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Quality of Reclaimed Domestic Water Irrigated Peppers - NPK Coupling Model and Optimized Combination Solution

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Abstract

Focusing on the coupling between the NPK content in Reclaimed domestic water irrigated peppers and capsaicin, a field experiment in the three-factor, five-level quadratic general revolving combination design was conducted for an in-depth analysis of capsaicin content coupling model by testing the significance of regression equation and coefficient with regression equation. The test result shows that : (1) factors affecting the content of capsaicin are in order of nitrogen fertilizer application level (x_1) > nitrogen fertilizer application level (x_2) > potassium fertilizer application level (x_3) according to the main factor effect analysis based on the established capsaicin-NPK coupling model; (2) the nitrogen-potassium interaction effectively improves the content of capsaicin. That is, the content of capsaicin theoretically tend to be 0g.kg^{-1} when both the nitrogen fertilizer application level and the level of potassium fertilizer application level are at the lowest; when the amount of nitrogen and potassium fertilizers application increases, the content of capsaicin increases accordingly. Medium nitrogen combined with medium potassium may result in the highest level of capsaicin content which can reach 0. 068g.kg^{-12} when the level of nitrogen and potassium fertilizers application reaches 120 g.kg^{-1} and 112.5g.kg^{-1} respectively . Under the circumstance of certain volume of potassium fertilizer application, the content of capsaicin further increases with the decrease in the level of phosphorus application. The maximum capsaicin content of 0. 21g.kg^{-1} is achieved when the level of potassium and phosphorus fertilizer application reaches 120 kg.hm^{-2} and 60 kg.hm^{-2} respectively; and (3) the range of the ideal target content of capsaicin in peppers irrigated with the reclaimed domestic water in China's Ningxia Region and the optimized NPK combination solution are obtained and developed. And in specific: the level of NPK fertilizers application would be 186.15kg.hm^{-2}, 71.17kg.hm^{-2} and 122.02kg.hm^{-2} respectively under the condition that the content of capsaicin being greater and beyond 0.12g.kg^{-1}.

Keywords: Reclaimed Domestic Water Irrigation; Capsaicin; Quality; Coupling Model; Optimized Combination Scheme.

1. Introduction

Pepper (Capsicum annuum L.), one of the major cash crops in China [1], has rich content of capsaicin, Vitamin C, and minerals like calcium, phosphorus and iron. With the pepper's sound adaptability, diverse varieties, vast growing area and sound economic returns, pepper growing has become, in many regions of China, a pillar industry to increase the income of farmers and promote the development of the rural areas [2]. Dong Siqiong and other researchers have developed and determined a best optimized combination solution through their researches of the impacts of different water qualities and water-fertilizer coupling on the yield, quality and safety of peppers. Result shows that the three major factors affecting the yield of pepper are ranked in order from the most to the least as W>F>S. The yield of pepper increases with the increase in irrigation quota and the proportion of reclaimed water in water for irrigation, and drops after increase with the increase in amount of fertilizer applied. The three factors affecting the Vitamin C and soluble protein in peppers and affecting the content of capsaicin are respectively arranged in order of F>S>W and F>W>S. A study conducted by Li Zhongyang and others[4] in terms of the impacts of different phosphorus fertilizers (diammonium phosphate, calcium magnesium phosphate fertilizer, and calcium superphosphate)

increase with the increase in amount of fertilizer applied. The three factors affecting the Vitamin C and soluble protein in peppers and affecting the content of capsaicin are respectively arranged in order of F>S>W and F>W>S. A study conducted by Li Zhongyang and others[4] in terms of the impacts of different phosphorus fertilizers (diammonium phosphate, calcium magnesium phosphate fertilizer, and calcium superphosphate)
on the growth, quality and yield of eggplant under the condition of reclaimed water irrigation shows that reclaimed water irrigation may result in remarkable increase in both the size and yield of eggplant; that the application of calcium magnesium phosphate fertilizer may remarkably improve the yield and quality of eggplant. It also shows that the calcium magnesium phosphate fertilizer application under reclaimed water irrigation may lead to the highest content of nutrients (N、P、Ca、Mg) in and the highest yield of eggplant. The studies show that the irrigation system applicable to the area is: the irrigation quota: 4860 m³.hm-2, and fertilizer application volume: 1440 kg.hm-2 for best growth, yield and quality eggplant under the mode of reclaimed water irrigation. It was found through studies conducted by Yang Zhenchao and others [6] that factors affecting the growth of lettuce are in the order of N＞P＞K. Cooke and others [7] found that appropriate increase in the application of nitrogen with interaction of

