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Effects of Soil Texture and Water Retaining Agent on the Emergence of Processing Tomatoes

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Abstract

In the present paper, effects of two factors including soil texture(sand content rate) and water retaining agent on the emergence ratio of processing tomatoes were investigated through general regression of agricultural design testing and data-processing system (DPS),with attempts to obtain the best agronomic measures according to the model The linear relationship between design factors and target values (Emergence rate) of the test model and effects of one degree item, quadratic item and interaction item were also observed in the present paper. Result showed the optimal intervals of X_1 and X_2 ranged from 0.83251~1.167949(g/100g) and 15.1765~34.8235%, respectively.

Keywords: Processing tomato, Soil texture, Water retaining agent, Emergence, Regression design and analysis

1. Introduction

Currently, processing tomato has been the leading industry and biggest export-oriented enterprise. Planting and processing of tomatoes has been the significant economic pillar for Xinjiang people of all nationalities to increase yield and benefit and wealth accumulation in rural areas(He, 2008, PP. 42~44). In order to solve the problem of supplying in balance and obtain high quality and high yield, planting patterns of processing tomato seedling transplantation have been extensively spread in recent years, especially plug-seedling in Xinjiang which resulted in extensive popularization and good results(Wang, 2007, P. 17). However, in actual practice, observation of emergence rate and its resultant control technique, especially effects of soil texture in combination with water retaining agent on the emergence of processing tomatoes have been less documented, and we thus know less about technological measures of increasing emergence rate of processing tomatoes. Therefore, in the present paper, we investigated effects of two factors including soil texture (sand content rate) and water retaining agent on the emergence ratio of processing tomatoes in order to obtain the best agronomic measures and look forward to provide scientific theoretical basis for producing(Zhi, 2003, PP. 360~361).

2. Materials and methods

2.1 Materials

The present study was undertaken in the NO.5 greenhouse of Vegetable institute of Shihezi in March, 2008, seeded on 1st March. The variety used was "rieger 87-5", a early maturing and main variety in Shihezi with 1000-grain weight of 3.0g and germination of 98%. Shufeng water-saving agent, loam soil and silt soil(diameter: 0.0625~0.0039mm) were applied in the present study. Basic nutritional constituent of loam was 3.6% organic matter, 0.18% total nitrogen, 0.27% total phosphorus, 6.5×10^{-6} available potassium and 2.2×10^{-5} available phosphorus (Fan, 2008, PP. 199~201, Jie, 2000, PP. 22~24). Tomatoes were seeded by the 72 plugs of polystyrene (50cm×30cm×30cm). 72 seeds were selected for treatment of each group with a thermometer, and 1 seed per plug.

2.2 Methods

According to the preliminary tests and empirical data, upper limit(+R) of water retaining agent consumption(per 100g soil) X_1 was valued as 2g/100g while lower limit(-R) as 0; loam soil and silt soil(diameter: 0.0625~0.0039mm) were prepared by different volume ratios(sand content rate) of percentage X_2 with the upper limit(+R) of 50% and lower limit(-R) of 0 in the present two factors model. The consumption used for study was prepared according to the data listed in Table 1. 13 tests were performed to study the effects of two factors on emergence rate (%) , namely variable Y by the quadratic general rotary unitized design with the aid of DPS v3.01. Processing flow was $X_1 \rightarrow X_2$. Maximum and minimum temperatures of greenhouse were recorded during the period of trial.

3. Results and analysis

3.1 Observation of experimental conditions

Air temperature of the greenhouse was observed during the period of trial, used as references for administration and emergence. Average lowest and highest temperature was 18.8℃ and 35.7℃, respectively, during the period from 1st March to 17th March while maximum and minimum temperature was 42.0℃ and 12.0℃, respectively. During the period, the hotter days were five in the early stage lasting shortly and thus had less interference with emergence.

