Comunicata Scientiae 2(3): 160-163, 2011

Original Article

Effects of different cropping patterns on maize yield in Lishu, China

Rui Yukui*, Rui Fafu, Hao Jing

College of Resources and Environmental Science, China Agricultural University, Beijing China, 100193
*Corresponding author, e-mail: ruiyukui@163.com

Abstract

Increasing maize yield per unit is the most important measure to address food security issues. Farmers from northeastern China created several cropping patterns to increase yield per unit, but which pattern is the best has not been researched. A randomized block design of six cropping patterns and four replicates was used. Six cropping patterns 65cm×65cm, 40cm×90cm, 30cm×100cm, 20cm×110cm, 2L:0 and 4L:0 respectively were studied. The results showed that all wide and narrow rows patterns and free-sow patterns have higher yield than the same spacing patterns, and 30cm×100cm is the optimal pattern to obtain the highest yield, followed by 20cm×110cm, 4L:0, 2L:0, 40cm×90cm and 65cm×65cm respectively. If all farmers carried out the 30cm×100cm pattern, problems on food security in China would be obviously improved.

Key words: row spacing, seedling distance in row, *Zea mays*

Efeitos de diferentes práticas de cultivo na produtividade do milho em Lishu, China

Resumo

O aumento de rendimento de milho por unidade é a medida mais importante para solucionar problemas de segurança alimentar. Agricultores do nordeste da China criaram várias práticas de cultivo para aumentar o rendimento por unidade, mas qual pratica é a melhor ainda não foi pesquisado. Um delineamento de blocos casualizados de seis padrões de cultivo e quatro repetições foi utilizado. Seis padrões de cultivo 65 cm × 65 cm, 40 cm × 90cm, 30cm × 100 cm, 20 cm × 110 cm, 2L: 0 e 4L: 0, respectivamente, foram estudados. Os resultados mostraram que todas as praticas largas e estreitos em linhas e livres de padrões de semeadura têm maior rendimento o que os padrões de mesmo espaçamento, e 30cm × 100 cm é o padrão ideal para obter o maior rendimento, seguido por 20 cm × 110 cm, 4L: 0, 2L: 0 , 40cm x 90cm e 65 cm × 65 cm, respectivamente. Se todos os agricultores realizassem o padrão de 30cm × 100cm, problemas na segurança alimentar da China seriam melhorados.

Palavras-chave: espaçamento entre linhas, distância de plantas em linha, *Zea mays*

Received: 21 January 2011 **Accepted:** 18 March 2011

Introduction

Food security is of great important for China since it has the largest population in the world, and it is going to face serious challenges on decreasing production resources, structural lack of grain supply, and still a large amount of population under poverty line (Zhang, 2005). Because of limited arable land, increasing maize yield per unit will be one of the most important measures. Nowadays, farmers have been creating many measures to increase the maize yield per unit (Zhang and Qian, 2010), such as applying optimal fertilizer (Amanullah, et al., 2010), applying trace elements, planting new cultivars (Jiang et al., 2010; Rui et al., 2009), applying good cropping patterns, especially applying different row spacing (Wang et al., 2010; Fan et al., 2010).

Gao's research showed that the row spacing can affect the length of barren ear tip, the Pn and chlorophyll content of ear leaf in later period of maize and degradation of chlorophyll finally affected yield significantly (Gao et al., 2010). Row spacing altered light quality (red: far-red ratio) perceived at the lowermost leaf stratum at high plant populations, and senescence during grain filling was related to the local light perceived by leaves and to N availability for actively growing kernels (L. Borras et al., 2003). "Wide and narrow rows" is a new cropping pattern created by farmers from northeastern China, the optimal planting density of maize varied according to the wide and narrow rows deployment; 80 cm and 40 cm for the wide and narrow rows is most popular deployment (Tong et al., 2009).

The planting method of "wide and narrow rows" can significantly increase yield than conventional planting, the canopy structure, especially atmospheric and light permeating conditions in the middle and lower layer were obviously improved and CO_2 concentration obviously increased, the same way leaf area index was increased and had a longer duration. Biological yield, seed weight and seed number per ear all increased, resulting in higher yield (Fan et al., 2010). In this study, we designed with different row spacing cropping patterns to verify the best cropping patterns for maize high yield.