nitrogen and potassium may strengthen the potash fertilizer's effect in increasing the yield of crops. Studies by Dong Yan et al [8] show that appropriate increase in amount of phosphate application may remarkably improve the yield of crops. In China, studies on the reasonable NPK combination and application focus on tomatoes and cucumbers only [9]. Researches on impacts of NPK interaction on the growth, quality and nutrients content of vegetables have been carried out in Japan with an efficient and high-quality mode and regression model for higher yield of lettuce [10] having been developed accordingly. A research on impacts of NPK coupling on yield of muskmelons conducted by Ye Lin and his colleagues [11] by employing the three-factor, five-level quadratic general revolving combination design shows that the amount of the applied fertilizers affecting the yield of muskmelons can be ranked in order of P＞N＞K. By taking the loose lettuces grown in Hong Kong as the test materials and adopting the three-factor, five-level quadratic general revolving combination design, Zhang Dong et al [12] analyzed the earlier and later stage impacts of NPK on the yield of the lettuces and found that in the earlier stage of the growth of hydroponic lettuce, the effect of NPK on the yield of the tested lettuce could be ranked in order of N>P>K which shows the interaction among such factors. By taking the seedlings of mid subtropical Chinese fir as research objects, Zhao Panpan et al carried out a study regarding the effects of short-term warming on microbial biomass nitrogen (MBN), microbial biomass phosphorus (MBP), nitrogen and phosphorus nutrients in soil and coupling of nitrogen and phosphorus. It was found through the study that the effect of the coupling is very much influenced by the interaction between nitrogen and phosphorus. Reasonable ratio of fertilizers [14] can help achieve the improved yield of peppers. Currently, however, research concerning the effect of NPK content in reclaimed domestic water irrigated peppers on coupling of capsaicin is quite limited in the world.

2. Materials and Methods

2.1. Background Information of the Test Area

The test was conducted at Reclaimed Water Test and Demonstration Base of Yingli Group Ltd in Shapotou District, Zhongwei City, Ningxia (37°34′N，105°10′E）from 2019 to 2021. Being located in the hinterland of China, the test area is of a semi-arid region that features typical continental monsoon climate and desert climate with strong wind and sandstorm, drought due to limited volume of rainfall, big difference of temperature during day and night, remarkable water evaporation during the daytime, short summer, and long winter, with most of the rainfall taking place during the period from June to August. The annual volume of rainfall is 179.6mm, accounting for 60% of the total volume of rainfall in a year round; The annual volume of evaporation:1829.6 mm; number of average annual frost-free days: 155; the annual total number of hours of sunshine: 2800; , the total annual volume of solar radiation: 5872.9 kJ · cm-2, the average temperature a year round : 8.8 ℃; large difference of temperature even during the daytime to range from 10 to 16 ℃ with the average annual temperature ranging between 7.3 and 9.5 ℃, the terrain of the field of the test is plain with well-balanced fertility; Texture of the field: loam; field water holding rate: 23.5% (accounting for % of dry soil weight), and the soil dry bulk density: 1.43 g cm3.

2.2. Test Design

The test is designed to adopt the three-factor, five-level quadratic general revolving combination design. It is determined in line with the actual condition of the agricultural production activities in the area of the test that volume of N, P, K fertilizers (including the original fertility of the soil) serve as the test factors (Z_j), for each of which, five levels are set. Number of test treatments (*n*): 20; the zero level （Z_{j0}） and the interval of changes（Δ_j） are：

