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INFLUENCE OF THE SOWING PERIOD AND DENESITYON YIELD AND YIELD COMPONENTS OF THREE SEMI -WINTER WHEAT VARIETIES

Qiaoyan Chen[1,2], Xingqi Ou[1], Wenhui Wie[1], Kandyba Nataliya[2]
[1] Henan Institute of Science and Technology, Chinese People's Republic
[2]Sumy National Agrarian University, Ukraine

Three semi-winter wheat varieties Zhoumai 18, Zhoumai 22 and Bainong 207 were selected as materials for this study to study quality seeds and reliable methods capable of supporting the dominant wheat cultivation technology in southern Huanghuai. In our experiments, each variety was used in six sowing times and seven planting densities. The results showed that: (1) varieties had significant effects on yield and yield components. The yield among different varieties in the order of high and low was Bainong 207 >Zhoumai 22 >Zhoumai 18; suitable sowing date from October 1 to October 22, and the density is 300 ~ 525 × 10^4 plant·hm^{-2}. (2) The interaction of the date and planting density affects the yield and its constituent factors.The best combination of sowing date and density for Zhoumai 18 and Bainong 207 were 450×10^4 plant·hm^{-2} on October 8, and the yields were 10829.0 kg·hm^{-2} and 11891.7 kg·hm^{-2}, respectively, and Zhoumai 22 is 450 × 10^4 plant·hm^{-2} on October 15 and the yield is 10792.5kg·hm^{-2}. It can be seen that the best sowing date is October 8~15, and the seeding density is 450 × 10^4 plant·hm^{-2}. All three varieties showed that the spikes was higher during the high-density and the suitable sowing date treatment (October 8~15, 525~675 × 10^4 plant·hm^{-2}), and the grain number per spike was higher when the density was suitable (300-525 ×10^4 plant·hm^{-2}), the thousand-grain weight is higher in the low-density treatment (225~300 × 10^4 plant·hm^{-2}). (3) There are significant differences in the percentage of tiller among different varieties. The order of the three varieties is Bainong 207 >Zhoumai 18 >Zhoumai 22. With the postponement of the sowing date and the increase of the sowing density, the population tiller number (PTN) increased, and the percentage of earring-tiller gradually decreased. In summary, the appropriate sowing date and density can make the yield and its constituent factors make full use of light energy and water which build a reasonable population structure, and increase yield.

Key words: *wheat, sowing date, density, yield, yield components, semi-winter wheat varieties.*

Introduction. Wheat yield is not only affected by the genetic characteristics of the variety, but also closely related to the ecological environment and cultivation measures [1–3].Sowing date and density are two important factors affecting wheat yield formation. Sowing at the right timecan make full use of the pre-winter light and heat resources and cultivate strong seedlings. The appropriate density is conducive to buffering the contradiction between individuals and populations, establishing a reasonable population structure, and facilitating the coordinated development of spikes, grain number per spike and grain weight [4]. Zhai Huqu et al. showed that sowing at an appropriate time can meet the different needs of light and heat in each growth and development stage of different varieties of wheat, and promote the development of wheat tillering [5]. Sowing too early, pre-winter growth is vigorous and individual growth is more vigorous resulting in more single invalid tillers after jointling and lower effective tillers and percentage of earring-tiller, all of which easily lead to lower yield. Sowing too late, the large tiller before winter is reduced, after overwintering there are more small tillers, which compete seriously for nutrients, less effective tillers, spikes, grain number, dry matter accumulation and lower yield. The difference in sowing density also affects the number of tillers, spike formation and individual development of wheat, thus affecting the rationality of population structure and causing a greater impact on yield. Studies on the effects of sowing date and sowing rate on individual traits and yield of wheat are well reported and the results are inconsistent. Liu Wandai et al. indicated that the effects of different sowing date and density treatments on wheat grain yield and its components reached significant difference levels, and the effect of density on yield components was greater than that of sowing period [6]. Ma Dongqin et al. showed that sowing date had a significant effect on wheat spike number, and planting density had a significant effect on yield, spike number and grain number per spike [7]. Ma Ronghui et al. showed that sowing date had a significant effect on thousand - grain weight, and sowing amount had a significant effect on yield and spike number [8]. In order to study the suitable sowing date and sowing density of the dominant varieties in the southern Yellow and Huanghuai wheat areas in production, this study conducts experiments on the regulatory effects of population traits and yield of three varieties in this regard, with a view to providing a reference basis for different wheat varieties to achieve high and stable yields.

Material and methods. The experimental varieties were A1 (Zhoumai 18), A2 (Zhoumai 22) and A3 (Bainong 207), all of which were vided by the Wheat Genetic Improvement Research Center of Henan Institute of Science and Technology.

The experiment will be carried out field in the village of Zhongxiaoying, Huixian 2019 - 2020 year. The field is flat, with good irrigation and drainage conditions and even fertility. Adopting sequential block design, 6 sowing dates, namely B1 (October 1), B2 (October 8), B3 (October 15), B4 (October 22), B5 (October 29) Day), B6 (November 5), 7 densities: basic seedlings are: C1 (225×10^4 plant·hm^{-2}), C2 (300×10^4 plant·hm^{-2}), C3 (375×10^4 plant·hm^{-2}), C4 (450×10^4 plant ·hm^{-2}), C5 (525×10^4 plant ·hm^{-2}), C6 (600×10^4 plant ·hm^{-2}), C7 (675×10^4 plant·hm^{-2}). There are 3 repetitions for each treatment, and the plot is 4 meters long and 1.5 meters wide.

