High Yield and Adaptability of New Oat Varieties in Different Regions

Zhi-Fen Zhang
Inner Mongolia Academy of Agricultural and Husbandry Sciences, Hohhot, China
zzf2663@126.com
National Oat Regional Test

- National Oat regional test is managed by National Agricultural Technology Extension and Service Center, Ministry of Agriculture.
- This test is performed by the Inner Mongolia Academy of Agriculture and Husbandry Sciences.
National Oat Regional Test

- The purpose of the national oat regional test is to assess new oat varieties (lines) under different ecological conditions, and screen varieties with high yield, adaptability and resistance, and provide a scientific basis for the new oat variety identification and extension.
National Oat Regional Test

- Naked Oat regional test started from year 2000, covered oat from year 2006. Each test for three years.
- By now, Naked Oat regional test carried out to the fifth, year 2012 is the first year of the fifth test; and covered oat to third, year 2012 is the first year of the third test.

<table>
<thead>
<tr>
<th>Number</th>
<th>Naked oat (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>2000-2002</td>
</tr>
<tr>
<td>Second</td>
<td>2003-2005</td>
</tr>
<tr>
<td>Third</td>
<td>2006-2008</td>
</tr>
<tr>
<td>Fourth</td>
<td>2009-2011</td>
</tr>
<tr>
<td>fifth</td>
<td>2012-2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Covered oat (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>2006-2008</td>
</tr>
<tr>
<td>Second</td>
<td>2009-2011</td>
</tr>
<tr>
<td>Third</td>
<td>2012-2014</td>
</tr>
</tbody>
</table>
National Oat Regional Test

• By now, the bayou3, mengyan1 ,baiyan7, bayan1 were screened through the national oat regional test, and identified through the National Examination Committee. These varieties with high yield and good stability.
Test Data Sources

• In this study, the fourth test data of naked oat and the second test data of covered oat were used to analyze the stability and adaptability of new varieties
The Fourth Test of Naked Oat

- The fourth test of naked oat started from year 2009 to year 2011.
- Including nine naked oat varieties. The varieties were provided by the breeding unit, unified management by the Inner Mongolia Academy of agriculture and husbandry.

<table>
<thead>
<tr>
<th>yy02-80</th>
<th>H44</th>
<th>Yan 2007 (燕2007)</th>
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<tbody>
<tr>
<td>9620-4</td>
<td>W04-96</td>
<td>W85</td>
</tr>
<tr>
<td>Bayou11</td>
<td>Xiyou1 (西莜1号)</td>
<td>Bayou3(ck) (坝莜3号)</td>
</tr>
<tr>
<td>坝莜11号</td>
<td>西莜1号</td>
<td>坝莜3号</td>
</tr>
</tbody>
</table>
The Fourth Test of Naked Oat

the distribution map of test sites

16 test sites are distributed in 10 provinces
The Second Test of Covered Oat

- The second test of covered oat started from year 2009 to year 2011
- Including seven covered oat varieties (lines)

<table>
<thead>
<tr>
<th>Variety</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Qingyin1 (青引1号) (CK)</td>
<td>W04-90</td>
<td>Bayan4 (坝燕4号)</td>
</tr>
<tr>
<td>Xiyan2 (西燕2号)</td>
<td>Jizhangyan4 (冀张燕4号)</td>
<td>Bayan4 (坝燕4号)</td>
</tr>
<tr>
<td>R3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The second test of covered oat

—the distribution map of test sites

8 test sites are distributed in 6 provinces
Analytical Methods

• The regional test was conducted at many test sites for many years, influenced by many factors, the interaction between factors.

• At present, the arithmetic mean method was used for analysis of regional test data. But the calculation of the arithmetic mean method is cumbersome, and did not consider the environmental and genetic interactions, can not accurately evaluate the high yield and stability of the varieties.
Analytical Methods

• the use of effective methods of statistical analysis, help to fully analyze the test data to make objective and comprehensive evaluation to the varieties.

• Therefore, we used the GGE software to analyze the fourth test data of naked oat and the second test data of covered oat.
Analysis Software-GGE biplot

• GGEbiplot software is founded by Pro. Wei Kai Yan, who is an oat breeding expert, from Canadian Ministry of Agriculture.

