Research on the Peanut Leaf Etiolation Prevention and Film Mulching Effect in Hubei Province

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Abstract The possible nutrient problems existing in leaf etiolation, the influence of film mulching on the yield of peanut and benefits of balanced fertilization were analyzed. The results showed that the deficiency of nutrient elements was not main limiting factor in leaf etiolation of peanut in Hong'an. Deep trench, film mulching, liming and organic manure could be used to prevent leaf etiolation. The film mulching could increase the yield of peanut by improving the rate of germination and seedling, the number of branches and full pod, and it was beneficial to playing the effect of balanced fertilization.

Key words Peanut, Leaf etiolation, Film mulching, Balanced fertilization

In recent years, there has been a large area of peanut leaf etiolation in Hong'an County as a main peanut producing area in Hubei Province, for example, the occurrence area was 340 hm^2 in 2010. The yield of peanut per unit area is substantially decreased, and even there is crop failure when it is serious. The farmers have no effective control measures but to switch to other crops or abandon the farmland. Generally, peanut etiolation is primarily caused by micronutrient deficiencies, especially the iron shortage. But in the peanut producing areas of Hong'an County, it is yet to be researched on whether the problem is related to micronutrient deficiencies.

Seasonal drought is another important factor affecting peanut production in Hubei Province. The prolonged drought in July and August annually in Hong'an County forces the farmers to harvest the peanut in advance in mid or late August. The too short growth period, on the one hand, leads to too low peanut production, and on the other hand, makes the light and heat resources fail to be fully utilized; the drought in June each year in Xiangyang region makes the germination and growth of peanut worse, affecting the production in the late period. Film mulching is an effective means to conserve water, keep warmth and promote crop growth. The average yield of peanut after film mulching can reach up to 7500 kg/hm^2[1], much higher than the average yield in Hong'an County (about 3 838 kg/hm^2[2]). Hong'an County has regarded the development of film mulching for peanut production as an important measure to increase farmers' income and increase agricultural efficiency[3]. How is the effect of peanut film mulching in different plots and how does it affect the effect of fertilizer under balanced fertilization? It is yet to be further researched.

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Based on this, we carry out indoor and outdoor experiment to analyze the effects of application of different nutrients on peanut leaf etiolation, and the effects of film mulching on peanut growth and fertilizer effect, in order to provide the basis for peanut nutrient management in Hubei Province.

1 Materials and methods

1.1 Experiment of peanut leaf etiolation Pot experiment: We selected the plots with serious leaf etiolation when planting peanut in Hong'an County in 2010. 0 – 20 cm soil was collected, and after being dried, sieved and mixed, it was put into 1.5 kg of plastic pots, respectively. Let there be seven treatments in total: OPT, OPT – Fe, OPT – Mg, OPT – Mn, OPT – Mo, OPT – Zn, OPT + Ca. OPT fertilizer utilization amount [g/(kg · soil)]: N 0.1, P_2O_5 0.05, K_2O 0.1, Mg 0.05, Fe 0.005, Mn 0.005, Cu 0.005, Zn 0.005, B 0.01, Mo 0.001. Other treatments were to subtract the corresponding nutrients or add Ca 20 [g/(kg · soil)]. Except for calcium as lime, all fertilizers used analytical pure reagent for the preparation of nutrient solution to be applied. It was planted twice continuously and every two varieties were repeated four times. The first batch of peanuts planted on September 12, 2010 used Zhonghua 12 and Yuanza 9102, and the second batch of peanuts planted from April to August 2011 used Zhonghua 6 and Zhonghua 15. The peanuts were all harvested after being mature and the dry matter production was determined after drying. The experiment was carried out in the greenhouse of Oil Crops Research Institute, Chinese Academy of Agricultural Sciences.

Field experiment: In May to August 2011, we selected the plots where the peanut leaf etiolation occurred last year in Xiongjiafan Farm, Hong'an County. Five treatments were set: spraying water, spraying 0.5% chelated ferrous sulfate, spraying 0.1% manganese sulfate, spraying 0.1% ammonium molybdate, and basal application of lime and spraying water. Each treatment was divided into open ground and film mulching. The area of single

plot was 30 m^2, and it was carried out on two farmers' plots. From the resettling stage of peanut, spraying was done once every 10 d (slightly delayed if rainy), and it was sprayed three times. 500 mL of water was used for each plot each time. After being sprayed for 10 d at the second and third time, total plots of ripe peanuts were harvested to measure yield according to the surveyed etiolation occurrence proportion.