Field management is the same as usual. When the seedlings emerged, each plot selected a representative 1 m double-row sample section to investigate pre-winter and post-winter population tiller number (PTN), and then converted into a population tiller number (PTN); spikes and grain number per spike were investigated at maturity, then harvested by plot, individually threshed, dried, recorded yield, and the thousand grain weight was determined. Data analysis was performed with Microsoft Excel and Spass statistical software.

$$\text{Percentage of earring-tiller(\%)} = \frac{\text{Final PTN}}{\text{The highest PTN}} \times 100\%$$

Results and discussion. Effect of variety, sowing date and density on yield and yield components of wheat. Multiple comparisons (Table 1) showed that yield and component factors showed highly significant differences among varieties. The yield among varieties in the order of high to low was Bainong 207>Zhoumai 22>Zhoumai 18, where Bainong 207 increased yield by 3.82% and 2.15% compared with Zhoumai 22 and Zhoumai 18, respectively. The spikes in descending order was Zhoumai 22>Bainong 207>Zhoumai 18; the grain number per spike in descending order was A3>A1>A2; the thousand grain-weight in descending order was Zhoumai 18>Zhoumai 22>Bainong 207. The results showed that the yields of the three varieties differed with different sowing conditions. There was no significant difference in yield within the suitable sowing period. Analysis of variance showed that there was a significant decrease in wheat yield between October 29 and November 5 sowings. Wheat yield gradually increased with increasing sowing density, and under low density conditions, the yield increased significantly with increasing density, and under high density conditions, the yield increase effect from increasing sowing density was small, and there was no significant difference between 600×10^4 plant·hm^{-2}and 675×10^4 plant·hm^{-2}.

The number of spikes gradually increased with increasing sowing density, and there was no significant difference between both under high-density conditions; conversely, the spikes and thousand grain weight gradually decreased with increasing sowing density, and there was no significant difference between the spikes and thousand grain-weight decreased with increasing sowing density under low-density conditions.

Table 1

Effects of different sowing date and densities on yield and components of three wheat varieties

Treatment	Spikes ($\times10^4$ plant ·hm^{-2})	Grain number per spike	Thousand-grain weight (g)	Grain yield (Kg·hm^{-2})
A1	537.2 cC	39.49 bB	46.68 aA	9865.40 cC
A2	569.4 aA	38.32 cC	46.25 bB	10027.25 bB
A3	564.3 bB	42.50 aA	42.13 cC	10242.57 aA
B1	548.5 cC	39.46 cC	46.61 bB	10103.70 bB
B2	571.4 aA	39.12 dC	47.46 aA	10599.10 aA
B3	561.0 bB	41.26 aA	42.61 fF	9863.02 cC
B4	573.8 aA	40.62 bB	43.70 eE	10182.08 bB
B5	543.3 cC	39.34 cdC	45.38 cC	9687.58 dD
B6	543.6 cC	40.83 bB	44.37 dD	9834.97 cC
C1	514.3 fF	41.45 aA	46.24 aA	9872.19 cB
C2	535.1 eE	41.06 bAB	46.08 aA	10150.04 abA
C3	547.3 dD	40.80 bcBC	45.99 aA	10256.20 aA
C4	557.8 cC	40.51 cC	45.29 bB	10233.51 abA
C5	574.3 bB	39.57 dD	44.60 cC	10114.45 bA
C6	587.6 aA	38.63 eE	43.18 eE	9823.58 cB
C7	582.3 aA	38.71 eE	43.75 dD	9864.83 cB

Note: Different capital and lower-case letter after processing the same column of data in the same category indicate the difference Significant levels of 0.01 and 0.05. Table 2 is the same.

Interaction of sowing date and density on yield and its composition factors. ***The interaction of sowing date and density on yield.*** As shown in Figure 1, the yield of the three different wheat varieties decreased with delayed sowing and increased sowing density under the same sowing date and density conditions. The yield of Zhoumai 18 was less fluctuating at 225~450×10^4 plant·hm^{-2} on October 8 and was highest at 450 ×10^4 plant·hm^{-2} with 10829.0 kg·hm^{-2} Zhoumai 22 was sown at both October 15 and 22 and density 300~450 ×10^4 plant·hm^{-2}, and the yield variation was small, and the highest yield of 10792.5 kg·hm^{-2} was achieved on October 15 at 450×10^4 plant·hm^{-2}; Bainong 207 was sown from October 1 to October 22 at a density of 225~450×10^4 plant·hm^{-2}, and the yield variation was small, the highest yield of 11,891.7 kg hm^{-2} was obtained under 450×10^4 plant·hm^{-2} conditions on October 8. In conclusion, proper sowing date and density will increase the yield.

