Field Information Collection Design and Experiment in Precision Agriculture

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Abstract. Under the guidance of modern precision agriculture management, the author followed the agronomic requirements of field operation and selected the experimental field to collect and test the agricultural field information with the quick test technique. It is concluded that the experimental field is alkaline soil, the nitrogen, phosphorus and potassium distributed unevenly in the soil, the organic matter contents in small amount, the trace element is in low effectiveness. Furthermore, the author discusses the improved method and provides the data support for the local agricultural operation, which can thus reduce the information collection period and cost of the field equipment.

1. Introduction
Precision agriculture is a modern agricultural concept which refers to the ability to determine appropriate farmland-management decisions based on field variation. The goal is to achieve the best harvest under the precondition of reducing consumption and protecting the environment, so as to change the traditional practice of unified fertilization time and fertilizer amount. It is a concept of sustainable development. And the precision agriculture consists of ten systems and three elements [1]: Among them, the rapid and accurate acquisition of field operation information is the basis. The acquisition of field work information is inseparable from the soil, soil is the source of nutrients required for crop growth, it is related to the growth and yield of crops, soil moisture content and solidity are two important factors that determine the growth of crops [2], nitrogen, phosphorus, potassium, organic matter and other elements of content in the soil are closely related to the quality of agricultural operations.

At present, soil quality and status of farmland operations are mainly tested by conventional means with high precision, but the analysis cycle is long and the cost is high, which is not suitable for the development of precision agriculture. Many surveys indicate that soil properties and variability are affected by the sampling and testing methods [3]. Therefore, it is of great significance to design farmland information collection methods and carry out experiments.

2. Experimental Overview

2.1. Experimental conditions
The farmland selected for the experiment is located in Kaian Town, Nongan County, Jilin Province. It is located on the golden corn belt of Jilin Province. The soil belongs to the fertile black soil.
2.2. Experimental Methods
The experiment adopts portable quick detection technology equipment, which is as follows:

Compactness meter: Built-in sensor encapsulation, high-power rechargeable lithium battery pack, large-scale digital circuit Array of chips, external large LCD screen displayed Chinese characters, the high quality stainless steel handle, measuring rod, which can directly test the compaction value in different depth of soil layers. The instrument was reset at first, then the operator can hold the sensor handle and press into the soil vertically to test the compaction value.

Highly intelligent agricultural testing instrument: A variety of functions agricultural testing instrument can measure soil composition, pesticide residues and other parameters.

According to the importance and practical application of each parameter, this experiment choose to measure seven parameters as the soil compaction, water, nitrogen, phosphorus, potassium, pH and organic matter.

3. Experimental design

3.1. Plow soil collection, Preparation and Storage
The collection of soil samples is an important link in determining whether the results of the analysis correctly reflect the soil characteristics. It is necessary to select the appropriate soil samples at the representative sites; different analysis purposes require different methods of collecting samples. Due to the plowing depth of deep loosening fertilization agricultural machinery is within 300 mm, this experiment adopts the mixed tillage soil sample collection method, samples are respectively from 0-100 mm, 100-200 mm, 200-300 mm soil layer in three experiments of plough layer so as to achieve an accurate experimental result. In addition, the depth of the sample can be increased in dealing with the deep root crops such as wheat soil. The number of sampling points may be determined according to the area of the land, small plots usually adopt 5 or more points, larger plots may adopt more than 20 points. The sampling points are distributed in serpentine or diagonals, the soil sample was mixed together, quartering screening, the last left 250 grams was used as the test soil sample.

3.2. Measurement of the Parameters
The moisture detection sensor in high intelligent agricultural testing instrument was used to measure the soil moisture, and the probe of the sensor was directly inserted into the soil sample used in the test.

Nitrogen, phosphorus and potassium solution were made by adding soil samples and distilled water, the three solutions were measured in the instruments. Nitrogen and phosphorus were in red light detection and potassium was in blue light detection.

The pH value of soil was determined by the electrode method, the test solution was prepared according to the standard and tested on the instrument, the measured value was determined by the classification of the five grades [4].