The varieties for experiment were 07 – 4103. Farmer A did the fertilizing, seeding and film mulching in April 14. The peanuts under film germinated in April 30, and the open-ground peanuts germinated in May 7. They were both harvested in August 28 at the same time. Farmer B did the fertilizing, seeding and film mulching in May 16. The peanuts under film germinated in May 25, and the open-ground peanuts germinated in May 26. In June 16, there was etiolation phenomenon. They were both harvested in September 12 at the same time.

1.2 Experiment of peanut film mulching effect In Xiongjiafan Farm, Hong'an County, based on the situation that the application of P and K was insufficient in this region[4] and P and K were the main limiting factors for the main nutrients in the soil[5], five treatments were set: OPT, FP, FP + P, FP + K, and CK. Each treatment was divided into open ground and film mulching. There was no repetition and the area of single plot was 50 m^2. OPT was to apply 196 kg/hm^2 of urea, 500 kg/hm^2 of superphosphate, 150 kg/hm^2 of KCl. FP was to apply 750 kg/hm^2 of 12 – 7 – 6 formulation compound fertilizer. FP + P was to add 126 kg/hm^2 of superphosphate based on FP. FP + K was to add 62.4 kg/hm^2 of KCl based on FP. CK was no fertilization. The varieties for experiment were Yueyou 200.

Two farmers were selected for experiment. Farmer A did the fertilizing, seeding and film mulching in April 21. The peanuts under film germinated in May 2, flowered in June 4, ripened in August 12 and were harvested in August 15. The open-ground peanuts germinated in May 4, flowered in June 5, ripened in August 24 and were harvested in August 26. Farmer B did the fertilizing, seeding and film mulching in April 14. The peanuts under film germinated in April 30, and there was etiolation phenomenon in May 25; the etiolation rate in June 14 reached 85% – 95%. They were both harvested in August 28 at the same time and we investigated the agronomic traits of peanut and pod yield.

In Wangji Town of Yicheng City, for potassium deficiency in the region[4] and K as the main factor limiting soil nutrient[5], we set five treatments (OPT, FP, FP + K, OPT – K and CK) to carry out comparison experiment. Each treatment was divided into open ground and film mulching. Two farmers were chosen for field experiment. There was no repetition and the area of single plot was 100 m^2. OPT was to apply 196 kg/hm^2 of urea, 500 kg/hm^2 of superphosphate, 150 kg/hm^2 of KCl. FP was to apply 375 kg/hm^2 of ammonium hydrogen carbonate and 525 kg/hm^2 of superphosphate. FP + P was to add 150 kg/hm^2 of KCl based on FP. OPT – K was to reduce 150kg/hm^2 of KCl based on OPT. CK was no fertilization. The varieties for experiment were Baisha 1016. Wheat stubble peanut was for Farmer A who did the fertilizing, seeding and film mulching in May 31. The peanuts under film germinated in June 24, and the whole growth period was 106 days; the open-ground peanuts germinated in June 27, and the whole growth period was 110 days. Oil crop peanut was for Farmers B who did the fertilizing, seeding and film mulching in May 24. The peanuts under film germinated in May 30, and the whole growth period was 104 days; the open-ground peanuts germinated in June 4, and the whole growth period was 108 days. During the growth period of peanut, the germination rate and rainfall were surveyed, and after being harvested, the biological characteristics and pod yield were surveyed.

2 Results and analysis

2.1 Effects of fertilizer on growth and leaf etiolation of peanut It was found from the experiment that during the pot – culture period, the peanut leaf did not exhibit etiolation. Meanwhile, except for treatment of adding calcium to reduce the dry matter yield (due to high amount of calcium, strong antagonism caused insufficient absorption of magnesium), various other treatments did not significantly reduce the yield compared with OPT (Table 1), indicating that there was leaf etiolation phenomenon in the experimental soil in Hong'an County, and micronutrient deficiencies are not the main reason.

Table 1 Effects of fertilizztion on dry matter of peanut Unit: g/pot

Treatment	The first season		The second season		Total
	Zhonghua 12	Yuanza 9102	Zhonghua 6	Zhonghua 15	
OPT	4.24	5.60	17.53	17.10	44.46
OPT – Fe	5.75	4.74	16.35	18.46	45.30
OPT – Mg	4.19	5.25	17.98	17.00	44.41
OPT – Mn	5.23	6.36	17.35	16.64	45.58
OPT – Mo	4.66	5.33	17.47	17.36	44.82
OPT – Zn	5.18	5.91	17.88	17.18	46.14
OPT + Ca	4.19	5.28	15.63	17.29	42.38

The field experiment (Table 2) showed that after the third time foliar treatment, the peanut was still completely etiolated, which further indicated that micronutrient deficiencies were not the main reason for peanut leaf etiolation in the experiment field.

