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Effects of Different Plant Growth Regulators on Agronomic Traits and Photosynthetic Performance of Mung Bean

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Abstract: This study is based on the early discovery that DCPTA has important regulation function to prevent mung bean flower and pod abscission, Spraying DCPTA at the initial flowering stage of mung bean has better effect than other commonly used plant growth regulators on reducing abscission of mung bean flowers and pods. It is further proved that it is an effective strategy to improve the yield of mung bean. Through the combination of pot experiment and field experiment, Spraying different plant growth regulators (PGRs) at the initial flowering stage of mung bean, study the effects of different plant growth regulators on agronomic traits, physiological and biochemical indexes and photosynthetic performance of mung bean, Lvfeng 2 and Lvfeng 5 mung bean varieties were used as materials, and spraying water at the initial flowering stage of mung bean was used as control. DCPTA and α-NAA were sprayed on the leaves. The morphological indexes of plant height were recorded, and determination of dry matter accumulation and photosynthetic indexes in different parts. The results showed that DCPTA could improve the plant height, main stem node number and leaf area of Lvfeng 5, and the fresh and dry weight of Lvfeng 5 could be significantly improved by DCPTA treatment. However, Taking "Lvfeng 2" as experimental material, the effect of different plant growth regulators on improving fresh and dry weight was not obvious. In terms of photosynthetic performance, each treatment of Lvfeng 5 can improve the photosynthetic performance related indicators, the comprehensive effect of DCPTA > α-NAA.

Keywords: DCPTA, α-NAA, Agronomic Traits, Photosynthetic Performance

1. Introduction

Mung bean (Vigna radiata) is one of the main edible legume crops in China, belonging to cowpea, butterflies subfamily. Its grain is rich in nutrients, not only can be processed and eaten, eliminated summer-heat by cooling, but also has a high care value. It has the effects of increasing immunity, reducing lipid and antibacterial, moistening intestines and relaxing bowel [1-3]. China is one of the countries of origin of mung bean and has a long history of cultivation. However, the further development of mung bean industry is limited by backward production level and low breeding efficiency [4-6]. How to safely and effectively improve the yield of mung bean has become an urgent problem to be solved in the mung bean industry.

In the context of modern agriculture, science and technology play an increasingly important role in agricultural cultivation, among which crop chemical control technology is one of the important cultivation measures. PGRs can regulatory and control in different stages of plant growth and development, to improve plant protein, sugar content, change morphology, and enhance

the ability of plants to cold, drought, salt and alkali resistance and pest resistance [7-9]. 2-(3,4-Dichlorophenoxy)-N(DCPTA) is a kind of substance which can regulates plant growth, show strong superiority in drought, low temperature and other adverse conditions [10-11]. α-NAA is an auxin plant growth regulator, which can promote seed rooting, prevent falling flowers and fruits, and promote fruits enlargement [12].

J. H. Keithly et al. found that spraying a certain concentration of DCPTA on sugarbeet leaves can promote the development of sugarbeet main roots and leaves, and significantly improve the photosynthetic efficiency and root sucrose content [13]. Hu et al. showed that the combination of 0.02% sodium nitrophenolate and 0.02% α-NAA acetate could significantly improve the root growth and root activity of plants and increase the yield [14]. However, the effects of these two different plant growth regulators on agronomic traits and photosynthetic performance of mung bean were less studied. In this study, two different genotypes of mung bean varieties (Lvfeng 2 and Lvfeng 5) were used as experimental materials, different plant growth regulators were sprayed at the initial flowering stage (R1). The agronomic traits and photosynthetic indexes of mung bean plants were measured, in order to provide reference for promoting mung bean yield increase and rational use of plant growth regulators.

2. Materials and Methods

2.1. Testing Material

Two different mung bean varieties, Lvfeng 2 and Lvfeng 5, were used as experimental materials. Plant growth regulators were DCPTA and α-NAA.

2.2. Experimental Design

The experiment was conducted at National Grain Engineering Technology Center of Daqing City, Heilongjiang Province in 2020. There were six treatments: (1) Spraying water on Lvfeng 2. (2) Spraying DCPTA on Lvfeng 2. (3) Spraying α-NAA on Lvfeng 2. (4) Spraying water on Lvfeng 5. (5) Spraying DCPTA on Lvfeng 5. (6) Spraying α-NAA on Lvfeng 5. Leaf spraying was conducted at the initial flowering stage, and each treatment was repeated five times. During the whole experiment, timely weeding and pest control. The morphological and photosynthetic indexes were measured every 7 days after foliar spraying of Plant growth regulators.