• In 2009, the chief expert of oats of China invited Dr. Yan to Bai Cheng, training the team members of the oat system. I attended a training course, learning the use of the GGE software.
Analysis Software-GGE biplot

• GGE-biplot method is a new analysis way of multi-factor interactions.
• GGE-biplot can clearly identify high-yield, stable yield varieties and the test sites with effective resolution using chart, so GGE-biplot is considered to be the ideal method of analysis of regional test data.
The Average Yield and Stability of the varieties - naked oat

- From the Visualization menu bar, choose Show Average Tester Coordinate. An average tester coordinate (ATC) based on the average environment will appear (Fig.). The ATC x-axis passes through the biplot origin and the marker of the average environment, which is defined by the average PC1 and PC2 scores over all environments. The oval indicates the positive end of the ATC x-axis. The ATC y-axis passes the plot origin and is perpendicular to the ATC x-axis. The average yield of the varieties is approximated by the projections of heir markers to the ATC x-axis.
The Average Yield and Stability of the varieties - naked oat

Thus, varietie W04-96 had the highest average yield, and 9620-4 had the lowest.

The stability of the cultivars is measured by their projection to the ATC y-axis. The greater the absolute length of the projection of a cultivar, the less stable it is. Thus Yan2007 and Xiyou1 were the least stable cultivar while W04-96 and YY02-80 were the most stable.
The Best Cultivar in Each Environment

From Visualization menu bar, choose Draw Convex Hull. The GGE biplot will become like Fig. The convex hull in Fig. is drawn on cultivars relatively remote from the biplot origin so that all other cultivars are contained within the convex hull. Figure also contains a set of lines perpendicular to each side of the convex hull. These perpendiculars divide the biplot into several sectors, and the environments inevitably fall into the sectors.
The Best Cultivar in Each Environment -naked oat

- There are five sectors in Fig., with cultivars xiyou 1, 9626-4, Yan2007, Bayou 3, and W04-96 as vertex cultivars. Almost all Environments, not including Keqi and Youyu), fell in the sector in which W04-96 was the vertex cultivar. This means that W04-96 was the best cultivar for Almost all Environments.
Differences Between Years - Naked Oat

There are five sectors in Fig., with cultivars Yyo2-80, 9626-4, Yan2007, Bayou 3, and W04-96 as vertex cultivars. Year 2010 and 2011 fell in the sector in which W04-96 was the vertex cultivar. This means that W04-96 was the best cultivar in 2010 and 2011 the difference of its yield between years was small.
Correlation Between Traits and Yield - naked oat

- The cosine of the angle between the index vector and the adjacent index can represent their correlation.

- As can be seen from the graph, the yield and grain weight were significantly associated.
The Average Yield and Stability of the varieties - Covered oat

It can be seen from the chart, varietie Bayan4 (坝燕4号) had the highest average yield, and Bayan 4（巴燕4号）had the lowest.

Jizhangyan 4 was the least stable cultivar while W04-90 were the most stable.

Qingyin1 was a stable low-yield varieties. So we changed ck for mengyan 1 in next test.
The Best Cultivar in Each Environment - covered oat

There are four sectors in Fig., with cultivars Xiyan2, Bayan4 (巴燕4号), Jizhangyan 4, Bayan4(坝燕4号) as vertex cultivars. Hezuo Bacheng and Xning fell in the sector in which Xiyan2 was the vertex cultivar. This means that Xiyan2 was the best cultivar for Hezuo Bacheng and Xning.
The Average Yield and Stability of the varieties - Covered oat

- Qitai, Wuchuan, Chongli, Zhangbei and Keqi fell in the sector in which Bayan 4 as the vertex cultivar. This means that Bayan 4 was the best cultivar for Qitai, Wuchuan, Chongli, Zhangbei and Keqi.
Correlation Between Traits and Yield -- covered oat

As can be seen from the graph, the yield and grain weight were significantly associated. This result is same with the result of naked oat.
Yield of BaYan4 was higher in 2010 and 2011; the difference of its yield between years was small.
Summary

• Nine lines of naked oat were tested in sixteen sites, and seven lines of covered oat were tested in eight sites. The results showed that W04-96, BaYan4, had higher yield and better yield stability than other lines.
• Yield of W04-96, BaYan4 was higher in year 2010 and year 2011; the difference of their yield between years was small. Grain weight of them was higher.
Summary

• The results showed the correlation between grain weight and yield was significantly.
• This study demonstrates that GGE biplot is simple and effective method for analyzing stability and adaptability of varieties and the difference of yield between years.
Acknowledgements

• thanks Pro. Yan for providing GGE biplot software to us.
Thank you for your attention