BIBLIOGRAPHIC STUDY OF GENETIC PROCESS IN *PHALARIS ARUNDINACEA*

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Abstract: *Reed canary grass (Phalaris arundinacea), is a C_3 – photosynthesis grass species that is invasive in temperate and boreal wetland communities in North America, where was a native species in North America prior to the arrival of European settlers. The introduction of varieties from many European sorces since the mid – nineteenth century resulted in invasive populations that now form near monocultures in former sedge meadows [17], [18], [11], [22], [19], [9]. Phalaris arundinacea has also been shown to reduce plant species richness in wetlands altered by beaver [23]. Today represent one of the most efficient producers of herbaceous biomass in boreal conditions [17]. Phalaris arundinacea occurs throughout most of the continental United States, it occurs north throughout Canada and into Alaska [31] and as far south as northern Mexico [1]. Allard and Evans [8] indicated that species in North America distribution is likely a reflection of its need for long days for flowering. In present Phalaris arundinacea is common species in the northern half of the United States and southern third of Canada [19], especially in the Pacific Northwest [6], [14]. Plants Database provides a map of Phalaris arundinacea North American distribution, excluding Mexico. This very large presence arrived because of its rapid above and belowground growth and tolerance of wet soils and has been planted for use in erosion and sedimentation management [3]. Reed canarygrass is exceptionally high-yielding for hay. However, low-quality hay is frequently made because this grass is usually grown alone in areas too wet to harvest until late in the season. Reed canarygrass requires heavy fertilization to maintain a high level of production. The tall, coarse nature of this grass makes it acceptable to harvest as silage. By making this crop into silage, it is often possible to save the crop when conditions are such that it is difficult to cure as hay.*

Key words: *Phalaris arundinacea, reed canary grass, genetics features, hay production, sillage*

RESEARCH CONCERNING PLANT MORPHOLOGY

Reed canary grass (*Phalaris arundinacea*) is a perennial, robust gramineae whose height often reaches 2 and even 3 m.

Phalaris arundinacea has thin fasciculate roots that can be accompanied by thicker whitish roots. Adventives roots start to develop two weeks after germination, replacing embryo roots whose number ranges within 1-7. If adventives roots development is hindered, the plant dies in 3-4 months [15]. Rhizomes, as caulide organs, are aerial and they le on the ground, are subterraneous and send aerial roots and stems. Their development depends on soil aeration; most of them are 5-6 cm deep in the soil.

Runners are long, creeping subterraneous shoots. They are covered by membrane whitish squamas and they grow in all directions, reaching up to 1 m in length [27].

The leaf is made up of a foliar blade of linear shape characteristic to gramineae, directly inserted through a developed split sheath, as well as of foliar annexes.

Reed canary grass has as foliar annexe only a membrane formation representing the passage from sheath to the blade.

Reed canary grass has a sharp or often broken blade 3-6 mm long and trunk-like, acute, usually lacerate, that can reach 6-10 mm in length.

The inflorescence of *Phalaris arundinacea* is a panicle. According to some research, it is a dense panicle made up of long branches of different orders on which spikelets are inserted. The panicle has a frontal close aspect after the blooming time also, but it is spread during the entire blooming period.

The colour of the panicle is white-greenish or white-violet, lobed distanced, with long inferior branches (about 5 cm), retracted before and after blooming.

The spikelets are one-flowered, pedicel-like, about 5 mm long, close fasciculate. The four glumes are lanceolate, acute, 3-nerved, dorsal with no winged careen, greenish-white or violet, sometimes yellowish, while the 2 superior ones are reduced, only 1 mm long, long white hairy, and set at the basis of the pallets.

The fruit of *Phalaris arundinacea* is a caryopsis covered by coriaceous pallets. It is about 5 mm long and it has a short sharp brown tip, containing a single seeds.

Green canary grass caryopses are about 3-4 mm long, of different colours (white, yellow, even black) and the mass of 1,000 grains is between 0.1 and 1 g. We need to mention the presence of the two pallets surrounding the caryopsis and that as short, dense hairs at the basis [32].

Rhizome fragments under heavy shade reduced survival by 25% and growth by 95% [13].

Was founded that populations of reed canary grass exhibited many different growth strategies that may be of importance in plant establishment and dominance [17]. High Morphological plasticity in response to changes in environmental pressures is also considered an important factor to facilitate the invasiveness of this species [9]. Reed canary grass altered its root to shoot ratio, the number of shoots per plant, and its leaf area per shoot in response to flooding, forming tussocks similar to those formed by certain *Carex* sedges during flooding [13] noted that reed canary grass allocates more biomass to its root system to improve its ability to compete for nutrients in nutrient-deficient conditions and tends to produce more tillers and rhizomes to maximize carbon gain and carbohydrate storage under high nutrient availability.

