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Investigation on Current Status of Rice Fertilization in the Plain Area of Hanzhong Basin

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Abstract. Scientific fertilization is the key to obtain a high-yield and good quality rice. In order to understand the present situation of rice fertilizer application in the Plain Area of Hanzhong Basin, a survey had been conducted. The investigation results showed that: in the Plain Area of Hanzhong Basin, N application was more higher, P₂O₅ application was reasonable and K₂O application was a little lower. Fertilization was very unbalanced and the application rates were quite different among farmers. The base to dressing ratio was unreasonable. All the P₂O₅, K₂O and most of N were applied as base fertilizer, and only a few farmers use top dressing N fertilizer. In the frame of fertilizer variety, there is a phenomenon that using more ammonium bicarbonate than formula fertilizer, using more chemical fertilizer than organic fertilizer and using more macro element fertilizer than trace fertilizer.

1. Introduction

At present, the level of scientific fertilization in China is still not high overall. There are still blind fertilization phenomena in some areas, and the knowledge of scientific fertilization is insufficient. Farmers still have many misunderstandings about fertilizers [1]. Rice is the most important food crop in China. To ensure the food security of 1.3 billion people, rice production must be continuously improved. However, in ensuring high yield of rice, we mostly rely on the large-scale application of chemical fertilizers [2]. Rice has many problems worthy of study in fertilization because of its variety, large amount of fertilizer, long growth period, frequent irrigation, frequent use of fertilizers, and single fertilization methods [3].

Rice is one of the main crops in Hanzhong City. The annual planting area is about 1.6 million mu. The safe production of rice plays an important role in the economic development of Hanzhong. This study is a survey of rice fertilization status in the plain area of Hanzhong basin, in order to provide a basis for rational scientific fertilization of rice.



2. Materials and methods

2.1 Survey area

Nanzheng County, Chenggu County, Yang County and Mian County of Hanzhong City, Shaanxi Province.

2.2 Survey method

The survey used a field questionnaire to investigate the family management of farmers, rice field management and fertilization status. A total of 500 households were surveyed, including 477 valid questionnaires.

2.3 Data Processing

The survey data was processed by Excel software, mainly analyzing the fertilization situation of rice.

3. Results and analysis

3.1 Rice nutrient input

The average dosage and standard deviation of N, P₂O₅ and K₂O in rice in the plain area of Hanzhong basin are shown in Table 1. It can be seen from Table 1 that the average amount of pure fertilizer N in the plain area of the Hanzhong basin was 152.7 kg/ha, the average dosage of P₂O₅ was 60.9 kg/ha, and the average dosage of K₂O was 52.5 kg/ha. The average amount of pure N, P₂O₅ and K₂O of organic fertilizer was 3.7 kg/ha, 2.1 kg/ha and 5.6 kg/ha, respectively. Whether it is chemical fertilizer or organic fertilizer, the standard deviation of nutrient input of rice N, P₂O₅ and K₂O is relatively large, indicated that there was a certain difference in fertilizer application between different farmers, and the fertilization was not balanced, because most farmers apply fertilization according to traditional fertilization habits. Without scientific fertilization guidance, even with scientific fertilization guidance, they were not willing to change traditional habits and accept to learn advanced fertilization techniques. There were still quite a few farmers who apply fertilizer according to the economic situation. The economic situation was good, the farmers applied a large amount of fertilizer, and the farmers with poor economic status applied a small amount of fertilizer.

Generally speaking, the reasonable nitrogen application rate of rice is about 120 kg/ha in Hanzhong City. From our survey data, it can be seen that the nitrogen application rate of rice in the plain area was 156.4 kg/ha, which was higher than the reasonable application rate. The reasonable phosphate fertilizer (P₂O₅) application rate of rice was about 60 kg/ha in Hanzhong City. It can be seen from the Table 1 that in the plain area the phosphate fertilizer rate was 63.0 kg/ha, which was a reasonable amount. The reasonable dosage of potassium fertilizer (K₂O) in Hanzhong was about 75 kg/ha. The survey showed that the average potassium application rate of rice was 58.1 kg/ha, and the application rate of potassium fertilizer is more lower.