Effect of sowing period and density interactions on spikes. The results showed (Fig. 2) that the spikes increased and then decreased with increasing sowing density at early sowing (B1) for all three varieties; the spikes increased with increasing sowing density under the same sowing conditions, and the difference in the spikes changed less with delayed sowing under the same density conditions. We found that Zhoumai 18 had the highest number of C7 spikes when it was sown appropriately early (October 8) and the lowest number of C1 spikes when it was sown late (October 29). Zhoumai 22 had the highest spikes of C5 when sown on October 15 and the lowest spikes of 375×10^4 plant·hm^{-2}when sown late (November 5). Bainong 207 had the highest spikes at high density (C6), gradually increasing from October 1 to October 15 sowing, and the highest spikes at October 15 sowing; at low density treatment (C1), the lowest spikes at late sowing (B6).

Effect of sowing date and density interactions on grain number per spike. As shown in Figure 3, the overall performance of spike grain number: Bainong 207 >Zhoumai 18 >Zhoumai 22; the higher the density, the lower the grain number per spike. On October 1 to October 22, the grain number per spike increased with delayed sowing date and increased with sowing densities, 225~375×10^4 plant·hm^{-2} has more grain number per spike than other density treatments, On October 22, Zhoumai 18 had the highest grain number per spike of 375×10^4 plant·hm^{-2}, and the least grain number per spike for late sowing (October 29) was 675×10^4 plant·hm^{-2}.

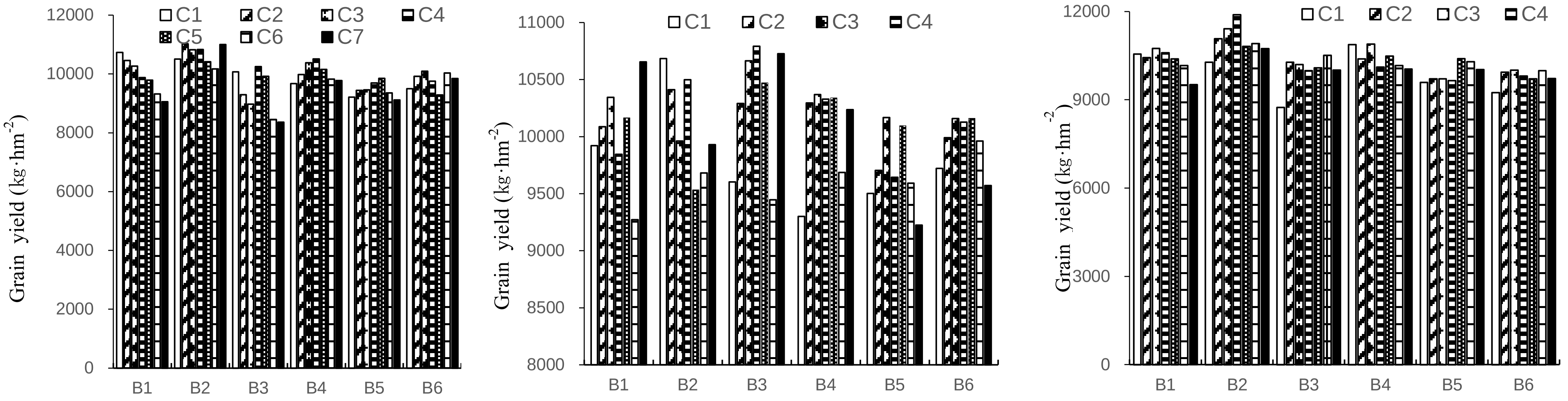

Fig. 1. Effect of sowing and density interaction on yield of three different wheat varieties

Note: The first chart is Zhoumai 18, followed by Zhoumai 22, and the last one is Bainong 207. The same below.

