

Timing of K fertilizer affects yield and quality of lettuce in Chongqing

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Under optimal fertilizer rates, adjusting timing of K fertilization can achieve better yield and quality of lettuce. Application of K to later stage has no benefit to lettuce production.

1. Introduction

Vegetables play an important role in daily diet, offering rich vitamin, mineral, protein, amino acid, sugar and so on. Lettuce (*Lactuca Sativa L.*) is a popular vegetable that can be consumed by eating leaves and/or both leaves and stem in China. It can grow year round in southern China and produce large quantity of yield. As people's living standard improves, consumers are more concerned about food quality than yield alone. Besides, fertilization related environment problems are also big concerns of the society. To produce better yield and quality of vegetables and reduce adverse environment impact, the 4R nutrient stewardship can be used to realize these goals. The objectives of field experiment was to examine effect of timing of potassium fertilizer on lettuce yield and quality.

2. Materials and methods

The field experiments were carried out in Jiulongpo district, Chongqing city. The soil in study was an alkali purple soil with pH 7.57, organic matter content 19.51 g/kg, available N 72.2 mg/kg, available P 47.4 mg/kg and available K 175 mg/kg, relatively abundant in N and P, and deficient in K.

The experiment consisted of 6 treatments with 3 replication (Table 1). The plot size was 7 m² (7 x 1 m) with plant density of 100 plants/plot (25cm×28 cm). Urea (N 46%), monopotassium phosphate (P₂O₅ 52.6% and K₂O, 34%), KCl (K₂O 60%) and rapeseed meal (N 5.243%, P 1.120%, K 1.434%) were used as fertilizer sources. The optimal fertilizer rate was set as 300-90-150kg/ha of N-P₂O₅-K₂O plus 1500kg/ha of rapeseed meal. Plots omitting P or K were included. The rapeseed meal was used as basal application, while N, P and K fertilizers were split into four times as basal application and at rosette, leaf folding and fast growing period. The yield and quality factors such as contents of vitamin C (Vc), nitrate, soluble sugar and amino acid in lettuces were determined at harvest.

Table 1 Treatments of the field experiment

Treatment	Basal	Rosette	Leaf folding	Fast growing
CK	N0P100K100	N20P0K0	N40P0K0	N40PK0
NP	N20P20K100	N20P20K0	N30P30K0	N30P30K0
NK	N20P100K20	N20P0K20	N30P0K30	N30P0K30
NPK1	N20P20K20	N20P20K20	N30P30K30	N30P30K30
NPK2	N20P30K30	N40P30K30	N40P40K40	N0P0K0
NPK3	N20P20K20	N40P40K40	N40P40K40	N0P0K0

3. Results

Compared to CK, addition of NP and NK fertilizers increased lettuce yield by 3.3% and 5.6%, indicating high fertility of the soil and better effect of K over P on lettuce yield (Table 2). In the treatment of NPK2, K applied in proportions of 30:30:40:0 as basal and at rosette, leaf folding and fast growing stages produced highest yield, implying that late application of K has no benefit to lettuce yield.

Table 2 Lettuce yield as affected by different fertilizer treatments

Treatment	I	II	III	Yield (kg/plot)	Yield (t/ha)	Relative yield (%)
CK	27.5	28.0	27.5	27.7±0.29	39.6 e*	100.0
NP	28.6	28.9	28.6	28.7±0.17	41.0 d	103.6
NK	29.3	29.5	29.0	29.3±0.25	41.9 c	105.7
NPK1	28.0	28.3	28.0	27.3±0.17	39.0 f	98.5
NPK2	31.0	31.2	31.0	31.1±0.12	44.4 a	112.3
NPK3	30.2	30.5	30.7	30.5±0.25	43.6 b	110.1

* Different letters in a column indicate significant differences ($p < 0.05$) between treatments.

Results in Table 3 showed that nutritional quality of lettuce leaf was reversely related to yield, probably due to dilute effect at elevated yield. This phenomenon is pretty common in vegetable production.

Table 3 Nutritional quality of lettuce leaf as affected by different treatments

Treatment	Vitamin C		Soluble sugar		Amino acid		Nitrate	
	mg/kg	%	%	%	mg/kg	%	mg/kg	%
CK	552.9	100.0	2.085	100.0	869.6	100.0	1387	100.0
NP	512.1	92.6	1.980	95.2	817.5	94.0	1495	107.8
NK	524.5	94.9	1.842	88.5	658.0	75.7	1475	106.3
NPK1	404.5	73.2	1.782	85.6	684.7	78.7	1464	105.6
NPK2	420.9	76.1	1.494	71.6	688.8	79.2	1717	123.8
NPK3	466.8	84.4	1.052	50.5	540.9	78.5	1866	134.5

Different from nutritional quality of lettuce leaf, soluble sugar and amino acids were considerably affected by timing of K applications. Though lower than CK, NPK2 can be considered as the best treatment to achieve both high yield and relatively better quality.

Table 4 Nutritional quality of lettuce stem as affected by different treatments

Treatment	Vitamin C		Soluble sugar		Amino acid		Nitrate	
	mg/kg	%	%	%	mg/kg	%	mg/kg	%
CK	222.4	100.0	1.887	100.0	1323	100.0	1473	100.0
NP	166.6	74.9	1.712	90.5	1106	83.6	1450	98.4
NK	162.5	73.1	2.013	106.3	1361	102.9	1425	96.7
NPK1	199.7	89.8	1.728	91.5	851	64.3	1681	114.1
NPK2	175.7	79.0	1.779	94.2	1090	82.3	1674	113.6
NPK3	195.1	87.7	1.791	94.7	1202	90.8	1599	108.5