3.2 Regression relation of water retaining agent, soil texture and seedling number

As seen from the emergence of each test, along with the level values of -R→+R, emergence rate decreased gradually. Y was obtained through seedling numbers, used as target values. Binary quadratic regression relation of two factors and target value was observed. Resultants Y (Table 2, 3) were input into programme, and through calculating, the following regression equation was obtained:

$$Y=42.50000 -2.76777X_1+ 0.52678X_2 +2.01134X_1^2 +12.76250X_2^2-1.05000X_1X_2 \quad (1)$$

Variance analysis and F value testing was undertaken to investigate the fitting degree and reliability of equation (1). As seen from Table 3, due to F_1=1.880<3.97(Critical value of $F_{0.05}$), lack of fit term was not significant, and thus we could taken further statistics analysis and test the quadratic regression model; due to F2=4.036>3.97, quadratic regression equation was significant at the level of 0.05 which indicated that experimental data was in line with the applied quadratic mathematic model, and quadratic regression equation fit actual situation closely and could be used as references for forecasting. At the level of 0.05, P values of X_1, X_2 and X_2^2 term were all lower than 0.05 which indicated that effects of one degree term of the three factors level on the emergence rate of rieger 87-5 were significant; P values of X_2 and X_1X_2 term were higher than 0.05 which indicated that effects of these two terms on the emergence rate were not significant and could be eliminated for no references.

At the significant level of α=0.10 after eliminating the insignificant term, regression equation was briefed as follows:

$$Y=42.50000-2.76777X_1+2.01134X_1^2+12.76250X_2^2 \quad (2)$$

Mathematical model equation(2) provide a information base which could be used as a reference to analysis effects of one degree term and square term and obtain the best agronomic measures for produce.

3.3 Effects analysis of each term according to the target value of emergence rate

According to equation(2), partial regression equation of one degree and square term X_i(i=1,2) against Y_{xi} was obtained as follows:

$$\hat{Y}x_1= 42.50000-2.76777X_1+2.01134X_1^2 \quad (3)$$

$$\hat{Y}x_2= 42.50000+12.76250X_2^2 \quad (4)$$

Through derivation of equation(3) and (4), we have

$$\hat{Y}x_1'= -2.76777+4.02268X_1 \quad (5)$$

$$\hat{Y}x_2'= 25.5250X_2 \quad (6)$$

Different level values were obtained through solving equation, and compared to value of zero level, within the range of -R≤Xi≤+R, level value X_1 which showed effects on emergence was 0.55 at the range of 0~+1 while X_2 was 0 at the range of -1~+1. Therefore, we could speculate that water retaining agent had the greater effects on emergence rate of processing tomatoes and soil texture followed.

3.4 Optimization of agronomic measures

Maximum of Y attained 91.67% in the tests. Taken emergence rate of 56.54% as target value, frequency analysis were undertaken through the designed mathematical model(Table 4), and corresponding factor values of two factors in 95% confidence interval were obtained, which were qualified for our interval estimate values of optimized agronomic measures(Table 5).

$$X_1=0.83251\sim1.167949g/100g$$

$$X_2=15.1765\sim34.8235\%$$

4. Conclusions

Effects of two factors, namely water retaining agent consumption X_1 (X_1g/100g) and soil texture X_2 (sand content rate, %) on emergence rate Y(%) were investigated in the present paper. According to the quadratic general rotary unitized design and analysis, results showed that there was a linear relationship between Y and two factors X_i (i=1, 2) and past through F_1 and F_2 value test. Through effect analysis of one degree and square term of equation, results showed that level value X_1 which showed effects on emergence was 0.55 at the range of 0~+1 while X_2 was 0 at the range of -1~+1 compared to value of zero level. Taken average emergence rate of 56.54% as ideal target value in each test, the optimal intervals of X_1 and X_2 ranged from 0.83251~1.167949(g/100g) and 15.1765~34.8235%, respectively. In the trial, we also could speculate that if water retaining agent consumption increased along with the increasing of soil content rate within the designed interval range, high emergence rate was obtained.

