The Spatial And Temporal Variability Analysis Of Wheat Yield in suburban of Beijing

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Abstract: The yield map is the basis of the fertilization maps and plant maps. In order to diagnose the cause of variation accurately, not only the spatial variation of annual yield data, but also the successive annual yield data of temporal variability should be understood.The introduction of yield monitor system, global positioning system (GPS), and geographic information system have provided new methods to obtain wheat yield in precision agriculture. Although the description of the spatial and temporal variability could be finished more easily, little information was known about the spatial and temporal variability of wheat yield patterns, currently. One important application of yield map data was the study of the spatial and temporal properties of yield distribution. It was important information before implementing any site-specific management strategy. The objective of this study was to analyze the spatial and temporal yield variability of wheat grown in suburban of Beijing. Wheat yield data was collected from 2004 to 2013 and the location was N 40.175442° ~40.179111°, E 116.439751° ~116.442436°. Because of the equipment cause, only eight years' data was collected, the missing data was 2010 and 2011. The harvest combine was CASE 2366 equipped with AFS yield monitor system. The yield monitor system included wheat yield flow sensor, moisture and temperature sensor, ground speed sensor, elevator speed sensor, header height sensor and DGPS. According to the wheat yield data of one year, spatial variability was analyzed. According to the past eight years' data, temporal variability was analyzed. On the basis of spatial and temporal analysis, a new farmland classified management method was proposed. According to the coefficient of variation, the entire field was divided into four parts: high and stable yield area, middle and stable yield area, low and stable yield area and unstable yield area. Typically, high degree of variation place had the potential to increase yield. For the high and stable yield area, middle and stable yield area and low and stable yield area, the wheat yield potential is small, however, for the unstable yield area, more research should be needed from soil physical and chemical properties, as well as fertilization, planting, and so on. When the reasons were conducted from the data, management method could be carried out to improve the wheat yield in the future. The site-specific method could make low cost and improve the potential wheat yield.

Key words: Wheat yield; Spatial-temporal variability; Classified management; Precision agriculture

1 Introduction

Yield monitoring and mapping technology that can measure, georeference, and record grain yields makes it possible to document the location and magnitude of yield variability with a spatial precision of meters. If the cause of this variability can be identified, then corrective action may be implemented to reduce costs, increase yield, and reduce environmental impacts by adopting site-specific management practices. Moreover, the availability of high-precision measurements may permit researchers to more efficiently test hypotheses by precisely measuring crop responses to environmental conditions as these conditions vary in the field. Both of these uses of precision-measurement technology require statistical methods that until now have more commonly been employed in ecological, epidemiological and econometric research.

The objective of this study was to assess the usefulness of summary statistics in quantification of the spatio temporal variability. And then it was used to divide the field with different spatiotemporal yield behaviors.

2 Material and methods

2.1 The yield monitor system introduction

Grain was harvested using a stripper harvester combine with real-time diferential global positioning system(DGPS) receiver in all years. The harvester followed a back-and-forth, north-to-south harvest pattern in the surburb in Beijing. Combine speed ranged from 1.1 to 1.25 $m.s^{-1}$. Header width ranged from 5.5 to 6.7 m. Grain flows were recorded once per second. And moisture content was recorded once per 15s. Yield map data files were collected and imported into the ArcView geographic information system for analysis. The yield monitor system was calibrated at the beginning of each harvest season by comparing with a sample of known weight, and yield measurements were adjusted based on this calibration. Figure 1 shows the CASE 2366 harvest combined with the yield monitor system.