Table 1. Rice nutrient input (kg/ha)

Fertilizer		Chemical fertilizer	Organic fertilizer
N	Average	152.7	3.7
	Standard deviation	24.5	14.6
P ₂ O ₅	Average	60.9	2.1
	Standard deviation	21.8	7.8
K ₂ O	Average	52.5	5.6
	Standard deviation	17.5	15.1
Samples number		477	477

3.2 Number and proportion of nutrient inputs in different periods of rice

Table 2 shows the amount and proportion of N, P₂O₅, and K₂O nutrient inputs in different periods of rice in the plain area of Hanzhong basin. In the plain area of Hanzhong, a reasonable method of nitrogen fertilizer application should be 70-80% of the two-stage nitrogen fertilizer for the base fertilizer, and the remaining 20-30% for the split fertilizer, and the later seedlings should be applied to the field. Dry fertility nitrogen fertilizer promotes the application of basal fertilizer, that is, 80% nitrogen fertilizer as base fertilizer and 20% nitrogen fertilizer as spike fertilizer, which is one of the necessary conditions for ensuring high yield of rice. However, according to our survey data, rice N in the plain area of Hanzhong Basin was mainly applied by base fertilizer. The nitrogen application rate of rice based fertilizer accounts for more than 91.4% of the total nutrient input. Such a base-tracking ratio was obviously unreasonable. Not only does it fail to achieve high yields, it also reduces fertilizer efficiency and wastes nutrient resources. Generally speaking, in the production process of rice, phosphate fertilizer is applied as a base fertilizer at one time. As can be seen from Table 2, the method of applying P₂O₅ by farmers was reasonable. Affected by traditional farming conditions, K₂O in the plain area of Hanzhong basin was also applied as a base fertilizer at one time, and a more reasonable method of applying potassium fertilizer is 60% to 70% of base fertilizer and 30% to 40% of spike fertilizer.

Table 2. Amount and proportion of nutrient inputs in different periods of rice (kg/ha)

Fertilizer		Base fertilizer	Top dressing
N	Amount	142.9	13.4
	proportion %	91.4	8.6
P ₂ O ₅	Amount	63.0	0
	proportion %	100	0
K ₂ O	Amount	58.2	0
	proportion %	100	0

3.3 Rice fertilization varieties

The varieties and proportions of fertilizer applied to rice in the plain area of Hanzhong basin were shown in Table 3. It can be seen from the table that 35.6% of the farmers were applied with ammonium bicarbonate, superphosphate and potassium chloride, and 20.3% of the farmers apply ammonium bicarbonate and superphosphate, and no potassium fertilizer was applied. Among the nitrogen fertilizer varieties applied by farmers, all of the ammonium bicarbonate was applied as the base fertilizer, and the farmers who applied the ammonium bicarbonate accounted for 96.2% of the total number of the surveyed farmers. 82.1% of the farmers used superphosphate as the main phosphorus source, 45.0% of the farmers use potassium chloride as the main potassium source, and superphosphate and potassium chloride were all used as the base fertilizer. Most of the surveyed farmers applied NPK as a base fertilizer at a time, and only 23.9% of the farmers applied topdressing nitrogen, which were all urea. Among the surveyed households, only 6.3% of the farmers applied organic fertilizer, and the farmers who applied the compound fertilizer accounted for 18.1% of the total, and 3.8% of the farmers only applied the compound fertilizer. According to the survey, most farmers are still accustomed to applying ammonium bicarbonate, and formula fertilizers and compound fertilizers only account for a small portion.

Table 3 Variety and proportion of fertilizer applied to rice

Fertilizer variety	Farmer number	proportion %
Compound fertilizer	18	3.8
Ammonium bicarbonate	1	0.2
Ammonium bicarbonate + Urea	1	0.2
Ammonium bicarbonate + Superphosphate	97	20.3

Ammonium bicarbonate + Compound fertilizer	47	9.9
Ammonium bicarbonate + Organic Fertilizer	1	0.2
Ammonium bicarbonate + Superphosphate + Urea	68	14.3
Ammonium bicarbonate + Superphosphate + Organic Fertilizer	8	1.7
Ammonium bicarbonate + Superphosphate + Potassium chloride	170	35.6
Ammonium bicarbonate + Compound fertilizer + Organic Fertilizer	17	3.6
Ammonium bicarbonate + Superphosphate + Potassium chloride + Urea	45	9.4
Ammonium bicarbonate + Superphosphate + Organic Fertilizer + Compound fertilizer	4	0.8

4. Discussion

Rice is the main food crop in Hanzhong City. Rational fertilization is an important measure for rice to obtain high quality and high yield. Judging from our survey results, there are still many problems worthy of attention in rice fertilization in Hanzhong.