$$Z_{j0} = \frac{Z_{j1} + Z_{j2}}{2} \quad (1)$$

$$\Delta_j = \frac{Z_{j2} - Z_{j1}}{\gamma} \quad (2)$$

As seen in the equations above that Z_{j2} and Z_{j1} represent the upper and lower limit of the factors respectively; J stands for the number of the factors: j=1，2，3；γ serves as asterisk and is determined according to the requirements of the universal rotative of quadratic regression; that is: $\gamma=2^{p/4}$（with *p* representing the number of factors）. Level code obtained after the linear change of the factor Z_j:

$$X_j = \frac{Z_j - Z_{j0}}{\Delta_j} \quad (3)$$

The Equation (3) shows that the natural variable Z_j turns into a unitless canonical variable X_j with the factors and levels after encoding being: -1.682, -1, 0, 1 and 1.682 (see Table 1 below).

2.3. Test Implementation

Treatments concerning time of sowing, density of planting, forms of planting and the original fertility of soil are the same. Technology adopted: beneath-mulch drip irrigation technique; Material adopted: embedded drip belts; Dripper spacing: 30 cm; Drip belt spacing: 45cm. Pre-planting irrigation was carried out before planting on 31 May 2018 with a set drip-irrigation quota of $96m^3$.hm-2; four irrigations per month; total number of irrigations: 12; quota of irrigation: $1152m^3$.hm-2. Fertilizer application was performed on 01 July and 01 August respectively. Different fertilizers of ammonia, urea and potassium were blended according to the set level (of N180-P2O590-K2O112.5 kg.hm-2). Sampling for yield survey was conducted on 22 September 2018. Harvest was accomplished on 23 September with quality of pepper plants, dry matters and the economic output of peppers having been surveyed and determined also.

2.4. Items Observed

Items observed include height of pepper plants, moisture content and bulk density of soil, water-holding capacity of field, capsaicin, total substances of capsaicin, Vitamin C and yield.

3. Test Results Analysis

3.1. Establishment of Coupled Model of Capsaicin and NPK

Contents of capsaicin obtained through tests are displayed in Column 12, (**Table 2)** below. Statistic analysis of the capsaicin contents obtained ($g.kg^{-1}$) was carried out with DPS on the basis of three-factor, five-level quadratic general revolving combination design.

The combined capsaicin-NPK regression model of quadratic general rotation obtained through statistics of the contents of capsaicin shown in (**Table 2**) below is:

$$y=0.068+0.0026x_1-0.0265x_2-0.0198x_3-0.0093x_1^2-0.00272x_2^2-0.0122x_3^2+0.0149x_1x_2-0.0085x_1x_3+0.0077x_2x_3$$

According to the equation: *y* represents the content of capsaicin ($g.kg^{-1}$); x_j represents the dimensionless variables after linear transmission; j=1，2，3.

Levels	Factors		
	Amount of Nitrogen (z1) (kg.hm-2)	**Amount of Phosphorus P2O5 (z2) (kg.hm-2)**	**Amount of Potassium K2O (z3) (kg.hm-2)**
1.682	240	120	150
1	215.7	107.8	134.8
0	180	90	112.5
-1	144.3	72.2	90.2
-1.682	120	60	75

Table 1: Codes of Factors and Levels.

Treatments	**Constant Terms x_0**	**N x_1**	**P x_2**	**K x_3**	**N-P**	**N-K**	**P-K**	**Nitrogen Quadratic Term**	**Phosphorus Quadratic Term**	**Potassium Quadratic Term**	**Capsaicin**
					x_1x_2	x_1x_3	x_2x_3	x_1^2	x_2^2	x_3^3	y
											($g.kg^{-1}$)
-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12
1	1	1	1	1	1	1	1	1	1	1	0.06
2	1	1	1	-1	1	-1	-1	1	1	1	0.1
3	1	1	-1	1	-1	1	-1	1	1	1	0.09
4	1	1	-1	-1	-1	-1	1	1	1	1	0.06
5	1	-1	1	1	-1	-1	1	1	1	1	0.06
6	1	-1	1	-1	-1	1	-1	1	1	1	0.02
7	1	-1	-1	1	1	-1	-1	1	1	1	0.15
8	1	-1	-1	-1	1	1	1	1	1	1	0.05
9	1	1.682	0	0	0	0	0	2.828	0	0	0.04
10	1	-1.682	0	0	0	0	0	2.828	0	0	0.04
11	1	0	1.682	0	0	0	0	0	2.83	0	0.07
12	1	0	-1.682	0	0	0	0	0	2.83	0	0.22
13	1	0	0	1.68	0	0	0	0	0	2.83	0.05
14	1	0	0	-1.7	0	0	0	0	0	2.83	0.02
15	1	0	0	0	0	0	0	0	0	0	0.1