[17] Found that species tends to dominate the communities that have sparse vegetative cover, which means less interspecies competition. However, when competition exists, reed canary grass tends to allocate more energy into its underground system instead of aboveground shoots, being able to produce more shoots in the early spring from the expanded rhizome system.

Following a major disturbance, shifts in the growth pattern of reed canary grass may also occur to maximize its invasive potential. During the first year of planting, *P. arundinacea* tends to put more biomass into shoot and tiller development than into its root system to build up more canopy to compete for light and suppress native species [16].

Reed canary grass plants exhibit rapid spring growth that culminates in a reproductive shoot that can be nearly 2 m tall by early summer. Early in the growing season, *P. arundinacea* plants generally become taller than most of the plants with which they compete, especially taller than most of the sedges, such as *Carex stricta*, a dominant native species of wet meadows [9], [24] also state that species can outgrow other wetland species including *C. stricta*. Much of the initial spring growth is supported by an extensive, robust rhizome system that stores considerable quantities of fructose polymers over the winter [24]. This rapid attainment of a dominant height and their ability to form numerous rhizomes, tillers, and seeds allows reed canary grass plants to form large monocultures in wetlands and quickly fill canopy gaps created by anthropogenic or natural disturbances [17], [18], [11], [22], [19].

In low soil moisture conditions the reed canarygrass is not a overcome production, [13] which facilitates the spread of this species, especially along major waterways where there may be no significant barriers to dispersal [10].

RESEARCHES CONCERNING THE SPECIES GENETICS FEATURES OF PHALARIS ARUNDINACEA

For this species exists several accessions from diploid to hexaploid, [30], generally, the species is considered to exhibit three major accessions: diploid (n = 14), tetraploid (n = 28), and hexaploid (n = 42) [17], [30].

Has been noted as the most abundant accession in North America is considered to be tetraploid, some hexaploid populations, possibly agronomic, apparently exist in North America and have been introduced into Australia. Usually the hexaploid accession has a somewhat higher productivity than the tetraploid accession, and the high ploidy levels have positive effects on photosynthetic characteristics and environmental tolerance [19].

The accessions confer genetic variability in reed canary grass but within a ploidy level considerable genetic diversity exists, indicated that tetraplpoid populations in North America contain all of the alleles studied that were found in different populations in Europe [17]. For that the North American populations are more diverse than the European accession most likely due to the repeated introduction of varieties for agricultural purposes from Europe [28].

RESEARCHES CONCERNING THE YIELD CAPACITY OF PHALARIS ARUNDINACEA

In Finland, the cultivation area of reed canary grass used mainly for combustion has increased quite rapidly within the last few years, and it is estimated to reach 70 000 hectares in year 2010 [12].

Production of *Phalaris arundinacea* for energy production has increased rapidly in 2008 the production area was about 20,000 ha in Finland. In Sweden the production area is under 1,000 ha. In other EU-countries this species is not cultivated with the exception of small experimental plots [20].

Pasture

The species has traditionally been seeded on poorly drained pastures, where it is difficult to grow other species. Poor animal performance has resulted on wet pastures where animals could not graze until the grass was well past heading. Also, can be the basis of a productive, drought-resistant pasture if it can be rotationally grazed with rest periods to allow regrowth. Because of its deep-rooted nature, it can be used to provide grazing during the "summer slump" of other species [35].

Grazing should be timed to keep the plants vegetative. This is particularly important in May and June, when the rapid spring growth should be limited. The reed canary grass does not tolerate close, continuous grazing, where the constant removal of growing points damages regrowth. Rotational grazing with a residual height of 4 inches will improve productivity [35].

Manage *Silage or Hay:*

To maximize both yield and quality, 3 cuttings should be harvested annually allowing for a 4 week fall growth period before first frost. The first cutting should be taken before seed heads emerge, generally early June. Subsequent growth will be leafy and productive. Properly managed the reed canary grass will produce 4-6 tons of forage dry matter per year. Forage quality components will vary, depending upon stage of maturity and nitrogen fertility. Fiber components will be similar to other cool season grassesment [36], [27].

Harvest of reed canary grass

The first crop can be harvested two years after sowing, if there is no ground frost the soil has to be dry enough to bear the combine harvester [20].

