
All water used for irrigation contains some dissolved salts and 1 ha foot of water (the amount of water covering 1 ha 30 cm deep) weighs approximately 3090 tons. Therefore 1ppm of salt in 1 ha foot of water weighs a little over 3 kilogram.

This means that one ha-foot of water containing only 735ppm (EC=1.15mS/cm) carries 2.47 ton of salt. Many growers apply well over 1 meter of irrigation water per year to produce a crop of alfalfa hay. In other words, they apply 8.6 – 9.9 tons of salt on every ha. every year if that water has an EC (Electrical Conductivity) of only 1.15mS/cm.

One of the hazards of irrigated agriculture is the possible accumulation of soluble salts in the root zone. Some plants can tolerate more salts than others, but all plants have a maximum tolerance. Where ample water and deep drainage is used to remove excess salt from the root zone, the salt level in the saturation extract is about 1.5 times that of the irrigation water. Where water is used more sparingly, there may be three times as much salt accumulated in the plant root zone. Leaching and drainage are critical over time.

Scientific data show approximately what a grower of alfalfa hay can expect when using increasing amounts (EC) of salt in irrigation waters. This data was developed using alfalfa varieties NOT developed for salt tolerance, but are very useful in general. The data gives the required percentage of additional water required for leaching salts (LR%) from the root zone in order to not increase the soil salt content, and salt (EC) content expected to reduce hay yields by: 0%, 10%, 25%, 50% and the point of no growth at all.

Crop		0%	10%	25%	50%	NO GROWTH
Alfalfa Hay	ECw	1.3	2.2	3.6	5.9	10.3
	LR%	4%	7%	12%	19%	–



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