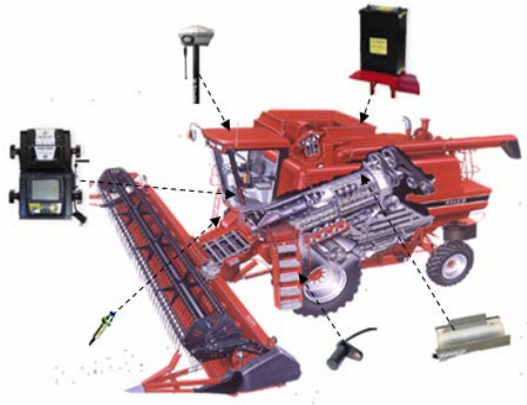

Figure 1 The CASE2366 harvest combined with the yield monitor system

2.2 Data acquisition of 2004 to 2013

The study was performed from 2004 to 2013 in the field of suburb in Beijing. The location was N 40.175442° ~40.179111° ,E 116.439751° ~116.442436° . All the area was divided into 23 fields. The experiment data was collected from the number 17 field. Figure 2 shows the 23 fields of the

demonstration area.

Figure 2 The grain field in the demonstration area

3 Results and discussion

3.1 Data pretreatment

In all the harvest period from 2004 to 2013, the harvest was CASE 2366 combined with grain yield monitor system. Because of the equipment causes, the yield data of 2010 and 2011 were lost. Table 1 was the grain yield data statistics from 2004 to 2013.

Table 1 Grain yield data statistics from 2004 to 2013

Serial number	Year	Grian moisture(%)	Average grain yield(kg/ha)
1	2004	14.95	5499.27
2	2005	9.07	4603.31
3	2006	8.35	4675.14
4	2007	7.65	5650.00
5	2008	9.17	4018.34
6	2009	21.15	3262.01
7	2012	27.12	3565.31
8	2013	17.30	3805.26

3.2 Spatial and temporal variability analysis

At the same field, there were high yield area and low yield area. It has certain spatio temporal variability. According to the different crops, the spatio variability was different. Figure 3 shows the spatio variability from 2004 to 2013. The highest value was 0.37 in 2008; the lowest value was 0.18 in 2004.

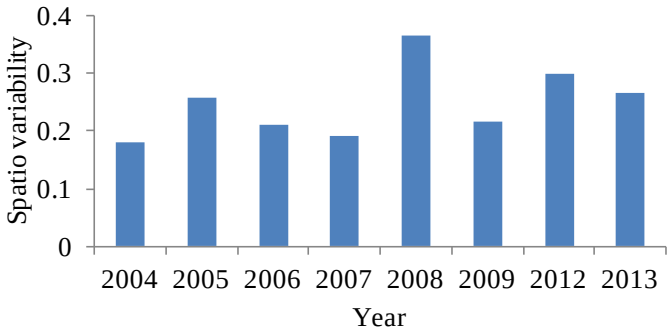

Figure 3 spatio variability from 2004 to 2013

According to the spatio variability value, all the field could be divided into three parts. When the Normalization yield data was below 0.3, it was low

yield. When it was between 0.3 and 0.5, it was middle yield. When it was more than 0.5, it was high yield. For the next two years results, different area with variable yield data could be obtained. Table 2 was the division rulers of the field.

Table 2 Division rulers of the field

Serial number	Yield data of next year	Yield data of next two year	Field area
1	>0.5	>0.5	High and stable yield area
2	<0.3	<0.3	Low and stable yield area
3	>0.3 and <0.5	>0.3 and <0.5	Middle and and stable yield area
4	Other values	Other values	Unstable yield area

General speaking, stable area and unstable area should be taken different management. For the High and stable yield area, Low and stable yield area and Middle and and stable yield area, it was easier to manage. For the unstable yield area, we should pay more attention. When the reasons were conducted from the data, management method could be carried out to improve the wheat yield in the future.

4 Conclusions

According to the analysis of the grain yield, the following conclusions could be obtained:

(1) The yield monitor system provides a feasible method to monitor the grain yield real time. The spatio and temporal variability could be analyzed.

(2) According to the traditional statistics method and geostatistics method, the grain field spatial variability was 0.18-0.37. Based on the spatial variability, the grain field could be divided into four levels. It was helpful for the site management of the filed in the next year.

(3)Although the field has been divided into four levels, the influences of factors were still complicated. In order to fullfill the site specific management precisely, more analysis should be achieved.

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