16	1	0	0	0	0	0	0	0	0	0	0.1
17	1	0	0	0	0	0	0	0	0	0	0.04
18	1	0	0	0	0	0	0	0	0	0	0.08
19	1	0	0	0	0	0	0	0	0	0	0.06
20	1	0	0	0	0	0	0	0	0	0	0.04

Table 2: Structure Matrix (X) of three-factor quadratic general revolving combination design and Tested Contents of Capsaicin**.**

3.2. Test of Capsaicin-NPK Coupling Model

Regression and mismatch test were carried out on the model obtained. The regression fitting F_r value obtained through calculation is 4.27 with level of significance level P being 0.005 (less than 0.05), and the mismatch test value F_{LF} value being 1.26, less than $F_{0.05}$=3.69 which is not quite significant, showing that the regression equation obtained is usable. Therefore, the content of capsaicin (in fresh weight) in peppers estimated and measured with the coupled regression model is highly reliable. Results of calculation through the t-test on the model are:

t_0=5.661, t_1=0.331, t_2=3.321, t_3=2.481,
t_{11}=1.204, t_{12}=1.435, t_{13}=0.816, t_{22}=3.504,
t_{23}=0.741, t33=1.575

The results above show that the constant terms, the primary terms of phosphorus and potassium and the quadratic terms of phosphorus have reached the level of extreme significance with the interaction terms of nitrogen and phosphorus having reached level of significance. The primary terms of nitrogen, the terms of interaction between nitrogen and potassium and that between phosphorus and potassium are not quite significant.

3.3. Capsaicin-NPK Coupling Model Analysis

3.3.1. Effect of Principal Factors

As the partial regression coefficient is not affected by the amount and unit of factor value after the change in dimensionless linear encoding or after it has actually become standardized and the amount of value can now directly reflect the extent to which the variable impacts the content of capsaicin, it is therefore concluded that factors affecting the content of capsaicin during the process of the test can be ranked in order of: amount of phosphorus (x_2) > amount of potassium (x_3)> amount of nitrogen (x_1).

3.3.2. Effect of Single Factor

Fix two of the three factors, nitrogen, phosphorus and potassium, in the regression model at Level Zero to obtain the regression sub-models of single factor on capsaicin content shown in equations (4-15) ～ (4-17):

Nitrogen：

$$- \ y1 = 0.068 + 0.0026\, x_1 - 0.0093 x_1 \quad (5)$$

Phosphorus：

$$y2 = 0.068 - 0.0265 x_2 + 0.0272 x_2^2 \quad (6)$$

Potassium：

$$y3 = 0.068 - 0.0198 x_3 - 0.0122 x_3^2 \quad (7)$$

According to the partial regression sub models above, such results as $x_1=0.141$， $x_2=0.4868$ and $x_3=-0.809$ can be obtained when $dy_1/dx_1=0$， $dy_2/dx_2=0$， $dy_3/dx_3=0$. And the content of capsaicin reaches the highest values of $y_1=0.0682$g/ kg and $y_3=0.076$ g/kg respectively when $x_1=0.141$ and $x_3=-0.809$.

The partial regression sub models above show that the predicted values of capsaicin content under different levels of single factor can be obtained respectively when other factors are at 0 (as shown in (**Table 3)**; see (**Figure 2)** for its trend of change).

As seen that the content of capsaicin is in an open downward trend during the process where the volume of nitrogen application rises from 120 kg.hm^{-2}（level -1.682）to 240 kg.hm^{-2}（level 1.682）throughout the test but shows a tend of decrease when volume of when the volume of phosphorus application climes from 60 kg.hm^{-2}（level -1.682）up to 120kg.hm^{-2}（level 1.68）. The content of capsaicin is also in an open downward trend during the process where the volume of potassium application rises from 75 kg.hm^{-2}（level -1.682）to 150 kg.hm^{-2}（level 1.682）.

