Balanced Fertilization Research and Demonstration on High Yield Cotton in Henan Province

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Research experiments and field demonstrations are showing farmers and leaders the positive effects of potassium (K) fertilization in balance with other nutrients for increased cotton production.

Cotton is an important cash crop in Henan, grown on more than one million hectares in the province. In recent years, to meet demand of the growing population, yield per unit area has been increased by using high-yielding varieties, heavier rates of nitrogen (N) and phosphorus (P), and an increased cropping index. However, through this process, the status of plant nutrients in the soil has changed, and K depletion (deficiency) has become a significant cotton yield and quality limiting factor. It was also found that with an increasing incidence of K deficiency, some diseases are becoming prevalent in cotton. Therefore, a study on balanced fertilization was developed to demonstrate to farmers the need for adequate inputs of all limiting nutrients, especially K.

Materials and Methods

The three locations selected were: Yanjing, Fuguo and Nanyang counties in northern, eastern and southern Henan. Soil types represented were a fluvo-aquic soil in Yanjing and Fuguo counties and a yellow cinnamon soil in Nanyang county. There were three replications with 20 to 30 m^2 plot sizes. The rates of N, P and K application to the summer cotton crop at Yanjing were lower than rates applied to the spring cotton sites at Fuguo and Nanyang counties (Table 1).

Table 1. Experimental treatments, rates as kg/ha.

Fuguo and Nanyang			Yanjing		
N	P_2O_5	K_2O	N	P_2O_5	K_2O
180	112	0	135	90	0
180	112	90	135	90	75
180	112	135	135	90	112
180	112	180	135	90	150
180	75	90	135	60	75
180[1]	75	0	135	60	0

[1]Farmer practice for fertilization. Other nutrients were applied to a sufficient level.

Large field demonstration plots were also established at all three sites. Treatments included a typical farmer fertilization practice as check, and balanced fertilization with K.

A high-yielding variety was selected for all trials. Other management practices such as pest control and irrigation were done to maximize yield. Cotton was picked from individual plots and yield calculated on the spot for the benefit of local leaders and farmers organized to inspect the experiments and demonstrations. This approach showed them the positive effect of K use on cotton and provided technology transfer by immediately expanding the influence of the results.

Experimental Results and Effect of Demonstrations

Yield effect: Cotton yield in Yanjing was lowest among the three sites (Tables 2 and 3). With adequate supply of N and P, cotton yields increased gradually with increasing rates of K application up to a maximum, then decreased. The best K rate for spring cotton was 135 kg K_2O/ha while for summer cotton it was 112 kg K_2O/ha. The K effect on summer cotton yield was much higher than on spring cotton. The reason postulated is that spring cotton absorbs more K from the soil due to its longer growing period (135 days). The effect of K application on yield between the Fuguo and Nanyang site was similar.

Table 2. Spring cotton lint yield from different P and K treatments.

Fertilizer, kg/ha			Fuguo		Nanyang	
N	P_2O_5	K_2O	Yield, kg/ha	Increase, %	Yield, kg/ha	Increase, %
180	112	0	1,318	–	1,353	–
180	112	90	1,432	8.6	1,470	8.6
180	112	135	1,520	15.2	1,550	14.6
180	112	180	1,450	10.0	1,483	9.6
180	75	90	1,401	6.3	1,467	8.4
180	75	0	1,306	-0.9	1,338	-1.1

Table 3. Summer cotton lint yields (kg/ha) at Yanjing.

Fertilizer, kg/ha				
N	P_2O_5	K_2O	Yield	Increase, %
135	90	0	777	–
135	90	75	944	21.4
135	90	112	974	25.3
135	90	150	967	24.4
135	60	75	838	11.2
135	60	0	724	-0.07

The lowest yield of cotton was obtained with the farmer's fertilization practice and was due to the absence of applied K and lower P use. It appears that the main effect benefitting cotton yield was from additions of K. With the same rate of N and K (180 and 90 as N and K_2O), there was no obvious difference between the two levels of P application on spring cotton at both locations. This could be due to the fact that the P application levels were tested at less than optimum levels of K (90 rather than 135). On the other hand, with summer cotton, lint yield at the lower rate of P was significantly lower than that of the higher dose, indicating the need for K and an increase in the recommended rates of P. In this case, P application rates were tested at an adequate level of K. Results may also be due to the fact that summer cotton absorbed less available P from the soil due to the shorter growing period.