Material and Methods

Basal soil

Maize variety was Jiyu301; seeds were sown at Xihe village of Lishu county, Jilin province of China on May 3, 2010; the density is 70,000 plants·ha^{-1}. The initial levels of soil, whose type is black soil, mineral N were 28 kg ha^{-1} in the 0–30 cm layer, the initial levels of soil mineral P, K 14.9 mg/kg, 74.58 mg/kg, and 60 mg/kg respectively.

Field management

The basal fertilizer was applied 700 kg·ha^{-1} compound fertilizer ($N:P_2O_5:K_2O$=15:15:15) and 20m^3·ha^{-1} chicken manure, seed fertilizer 50Kg·ha^{-1} ammonium dihydrogen phosphate, and 50 kg·ha^{-1} trace elements fertilizer (Cu + Fe + Mn + Zn + B + Mo≥10%). First top dressing 500 kg·ha^{-1} was applied compound fertilizer ($N:P_2O_5:K_2O$=30:0:4) at big trumpet period, second top dressing was applied 175 kg·ha^{-1} $CO(NH_2)_2$ (total N is no less than 46.4%) at maize tasseling stage respectively. Spraying Jade Gold (A plant regulator whose major component is 30% ethephon) to prevent plant lodging. Water management depended only on rainfall (Figure 1).

Ostrinia furnacalis control

Controlling corn Borer by trichogramma at earkier stage (Jul. 1-2), preventing Ostrinia furnacalis Larvae by Beauveria bassiana at Jul. 10-12, and spraying lambda cyhalothrin insecticide seven days before or after the above two measures.

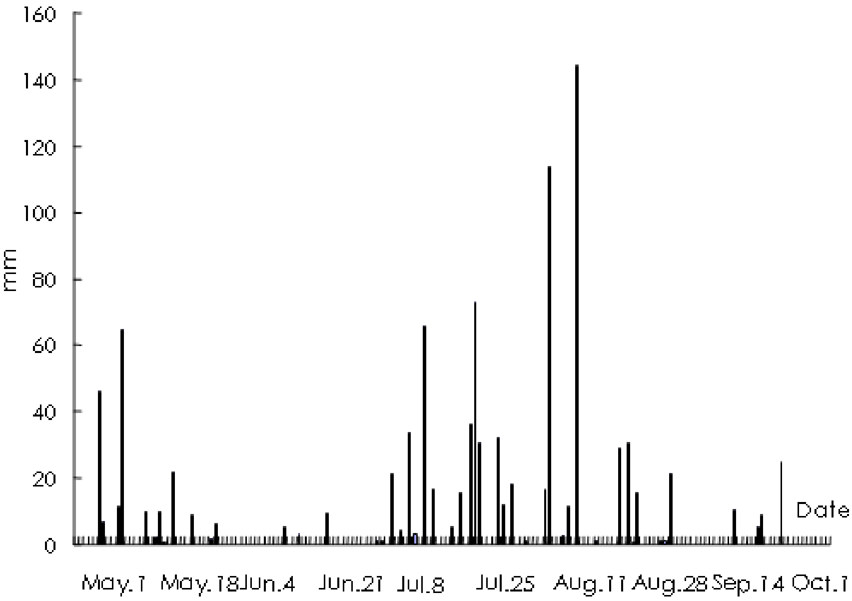

Figure 1. Rainfall from May,1 to Oct,8 at Xihe village of Lishu county, China.

Experimental design

A randomized block design of six cropping patterns and four replicates was used. Row spacing of six cropping patterns are respectively 65cm×65cm, 40cm×90cm, 30cm×100cm, 20cm×110cm, 2L:0 (planting two rows with 65cm×65cm and a blank line as a unit) and 4L:0 (planting four rows with 65cm×65cm and a blank line as a unit), just as Figure 2.