As seen, moreover, that the content of capsaicin is in a trend of rise from 0.037 g.kg^{-1} to 0.061g.kg^{-1} when the volume of nitrogen application increases from 120 kg.hm^{-}2 (level -1.682)to 180 kg.hm^{-2}（level 0）with the increase in yield reaching 0.0004 g.kg^{-1} when the unit nitrogen application increases. It is concluded therefore that the content of capsaicin comes to the highest level under the test circumstance when the applied amount of nitrogen fertilizer reaches 180 kg.hm^{-2}, but the content will drop with more nitrogen applied subsequently.

The content of capsaicin shows a trend of decrease from 0.189 g.kg^{-1} down to 0.061 g.kg^{-1}when the level of phosphorous application rises from 60 kg.hm^{-2}（level -1.682水平）to 90 kg.hm^{-2} (level 0) and drops down to 0.0043 g.kg^{-1} when the unit phosphorus fertilizer application is increased, which clearly shows that the content of capsaicin is at its highest when nitrogen level is at 60 kg.hm^{-2}, and shows that increase in phosphorus application will lead to the decrease in the content of capsaicin.

The content of capsaicin shows a trend of rise from 0.01 g.kg^{-1} to 0.065 g.kg^{-1} when potassium fertilizer amount increases from 75 kg.hm^{-2}（level -1.682）to 134.8 kg.hm^{-2}（level +1）. When the amount of potassium applied increases, the increased amount of yield is 0.0092 g.kg^{-1}, which clearly shows that increase in the amount of potassium fertilizer to certain extent may result in an increased content of capsaicin. In general, phosphorus fertilizer has the most impacts on the content of capsaicin, that is, the content of capsaicin will be 0.037 g.kg^{-1}, 0.1 g.kg^{-1} and 0.0628 kg.hm^{-2} accordingly when the levels of NPK fertilizer application are all at 120 kg.hm^{-2}.

4. Interaction Between Different Factors

It is discovered through the in-pair analysis of the interactions between the test results that under the circumstance of test, all the factors interact with one another (see Fig 2 for the trend of interaction).

$$y1 = 0.068 + 0.0026x_1 - 0.0265x_2 - 0.0093x_1^2 + 0.0272x_2^2 + 0.0149x_1x_2 \quad (8)$$

$$y2 = 0.068 + 0.0026x_1 - 0.0198x_3 - 0.0093x_1^2 - 0.0122x_3^2 - 0.0085x_1x_3 \quad (9)$$

$$y3 = 0.068 - 0.0265x_2 - 0.0198x_3 + 0.0272x_2^2 - 0.0122x_3^2 + 0.0077x_2x_3 \quad (10)$$

As seen from Fig. 2b below that impact of interaction between nitrogen and phosphorus under the condition of test on the content of capsaicin is a complicated process.

