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Effects of Calcium Application Rate on Dry Matter Accumulation and Yield of Peanut

Junjie XIU, Xueliang LIU *

Tieling Academy of Agricultural Sciences, Tieling 112000, China

Abstract The effects of calcium application rate on dry matter accumulation and yield of peanut were studied under high-yielding field condition. The variety used for the study was Tang A8252 (Spanish peanut). The results showed that number of full fruit, dry weight per plant, kernel yield, and pod yield all increased with calcium application increased, and they decreased when calcium application rate was more than 150 kg/ha. Both the height of main stem and the length of side shoot decreased with calcium application increased. Therefore, to obtain the optimal agronomic character index and the highest yield benefit, the suggested calcium application rate would be 150 kg/ha for peanut.

Key words Peanut, Calcium application rate, Dry matter accumulation, Yield

1 Introduction

Ca is one of essential nutrient elements in plant growth process[1]. Peanut needs more Ca, and Ca^{2+} concentration seriously affects fruiting and yield of peanut[2]. When pod could not obtain enough Ca during fruiting period, although it could expand and become mature, the plumpness declines and empty grain rate increases[3-4]. At present, Ca deficiency phenomenon in peanut field is common, and the phenomenon of rotten fruit and empty fruit is obvious. Especially with continuous popularization of balanced fertilization technology for peanut, people value applying N, P, K fertilizers but neglect Ca fertilizer[5]. Adding the increase of peanut yield, its absorbed Ca amount from soil increases, causing insufficient Ca supply in soil, and aggravating nutrient deficiency and imbalance of plant[6]. Therefore, balanced fertilization is especially important for yield increase of peanut. In this paper, the impacts of Ca application on dry matter accumulation and yield of peanut were studied under certain fertilizer supply, which aimed to provide theoretic basis for rationally applying Ca fertilizer and realizing high-yield cultivation of peanut.

2 Materials and methods

2.1 Materials Test peanut variety was Tang A8252 (Spanish peanut).

2.2 Methods

2.2.1 Test design. The experiment was conducted in test field of Tieling Academy of Agricultural Sciences in 2017. There were four CaO treatments: 0, 75, 150, and 225 kg/ha, which was shown by Ca0 (CK), Ca1, Ca2 and Ca3. They were repeated for three times and arranged randomly. N, P, K fertilizers were all applied in each treatment. N fertilizer was urea, P fertilizer was potassium dihydrogen phosphate, K fertilizer was K_2SO_4. Ca fertilizer was marine biological calcium fertilizer, and its main component was CaO (≥60%). The above fertilizers were applied according to design requirement before sowing. N, P, K fertilizers were applied in deep layer, while Ca fertilizer was applied in fruiting layer during seedling period, to avoid the interaction between K and Ca. They were arranged randomly and repeated for three times. Small-ridge close-planting was conducted, and ridge distance was 55 cm, with single row and three repeats. The row was 5 m long, and there were four row districts. The area of the district was 10.8 m^2, bare-land and single-grain planting was conducted, with 180 000 holes/ha. Other management was same with that in the field.

2.2.2 Measuring projects and methods. Ten representative peanut plants were obtained in harvesting season, and the height of main stem, the length of side shoot, total branch number and number of fruiting branch were investigated. They were harvested according to the district, and the pod was dried and weighed after balanced for ten days in the room. Five peanut plants with consistent growth situation were selected in each district, and they were packed respectively according to stem, leaf, petiole and pod. After natural drying, they were weighed by one percent of electronic balance, and then dry matter and distribution ratio were calculated.

2.2.3 Data analysis. Microsoft Excel 2007 was used for data treatment and analysis.

3 Results and analyses

3.1 The impacts on main agronomic characters of peanut by different Ca treatments Seen from Table 1, different Ca fertilization amounts could generate different impacts on peanut growth and main agronomic characters. Compared with control (Ca0), the height of main stem, the length of side shoot, total branch number, number of fruiting branch, number of blighted pod and number of rotten fruit all declined to certain extent in treatments

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* Corresponding author. E-mail: lxliang0@yeah.net

Ca1, Ca2 and Ca3 with Ca application amount increased. Both number and rate of full fruit increased with Ca application, in which the impact was the most obvious in treatment Ca2. It illustrated that proper Ca application could improve full pod rate of peanut and promote yield increase.

Via the investigation on related agronomic characters of peanut during harvest period, it was found that aboveground part of peanut plant under the condition of no Ca application was obviously stronger than that in Ca application group, leaf was green, and root system was developed. There was more peanut needle, but most decayed. The putrescence of peanut pod was serious under the condition of no Ca application, and there were more empty pods. When there was enough Ca, peanut pod was bright, kernel was full, and there was no the phenomenon of rotten fruit or empty pod.

Table 1 The impacts on agronomic characters of peanut by Ca application

Treatment	The height of main stem//cm	The length of side shoot//cm	Total branch number	Number of fruiting branch	Number of full fruit	Number of blighted fruit	Number of rotten fruit	Rate of full fruit//%
Ca0 (CK)	27.83	30.86	8.26	6.63	6.01	9.14	3.86	31.61
Ca1	26.37	28.50	7.94	6.50	10.65	7.53	0.59	56.72
Ca2	24.84	27.61	7.83	6.24	14.94	4.65	0.00	76.29
Ca3	23.31	26.26	7.71	6.22	7.16	6.48	1.34	47.79

3.2 The impact on dry matter accumulation of peanut by Ca Seen from Table 2, dry matter accumulation of root, stem, leaf, petiole and fruit needle from peanut in each treatment showed a decreasing trend with Ca application amount increased, the minima were in the treatment Ca2, and they showed rising trends when increased Ca amount again. Dry matter accumulation of fruit in each treatment showed a rising trend, which was the maximum in the treatment Ca2, and it showed a declining trend when increased Ca amount again. Dry weight of single plant showed a rising trend with Ca application amount increased, which was the maximum in treatment Ca2, and it showed a declining trend when increased Ca amount again. It illustrated that dry matter accumulation of peanut did not increase with Ca application amount increased when Ca application amount increased to certain level.