2.3. Determination Items and Methods

Agronomic traits. Five representative mung bean plants were taken from each treatment. The plant height (cm) was measured with a steel ruler, and the middle diameter (mm) between stems was measured with a vernier caliper. Measure total leaf and leaf fresh weight (FW). Then the leaves, main stems and branches were separated and dried to constant weight in an oven at 100°C, and their dry weights were weighed respectively.

Photosynthetic index. The net photosynthetic rate (Pn), transpiration rate (Tr), stomatal conductance (Gs) and intercellular carbon dioxide concentration (Ci) of mung bean leaves treated with different Plant growth regulators were measured by Li-6400 Portable Photosynthetic System Analyzer in sunny and cloudless weather.

2.4. Data Management Analysis

SPSS Statistic 25 was used for data analysis and LSD method was used for multiple comparisons. Draw charts using Microsoft Excel 2019.

3. Results and Analysis

3.1. Effects of Two Plant Growth Regulators on Morphological Indexes of Mung Bean

The results showed that the plant height of Lvfeng 2 treated with DCPTA was higher than that of the control by 12.34%, the plant height of α-NAA was lower than that of the control. There were significant differences between mung bean plants treated with DCPTA and α-NAA. No significant difference in stem diameter among different treatments of Lvfeng 2. The number of main stem nodes of mung bean plants treated with DCPTA was significantly different from other treatments and the control. Compared with the control, the number of main stem nodes of mung bean plants treated with α-NAA decreased by 11.16%. The leaf area of DCPTA and α-NAA treatment increased by 4.47% and 12.66% compared with the control, respectively, and there was a significant difference between the α-NAA treatment and the control. For Lvfeng 5, there was no significant difference in plant height between treated and control plants. No significant difference in stem diameter between treated and control plants. There was no significant difference in the number of main stem nodes and branches between the plants after each treatment and the control. In terms of leaf area, the leaf area of each treatment was higher than that of the control by 55.64% and 28.92%, respectively, and the leaf area of plants treated with DCPTA was significantly different from that of α-NAA, and the leaf area of plants treated with α-NAA was significantly different from that of the control.

3.2. Effects of Two Plant Growth Regulators on Fresh and Dry Weight of Mung Bean

For Lvfeng 2, the leaf fresh weight of DCPTA treatment plants was 10.05% higher than that of control plants, and the α-NAA treatment was lower than that of control plants. Total leaf fresh weight of the two treatments were lower than the control, which were lower than 24.73% and 38.43% respectively. Leaf dry weight of each treatment was lower than that of control. For branch dry weight, there is no difference between two plant growth regulators. Dry weight of main stem in addition to α-NAA treatment plants were significantly lower than the control, the other treatments were equal to the control.

For Lvfeng 5, the leaf fresh weight of DCPTA treatment

was 35.06% ~ 80.12% higher than other treatments, and each treatment was higher than the control. In total leaf fresh weight, only DCPTA treatment was higher than the control, and higher than other treatments 12.51% to 40.42%. Plants treated with DCPTA were 11.45% higher than control in leaf dry weight. On branch dry weight, there is no difference between two plant growth regulators. The dry weight of main stem in DCPTA treatment was higher than that in control, and α-NAA was lower than that in control.