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Table 1. Values and levels of the independent variables (R=1.41)

independent variables	levels				
	-R	-1	0	+1	+R
X_1g/100g	0	0.29	1	1.71	2
(x_2,%)	0	7.3	25.0	42.7	50.0

Table 2. Experimental design and results

Experiment NO.	X_1	X_2	Seedling number
1	1	1	41
2	1	-1	43
3	-1	1	66
4	-1	-1	63
5	-R	0	47
6	R	0	32
7	0	-R	44
8	0	R	45
9	0	0	38
10	0	0	29
11	0	0	35
12	0	0	28
13	0	0	20

Table 3. Variance analysis of the test results

Source of variance	Sum of squares	Degree of freedom	Mean square	F ratio	P value
X_1	75.5124	1	75.5124	11.6599	0.0112
X_2	110.1997	1	110.1997	0.0160	0.9030
X_1^2	17.8574	1	17.8574	8.4204	0.0229
X_2^2	140.8696	1	140.8696	14.4316	0.0067
X_1X_2	6.1951	1	2.1951	0.0438	0.8402
Regression	361.2026	5	167.5777	F_2=4.036	0.0686
Residual	52.4888	7	46.9384		
Lack of fit	17.3528	3	55.268	F_1=1.880	0.1664
Pure error	32.3840	4	28.552		
Total	423.4902	12			

Table 4. Each factor group of top value

Frequency distribution of variances in 18 tests with target value over 56.54%				
Level	X_1	Frequency	X_2	Frequency
-1.4142	3	0.2278	3	0.2778
-1.0000	3	0.2278	3	0.1667
0.0000	2	0.1111	1	0.1111
1.0000	2	0.1111	1	0.2667
1.4142	1	0.2222	2	0.2778

Table 5. Frequency of of variances in 18 tests with target value over 56.54%

	Weighted mean square	Standard error	95% confidence interval
x_1	-0.2450	0.2720	-0.778... 0.287
x_2	0.1000	0.2630	-0.555...0.555

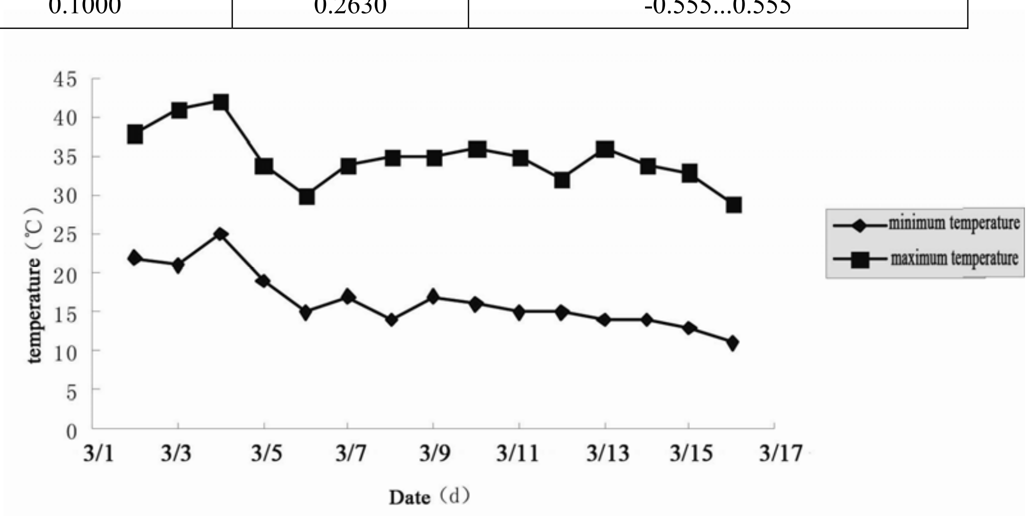

Figure 1. Changing curves of temperature during the period of trial