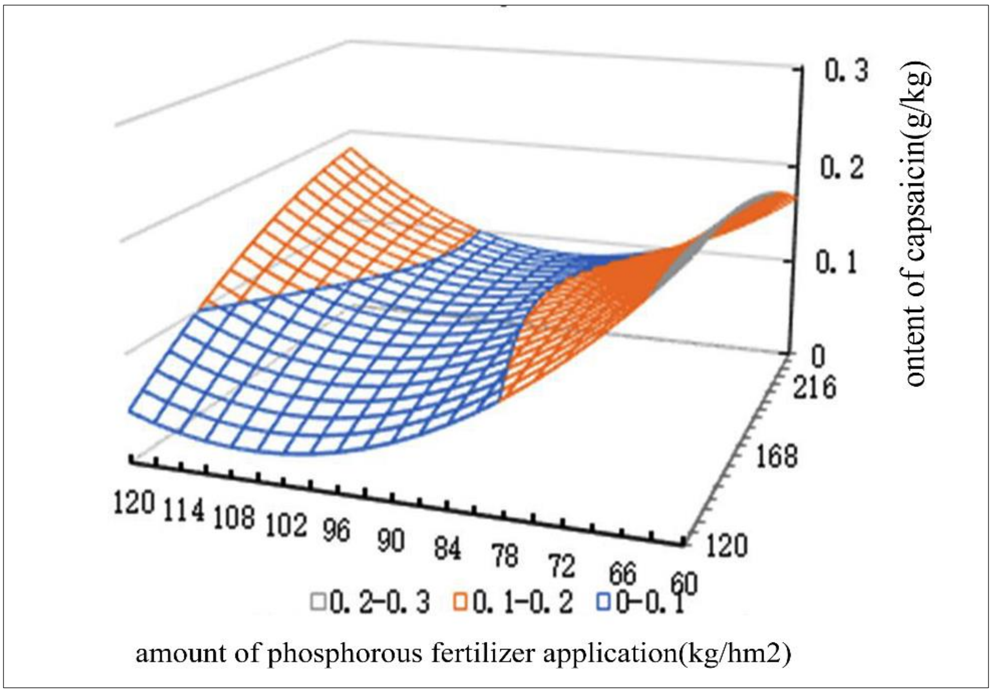

Figure 1: Interaction between nitrogen and phosphorus.

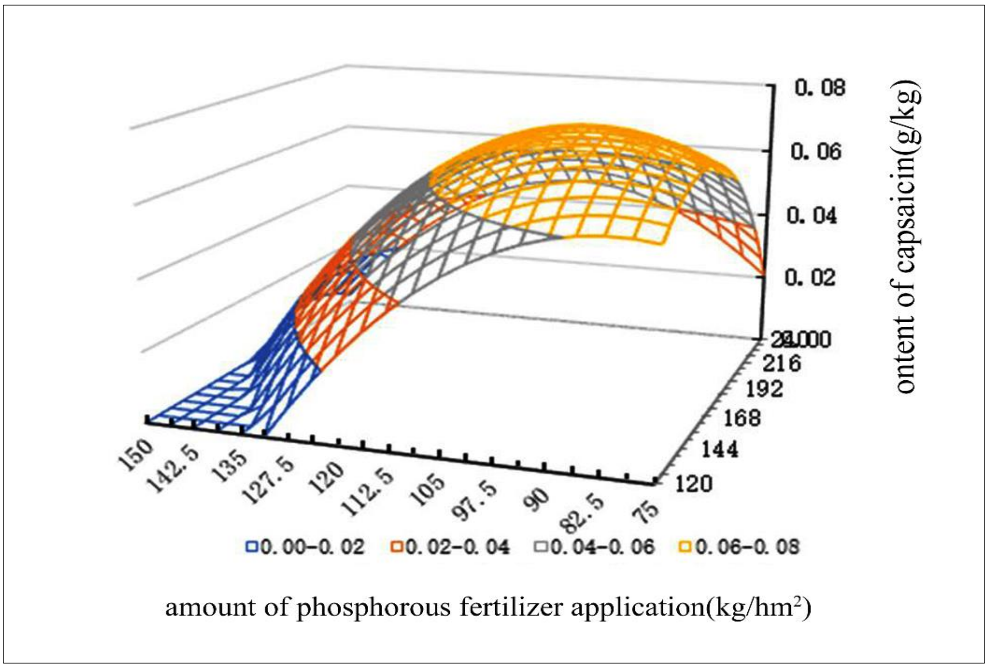

Figure 2: Interaction between nitrogen and potassium.