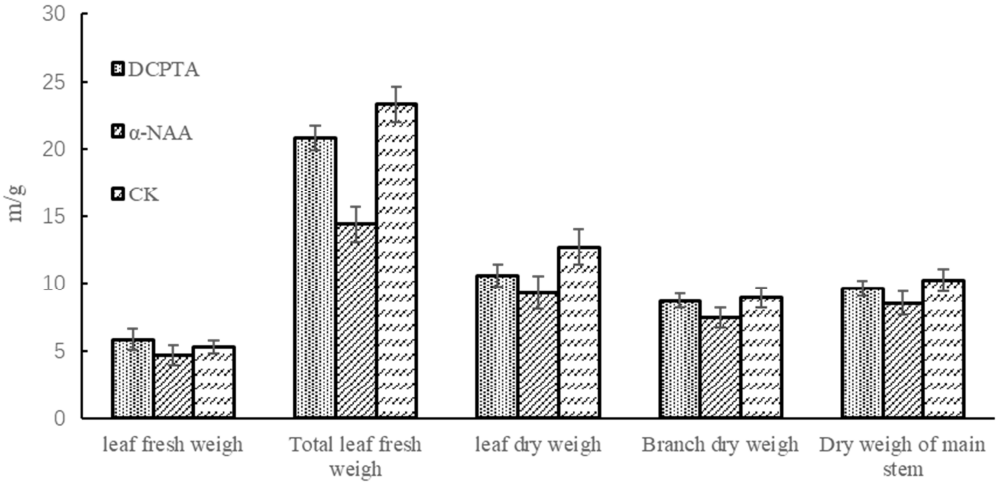

Figure 1. *Comparison of dry and fresh weight of Lvfeng 2 under two plant growth regulators.*

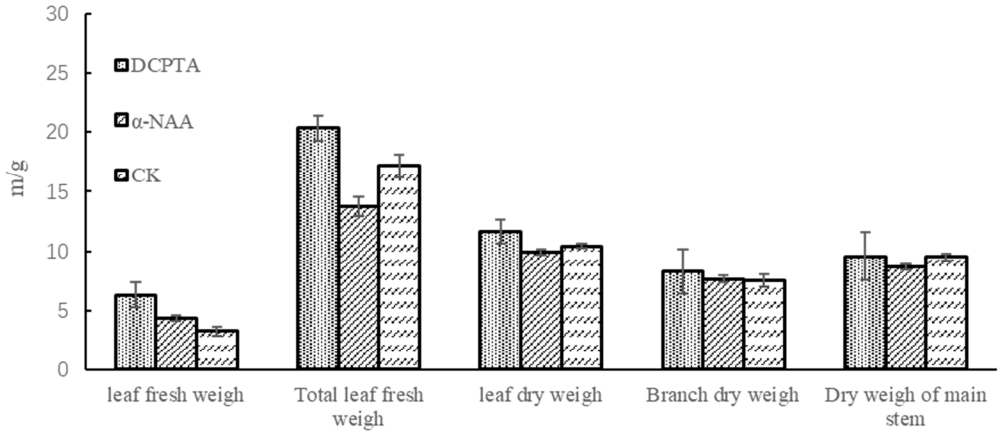

Figure 2. *Comparison of dry and fresh weight of Lvfeng 5 under two plant growth regulators.*

3.3. Effects of Two Plant Growth Regulators on Photosynthetic Performance of Mung Bean

It can be seen from Table 1 that after spraying DCPTA and α-NAA on mung bean variety Lvfeng 2 at the initial flowering stage, the net photosynthetic rates were 10.29% and 4.00% higher than those of the control, respectively, but there was no significant difference between the treatments, indicating that two different plant growth regulators could improve the net photosynthetic rate of mung bean plants. The stomatal conductance of DCPTA and α-NAA treated plants were 17.24% and 3.30% higher than that of the control, respectively. The intercellular carbon dioxide concentration of DCPTA and α-NAA treated plants were higher than that of the control, 7.40% and 2.8%, respectively, but there was no significant difference between each treatment. In terms of transpiration rate, the treatment increased by 9.97% and 3.08% compared with the control, respectively. It can be seen from Table 2 that after spraying DCPTA and α-NAA on Lvfeng 5, the net photosynthetic rates were 28.52% and 1.78% higher than those of the control, respectively. There were significant differences between DCPTA treatment and each treatment, and the net photosynthetic rate was much higher than that of other treatments. In terms of stomatal conductance, the stomatal conductance of each treatment was higher than that of the control by 53.57% and 39.29%, respectively, but there was no significant difference between treatments. The intercellular carbon dioxide concentrations of plants in each treatment were 6.36% and 8.68% higher than those 6.36% and 8.68%, respectively, but the differences among the treatments were not significant. The transpiration rate of each treatment increased by 37.60% and 48.77% respectively compared with the control, and there were significant differences between the two different plant growth regulators treatments and the control. At the same time, there were significant differences between DCPTA and α-NAA.