However, the fertilizer treatment effects are different in different plots. For Farmer A (paddy spring peanut), the etiolation proportion after three kinds of fertilizer were sprayed onto the leaf was still higher than that under the control; for Farmer B (dry land summer peanut), the etiolation proportion after three kinds of fertilizer were sprayed onto the leaf was lower than that under the control, indicating that there was possibility of potential lack of trace elements in Farmer B's plots. After liming, the etiolation phenomenon was reduced, but film mulching aggravated or accelerated etiolation. The fresh pod yield of peanut was the best by increasing liming (Table 2), and Farmer B's fertilizer spraying played a certain role in increasing yield.

2.2 Effects of film mulching on peanut production The experimental results (Table 3) showed that in the experimental

points of Hong'an County, the average peanut yield of the two farmers after film mulching was 2698.1 kg/hm^2, 22.2% higher than the open-ground yield, indicating good effects of yield increase. For Farmer A (paddy peanuts), OPT yield was significantly higher than that under other treatments, and applying phosphorus and potassium also showed certain effects of yield increase; for Farmer B (dry land peanuts), due to poor overall soil moisture, combined with etiolation, there were smaller differences between different fertilization treatments, and film mulching had a better effect in reducing etiolation than open ground.

Table 2 Effects of fertilization on leaf etiolation and fresh pod weight of peanut in Hong'an site

Treatment	10 d after the second spraying, etiolated//%				10 d after the third spraying, etiolated//%				Yield//kg/hm^2			
	Farmer A		Farmer B		Farmer A		Farmer B		Farmer A		Farmer B	
	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground
Basal liming	30	20	20	8	100	100	100	100	4 333.3	5 166.7	6 666.7	6 833.3
Molybdenum spraying	40	25	30	10	100	100	100	100	3 500.0	4 500.0	5 000.0	3 666.7
Manganese spraying	52	25	30	11	100	100	100	100	3 166.7	2 833.3	4 666.7	4 666.7
Iron spraying	50	30	35	12	100	100	100	100	3 500.0	2 500.0	4 666.7	3 333.3
Control	40	35	40	15	100	100	100	100	3 333.3	3 333.3	4 000.0	3 000.0

Table 3 Effects of film mulching under different fertilization on production and agronomic traits of peanut in Hong'an site

Treatment	Yield//kg/hm^2				Plant height//cm		Number of branches		Number of full pod	
	Farmer A		Farmer B		Farmer A		Farmer A		Farmer A	
	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground
OPT	4 020.0	3 439.5	1 933.5	1 699.5	70.6	76.3	5.2	6.0	7.6	6.7
FP	3 460.5	3 000.0	2 067.0	1 333.5	73.0	73.0	6.4	5.0	6.5	5.8
FP + P	3 679.5	3 100.5	1 966.5	1 600.5	79.1	79.6	6.0	5.2	6.9	6.0
FP + K	3 880.5	3 240.5	1 999.5	1 399.5	77.3	78.2	5.6	5.0	7.3	6.3
CK	2 340.0	2 080.5	1 633.5	1 500.0	65.4	67.1	4.5	4.2	4.4	4.1

Taking Farmer A with normal production for the analysis of agronomic traits, the results (Table 3) showed that after film mulching the peanut plant height was lowered, the number of branches tended to increase and the number of full pod was increased significantly. Different fertilization treatments were to apply the phosphorus or potassium, to increase plant height, number of branches and number of full pod, but compared with traditional application of fertilizer, the recommended fertilization will reduce plant height, but significantly increase the number of full pod.