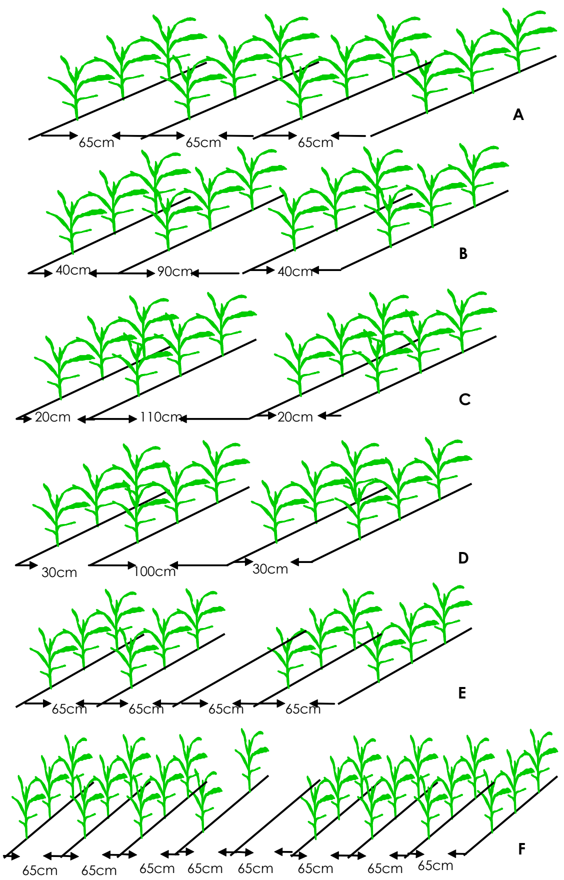

Figure 2. Schematic diagram of different cropping patterns. A represents the same spacing pattern (65cm×65cm), B represents wide and narrow rows with 40cm×90cm, C represents wide and narrow rows with 30cm×100cm, D represents wide and narrow rows with 20cm×110cm, E represents one line free every three lows, and F represents one line free every five lows.

Results and Discussion

The growth and yield of the corn in different community construction were very different. In low density condition, the competition among individuals were lesser, the growth of individuals were better, and community light utilization was lower. Considering the increase of density the aeration-euphotic ability would get worse, going against yield formation (Yang et al., 2003). So it is important to improve light utilization when the density is enough, wide-narrow row planting mode is a good mode to increase corn yield (Liang et al., 2010). The optimal design of wide row and narrow row still needs to be researched.

The results showed that all wide and narrow row patterns and free-sow patterns have higher yield than the same spacing patterns, and 30cm×100cm is the optimal pattern to obtain the highest yield followed by 20cm×110cm, 4L:0, 2L:0, 40cm×90cm and 65cm×65cm, respectively (Figure 3). Former researches proved that plant spacing can influence crop production significantly (El-Morsy, 2009), and Qi (2010) concluded that reasonable spacing had good canopy structure, smaller stem-leaf angle in the upper side and it would be bigger in under Side, what is important for crop high yield, so 30cm×100cm pattern should have optimal use over the other parameters.

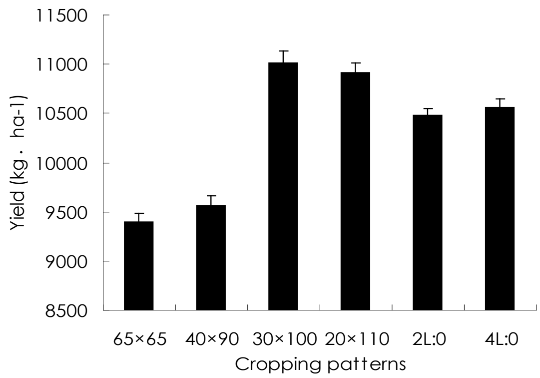

Figure 3. Effects of cropping patterns on maize yield. Note: Different letters represent significance (P<0.05, n=4)

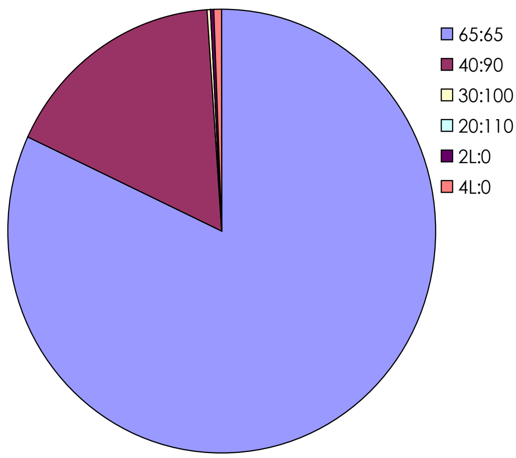

Figure 4. The proportion of a variety of different cropping patterns. Note: All the data are according to our survey visit.

