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Optimum Application Rate of Nitrogen in Summer Peanut in Southern Shandong Area

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Abstract [**Objectives**] To study the effect of nitrogen (N) on the growth demand of summer peanuts under a certain level of phosphorus and potassium fertilizers, and to carry out experiments on nitrogen fertilizer control of summer peanuts. [**Methods**] Four treatments were set up in the experiment: no-nitrogen plot ($N_0P_4K_4$), optimized nitrogen plot ($N_7P_4K_4$), 70% optimized nitrogen plot ($N_5P_4K_4$), 130% optimized nitrogen plot ($N_9P_4K_4$), repeated 3 times, and arranged in random blocks. The area of the plot was 42 m^2, ridges were set between the plots, and protective rows of more than 1 m were set around the experimental site. The types of fertilizers were urea, superphosphate, and imported potassium chloride, and the variety of peanuts was Linhua 5. Except for the level of fertilization, other agricultural operations were the same, and soil sampling tests, field records, and yield testing were carried out according to the requirements of the plan. [**Results**] On the basis of 60 kg/ha of phosphorus and potassium fertilizer application, the optimum economical fertilizer application rate and the highest application rate of pure nitrogen were about 115.20 and 131.25 kg/ha, respectively. [**Conclusions**] This study is expected to provide a certain basis for the high-quality and high-yield summer peanuts in southern Shandong area.

Key words Southern Shandong area, Summer peanut, Nitrogen fertilizer, Optimum application rate

1 Introduction

In order to study the nitrogen (N) fertilizer demand effect of summer peanuts at a certain level of phosphorus and potassium fertilizers in southern Shandong area, explore the reasonable amount of N fertilizer, and improve the indicator system of summer peanut fertilization, we conducted an experimental study on the optimal nitrogen application rate of summer peanuts.

2 Materials and methods

This experiment was carried out in Diantou Town, Linshu County of Shandong Province in 2022. The soil type was sand ginger black soil, the previous crop was wheat, and the yield was 6 750 kg/ha. The soil fertility level was relatively high, and the nutrient content was as follows: total nitrogen 1.49 g/kg, alkaline nitrogen 127 mg/kg, available phosphorus 31.9 mg/kg, available potassium 240 mg/kg, and organic matter 25.7 g/kg.

Four treatments were set up in the experiment: no-nitrogen plot ($N_0P_4K_4$), optimized nitrogen plot ($N_7P_4K_4$), 70% optimized nitrogen plot ($N_5P_4K_4$), 130% optimized nitrogen plot ($N_9P_4K_4$), repeated 3 times, and arranged in random blocks. The area of the plot was 42 m^2, ridges were set between the plots, and protective rows of more than 1 m were set around the experimental site.

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3 Results and analysis

3.1 Growth dynamics and resistance performance Peanuts were sown on May 12, 2022 and harvested on September 15, 2022. The survey of experimental pests and diseases showed that root rot occurred sporadically, and leaf spot disease occurred more severely in the later stage. Insect pests were mainly leaf-eating pests, and the occurrence degree was relatively serious. Due to the long-term drought in May, 2022, peanuts were planted through entropy generation, and two irrigations were carried out in the early stage. However, continuous rainfall occurred during the pod setting period, which had a certain impact on the formation of peanut production.

3.2 Yield performance and components When the amount of phosphorus and potassium fertilizers was constant and relatively moderate, with the increase of N fertilizer amount, the peanut yield showed a parabolic trend[1-2]. The peanut yield in 70% optimized nitrogen plot and optimized nitrogen plot was significantly increased. The yield in optimized nitrogen plot reached the highest point, while the yield in 130% optimized nitrogen plot was decreased. Compared with no-nitrogen plot, with the increase in nitrogen fertilizer application, the number of fruit per plant in the optimized nitrogen plot was increased, and the 100-fruit weight was decreased[3]. Compared with 130% optimized nitrogen plot, number of fruit per plant in the optimized nitrogen plot was decreased, while the 100-fruit weight was increased. The three elements of yield in the optimized nitrogen plot were the most coordinated (Table 1).

Table 1 Experimental results of optimal nitrogen application rate of summer peanuts

Treatment	Plot yield//kg /42 m²			Mean yield kg/ha	Rank
	Repetition I	Repetition II	Repetition III		
Optimized nitrogen plot	278.02	278.37	290.24	4 233.15	1
130% Optimized nitrogen plot	281.55	263.04	276.25	4 104.15	2
70% Optimized nitrogen plot	254.35	238.58	248.06	3 705.00	3
No-nitrogen plot	191.39	181.02	187.94	2 801.70	4

3.3 Analysis of variance and *F* test The one-way classification method was used to carry out one-way analysis of variance on the test, and the *F* test was carried out (Table 2).

F = (S^2 between treatments/df)/(probable error S^2/df)
= (16 719.749/3)/(460.268/8)
= 162.503

Checked the *F* value table, $F_{0.05}=4.07$, $F_{0.01}=7.59$. $F=162.503>F_{0.01}=7.59$, showing that the difference between treatments reached a very significant level.

