# Effect of Annual Potassium Application in Fixed Location Trials with Rice in Jiangxi Province

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*Jiangxi is one of the major rice producing provinces in south China. There are 2.54 million hectares sown to paddy rice in the province. The double rice cropping system occupies over 80 percent of the total cultivated area. About 80 percent of the potassium (K) consumed in the province is used on paddy soils.*

This study to determine the best K rates when manure is used, and the resulting soil K balance for the double rice cropping system, began in 1986. It was conducted for five years at two locations. One soil was derived from alluvial material (Liantang town), the other from sandy rock (Gao'an county).

The five plant nutrient treatments used were: (1) $NPK_0$; (2) $NPK_{45}$; (3) $NPK_{90}$; (4) $NPK_{135}$; (5) $NPK_{90}$ (OM), where the numbers indicate the amount of applied $K_2O$ per ha for each crop. In treatment 5, half the K came from inorganic fertilizer...potassium chloride (KCl), the other half from organic manure (OM)...milk vetch for early rice, rice straw for late rice. The same adequate rates of nitrogen (N) and phosphorus (P) were applied to all treatments.

Yield results over five years with 10 rice crops indicated that for both locations very significant yield responses resulted as the K rate increased from zero to 135 kg $K_2O$/ha for each crop (Table 1). For early rice, the average yield increase was 405 to 1,345 kg/ha (percent increase ranging from 8.9 to 23.9 percent). One kg $K_2O$ produced 5.7 to 18.6 kg rice with a profit of 486 to 1,614 yuan/ha and a value: cost ratio (VCR) ranging from 8.1 to 26.4.

For late rice, the same rates of applied K increased rice yield by 765 to 1,329 kg/ha

Table 1. Response of different rates of K application on rice yield during 1986 to 1991.

| | | | Early rice, 5-year average | | | Late rice, 5-year average | | |
|---|---|---|---|---|---|---|---|---|
| Soil | $K_2O$ rate, kg/ha | 5-yr total yield | Yield, kg/ha | Increase from K, % | kg rice/ kg $K_2O$ | Yield, kg/ha | Increase from K, % | kg rice/ kg $K_2O$ |
| Alluvial soil | $NPK_0$ | 47,399 | 4,842 | – | – | 4,488 | – | – |
| | $NPK_{45}$ | 56,543 | 5,827 | 16.7 | 18.6 | 5,457 | 21.6 | 21.5 |
| | $NPK_{90}$ | 59,082 | 6,061 | 21.4 | 11.9 | 5,755 | 28.2 | 14.1 |
| | $NPK_{135}$ | 60,167 | 6,187 | 23.9 | 8.9 | 5,815 | 29.6 | 10.2 |
| | $NPK_{90}$(OM) | 57,764 | 5,829 | 16.8 | 9.3 | 5,722 | 27.5 | 13.7 |
| Red sandy soil | $NPK_0$ | 48,273 | 4,557 | – | – | 5,277 | – | – |
| | $NPK_{45}$ | 55,016 | 4,962 | 8.9 | 9.0 | 6,042 | 14.5 | 17.0 |
| | $NPK_{90}$ | 57,137 | 5,257 | 15.4 | 7.8 | 6,169 | 16.9 | 9.9 |
| | $NPK_{135}$ | 58,113 | 5,322 | 16.8 | 5.7 | 6,300 | 19.4 | 7.8 |
| | $NPK_{90}$(OM) | 57,396 | 5,238 | 14.9 | 7.6 | 6,153 | 16.6 | 9.7 |