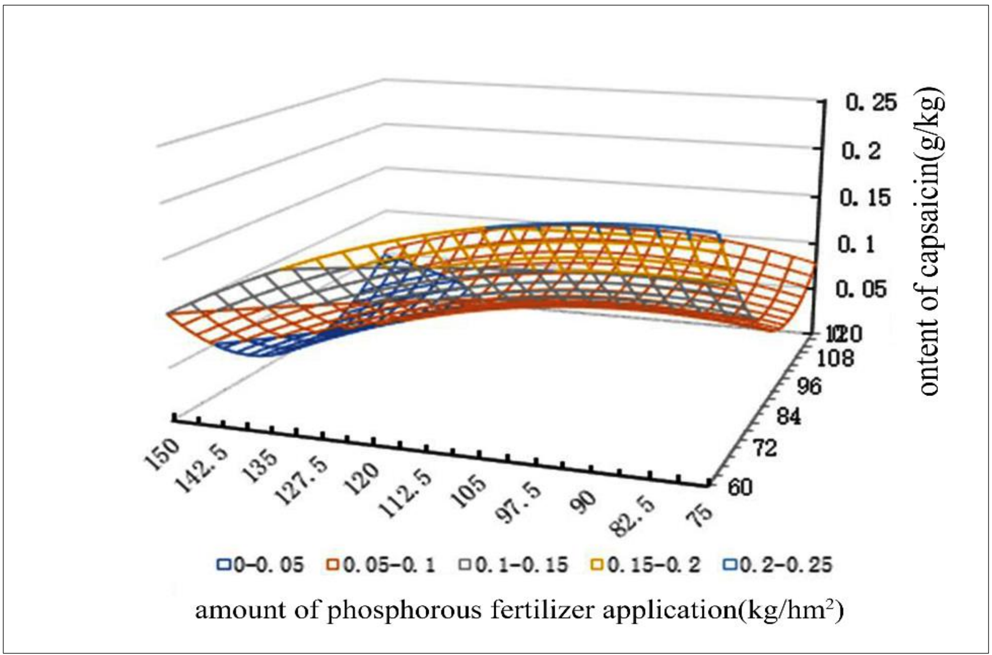

Figure 3: Interaction between phosphorus and potassium.

Excessive application of phosphorus fertilizer may lead to decreased capsaicin content while content of capsaicin may be efficiently improved to reach 0.217g.kg^{-1} with medium amount of nitrogen plus low amount of phosphorus. The Fig 2c shows that under the test, interaction between nitrogen and potassium may effectively improve the content of capsaicin. When both of the level of nitrogen and potassium fertilizer application are at the lowest, the content of capsaicin will theoretically tend to be 0 g.kg^{-1}. On the other hand, however, increase in both the level of nitrogen and potassium fertilizer application, the content of capsaicin increases accordingly. The maximum content of capsaicin may be achieved under the circumstance of application of fertilizer with medium amount of nitrogen plus low amount of phosphorus. And such content may reach 0. 068g.kg^{-2} when the applied amount of nitrogen and potassium are 120 g.kg^{-1} and 112.5g.kg^{-1} respectively. Fig.2d shows that under certain circumstance during the process of the test, the content of capsaicin will further increase with the decrease in the applied amount of phosphorus with the highest volume of 0.21g.kg^{-1} of capsaicin content being obtained when the amount of potassium and phosphorus fertilizer applied reaches 120 kg.hm^{-2} and 60 kg.hm^{-2} respectively. Subsequently, however, the content drops somehow with the increase in the amount of phosphorus fertilizer.

Calculation was conducted according to the established coupling model of NPK in peppers and carried out the simulation of the optimized combination scheme under different objectives by taking five levels (of -1.682, -1, 0, +1,+1.682) between (-1.682, -1, 0,+1,+1.682) with 33 combinations showing the content of capsaicin in peppers greater than 0.12 g.kg^{-1} having been obtained.

6. Discussion

The test conducted focused on the analysis of the quadratic regression model of the yield factors through the three factors of nitrogen (N), phosphorus (P) and potassium (K). Factors affecting the content of capsaicin ranked in order of (x1) > applied amount of phosphorus (x2) > applied amount of potassium (x3) were obtained through the analysis of the effects of the main factors. As seen, that under the reclaimed

Levels	X_1		X_2		X_3	
	Number of Times	Frequencies	Number of Times	Frequencies	Number of Times	Frequencies
-1.682	6	0.18	20	0.61	4	0.12
-1	5	0.15	8	0.24	5	0.15
0	6	0.18	1	0.03	5	0.15
1	9	0.27	0	0	9	0.26
1.682	7	0.22	4	0.12	10	0.3
Total Number of Times	33	1	33	1	33	1
Weighted Average	186.15		71.17		122.02	
Standard Error	7.63		3.37		4.66	
95% Interval of Distribution	171.18～201.11		64.57～77.77		112.89～131.16	