Table 2 Analysis of variance of optimum N fertilizer application rate of summer peanut

Group	Number of observations	Sum	Mean	Variance
Row 1	3	846.63	282.21	48.36
Row 2	3	820.84	273.61	90.94
Row 3	3	740.99	247.00	62.96
Row 4	3	560.35	186.78	27.88

Source of variance	*SS*	*df*	*MS*	*F*	*P*	*F-crit*
Inter-group	16 719.749	3	5 573.250	96.870	1.254E-06	4.066
Intra-group	460.268	8	57.533			
Total	17 180.017	11				

3.4 Multiple comparisons According to the requirements of the experiment, it is necessary to test not only the significance of the difference between the treatment and the control, but also the significance of the difference between the treatments. In this experiment, we used the *LSR* method, that is, the sum of squares regression. Compared with this method, the standard error *SE* of the variety should be calculated first.

$SE=\sqrt{S^2/N}=\sqrt{57.533\div 3}=4.38$

Checked the *SSR* value table, when $df=8$, the SSR_a values of $k=2$, 3, and 4 were obtained, and according to the formula $LSR_a=SE\times SSR_a$, the calculated LSR_a values were listed in Table 3.

Table 3 Calculation of LSR_a value for optimal nitrogen application rate in summer peanut

k	2	3	4
$SSR_{0.05}$	3.26	3.39	3.47
$SSR_{0.01}$	4.74	5.00	5.14
$LSR_{0.05}$	14.28	14.85	15.20
$LSR_{0.01}$	20.76	21.90	22.51

Then, we used the letter notation method to measure the significance of the yield difference between different treatments with LSR_a in Table 3, and listed the comparison results in Table 4.

Table 4 Results of *LSR* method in the optimal nitrogen application rate experiment for summer peanuts

Treatment	$\bar{x}$	Inter-comparison difference			Difference significance	
					5%	1%
Optimized nitrogen plot	282.21				a	A
130% Optimized nitrogen plot	273.61	8.6			ab	AB
70% Optimized nitrogen plot	247.00	35.21**	26.61**		c	C
No-nitrogen plot	186.78	95.43**	86.83**	60.22**	d	D

Note: Two mean values without the same letter mean that the difference reached 5% or 1% significant level by *t* test.

The results showed that: compared with the no-nitrogen plot treatment, each treatment reached a very significant difference. Compared with 70% optimized nitrogen plot and no-nitrogen plot treatment, the optimized nitrogen plot treatment reached a very significant difference. Compared with 130% optimized nitrogen plot treatment, 70% optimized nitrogen plot treatment reached extremely significant difference, indicating that when the application rate of phosphorus and potassium fertilizer was 79 kg/ha and the application rate of pure nitrogen is 105 – 135 kg/ha, the yield increase effect of summer peanut was the best.

3.5 Unary quadratic regression of N With the aid of Excel, we drew the *xy* scatter diagram and added a polynomial trend line to plot a regression curve on the relationship between the amount of nitrogen fertilizer (x) and peanut yield (y), and finally obtained the regression equation and coefficient of determination.

$y=-0.9084x^2+18.451x+185.73$, and coefficient of determination $R^2=0.9586$, indicating that the data corresponding to *xy* had a high correlation with the regression curve (Fig. 1).

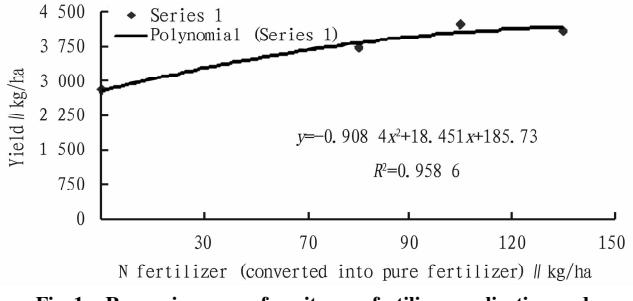

Fig. 1 Regression curve for nitrogen fertilizer application and summer peanut yield

According to the regression equation, it can be found that the highest yield fertilization amount was 8.75 kg of pure nitrogen, corresponding to a yield of 299.42 kg. Combined with fertilizer price of 5 yuan/kg of pure nitrogen and peanut price of 6 yuan/kg, the amount of fertilizer applied for the best economic yield was 7.68 kg, corresponding to a yield of 279.22 kg (Table 5).

Table 5 Economic benefit analysis of optimal nitrogen application rate experiment in summer peanut

Treatment	Fertilizer cost	Peanut yield			Net income	
	yuan/ha	Yield//kg/ha	Unit price//yuan	Income //yuan/ha	yuan/ha	Rank
Optimized nitrogen plot	1 215	4 233.15	6	24 183.9	25 398.9	1
130% Optimized nitrogen plot	1 365	4 104.15	6	23 259.9	24 624.9	2
70% Optimized nitrogen plot	1 065	3 705.00	6	21 165.0	22 230.0	3
No-nitrogen plot	690	2 801.70	6	16 120.2	16 810.2	4

4 Conclusions

The experimental results indicate that for the blue-black soil field with higher fertility level, the optimum economic nitrogen fertilization rate was 115.2 – 131.25 kg/ha, and the highest fertilization rate was 131.25 kg/ha on the basis of 70 kg/ha of phosphorus and potassium fertilizer application. When the nitrogen fertilizer application rate exceeded the optimal economic fertilization rate, although there was still room for a small increase in peanut yield, the economic benefits declined instead. When the nitrogen fertilizer application rate exceeded the maximum fertilization rate, the peanut yield would show a downward trend, and the economic benefit would be further decreased[4-5]. Combined with local soil fertility conditions, rational application of nitrogen fertilizer can not only realize the simultaneous increase of summer peanut yield and benefits, but also reduce the waste of fertilizer resources and environmental pollution[6].

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