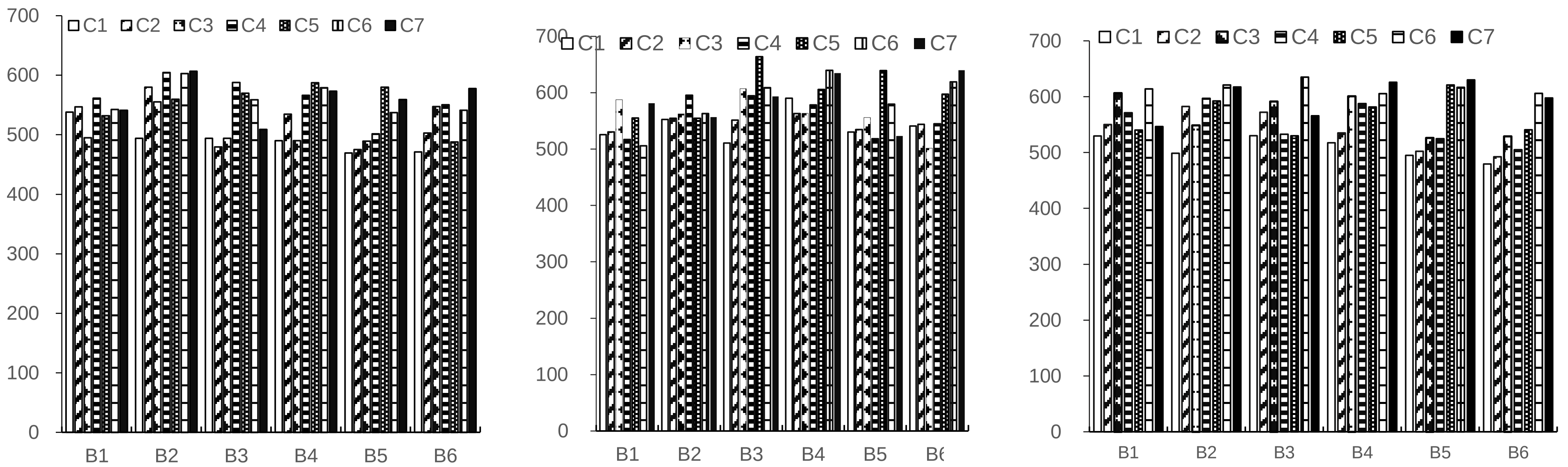

Fig. 2. Effect of sowing period and density interactions on spike number

Zhoumai 22 has relatively small differences among various treatments in general, showing a trend of high-low-high. There are more grain number per spike during the sowing date from October 15 to November 5, especially under the condition of density 225~450×10^4 plant·hm^{-2} the grain number per spike is the most with late sowing (October 29) and 450×10^4 plant·hm^{-2}, the grain number per spike is the least with appropriate to sow early (October 8) and 525×10^4 plant·hm^{-2}.

The overall performance of Bainong 207 is that sowing date is earlier and the grain number per spike is higher; the higher the density, the less g grain number per spike. The grain number per spike was the highest with 525×10^4 plant·hm^{-2} on October 15, the grain number per spike is the least with the late sowing (October 29) and 675×10^4 plant·hm^{-2}.

Effect of sowing date and density interactions on thousand grain weight. The overall thousand grain weight of Zhoumai 22 >Zhoumai 18 >Bainong 207 was shown in Fig. 4. All three varieties showed the least variation in thousand grain weight under different sowing densities and early sowing date (B1 and B2); the lower the sowing density, the higher the thousand grain weight in different sowing date. The thousand grain weight of Zhoumai 18 showed an increasing-decreasing-increasing trend, and the thousand grain weight was greater under low density than high density at the same sowing period; the maximum thousand grain weight was 300 × 10^4 plant·hm^{-2} on October 29 and the lowest was 675×10^4 plant·hm^{-2} on October 15. The thousand grain weight of Zhoumai 22 showed a rising-declining-rising trend with the delay of sowing date in sowing density of 225~375×10^4 plant·hm^{-2} . the corresponding increase or decrease was larger, while the trend thousand grain weight was similar with the same as the former in 450~675×10^4 plant·hm^{-2}, but the increase or decrease was smaller; the smaller the density, the higher the thousand grain weight;The thousand grain weight was the highest with 675×10^4 plant·hm^{-2} on October 1, and the lowest with 600×10^4 plant·hm^{-2} on October 15 .

The overall thousand grain weight of Bainong 207 was between that of Zhoumai 18 and Zhoumai 22, and was lower than that of Zhoumai 18 and Zhoumai 22 at all sowing densities on October 15. The thousand grain weight was the highest with 300×10^4 plant·hm^{-2} on October 29 and the lowest with 375 × 10^4 plant·hm^{-2}on October 15.

The effect of variety, sowing date and density on percentage of earring-tiller. The results of multiple comparisons (Table 2) indicate that the percentage of earring-tiller of different varieties shows extremely significant differences. The percentage of earring-tilleramong the varieties was Bainong 207, Zhoumai 18 and Zhoumai 22 in the order of high and low.

Table 2

Effect of different treatments on percentage of earring-tiller

Treatment	PTN before winter (×10^6 plant·hm^{-2})	The highest PTN (×10^6 plant·hm^{-2})	Final PTN (×10^4 plant·hm^{-22})	Percentage of earring-tiller(%)
A1	14.58 bB	16.47 bB	537.2 cC	35.26%bB
A2	16.05 aA	18.66 aA	569.4 aA	31.76%cC
A3	13.46 cC	14.61 cC	564.3 bB	40.16%aA
B1	11.79 dD	12.03 fF	548.5 cC	47.26%aA
B2	15.15 cC	15.23 eE	571.4 aA	38.11%bB
B3	18.12 aA	18.69 bB	561.0 bB	30.46%eE
B4	16.73 bB	19.99 aA	573.8 aA	29.48%eE
B5	11.78 dD	16.35 dD	543.3 cC	36.01%cC
B6	9.12 eE	17.18 cC	543.6 cC	33.04%dD
C1	10.93 eE	13.50 gF	514.3 fF	40.2%aA
C2	11.86 dD	14.96 fE	535.1 eE	37.58%bB
C3	13.31 cC	15.92 eD	547.3 dD	35.84%cBC
C4	13.81 cC	16.81 dC	557.8 cC	34.79%cCD
C5	14.82 bB	17.45 cBC	574.3 bB	34.64%cCD
C6	15.58 aAB	18.05 bB	587.6 aA	34.47%cCD
C7	16.16 aA	19.36 aA	582.3 aA	32.57%dD