At the same time, percentage of every cropping patterns was investigated in northeastern China (Figure 4), more than four-fifths have the same spacing pattern (65cm×65cm), whose yield was 1.5t·ha^{-1} lower than wide and narrow rows with 30cm×100cm. If all farmers carried out the 30cm×100cm pattern, problems on food security in China would be obviously improved.

Acknowledgments

The authors appreciate the financial support from the innovative group grant of Natural Science Foundation of China (No.30821003), Best Nutrient Management Technology Research and Application of Ministry of Agriculture

(No. 200803030), National Key Basic Research Development Plan (973) Project: Basic Research on High Yield Crop Management and High Resource Use Efficiency for Major Cereal Crops (No. 2009CB118600) and National Project of Scientific and Technical Supporting Programs in the Eleventh 5-year Plan Period Funded by the Ministry of Science & Technology of China (No. 2006BAD25B02).

References

Amanullah, Zakirullah, M., Khalil, S.K. 2010. Timing and rate of phosphorus application influence maize phenology, yield and profitability in northwest Pakistan. *International Journal of Plant Production* 4 (4): 281-292.

Borras, L., Maddonni, G.A., Otegui, M.E. 2003. Leaf senescence in maize hybrids: plant population, row spacing and kernel set effects. *Field Crop Research* 82: 13-26.

El-Morsy, M.H.M. 2009. Influence of cutting height and plant spacing on Sesbania (Sesbania aegyptiaca [Poir]) productivity under hyper-arid conditions in El-kharga Oasis, El-Wadi El-Gaded, Egypt. *International Journal of Plant Production* 3(2): 77-83.

Fan, X.L., Li, F.H., Shi, Z.S., Wang, Z.B., Zhang, F. 2010. Research on Yield Increasing Effect and Physiological Characteristics of Maize Planted in Partial Ridge-Narrow/wide Row. *Journal of Maize Sciences* 18(1): 108-111.

Gao, Y.N., Cao, Q.J., Han, X.F., Cui, J.H., Wang, H.Y. 2010. Effect of Different Row Spacings on Yield and Chloroplast Rats of Spring Maize. *Journal of Maize Sciences* 18(2): 73-76.

Jiang, L.L., Han, X.R., Yang, J.F., Liu, X.H., Gao, X.N., Ma, B. 2010. Effects of Fertilization on Photosynthetic Physiological Characteristics in Maize of High Yield Variety with Different Planting Density. *Journal of Shenyang Agricultural University* 41(3): 265-269.

Liang, S.R., Zhao, H.J., Li, H.Q., Wang, J.Z., Wang, L.H., Qu, X.F., Lü, S.M. 2010. Effects of planting densities and modes on developmental characteristics of summer maize populations in two varieties. *Acta Ecologica Sinica* 30(7): 1927-1931.

Qi, H., Liang, Y., Zhao, M., Wang, J.Y., Wu, Y.N., Liu, M. 2010. The Effects of Cultivation Ways on Population Structure of Maize. *Acta Agriculturae Boreali-Sinica* 25(3): 134-139.

Rui, Y.K., Peng, Y.F., Wang, Z.R., Shen, J.B. 2009. Stem Perimeter, height and biomass of maize (Zea mays L.) grown under different N fertilization regimes in Beijing, China. *International Journal of Plant Production* 3(2): 85-90.

Tong, Y.C., Zhang, H.N., Zuo, X.L., Liu, Z., Zhang, W., Ruan, L., Chen, H.J. 2009. Effects of Planting Density and Row Distance on the Yield of A Hybrid Maize Cultivar'Hongda 8'. *Chinese Agricultural Science Bulletin* 25(13): 62-65.

Wang, Q.J., Li, H.W., He, J., Li, W.Y., Liu, A.D. 2010.Effects of wide-ridge and narrow-row no-till cultivation on soil water and maize yield. *Transactions of the CSAE* 26(8): 39-43.

Yang, K.J, Li, M., Li, Z.H., Gai, D.M. 2003. Study on the Influence of Community Construction to Growth and Yield of Compact Corn. *Journal of Heilongjiang August First Land Reclamation University* 15(3): 29-32.

Zhang, G.C. 2005. China's Current Situation and Future Food Security. *Population Journal* 3: 37-41.

Zhang, Y., Qian, C.R. 2010. Level status quo and development strategy of maize unit yield in Heilongjiang Province. *Journal of Northeast Agricultural University*. 41(7): 155-160.