Table 2 The impact on dry matter accumulation of peanut by Ca application

Treatment	Dry matter accumulation//g						Dry weight//g/plant
	Root	Stem	Leaf	Fruit	Petiole	Fruit needle	
Ca0 (CK)	4.26	8.08	6.96	10.23	1.77	1.70	33.00
Ca1	4.19	7.55	5.65	14.58	1.45	1.54	34.96
Ca2	3.48	7.09	5.19	16.63	1.31	1.37	35.07
Ca3	3.95	7.25	5.34	14.49	1.40	1.42	33.85

3.3 The impact on stage distribution of dry matter of peanut by Ca Seen from Table 3, the distribution proportion of dry matter toward fruit increased with Ca application amount increased. Compared with control, the distribution ratios to root, stem, leaf, petiole and fruit needle decreased with Ca application amount increased, which was the minimum in the treatment Ca2, and they showed rising trends when increased Ca again. The distribution rate to fruit firstly increased and then decreased, which was the maximum in the treatment Ca2. To fruiting period, peanut plant growth transformed from leaf and stem to pod, and nutrient distribution of pod rose.

Table 3 The impact on dry matter distribution rate of peanut by Ca

Treatment	Distribution rate of dry matter//%					
	Root	Stem	Leaf	Fruit	Petiole	Fruit needle
Ca0 (CK)	12.91	24.48	21.09	31.00	5.36	5.15
Ca1	11.99	21.60	16.16	41.70	4.15	4.41
Ca2	9.92	20.22	14.80	47.42	3.74	3.91
Ca3	11.67	21.42	15.78	42.81	4.14	4.19

3.4 The impacts on peanut yield and constituent elements by different Ca treatments Seen from Table 4, different Ca application amounts affected peanut yield to different degrees. Compared with control, pod yield of peanut was improved to different degrees in the treatments Ca1, Ca2 and Ca3. Among them, yield increase extent in the treatment Ca2 was 24.13%, which was the maximum, followed by Ca1 (13.17%) and Ca3 (8.13%). It illustrated that Ca application could significantly increase the yields of peanut pod and seed kernel, the increase extent was the maximum when Ca application amount was 150 kg/ha, and pod yield reduced when increased Ca application amount again. The reason for yield increase was increasing fruiting number and shelling percentage per plant.

Table 4 The impact of Ca on peanut yield

Treatment	100-fruit weight//g	Number of peanut per kilogram	Ratio of shelled peanut//%	Yield//kg/ha	Increase rate//%
Ca0 (CK)	161.3	742	67.56	2 411.40	0.00
Ca1	175.1	730	69.24	2 729.10	13.18
Ca2	187.6	686	72.80	2 993.25	24.13
Ca3	168.1	714	68.72	2 607.45	8.13

4 Conclusions and discussions

The research shows that Ca application could inhibit vegetative growth of peanut and is favorable for preventing rapid growth and lodging. Under the condition of Ca deficiency, more assimilation products are stranded in the stem and leaves, there is overnutrition in aboveground part of peanut plant, and pod development is hindered. Under the condition of sufficient Ca, assimilation products of peanut could be normally transferred to pod for storage. With pod expands, stem and leaf gradually wither. The research results showed that the height of main stem, the length of side shoot, total branch number, number of fruiting branch, number of blighted fruit and number of rotten fruit all declined to a certain degree with Ca application amount increased. Both number and rate of full fruit increased with Ca application amount increased, in which the impact was the most obvious in the treatment Ca2, and biological yield was also the highest. Accumulation amount and distribution rate of dry matter in root, stem, leaf, petiole and fruit needle in each treatment showed declining trends with Ca application amount increased, which was the least when Ca application amount was 150 kg/ha, and they showed rising trends when increased Ca amount again.

The past research results showed that accumulation amount of dry matter showed positive correlation with yield, and pod yield increased with dry matter increased. That is to say, the more the dry matter accumulation, the higher the pod yield[7-8]. The research results showed that change trends of accumulation amount and distribution ratio of dry matter in pod were consistent with that of dry matter accumulation amount per plant with Ca application amount increased, and they all increased obviously. Yield increase extent was the maximum when Ca application amount was 150 kg/ha, which was 24.13%, followed by Ca1 (13.17%) and Ca3 (8.13%). Marine biological Ca fertilizer could increase effective fruit number and rate of full fruit, and decline fruit number per kilogram, to realize yield increase. Ca fertilizer not only provides rich Ca for crop but also could improve soil, anti-disease, anti-continuous cropping ability and anti-adversity of crop, yield and quality. Therefore, peanut plantation could properly use Ca fertilizer to compensate yield loss brought by nutrient deficiency, reaching the target of yield increase.

In this paper, Ca application could make dry matter accumulation of root decline, which was consistent with the conclusion of Zhang Juncheng. But many research reports prove that root system growth of plant is hindered under the condition of Ca deficiency, and the cause needs further test demonstration.

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