Table 1. *Effects of two plant growth regulators on photosynthetic performance related indexes of Lvfeng 2.*

Treatment	net photosynthetic rateumol·m^{-2}·s^{-1}	stomatal conductivitymol·m^{-2}·s^{-1}	intercellular CO_2 concentrationumol·mol^{-1}	transpiration ratemmol·m^{-2}·s^{-1}
DCPTA	21.22±1.71a	0.34±0.07ab	234.28±13.39a	6.07±0.75ab
α-NAA	20.01±1.62a	0.29±0.03ab	224.21±18.19a	5.69±0.43b
CK	19.24±1.78a	0.29±0.11ab	218.13±40.22a	5.52±1.33ab

Table 2. *Effects of two plant growth regulators on photosynthetic performance related indexes of Lvfeng 5.*

Treatment	net photosynthetic rateumol·m^{-2}·s^{-1}	stomatal conductivity mol·m^{-2}·s^{-1}	intercellular CO_2 concentrationumol·mol^{-1}	transpiration ratemmol·m^{-2}·s^{-1}
DCPTA	26.72±1.41a	0.43±0.03a	248.07±14.02a	5.05±0.24b
α-NAA	21.61±1.10b	0.39±0.10a	253.48±20.29a	5.46±0.95b
CK	20.79±0.72b	0.28±0.07a	233.23±25.54a	3.67±0.54c

4. Discussion

Plant growth regulators have many functions, such as promoting rooting and germination, regulating the growth and development of crops, preventing flowers and fruits falling, promoting seed setting, improving quality, and promoting early maturity. Plant growth regulators play an important role in the development of agricultural production and have been increasingly applied in agriculture. Ma et al. found that spraying different plant hormones at the starting stage of winter wheat could significantly reduce the agronomic traits such as basal internode length, plant height, and center of gravity height of wheat, which could improve stem strength, stem quality, and enhancing lodging resistance of wheat [15]. In this study, water spraying was used as the control, and two different plant growth regulators were sprayed on two mung bean varieties. It was found that spraying DCPTA could increase the plant height of Lvfeng 2, and spraying α-NAA could increase the plant height of Lvfeng 5. The differences between different plant growth regulators of the two varieties were also inconsistent, indicating that different varieties had different sensitivities to different plant growth regulators effects on plant height. Leaf area and stem diameter are two relatively stable important morphological indexes of crops, which can represent the accumulation of assimilation products in plants to a certain extent. In this study, only the stem diameter of Lvfeng 5 sprayed with DCPTA increased, and the leaf area of Lvfeng 2 sprayed with α-NAA and DCPTA increased compared with the control. The larger the leaf area, the more conducive to photosynthesis. Photosynthesis is an important energy conversion and metabolism system during crop growth and development. Higher accumulation of photosynthetic products is an important prerequisite for high yield of crops [16-18]. Wang et al. found that spraying the mixture of DCPTA and CCC on maize can effectively increase the chlorophyll content, reduce the decomposition of chlorophyll, increase the time of photosynthesis and reduce the damage to leaves [19]. In this study, two varieties of each treatment plants can improve the net photosynthetic rate, but had different effects on stomatal conductance, intercellular carbon dioxide concentration and transpiration rate.

Comprehensive analysis of mung bean application DCPTA mung bean morphological indicators, photosynthetic performance and mung bean plant parts of dry and fresh weight compared with α-NAA for plant growth regulators and control treatment has better effect. This study only discussed the effects of two different plant growth regulators on morphological indexes and photosynthetic performance of mung bean plants, but the specific mechanisms of different plant growth regulators affecting endogenous hormones, gene expression and enzyme activity of mung bean need to be further explored.

In the future, we will determine the enzyme activity of mung bean after using different plant growth regulators and analyze the results. At the same time, we will further study the specific mechanisms of different plant growth regulators affecting endogenous hormones, gene expression and enzyme activity of mung bean.

5. Conclusion

The effects of two different plant growth regulators on the agronomic traits and photosynthetic performance of two mung bean varieties are not exactly the same. The morphological indexes and photosynthetic indexes of Lvfeng 2 plants treated with two different plant growth regulators are often higher than those of the control but not significant. However, spraying two different plant growth regulators in Lvfeng 5 can significantly improve the morphological indexes and photosynthetic indexes of plants, which have a beneficial effect on the agronomic traits and photosynthetic performance, and then improve the yield and quality of mung bean. In conclusion, the effect of two different plant growth regulators on mung bean is DCPTA > α-NAA.