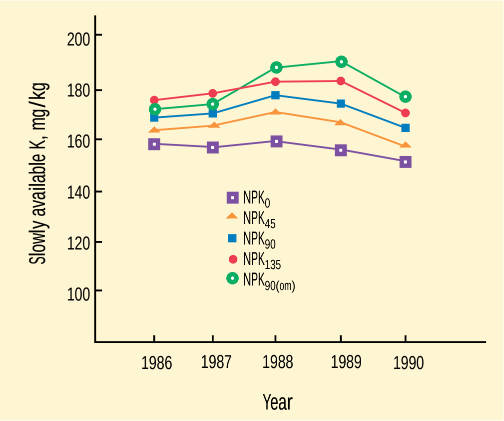


*Figure 1. Annual dynamics of slowly available soil-K in different treatments.*

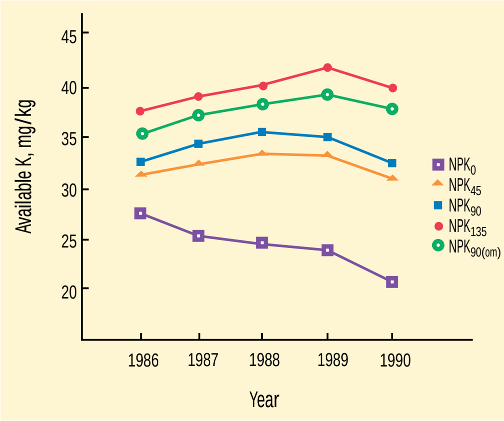


*Figure 2. Annual dynamics of available soil-K in different treatments.*

(percent yield increase ranging from 14.5 to 29.6). Profit ranged between 399 to 640 yuan/ha with a VCR of 2.4 to 8.7.

The response to K application by late rice was better than early rice for two possible reasons. Reason 1: The soil's K-supplying capacity when early rice is growing is better than during late rice growing period. This reason relates to the long fallow period between late rice harvesting and early rice transplanting. Soil weathering could release more available K during this time whereas available K content during late rice growth may be very low because of uptake by early rice. Reason 2: Hybrid rice which is very popular for late rice plantings requires more K than traditional varieties.

Rice yield was increased by increasing K fertilization. The optimum rate calculated by regression analysis between yield and fertilizer rate was 117 to 135 kg $K_2O$/ha/yr. The ratio of K needed for early rice to that needed for late rice was about 1:1.4 to 1.6 or 45 to 63 kg $K_2O$/ha for early rice and 72 to 90 kg $K_2O$/ha for late rice.

When comparing K from inorganic fertilizer ($NPK_{90}$) and organic manure [$NPK_{90}$(OM)], the responses were similar. This indicates that K from milk vetch or rice straw had the same effect as K from mineral fertilizer except for early rice on the alluvial soil. Planting green manure and returning rice straw to the field in combination with fertilizer K should improve soil K balance as well as reduce the K fertilizer requirement needed to grow the other three treatments.

Grain K content was not influenced by different rates of K application. The K content of grain depended mainly on genetic characteristics of the variety. Potassium content of rice straw was, however, influenced by K rates. In treatments with the highest K rate, plants showed luxury consumption of K. There was some difference in K utilization efficiency between different treatments with efficiency for

Table 2. Effect of different rates of K application on K uptake by rice plants.

| Soil | Treatment $K_2O$ rate, lb/A | Total K uptake in five years, kg $K_2O$/ha | Total K input, kg $K_2O$/ha | K uptake increase kg/ha ($NPK_{45}$-NP) | K uptake increase % ($NPK_{45}$-NP/NP) | K utilization efficiency, % |
|---|---|---|---|---|---|---|
| Alluvial soil | $NPK_0$ | 754.7 | – | – | – | – |
| | $NPK_{45}$ | 1,181.9 | 450 | 427.2 | 56.6 | 95.1 |
| | $NPK_{90}$ | 1,536.6 | 900 | 781.9 | 103.6 | 86.7 |
| | $NPK_{135}$ | 1,871.4 | 1,350 | 1,116.7 | 148.0 | 82.7 |
| | $NPK_{90}$(OM) | 1,549.4 | 900 | 794.7 | 105.3 | 88.3 |
| Red sandy soil | $NPK_0$ | 813.9 | – | – | – | – |
| | $NPK_{45}$ | 1,241.3 | 450 | 427.4 | 52.5 | 94.7 |
| | $NPK_{90}$ | 1,643.4 | 900 | 829.5 | 101.9 | 92.2 |
| | $NPK_{135}$ | 1,825.8 | 1,350 | 1,011.9 | 124.3 | 75.0 |
| | $NPK_{90}$(OM) | 1,607.3 | 900 | 793.4 | 97.5 | 88.2 |


Comparison of NP and NPK treatments in the field.

Long-term experimental field for different rates of K on rice.

grain production decreasing as rates of application increased (Table 2).

