Effect of Fertilizing Timing on Yield and Quality of Lettuce in Chongqing

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1. Introduction

Vegetables play an important role in people's daily lives and food structure, providing people with rich vitamins, minerals, protein, amino acid, sugar and so on. Lettuces (Lactuca Sativa L.) are rich in nutriments and can grow around the whole year, so it was cultivated in large area in south of china and loved very much by consumers, whose yield and quality were concerned by more and more people . Although more rates of fertilizers were used increasingly recently, fertilizer use efficiencies and vegetable qualities were decreased, because unbalanced fertilization limited vegetable yield and quality improvement. In field experiment, the effect of nitrogen, potassium and phosphorus fertilizer on yield and quality of lettuces grown in different soils were studied for producing high quality lettuce under subsidizing of IPNI.

2 Materials and methods

The field experiments were carried out at vegetable demonstration plot in Jiulongpo district , Chongqing city on the purple alkali soil with pH 7.57, soil organic matter content19.51 g/ kg， available N 72.2 mg/kg, available P47.4 mg/kg, available K 175 mg/kg, respectively. The soil was relatively abundant in N, P, Ca and Zn, marginal in Mg and deficient in K.

The N fertilizer was used as urea (N 46%), phosphate fertilizer as potassium dihydrogenphosphate single superphosphate (P_2O_5 52.6% and K_2O， 34%) , potassium fertilizer as KCl (K_2O 60%)and rapeseed meal （total N 5.243%，total P 1.120%,total K 1.434%）. All fertilizers were applied at N-P_2O_5-K_2O as 300-90-150kg/ha and all treatments were applied with rapeseed meal 1500kg/ha as basal.

The experiment was designed of 6 treatments with 3 replications (Table 1). The plot size was 7 m^2 (7 x 1 m) with plant density of 100 plants/plot at 25×28 ㎝. Seed breeding was on February 15th and transplanting was on April 10th. The rapeseed meal was applied as basic dressing on all plots, and nitrogen, phosphorus and potassium fertilizer was applied at the stages for rosette, leaf folding and fast growing. The yield and content of Vc, nitrate, soluble sugar and amino acid in lettuces were determined on May 30th, 2011.

Table 1 Treatments of the field experiment

NO	Treatment	Basal	Rosette	Leaf folding	Fast growing
1	CK	N0P100K100	N20P0K0	N40P0K0	N40PK0

2	NP	N20P20K100	N20P20K0	N30P30K0	N30P30K0
3	NK	N20P100K20	N20P0K20	N30P0K30	N30P0K30
4	NPK1	N20P20K20	N20P20K20	N30P30K30	N30P30K30
5	NPK2	N20P30K30	N40P30K30	N40P40K40	N0P0K0
6	NPK3	N20P20K20	N40P40K40	N40P40K40	N0P0K0

Table 2 Lettuce yield as affected by different fertilizer treatments

No	Treatment	Ⅰ	Ⅱ	Ⅲ	Yield (kg/plot)	Yield （kg/ha）	Relative yield (%)
1	CK	27.5	28.0	27.5	27.7±0.29	27.7±0.29 eEF*	100.0
2	NP	28.6	28.9	28.6	28.7±0.17	28.7±0.17 dD	103.3
3	NK	29.3	29.5	29.0	29.3±0.25	29.3±0.25 cC	105.6
4	NPK1	28.0	28.3	28.0	27.3±0.17	27.3±0.17 fF	102.2
5	NPK2	31.0	31.2	31.0	31.1±0.12	31.1±0.12 aA	112.3
6	NPK3	30.2	30.5	30.7	30.5±0.25	30.5±0.25 bB	110.3

* Different letters above the bars indicate significant ($p < 0.05$) differences between treatments.

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

No	Treatment	Vitamin C		Soluble sugar		Amino acid		Nitrate	
		mg/kg	%	%	%	mg/kg	%	mg/kg	%
1	CK	552.9	100.0	2.085	100.0	869.6	100.0	1387	100.0
2	NP	512.1	92.6	1.980	95.2	817.5	94.0	1495	107.8
3	NK	524.5	94.9	1.842	88.5	658.0	75.7	1475	106.3
4	NPK1	404.5	73.2	1.782	85.6	684.7	78.7	1464	105.6
5	NPK2	420.9	76.1	1.494	71.6	688.8	79.2	1717	123.8
6	NPK3	466.8	84.4	1.052	50.5	540.9	78.5	1866	134.5

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

No	Treatment	Vitamin C		Soluble sugar		Amino acid		Nitrate	
		mg/kg	%	%	%	mg/kg	%	mg/kg	%
1	CK	222.4	100.0	1.887	100.0	1323	100.0	1473	100.0
2	NP	166.6	74.9	1.712	90.5	1106	83.6	1450	98.4
3	NK	162.5	73.1	2.013	106.3	1361	102.9	1425	96.7
4	NPK1	199.7	89.8	1.728	91.5	851	64.3	1681	114.1
5	NPK2	175.7	79.0	1.779	94.2	1090	82.3	1674	113.6

6	NPK3	195.1	87.7	1.791	94.7	1202	90.8	1599	108.5

Table 5 Nutrient contents in lettuce leaf as affected by different treatments

No	Treatment	N		P		K	
		%	Relative %	%	Relative %	%	Relative %
1	CK	5.51	100.0	0.45	100.0	3.60	100.0
2	NP	5.49	99.6	0.42	93.3	4.08	113.3
3	NK	5.62	101.9	0.45	100.0	4.14	115.0
4	NPK1	5.62	102.0	0.44	97.8	4.05	112.5
5	NPK2	5.20	94.4	0.25	55.6	4.93	136.9
6	NPK3	5.45	98.9	0.16	35.6	4.82	133.9

Table 6 Nutrient contents in lettuce stem as affected by different treatments

No	Treatment	N		P		K	
		%	Relative %	%	Relative %	%	Relative %
1	CK	5.14	100.0	1.06	100.0	6.77	100.0
2	NP	5.34	104.0	1.08	101.9	6.97	103.0
3	NK	5.36	104.3	1.04	98.1	7.69	113.6
4	NPK1	5.26	102.4	1.12	105.7	7.28	107.5
5	NPK2	5.03	98.0	1.12	105.7	7.55	111.5
6	NPK3	5.13	99.9	1.12	105.7	7.15	105.6

3 Results and Discussion

Results indicated that lettuce yields were increased by 2.2-12.3%，compared to the conventional fertilization, and the NPK2 treatment produced the highest one. The contents of vitamin C, soluble sugar and amino acids of the lettuce leaf were decreased by 5.1 -26.8%, 4.8 -49.5% and 6.0 -4.3%, and nitrate content was increased by 5.6%-34.5%.Content of vitamin C of lettuce stem were decreased by 0.2 -26.9%. The content of soluble sugar was increased by 6.3% and amino acid content increased by 2.9% in the NK treatment, and reduced in the other treatments. The total nitrogen content was increased by 1.9% and 2.0% in the NK and NPK1 treatments, and reduced the rest treatments. Except the NK, total phosphorus content of all the other treatments were reduced by 2.2 -64.4%, the most decrease was in the NPK3 treatment. Splitting fertilization could improve total potassium content of lettuce and the maximum was in the NPK2 treatment. Total nitrogen content of lettuce stem was increased by the other treatments except the NPK2 and NPK3. Total phosphorus content was improved besides the NK. And total potassium content was increased by all the treatments.