One realistic yield level in Finland is 4 – 7 tdm/ha, when harvest losses are taken into account, because the energy content of *Phalaris arundinacea* is about 4.5 MWh/tdm, current production is about 450 GWh/year, if the yield level is assumed to be 5 tdm/ha [20].

Yield quality

In the spring-harvested crop ash content is lower and ash smelting point is higher than in an autumn-harvested crop. Also Cl, K, Ca, N and P contents have decreased during the winter. Ash content can range between 2 % and 10 % according to fertilisation and soils. Ash content is lower in stems compared with leaves. At spring harvest up to 70 % of the biomass can be represented by stems [20].

Reed canary grass as a fuel

In Finland this species is used in a mix with a mainfuel in CHP plants. The main fuel is peat in most cases, which is mixed before feeding into the boiler. The main fuel can also be wood or a mix of wood and peat. The reed canary grass has low density, higher chlorine and alkali content and lower ash smelting point compared with typical solid fuels like peat, wood or coal, for these reasons the proportion is usually limited to 10 – 20 % of total energy content of the fuel mix [20].

RESEARCHES CONCERNING THE PRESENT AND FURTHER RESEARCH OF PHALARIS ARUNDINACEA

In the recent years several reports have been made on how to increase the utilization of bioenergy potential in Norway. The farmers union (Norges Bondelag) focus on improved use of wastes and less on agroenergy crops. A group of research institutes and organisations have written a report called “From Biomass to Biofuels – A Roadmap for Future Solutions in Norway” [4].

Previous research and testing of perennial grasses for bioenergy production in the Nordic countries (especially in Sweden and Finland) [17], [12] has documented that the perennial rhizomatous grass (*Phalaris arundinacea* L.) is the most productive perennial grass in terms of stable biomass yield at northern latitudes.

The delayed harvesting method has been evaluated and accepted in Sweden, Finland, Denmark and many other countries. The harvesting method produces a dry biomass product (10- 15 % of moisture). This means that drying costs will be reduced or even eliminated in the production chain. In an experiment at Rothamsted, England, the effect of harvest date on the yield and mineral content was examined in 15 genotypes of reed canary grass [29].

The yield level of *Phalaris arundinacea* obtained in Finland was 4 – 7 tdm/ha, when harvest losses are taken into account. Fields have produced 10 tdm/ha yields. Because the energy content of this species is about 4.5 MWh/tdm, current production is about 450 GWh/year, if the yield level is assumed to be 5 tdm/ha. But if the reed canary grass area were increased to 100,000 ha, annual energy production would be about 2.25 TWh [20].

CONCLUSIONS

Use for Hay

Reed canarygrass is exceptionally high-yielding for hay. However, low-quality hay is frequently made because this grass is usually grown alone in areas too wet to harvest until late in the season. When harvested at the early heading stage, its nutritive value is comparable to that of other forage grasses. The best quality hay is obtained from stands that have been pastured early in the spring to set back the haying period, thus reducing the coarseness of

growth. Reed canarygrass requires heavy fertilization to maintain a high level of production. The tall, coarse nature of this grass makes it acceptable to harvest as silage. By making this crop into silage, it is often possible to save the crop when conditions are such that it is difficult to cure as hay.

Use for Pasture

The relatively low palatability of this grass makes it necessary to have it fenced separately, giving livestock no alternative. Reed canarygrass is very useful for pasture. It starts to grow early in the spring, showing good distribution of growth throughout the season. To maintain good quality, reed canarygrass should not be allowed to get more than 12 inches high. However, it is intolerant of continuous close grazing, and should not be grazed shorter than 4 inches. Controlling the height of the reed canarygrass by grazing or clipping makes it possible to include a legume in the stand, except on the very moist sites. Regrowth after hay or seed harvest is fair, and can be used for grazing.

Seed Production

Seed matures from the top of the panicle downward. There is a period of only two or three days between the ripening of the first seed and the time when shatter is too great to warrant harvesting the seed crop. The seed can be either direct combined or swathed. If swathed, leave at least a 3-foot stubble, and try to position the windrow so that it is perched on the stubble rather than falling to the ground between rows. Seed production is possible under irrigated or subirrigated conditions. The seeds mature during the first half of July. Good seed will remain viable for three to four years, compared to six to eight years for most other grasses.

Phalaris arundinacea is a sustainable, high yielding crop suitable for the Nordic countries when the delayed harvesting method is used. Delayed harvested RCG is already successfully used as a fuel raw material and this sector is rapidly expanding.

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