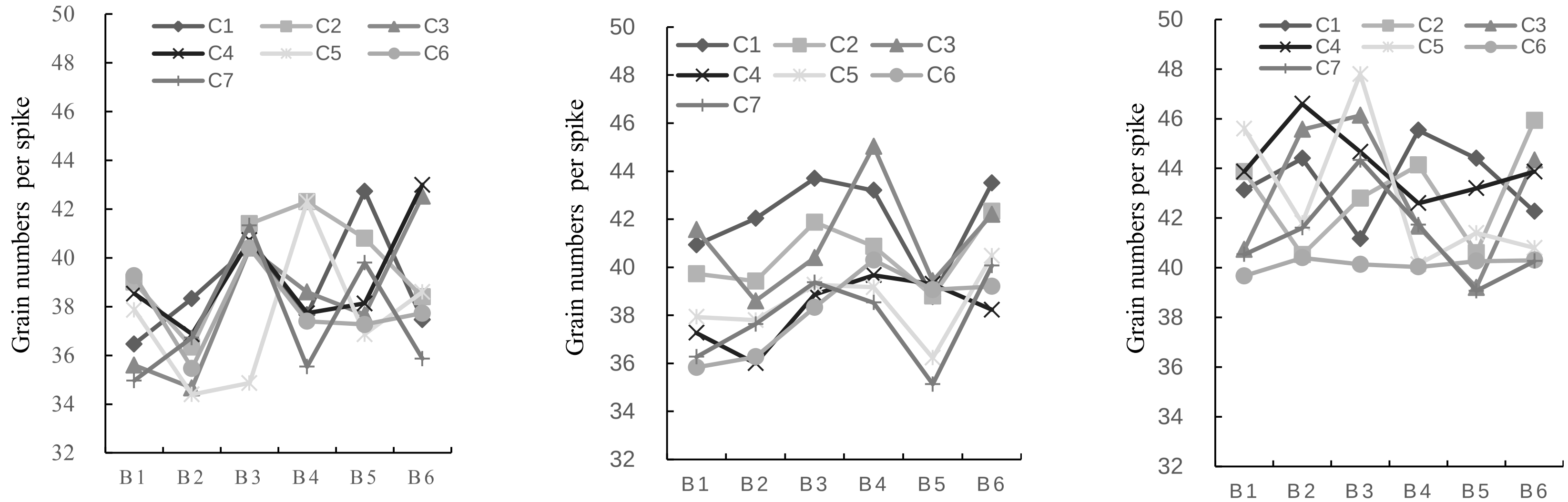

Fig. 3. Effect of sowing date and density interactions on grain number per spike

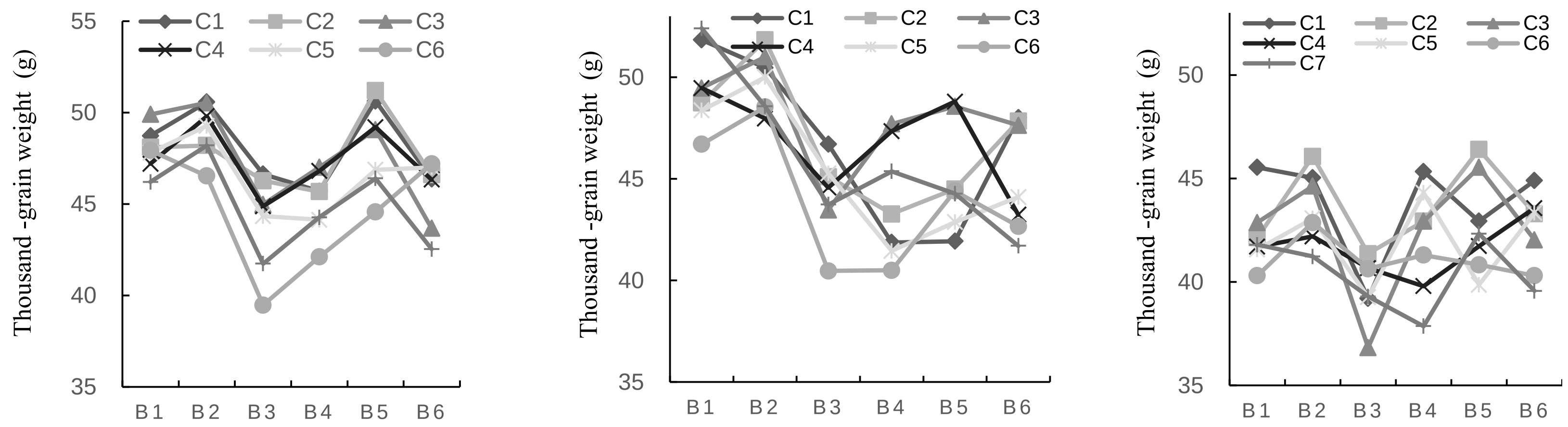

Fig. 4. Effect of sowing date and density interactions on thousand grain weight

There were significant differences in the population tiller number (PTN) and the percentage of earring-tillerin different sowing dates. With the postponement of the sowing date, the pre-winte rand the highest population tiller number (PTN) first increased and then decreased, but the percentage of earring-tiller first decreased and then increased.

With the increase of planting density, the number of stalks gradually increased, and the percentage of earring-tiller was reversed. Under high density treatment, there was no significant difference in the population tiller number (PTN) and the percentage of earring-tiller.