Table 4 Effects of film mulching under different fertilization on seedlings growth and agronomic traits of peanut in Yicheng site

Treatment	Farmer A								Farmer B							
	Germination rate//%		Seedling rate//%		Plant height//cm		Side branch length//cm		Germination rate//%		Seedling rate//%		Plant height//cm		Side branch length//cm	
	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground
OPT	83.3	50.0	76.2	50.0	40.0	44.2	45.7	48.0	100.0	83.3	85.7	40.5	33.8	41.5	37.8	50.0
FP	76.2	61.0	69.0	47.6	35.8	40.4	41.2	43.8	100.0	90.5	92.9	61.9	35.2	37.8	39.7	43.0
FP + K	66.7	61.9	61.9	40.5	34.2	40.0	40.4	44.8	97.6	90.5	83.3	45.2	33.2	34.7	33.3	39.5
OPT – K	73.8	64.3	66.7	57.1	35.0	45.0	45.6	47.8	100.0	85.7	83.3	69.0	38.0	43.7	38.2	43.2
CK	73.8	61.9	73.8	50.0	33.8	33.2	35.4	36.2	95.2	88.1	88.1	47.6	42.0	39.7	43.8	41.8

In the experiment point of Yicheng, after the peanut was planted and germinated (within 10 d), the precipitation in the experimental area was only 9 mm, far below the evaporation, affecting peanut emergence, but compared with open ground, the germination rate under film mulching increased by an average of 17.6%, and seedling rate increased by an average of 53.3% (Table 4). Film mulching decreased plant height by an average of 9.8% and shortened side branch length by an average of 8.4%.

Table 5 Effects of film mulching under different fertilization on pod number and yield of peanut in Yicheng site

Treatment	Farmer A				Farmer B			
	Pod number//m^2		Yield//kg/hm^2		Pod number//m^2		Yield//kg/hm^2	
	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground	Film mulching	Open ground
OPT	323	285	5 002.5	4452.3	414	279	4 622.3	3 752.0
FP	301	272	5 052.6	47 02.4	452	314	4 702.4	3 752.0
FP + K	274	238	5 652.9	4 752.5	378	291	5 002.5	4 062.0
OPT – K	379	315	4 802.4	4 402.2	386	284	4 142.1	3 361.7
CK	334	253	4 452.3	4 352.3	458	248	4 622.3	4 062.0

Film mulching made the pod number of peanut per square meter increase by an average of 33.1% and pod yield increase by 15.4% in Yicheng experimental point (Table 5). Under different fertilizer treatments, increasing potassium on the basis of traditional application of fertilizer will make the yield increase by 6.9%, and decreasing potassium on the basis of recommended fertilization will make the yield decrease by 6.3%, indicating that potassium application had a certain role in increasing yield in the experimental area. Due to high basis fertility of this region, compared with traditional application of fertilizer, the recommended fertilization did not reflect yield advantage.

Table 6 Effects of film mulching on balanced fertilization effect of peanut Unit: %

Hong'an Farmer A			Yicheng Farmer A			Yicheng Farmer B		
Comparison object	Changes		Comparison object	Changes		Comparison object	Changes	
	Film mulching	Open ground		Film mulching	Open ground		Film mulching	Open ground
FP + P versus FP	6.33	3.35	FP + K versus FP	11.88	1.07	FP + K versus FP	6.38	8.26
FP + K versus FP	12.14	8.02	OPT versus OPT - K	4.17	1.14	OPT versus OPT - K	11.59	11.61

Film mulching helped to exert the balanced fertilization effect, and the effect was different in different fertility plots (Table 6). In the plots of Hong'an Farmer A and Yicheng Farmer A, the yield increase effect of film mulching was significantly better than that of open ground; in the plots of Yicheng Farmer B, the yield increase effect of film mulching was lower than that of open ground.

3 Conclusions

According to field observations and interview, it is believed that due to high water table, the paddy field peanut may suffer from root hypoxia lesions, leading to nutrient and water absorption difficulties, thereby causing leaf etiolation; due to excessively acid soil, lack of various ions, drought and other factors[5], the dry land peanut may suffer from leaf etiolation. In the production, we can adopt various measures to regulate, such as digging deep ditch, ridge tillage, film mulching, liming and applying organic fertilizer. In addition, there was a large area of etiolation in the ordinary farmers' plots before the peanut harvest in the Yicheng experimental area in 2011, but it had little effect on pod maturity, possibly due to long rainy days during the harvest period (causing peanut root lesions, and insufficient nutrition and water supply to new leaves).

Film mulching can significantly increase the peanut pod yield. For the paddy field peanuts in Hong'an, film mulching is to increase yield mainly through increasing the number of full pod; for the dry land peanuts in Yicheng, film mulching is to increase yield mainly through increasing germination rate and seedling rate of peanut, number of branches, and number of full pod. Meanwhile, film mulching really helps to play the balanced fertilization effect.

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