Yield Component Effect

With increased rates of applied K at Fuguo, both the boll weight and number of bolls per plant increased. There was no obvious difference with the number of fruit branches per plant among treatments. Fiber length also increased when K was applied.

Economic Analysis

Maximum net profit (Tables 4 and 5) resulted with the same treatment that gave the highest yield (135 kg K_2O/ha for spring cotton and 112 kg K_2O/ha for summer cotton). Net profits for the farmer fertilization treatment and the one without K were much lower, although each had higher VCRs compared with other treatments. This serves as a good example that VCR should not be the factor that determines the rate of fertilizer to recommend unless it is extremely low (VCR less than 2). Otherwise, net profit should be used for determining rates of fertilizer to recommend.

Results and Impact of Field Demonstrations

Simple field demonstrations were established near the experimental sites. The application of 150 kg K_2O/ha increased lint yield by 8.9 percent and 9.6 percent at Nanyang and

Table 4. Spring cotton economic analysis (RMB yuan/ha).

Fertilizer, kg/ha			Fuguo			Nanyang		
N	P_2O_5	K_2O	Cost	Net profit	VCR	Cost	Net profit	VCR
180	112	0	1,213	30,431	25.1	1,213	31,259	25.8
180	112	90	1,411	32,969	23.4	1,411	33,869	24.0
180	112	135	1,510	34,958	23.2	1,510	35,714	23.6
180	112	180	1,609	32,203	20.6	1,609	33,995	21.1
180	75	90	1,294	32,329	24.9	1,294	33,914	26.2
180	75	0	1,096	30,259	27.6	1,096	31,016	28.3

Note: Price (yuan/kg) N = 4.8, P_2O_5 = 3.1, K_2O = 2.2, cotton = 24. US$1 = 8.2 RMB.

Table 5. Summer cotton economic analysis (RMB yuan/ha).

Fertilizer, kg/ha			Yanjing		
N	P_2O_5	K_2O	Cost	Net profit	VCR
135	90	0	927	17,721	19.1
135	90	75	1,092	21,552	19.7
135	90	112	1,175	22,189	18.9
135	90	150	1,257	21,944	17.5
135	60	75	999	19,106	19.1
135	60	0	834	16,554	19.8

Table 6. The effect of K application on lint yield in field demonstrations.

	Fuguo		Nanyang		Yanjing	
Treatment	Yield, kg/ha	Increase %	Yield, kg/ha	Increase %	Yield, kg/ha	Increase %
Check	1,360	–	1,381	–	867	–
K_2O150[1]	1,491	9.6	1,504	8.9	952	9.8
K_2O225	1,547	13.8	–	–	–	–

[1]Rate at Yanjing site, 120 kg/ha.

Fuguo, respectively. At Fuguo, an additional 4 percent yield increase was obtained with the application of 225 kg K_2O/ha. At the Yanjing summer cotton site, the application of 120 kg K_2O/ha increased lint yield by 9.8 percent (Table 6).

Local leaders and farmers were organized to inspect the demonstrations. At the Fuguo spring cotton site, the Fuguo county Commission of Science and Technology, one of the cooperating units in the demonstrations, persuaded local leaders and more than 60 farmers to visit both the research and demonstrations at Gaohetao village and the Guaiwang farm demonstration site in Dalizhuang township. These organized field days made a good impression on both the leaders and farmers, demonstrating the agronomic and economic benefits of balanced fertilization. This approach helps get research results put into practice on farmers' fields quickly.

From a practical point of view, it was essential to combine research trials with demonstrations. This brought together researchers, local leaders and farmers to see the benefits of balanced fertilization and the fruits of research as well as convey research results to the mass media. BCI

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