Under the treatment of low density, both reached significant differences. In short, early sowing and low density are conducive to the percentage of earring-tiller.

Conclusion and discussion. Sowing period and density are two important factors affecting wheat yield, and their findings vary depending on factors such as variety, climate, and water and fertilizer conditions [9–14]. The results of this study showed that considering the combined yield and composition factors, Bainong 207 yielded higher than Zhoumai 18 and Zhoumai 22, and the suitable sowing period was from October 1 to October 22, with a density of 300~525×10^4 plant·hm^{-2}. The best combination of sowing date and density for Zhoumai 18 is 450×10^4 plant·hm^{-2} on October 8, and the suitable sowing date and density is 225~450×10^4 plant·hm^{-2} on October 8; the best combination of sowing date and density for Zhoumai 22 is 450×10^4 plant·hm^{-2} on October 15, and the suitable sowing date is October 15~22, and the sowing density.

The best combination of sowing date and density is 450×10^4 plant·hm^{-2}on October 8, the suitable sowing date is October 1~22, and the sowing density is 225~450×10^4 plant·hm^{-2} for Bainong 207. It can be seen that each wheat variety can create good growth and development conditions and build a reasonable population structure only when the best combination of sowing date and density is used to improve yield.

As the sowing date is delayed, the yield and constituent factors first increase and then decrease, and the appropriate sowing date and density, the spikes, the grain number per spike and the thousand grain weight are coordinated to achieve high yield. With the increase of sowing density, the spikes gradually increases, the the grain number per spike and the thousand grain weigh decrease, and the yield first increases and then decreases, so the sowing density is too large or too small, which is not conducive to its yield increase [15]. This shows that the optimal sowing date and density combination plays an important role in high yield of wheat.

The results of the experiment showed that the percentage of earring-tiller gradually decreased with the delay of sowing date and the increase of sowing density, which was consistent with the results of Zhou [16].

Therefore, the appropriate sowing date and density are conducive to increase the percentage of earring-tiller, and sowing too early or too late is not conducive to percentage of earring-tiller. Sowing too early is easy to form pre-winter vigorous seedlings, and some tillers die or suffer from freezing damage during the overwintering process; too late sowing causes a large number of tillers formed in spring to gradually die due to insufficient nutrients in the jointing stage.

Among the density treatments, the population tiller number in the low density was smaller than the other treatments, and there was no significant difference in the population tiller number in the pre-winter period compared to the high density, which deteriorated the quality of the population and was not conducive to the utilization of light energy, thus affecting the percentage of earring-tiller [6]. Wang Lina et al. investigated the grain number per spike were 34.3 to 37.3 in Zhoumai 18 from 2007 to 2008 year [17]; Cao Jun et al. investigated the grain number per spike were 36 to 37 in Zhoumai 22 in 2006–2007 year [18]; Li Hongzhuang et al. investigated the grain number per spike were 32.4 to 36.8 from 2014 to 2015 year in Bainong 207 [19].The results of this year showed that the grain number per spike were respectively 39.49, 38.32, and 42.5 for Zhoumai 18, Zhoumai 22, and Bainong 207 which increased compared with previous surveys in different years.

However, the grain number per spike is jointly determined by genetic traits and environmental factors, and grain number per spike is restricted by factors such as temperature, light, and moisture [20]. Zhang Wen et al. showed that the optimum temperature from tetra molecular to flowering was 15-17.5 ºC Below this temperature range, the grain number per spike increased with increasing temperature, and the number of sunshine hours and radiation from tetra molecular to flowering affected the energy of photosynthesis; the more sunshine and radiation, the more organic matter accumulated, the fewer degenerate florets, and the grain number per spike increased [21].

The study by Sun Benpu et al. showed that the 5d sliding average temperature of wheat after turning green is ≥ 4ºC for the first time, and the number of days before jointing is the primary factor in determining the grain number per spike. The more days there are, the more grain number per spike [22]. Wang et al. concluded that seed formation goes through several stages of spike differentiation, pollination, fertilization, and fruiting, and the young spike differentiation process is very sensitive to moisture, and sufficient moisture can prolong the time of young spike differentiation, which is conducive to increasing the number of fertile florets, and with a high number of florets, reducing the number of degenerated florets, the number of fertilization abortions, and the number of degenerated adult embryos is the key to increasing the grain number per spike[23].

In summary, combined with the weather situation in Huixian in 2019–2020 year, the overwintering period of wheat from October 2019 to February 2020 has a high cumulative temperature and fast growth and development; the average low temperature of 3ºC and average high temperature of 15ºC during the rejuvenation and jointing period in March 2020; the average low temperature of 11ºC and average high temperature of 23ºC during the plucking-flowering period in April, and there are cloudy and rainy days before the flowering period, so the therefore, there is sufficient temperature, light and moisture from the overwintering to flowering period of wheat, which brings favorable conditions for the increase of grain number per spike. This is only the result of a one-year trial, and it needs to be identified in multi-year trials.