The content of organic matter in soil can be measured by comparing the phosphorus solution with the standard color scale.
4. Experimental results and analysis

4.1. Experimental results

**Table 1.** Soil compactness

| Position number | Soil compactness (Pa) |
|-----------------|-----------------------|
|                 | 0-10cm | 10-20cm | 20-30cm |
| 1               | 4047   | 5916    | 6853    |
| 2               | 4170   | 4580    | 5600    |
| 3               | 4260   | 6660    | 6690    |
| 4               | 4520   | 5090    | 5670    |
| 5               | 5310   | 6430    | 7280    |
| 6               | 4040   | 6320    | 7050    |
| 7               | 4200   | 5030    | 6910    |
| 8               | 5790   | 6490    | 7540    |
| 9               | 4580   | 6850    | 7320    |
| 10              | 5250   | 5560    | 6560    |
| average         | 4616.7 | 5892.6  | 6747.3  |

**Table 2.** Soil moisture content

| Position number | Soil moisture content (%) |
|-----------------|---------------------------|
|                 | 0-10cm | 10-20cm | 20-30cm |
| 1               | 22.39  | 20.37   | 21.18   |
| 2               | 13.55  | 24.64   | 32.62   |
| 3               | 17.90  | 29.39   | 38.31   |
| 4               | 10.41  | 21.72   | 27.28   |
| 5               | 16.74  | 21.09   | 25.04   |
| 6               | 10.05  | 17.23   | 29.53   |
| 7               | 11.35  | 21.18   | 30.83   |
| 8               | 20.64  | 36.21   | 37.2    |
| 9               | 17.14  | 29.53   | 30.16   |
| 10              | 16.87  | 26.75   | 30.56   |
| average         | 15.704 | 24.811  | 30.271  |

**Table 3.** Composition of the soil

| Soil composition detection (PPM) |
|----------------------------------|
| species                          |
| 0-10cm  | 10-20cm | 20-30cm |
| nitrogen | 45.45   | 38.259  | 19.2    |
| phosphorus | 40.58   | 56.7    | 28.35   |
| potassium | 42.13   | 52.93   | 73.15   |
| PH     | 8.12    | 8.32    | 8.43    |
| The organic matter | 0.50% | 0.50% | 0.50% |

4.2. Analysis

From the analysis of table 1, the soil compactness increases with the increase of soil tillage, and the average value is from 4.6kpa to 6.7 KPA.

From the analysis of table 2, the water content of the soil increases from 15% to 30% with the increase of soil tillage.
From the analysis of table 3, the nitrogen content of soil decreases with the increase of the soil tillage, phosphorus and potassium element mostly distribute in the top layer of 100-200 mm, with the PH value close to 8.5 (Strong alkaline), the organic matter content is the lowest one in the five kinds of standards (4.0%, 3.0%, 2.0%, 1.0%, 0.5%).

5. Conclusions and Discussion

5.1. Conclusion
According to the analysis of experimental results: the plot is in alkaline soil (PH value 7.5-8.5); according to the standard of fertile soil [5] (the soil has more than 1% organic matter and more than 40ppm available nitrogen, more than 20ppm available phosphorus, and more than 100ppm Potassium), the organic matter content of soil is low, the effectiveness of Trace elements is poor, nitrogen, phosphorus and potassium content are low.

According to the survey, the output of corn per hectare is 23,000-25,000 kg (calculated at 23,000 kg). Calculated by 1g per cubic centimeter of soil mass, so 385.5 kg of pure nitrogen, 180 kg of pure phosphorus and 480 kg of pure potassium are required per hectare of soil.

According to the experiment, the utilization rate of nitrogenous fertilizer is about 40% -50% (by 40%), phosphorus and potassium fertilizer are about 30% -40% (by 30%), urea contains 46% effective nitrogen, Calcium super phosphate contains 16% available phosphorus and potassium chloride contains 50% available potassium, according to the formula: fertilizer application amount = (planned yield to the requirement of a certain element - the supply of a certain element to soil) / (the content of some element in fertilizer (%)× fertilizer seasonal utilization (%)), so the amount of fertilizer in season can be calculated.

Due to great changes of the fertilizer utilization in season, the amount of fertilizer should be made with multiple factors.

5.2. Discussion
Field information rapid measurement technology is fast, easy to carry and with high precision, which reduces the difficulty and cost of obtaining basic information of machine field operations, shortens the analysis time and meets the requirement of fine agriculture for rational use of chemical fertilizers and the requirement of reducing agricultural non-point source pollution.

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