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SESSION 5: BIOMASS RESOURCES

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Potential of Giant Grass *Triarrhena lutarioriparia* to grow in cold, dry and saline conditions as Energy source

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Abstract: Giant grass *Triarrhena lutarioriparia* (a special type of *Miscanthus sacharilorus*) is originally a subtropical plant growing in humid condition or even in water in regions of about 28-29° N. latitude, with yields from 20-40 t (dm) /ha in its natural vegetation. To our great surprise we found that this plant can also be grown in cold and dry regions and even in saline soils, though the plant has adapted to moderately acid soils in its long growing history in the subtropical lake area. Experimental cultivation has been successfully conducted in Yuncheng (35.02° N. lat), Dongying (37.27° N. lat), Beijing (39.55° N. lat) and Braunschweig (52.16° N. lat). The results show that the yield of this plant can be over 20 t (dm) /ha in Yuncheng and in Beijing without problem. The yield of the plant in saline soils in Dongying is lower, but still to be observed in the next years. The materials used for these experiments were from the natural vegetation of the plant in 1994-95. We believe the plant have adjusted its adaptability to new conditions step by step in the process of transplantation, because it is very elastic to the growing conditions and therefore has a very strong viability. This plant is a very good choice to produce bio-energy materials in various regions with diverse conditions.

Other giant grasses such as *Arundo donax* are also taken into test to compare their adaptabilities to adverse conditions. The result showed that *A. donax* was somewhat frost-sensitive in the first growing year. Further it would grow better.

Keywords: Giant grass, *Miscanthus*, Bio-energy, renewable materials, biomass

1. Introduction

Miscanthus is a group of well known energy plants which produce large amounts of biomass in humid and warm or moderate climate conditions. The widely cultivated species *M. x giganteus* is actually a hybrid plant derived probably from *M. sinensis* and *M. sacchariflorus* (Greef & Deuter 1993). The latter is recently classified as 2 species: *Triarrhena sacchariflora* and *T. lutarioriparia* (Liu 1997). *T. sacchariflora* is a relatively small plant distributed in northern regions, while *T. lutarioriparia* is the one which grows normally in the South. But in fact, the species *T. lutarioriparia* itself consists of various types with different plant heights, culm thickness and growing densities. Many types of this species show a wide range of adaptability to their growing conditions. This means that they could also have high productivity in regions with conditions far different from their original growing sites (Xi 2000). Based on this knowledge the author began to collect natural resources of this plant species and to transplant them in different places with cold and dry climate and even with saline soils, in order to examine their productivities and related cultural properties. It is believed that this plant, the

real "China reed", will be developed to a new crop which is useful for energy supplying, for landscape and soil conservation, for gardening and for environment protection both in southern and in northern regions.

A. donax is another important giant grass species and should be taken into test as a comparison.

2. Materials and Methods

Since 1994 the author has collected a series of *T. lutarioriparia* strains for test transplantation and cultivation. Among them 2 strains were intensively observed in Yuncheng China (35.02° N. lat) and 1 strain were tested in Braunschweig Germany (52.16° N. lat). All the results are positive to persuade people that the 2 strains, Monan-Lingdi and Hanshou, can grow and overwinter in dry, cold climate (-14-21°C) and even in a little alkaline soil condition (pH 8.1).

Since 2002 the author have taken the above 2 strains for more test-cultivation in the North both in Beijing (39.55° N. lat) and in Dongying (37.27° N. lat). The climate in Beijing is more extreme than in Yuncheng, i.e. similarly dry in Spring and Summer but more cold in Winter. The lowest temperature in the Winter 2002-2003 was under -16°C. The soils in the test field in Beijing has a pH-value of about 7.7. The climate condition in Dongying (lowest temperature in the Winter 2002-2003 was under -19°C) is more extreme than in Beijing, and the soils in Dongying are heavily saline. The site for growing Hanshou-Strain of *T. lutarioriparia* has a soil salt content of about 1%. The pH-value of the soils is about 8.5. Despite of these adverse conditions, the tested plant strains Monan-Lingdi and Hanshou grew very well in Beijing, and the strain Hanshou withstood the saline problem and established its vegetation indomitably in Dongying.