References

1. Zhang Dingyi, ZhangYongqing,Yan Cuiping et al. Effects of genotype, sowing date and planting density on grain filling and yiel of wheat varieties with different ears forming characteristics. Chinese Journal of Applied & Environmental Biology. 2009; 15(1): 28–34.
2. GuoTiancai, Zhu Yunji , Wang Chenyang et al. Study on yield formation of two kinds of spike of winter wheat cultivars and their key cultivation techniques for super-high yield. Review of China Agricultural Science and Technology. 2004; 64:46–50.
3. Yang Chunling,Guan Li, Hou Junhong et al. Study on the yield components of wheat in Huang-huai Region. Shandong Agricultural Sciences. 2007; 4:19–23.
4. Zhang Yongli, Yu Zhenwen, Wang Dong et al. Effects of different densities on grain quality and yield in winter wheat. Shandong Agricultural Sciences. 2004; (5): 29–30.
5. Zhai Huqu. Reflection on China‟s food security strategy. Issues in Agricultural Economy. 2011.
6. Liu Wandai,Chen Xianyong, Yin Jun et al .Effect of sowing date and planting density on population trait and grain yield of winter wheat cultivar Yumai 49–19,8. Journal of Triticeae Crops. 2009; 29(3): 464–469.
7. Ma Dongqin,WangXiaowei, ZhuYoupeng et al. Effect of sowing time and seedling density on the yield formation of a new wheat cultivar Yunong 202. Chinese Agricultural Science Bulletin. 2010; 26 (1): 91–94.
8. Ma Rong hui, Zhu Yunji, GuoTiancai et al. Effects of planting date and seed rate in group development and yield of Guomai 1. Shandong Agricultural Sciences. 2004; 4: 12–15.
9. Xu Mengbin, Hou Lili, Wang Fei et al. Effects of different sowing dates and planting densities on barley yield and its components. Barley and Cereal Sciences. 2019; 5.
10. Li Xiaohang, Ma Huaping. Sowing date and planting density: effect on yield formation of winter wheat cultivar Xin Mai 29. Chinese Agricultural Science Bulletin. 2019; 35(536-29): 20–25.
11. Tan Juan, Wang Jingshao, Dong Wei et al. Effects of planting density, sowing date and nitrogen application dosageon wheat yield and quality. Journal of Anhui Agricultural Sciences. 2019; 47(628-15): 43–44.

12. Tian Xin, Sun Min, Gao Zhiqiang et al. Effects of sowing date and seeding rate on soil water consumption and plant nitrogen translocation in dryland wheat.Chinese Journal of Applied Ecology. 2019; 30(10): 3443–3451.
13. Zhang Qiaofeng, Chen Mingtang, Fu BIsheng et al. Effects of sowing date, density and nitrogen management on growth and yield of new wheat cultivar Ningmaizi 126 with late planting resistance. Jiangsu Agricultural Sciences. 2019; 47(16): 123–126.
14. Hua Wang, Fuwen Ke, Hailin Wang et al. Effects of sowing time, density and fertilizer application on the economic characters of Zhuoyou 058. Agricultural Biotechnology. 2019; 3:54–56.
15. Wang Fangrui. Effects of seeding rate on yield in wheat cultivars from different eras and its physiological basis. Nanjing Agricultural University, 2012.
16. Zhou Xiaohu, He Mingrong, Dai Xinglong et al .Effects of sowing time and density on yield and nitrogen utilization efficiency of different wheat varieties. Shandong Agricultural Sciences. 2013; 45(009): 65–69.
17. Wang Lina, Yin Guihong, Han Yulin et al. Effects of different planting date and density on yield and yield components of winter wheat Zhoumai 18.Crops. 2012; 000(001): 102–104.
18. Cao Jun. Research and application of integrated techniques with high yield, high quality and multi-resistance for the new wheat variety Zhoumai 22. Anhui Agricultural Science Bulletin. 2011; 05(17-171): 66–67+104.
19. Li Hongzhuang, Li Haozhong, Xie Yanchen. Effect of different sowing date and density on the new wheat variety Bainong 207. Bulletin of Agricultural Science and Technology. 2016; 530(02): 52–54.
20. Chen Da. Genetic Analysis and fine mapping A QTL GN1.2 controlling grain number in rice (*Oryza sativa* L.). Yangzhou University, 2017.
21. Zhang Wen, Cao Guangcai, Li Jianhua et al. Environmental variation of the heading period of common wheat varieties and its thermo–photo–period model. Southwest China Journal of Agricultural Sciences**.** 1993; 000(003): 21–26.
22. Sun Ben Pu, Wang Yong, Li Xiu Yun et al. The effect of climatic elements on the grain number per spike of winter wheat. Chinese Journal of Eco-Agriculture**.** 2004; 12(3): 137–139.
23. Wang Xiao-Nan, Fu Lian-Shuang , Li Zhuo-Fu et al. Morphogenesis and physiological basis in wheat cultivars with different levels of cold-resistance during cold acclimation and freezing period. Acta Agronomica Sinica. 2009; 35(007): 1313–1319.