The total annual K uptake by rice plants in the $NPK_0$ treatment (without applied K) declined rapidly year by year. For instance, total K uptake by rice plants for this treatment on the alluvial soil in the fifth year was only 50.9 percent of that in the first year. In the red sandy soil, it declined even more rapidly to only 27.2 percent of the amount of K taken up in the first year (Table 3).

Data from the red sandy soil (Table 4) show that total soil K, slowly available K and available K in the $NPK_0$ treatment after five years of cropping were much lower than before the experiment began. While the soil K status for treatment $NPK_{45}$ generally remained unchanged, the content of available K and slowly available K increased for treatments $NPK_{90}$ and $NPK_{135}$ compared with original levels. This demonstrates that in the case of high rates, K can accumulate in the soil. Applying organic manure with K fertilizer favored a good soil K supplying capacity as this treatment increased K supply from all soil K sources. See Figures 1 and 2.

## Conclusions

- The application of K to either early (45 to 63 kg $K_2O$/ha) or late rice (72 to 90 kg $K_2O$/ha) produced significant responses and was profitable.
- Potassium response on late rice was greater than with early rice.
- Growing and incorporating green manure and/or returning rice straw to the field added supplemental K to the soil, allowing for reduction in mineral K requirements to sustain the same yield level.
- When K was applied, high levels were found in the rice straw which acted as a reservoir

Table 3. Total annual K uptake in $NPK_0$ treatment.

| Soil | 1986 | 1987 | 1988 | 1989 | 1990 | Total |
|---|---|---|---|---|---|---|
| | kg/ha | | | | | |
| Alluvial soil | 213.3 | 125.3 | 175.5 | 131.8 | 108.7 | 754.5 |
| Red sandy soil | 354.0 | 136.7 | 120.8 | 105.8 | 96.3 | 813.9 |

Table 4. Comparison of soil K content in different forms between experiment initiation and after 5 years on a red sandy soil.

| Experiment initiation | | | | After five years of experiment | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Total K, % | Slowly available K, ug/g | Available K, ug/g | Treatment | Total K % | ± | Slowly available K ug/g | ± | Available K ug/g | ± |
| | | | $NPK_0$ | 1.72 | 0 | 154 | -7 | 21.4 | -5.6 |
| | | | $NPK_{45}$ | 1.72 | 0 | 161 | 0 | 30.5 | 3.1 |
| 1.72 | 161 | 27.4 | $NPK_{90}$ | 1.72 | 0 | 167 | 6 | 34.0 | 6.6 |
| | | | $NPK_{135}$ | 1.74 | .02 | 174 | 12 | 38.0 | 10.6 |
| | | | $NPK_{90}$(OM) | 1.74 | .02 | 180 | 19 | 40.0 | 12.6 |

that could be returned to the soil.

- As expected when K was not applied, soil K was depleted. This is a prime example of soil nutrient mining and proves that if adequate K is not applied with present crops, more will be needed in the future.
- Potassium is an important plant nutrient for rice production in the alluvial and red sandy soils of Jiangxi province. BCI

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# Potash Development Institute Established in Pakistan

To sustain the CIDA-Canpotex-PPIC inititative on research and development of potash (MOP) use in Pakistan, the Pakistan Agricultural Research Council (PARC) has set up the Potash Development Institute. Inaugurated on March 17, 1998, at the National Agricultural Research Centre, Islamabad, by Dr. Zafar Altaf, Chairman, PARC, and Dr. Mark D. Stauffer, President, PPIC, the Institute operates with the following objectives:

- To study the behavior of potassium (K) in Pakistan soils.
- To monitor the effects of fertilizers on a long-term basis at selected sites.
- To promote the use of balanced fertilization, with emphasis on potash, through demonstrations in farmer fields.
- To disseminate technical information amongst extension agronomists and farmers.
- To address environmental concerns related to soils and fertilizer use.
- To liaise with the government and fertilizer industry on issues related to current and future use of potash in Pakistan. BCI

*Dr. M.D. Stauffer, left, and Dr. Zafar Altaf, right, at opening of Potash Development Institute. M. Tahir Saleem, second from right, serves as PPIC project coordinator.*