Together with *T. lutarioriparia* some other giant grass species have also been taken into the examination. All the cultivation tests were made without irrigation and fertilization. For planting materials all the plants were taken from Yuncheng test-field as rhizomes which were than buried in new test-fields in Beijing and in Dongying within 1 week after the rhizomes were dug out. The burying time was 27th April, 2002. The burying depth was about 20 cm.

In 8-13th November 2002 the same rhizome materials of the above plants were buried in Beijing test-field to see the effect of Autumn-transplantation.

3. Results and Discussion

(1) The cultivation test in Beijing

All transplanted plant species or strains grew very well in the first year. The *T. lutarioriparia* strains sprouted panicles between 10-20th September. By 23th October both the *T. lutarioriparia* strains grew to 250 cm (Tab.1). On 23th October an early frost (-2°C) came suddenly and all the plants were frozen to die and to keep a green-dry status. The rhizomes of this species overwintered under ground safely and showed new sprouts by the end of the next March.

In 2003 the strains of *T. lutarioriparia* are growing stronger than the last year. On 11th September their max height is about 3 meter. At the same time, they have increased their culm numbers greatly. The final biomass yield are estimated as not less than 20 t/ha.

Tab.1 The plant height of various species or strains of giant grasses in the first year of transplantation (cm)

Time Species or Strains	02.05.09	02.07.11	02.08.29	02.10.23
<i>T. l. Hanshou</i>	20	180	195	250
<i>T. l. Monan-Lingdi</i>	18	180	190	250
<i>Miscanthus x giganteus</i>	10	130	160	200
<i>Arundo donax</i>	20	195	300	350

Miscanthus x giganteus can also establish its vegetation in drought climate conditions in Beijing, though it grew a little smaller than the above 2 strains of *T. lutarioriparia*. To overwinter was also no problem for *M. x giganteus*.

Arundo donax showed a still better growth in the first vegetation period and got a height to 3.5 meter, higher than other plant species or strains. It sprouted panicles also in the middle of September. But anyway, as far as to the overwinter problem, it showed an unfortunate result. The plant was heavily frozen to die on 23th October. Its rhizome had also entirely died out and could not get any sprout in the next Spring.

It is interesting that the in November buried rhizomes of *Arundo donax* overwintered and grew out its sprouts in April. By September they grow to about 2.5 meter. This result can give explanation to the death of rhizomes of *Arundo donax* in October: The plant showed weakness to a sudden frost. It is probably that the frost effect could transmit from the culms to their rhizomes. More details should be further investigated.

The Autumn-buried rhizomes of *T. lutarioriparia* have also overwintered alive and sprouted in April 2003. But the plants are growing weakly. Till the Beginning of September the plant height was not over 1.5 meter, and without tillering.

From the above results we can conclude that the tested strains of *T. lutarioriparia* can grow well in Beijing, and their plantation time should be in spring.

The rhizomes of *Arundo donax* must be well protected in winter between 20th October and 20th February. The cultivation methods should be further investigated.

(2) The cultivation test in Dongying

The same plant materials of various species and strains mentioned above were also transplanted in saline field in Dongying. Most of the rhizomes sprouted out in 5-10 days after the burying. But they grew or only kept alive with difficulty due to the saline soils. By 2th October only a part of plants of Hanshou strain stood growing with a max height of 1.5 meter.

In 2003 the alive Hanshou strain of *T. lutarioriparia* sprouted out again in the saline soils in Dongying. It is growing stronger than the last year. By 1th September its max height is near to 1.8 meter.

It is commonly known that *T. lutarioriparia* is a plant adapted to warm and humid climate, growing in light acidic soils. But the above experiments show that this plant has not only a wide range of adaptability to their growing conditions, but also a possibility to widen their distribution or change their habitat step by step. The experimental materials were collected from the natural vegetation and thereafter cultivated by the author in the North for near to 10 years. They have build up their new properties and adapted to their new environment gradually? For this question some comparison experiments and long time observations are necessary.

4. Conclusion

Some ecological strains of *T. lutarioriparia* have an wide and quite elastic adaptability to their growing conditions. Therefore they are easy to be transplanted and bred to a new crop in other places. Due to their high biomass productivity they have quite bright prospects to be grown as a type of energy plants not only in the South, but also in the North.

A. donax is another potential giant grass species which can be used as energy plant, but it is somewhat sensitive to sudden frost in the north.

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