Table 4: Optimization Scheme under the Circumstance of Capsaicin Content Greater than 0.12g·kg 1

domestic water irrigation circumstance, the NPK influence on the content of capsaicin decrease successively, and that the treatment of the low-amount application and zero application of NPK fertilizers may result in the premature senility and weak growth of peppers. The optimal combination scheme of nitrogen, phosphorus and potassium in the content range of capsaicinoids goes like this that: the applied amount of NPK fertilizers is 186.15kg.hm^{-2}, 71.17kg.hm^{-2} and 122.02kg.hm^{-2} respectively under the condition of the content of capsaicin being greater than 0. 12g.kg^{-1}. Results obtained from the research show amounts of fertilizer application lower than the guiding amounts proposed by Lyv Changshan [15] and Huang Ke [15, which may be due to the condition of soil fertility and or variety of the peppers. Impact of interaction between nitrogen and phosphorus under the condition of test on the content of capsaicin is a complicated process. Excessive application of phosphorus fertilizer may lead to decreased capsaicin content while content of capsaicin may be efficiently improved to reach 0. 217g.kg^{-1} with medium amount of nitrogen plus low amount of phosphorus.

Under certain circumstance during the process of the test, the content of capsaicin will further increase with the decrease in the applied amount of phosphorus with the highest volume of 0. 21g.kg^{-1} of capsaicin content being obtained when the amount of potassium and phosphorus fertilizer applied reaches 120 kg.hm^{-2} and 60 kg.hm^{-2} respectively. Subsequently, however, the content drops somehow with the increase in the amount of phosphorus fertilizer. And these are due to the fact that increase in nitrogen level may lead to an increase in nitrogen metabolism, which has a positive effect on synthesis of capsaicin as a nitrogen-containing compound. The effects of phosphorus and potassium on capsaicin synthesis present themselves in the promotion of the activity of protease and in the promotion of the activity and absorption of nitrogen respectively. Therefore, under the condition of reclaimed water irrigation, attention should also be paid to the NPK coupling amount, which will not only result in an improved yield and quality of pepper, but also a well relieved pollution to the environment for sustainable development.

7. Conclusion

1. Establishment of Capsaicin-NPK Coupling Model with factors affecting the content of capsaicin in order of nitrogen fertilizer application level (x_1) > nitrogen fertilizer application level (x_2) > potassium fertilizer application level (x_3) having obtained through analysis of effects of main factors;

2. The interaction analysis shows that impact of interaction between nitrogen and phosphorus under the condition of test on the content of capsaicin is a complicated process. Excessive application of phosphorus fertilizer may lead to decreased capsaicin content while content of capsaicin may be efficiently improved with medium amount of nitrogen plus low amount of phosphorus; and that interaction between nitrogen and potassium may effectively improve the content of capsaicin. When both of the level of nitrogen and potassium fertilizer application is at the lowest, the content of capsaicin will theoretically tend to be 0 g.kg ^{1}. On the other hand, however, increase in both the level of nitrogen and potassium fertilizer application, the content of capsaicin increases accordingly. The maximum content of capsaicin may be achieved under the circumstance of application of fertilizer with medium amount of nitrogen plus low amount of phosphorus. And such content may reach 0.068g.kg^{-2} when the applied amount of nitrogen and potassium are 120 g.kg^{-1} and 112.5g.kg^{-1} respectively; Under certain circumstance during the process of the test, the content of capsaicin will further increase with the decrease in the applied amount of phosphorus with the highest volume of 0.21g.kg^{-1} of capsaicin content being obtained when the amount of potassium and phosphorus fertilizer applied reaches 120 kg.hm^{-2} and 60 kg.hm^{-2} respectively. Subsequently, however, the content drops somehow with the increase in the amount of phosphorus fertilizer.

The optimal combination scheme of nitrogen, phosphorus and potassium in the content range of capsaicinoids: the applied amount of NPK fertilizers is 186.15kg.hm^{-2}, 71.17kg.hm^{-} and122.02kg.hm^{-2} respectively under the condition of the content of capsaicin being greater than 0. 12g.kg ^{1}.

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