ВПЛИВ ТЕРМІНУ І ГУСТОТИ ПОСІВУ НА ВРОЖАЙНІСТЬ ТА ВРОЖАЙНІ СКЛАДОВІ ТРЬОХ НАПІВОЗИМИХ СОРТІВ ПШЕНИЦІ

Цяоянь Чень[1,2], **Сінгці Оу [1],** Веньхуей Вей[1], Кандиба Наталія[2]
[1]Хенанський інститут науки і технологій, Китайська Народна Республіка
[2] Сумський національний аграрний університет, Україна

Для вивчення якісного насіння і надійних методів, здатних підтримувати технологію вирощування домінуючих сортів пшениці в південній області Хуанхуай, як матеріали для цього дослідження були обрані три сорти напівозимої пшениці Zhoumai 18, Zhoumai 22 і Bainong 207. У наших дослідах кожен сорт був використаний для шести строків сівби і для семи варіантів густоти посіву. Результати показали, що: (1) сорти мають значний вплив на урожайність і компоненти врожаю. (2) Взаємодія дати і густоти посіву впливають на врожайність і її складові чинники. (3) Існують значні відмінності в процентному співвідношенні появи пагонів серед різних сортів. Таким чином, відповідна дата і густота посіву можуть сприяти підвищенню врожаю та його складових факторів при повному використанні світлової енергії і води, які створюють розумну популяційну структуру і підвищують врожайність.

Ключові слова: *пшениця, строк сівби, густота, урожайність, складові врожаю, напівозимі сорти пшениці.*

ВЛИЯНИЕ СРОКА И ГУСТОТЫ ПОСЕВА НА УРОЖАЙНОСТЬ И УРОЖАЙНЫЕ СОСТАВЛЯЮЩИЕ ТРЕХ ПОЛУОЗИМЫХ СОРТОВ ПШЕНИЦЫ

Цяоянь Чень[1,2], Сингци Оу[1], Веньхуэй Вэй[1], Кандыба Наталия[2]
[1]Хенанський институт науки и технологий, Китайская Народная Республика
[2] Сумской национальный аграрный университет, Украина

Для изучения качественных семян и надежных методов, способных поддерживать технологию выращивания доминирующих сортов пшеницы в южной области Хуанхуай, в качестве материалов для этого исследования были выбраны три сорта полузимой пшеницы Zhoumai 18, Zhoumai 22 и Bainong 207. В наших опытах каждый сорт был использован в шести сроках посева и в семи вариантах густоты посева. Результаты показали, что: (1) сорта оказывают значительное влияние на урожай и компоненты урожая. (2) Взаимодействие даты и густоты посева влияют на урожайность и ее составляющие факторы. (3) Существуют значительные различия в процентном содержании появлении побегов среди разных сортов. Таким образом, подходящая дата и густота посева могут способствовать повышению урожая и его составляющих факторов при полном использовании световой энергии и воды, которые создают разумную популяционную структуру и повышают урожайность.

Ключевые слова: *пшеница, срок посева, густота, урожайность, составляющие урожая, полуозимые сорта пшеницы.*

INFLUENCE OF THE SOWING PERIOD AND DENESITYON YIELD AND YIELD COMPONENTS OF THREE SEMI -WINTER WHEAT VARIETIES

Qiaoyan Chen[1,2], Xingqi Ou[1], Wenhui Wie[1], Kandyba Nataliya[2]
[1] Henan Institute of Science and Technology, Chinese People's Republic
[2]Sumy National Agrarian University, Ukraine

Three semi-winter wheat varieties Zhoumai 18, Zhoumai 22 and Bainong 207 were selected as materials for this study to study quality seeds and reliable methods capable of supporting the dominant wheat cultivation technology in southern Huanghuai. In our experiments, each variety was used in six sowing times and seven planting densities. The results showed that: (1) varieties had significant effects on yield and yield components. The yield among different varieties in the order of high and low was Bainong 207 >Zhoumai 22 >Zhoumai 18; suitable sowing date from October 1 to October 22, and the density is 300 ~ 525 × 10^4 plant·hm^{-2}. (2) The interaction of the date and planting density affects the yield and its constituent factors.The best combination of sowing date and density for Zhoumai 18 and Bainong 207 were 450×10^4 plant·hm^{-2} on October 8, and the yields were 10829.0 kg·hm^{-2} and 11891.7 kg·hm^{-2}, respectively, and Zhoumai 22 is 450 × 10^4 plant·hm^{-2} on October 15 and the yield is 10792.5kg·hm^{-2}. It can be seen that the best sowing date is October 8~15, and the seeding density is 450 × 10^4 plant·hm^{-2}. All three varieties showed that the spikes was higher during the high-density and the suitable sowing date treatment (October 8~15, 525~675 × 10^4 plant·hm^{-2}), and the grain number per spike was higher when the density was suitable (300-525 ×10^4 plant·hm^{-2}), the thousand-grain weight is higher in the low-density treatment (225~300 × 10^4 plant·hm^{-2}). (3) There are significant differences in the percentage of tiller among different varieties. The order of the three varieties is Bainong 207 >Zhoumai 18 >Zhoumai 22. With the postponement of the sowing date and the increase of the sowing density, the population tiller number (PTN) increased, and the percentage of earring-tiller gradually decreased. In summary, the appropriate sowing date and density can make the yield and its constituent factors make full use of light energy and water which build a reasonable population structure, and increase yield.

Key words: *wheat, sowing date, density, yield, yield components, semi-winter wheat varieties.*