4.1 *N, P, K ratio imbalance, more nitrogen fertilizer, less potassium fertilizer*

The imbalance of N, P, and K severely restricts the yield of rice. Excessive application of nitrogen fertilizer will not increase the yield, and sometimes it will cause the crop yield to decrease, which will cause certain harm to the environment. Potassium fertilizer can not only promote nitrogen metabolism, increase nitrogen absorption and utilization, but also improve rice lodging resistance and disease resistance, and have a good effect on improving rice quality. Therefore, for the plain area area of Hanzhong basin, in order to obtain high-quality and high-yielding rice, it is necessary to appropriately reduce the amount of nitrogen fertilizer and increase the application of potassium fertilizer.

4.2 *Unreasonable base fertilizer and topdressing, heavy base fertilizer, light topdressing*

The nitrogen fertilizer of rice in the plain area of Hanzhong basin was mainly applied as base fertilizer, and the nitrogen application rate of based fertilizer accounted for more than 91.4% of the total nitrogen input. Potash was also applied to the soil in the form of base fertilizer. Studies have shown that in order to ensure the continuity of nutrient supply in rice growth and yield formation, generally nitrogen fertilizer in paddy fields can be divided into three applications: base fertilizer, tiller fertilizer and panicle fertilizer. For grain spills and poor fertilizer retention capacity, a grain fertilizer should be added to ensure the continuous supply of nutrients and maximize the benefits of fertilization [4]. For phosphate fertilizers, the optimum application time is before the soil is turned or smashed, and the best application method is to apply as base fertilizer. Potassium fertilizer is applied twice, once as a base fertilizer mixed with nitrogen and phosphorus fertilizer, and once as a top dressing application.

4.3 *Single fertilization variety, unreasonable fertilizer ratio, heavy ammonium bicarbonate, light formula fertilizer*

According to the survey, most farmers in the plain area of Hanzhong basin were still accustomed to applying ammonium bicarbonate, and formula fertilizers and compound fertilizers only account for a small portion. As we all know, ammonium bicarbonate is a quick-acting fertilizer, and the fertilizer efficiency is fast, but the utilization rate of N is very low, only about 30%. The formula fertilizer has many advantages. According to the soil fertility condition and the rice fertilizer requirement characteristics, the soil testing formula is formulated, and the fertilizer station is formulated according to the nutrient condition of various soils to produce the corresponding formula fertilizer, which can improve the fertilizer utilization rate and increase the yield of rice. Save fertilizer costs and reduce

agricultural non-point source pollution [2]. In recent years, the rice soil testing and fertilization project in Hanzhong City has been carried out in general and has achieved certain results. However, due to the influence of traditional concepts, the formula fertilizer produced by this technology cannot be accepted by the majority of farmers. Further increase publicity, print brochures, conduct regular training, enter the countryside, and approach farmers, so that the achievements of this technology are truly deeply rooted in the hearts of the people.

4.4 Heavy chemical fertilizer, light organic fertilizer

Excessive application of chemical fertilizers will pollute the environment and consume energy and increase energy shortages. If it is necessary to improve rice yield, improve quality and safety, and protect the ecological environment, it is necessary to combine inorganic fertilizer and organic fertilizer, appropriately reduce the application amount of chemical fertilizer (especially N fertilizer), and increase the application rate of organic fertilizer [2]. For the plain area of Hanzhong basin, it is necessary to make full use of existing organic fertilizer sources such as straw, and use straw to return to the field to make N, P, K and other nutrients recycled.

4.5 Heavy element fertilizer, light trace element fertilizer

It can be seen from our survey that farmers in the plain area of Hanzhong basically do not apply trace element fertilizers, but rice growth requires not only a large amount of elemental fertilizer, but also an appropriate amount of micro-fertilizer, such as silicon fertilizer and zinc fertilizer. Rice is a typical silicate crop. The silicon content in stems and leaves accounts for 10%-20% of the dry matter weight. Silicon fertilizer can enhance the oxidative capacity of rice roots and promote the absorption of other nutrients by roots. Silicon fertilizer can also enhance rice pests and diseases. The resistance is good for preventing rice from lodging. Therefore, the application of an appropriate amount of silicon fertilizer throughout the growing season of rice can significantly increase the yield and quality of rice. Zinc is one of the trace elements necessary for rice growth and development. Zinc deficiency in rice will show obvious symptoms, and the phenomenon of dead seedlings will occur [6], which will cause the decline of rice yield and quality. Studies have shown that the application of zinc fertilizer on zinc-deficient soil, the agronomic traits of rice have increased, the number of stems increased significantly, the hollowing rate decreased significantly, the number of grains per ear and 1000-grain weight increased, also promoting rice filling[5]. In addition, the cost of applying zinc fertilizer is small, and the yield increase is obvious, which has the effect of increasing the income and reducing environmental pollution.

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