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References

[1] Ji hua, Chen Jinping, Lu Daxin. Nutritional value and comprehensive utilization of mung bean [J]. Progress in Modern Biomedicine, 2006 (10): 143-144+156.

[2] Zhang haijun, Jia dongying, Yao kai. Nutritional and Health-protective Functions of Mung Bean [J]. Food and Fermentation Sciences & Technology, 2012, 48 (01): 7-10.

[3] Wang Shaoyun, Ye Xiuyun, Rao Pingfan. Research Progress on the Biological Activities and Functions of Mung Beans [J]. Journal of Chinese Institute of Food Science and Technology, 2004 (01): 101-105.

[4] Han Xinru, Song Lili. Study on Production and Consumption Characteristics and Industrial Development Trends of Mung Bean and Adzuki Bean in China [J]. Journal of Agricultural Science and Technology, 2019, 21 (08): 1-10.

[5] Liu Hui. China's mung bean production status and development prospects [J]. Agricultural Outlook, 2012, 8 (06): 36-39.

[6] Wang Lixia, Cheng Xuzhen, Wang Suhua. Advances in Research on Genetic Resources, Breeding and Genetics of Mungbean (Vigna radiata L.) [J]. Scientia Agricultura Sinica, 2009, 42 (05): 1519-1527.

[7] Tao Longxing, Wang Xi, Huang Xiaolin, Yu Meiyu. Application and prospects of plant growth regulators in agriculture [J]. Acta Agriculturae Zhejiangensis, 2001 (05): 84-88.

[8] Fu Hualong, He Tianjiu, Wu Qiaoyu. Research and application on plant growth regulators [J]. Chinese Journal of Bioprocess Engineering, 2008 (04): 7-12.

[9] Yang Xiurong, Liu Yixue, Liu Shuifang, Sun Fengzhi, Sun Shuqin, Zhang Xuewen, Zhang Wei, Gao Junfeng. Study and Application on Plant Growth Regulators [J]. Tianjin Agricultural Sciences, 2007 (01): 23-25.

[10] Si Zongxing, Liu Shangzhong. Study on synthesis of DCPTA [J]. Agrochemicals, 1992 (01): 15-21.

[11] Yokoyama H, Hayman E P, Hsu W J, et al. Chemical bioinduction of rubber in guayule plant [J]. Science, 1977, 197 (4308): 1076-1078.

[12] Guo Yunna. Effects of Sodium Naphthalene Acetate on Growth, Physiological Characteristics and Production of Tomato under Suboptimal Temperature and Light Intensity [D]. Chinese Academy of Agricultural Sciences, 2015.

[13] Keithly J. H., Yokoyama H., Gausman H. W. Effect of 2-(3, 4-dichlorophenoxy) triethylamine (DCPTA) on the growth and development of sugarbeet [J]. Elsevier, 1990, 68 (1).

[14] Hu Zhaoping, Li Wei, Chen Jianqiu, Chen Haining, Gao Rongqing, Jia Liang, Liu Yi, Li Xinzhu, Guo Zongduan, Liu Guangfu. Effect of Sodium Nitrophenolate, DA-6 and NAA on the Eggplant Yield and Quality [J]. Chinese Agricultural Science Bulletin, 2013, 29 (25): 168-172.

[15] Ma Ruiqi, Qi Zhen, Chang Xuhong, Wang Demei, Tao Zhiqiang, Yang Yushuang, Feng Jinfeng, Sun Min, Zhao Guangcai. Regulation Effects of Growth Regulators on Plant Characters, Yield and Quality of Winter Wheat [J]. Crops, 2018 (01): 133-140.

[16] Yu Qi, Feng Naijie, Wang Shiya, Zuo Guanqiang, Zheng Dianfeng. Effects of S3307 on the photosynthesis and yield of mung bean at R1 and R5 stages under waterlogging stress [J]. Acta Agronomica Sinica, 2019, 45 (07): 1080-1089.

[17] Bjorn M, Kebede H, Rilling C. Photosynthetic differences among Lycoperisiconspecies and Triticumaestivumcultivars. CropSci, 1994, 34: 113-118.

[18] Bhatnagar-Mathur P., Jyostna Devia M., Vadeza V., and SharmaKiran K., 2009, Differential antioxidative responses in trans-genic peanut bear no relationship to their superior transpira-tion efficiency under drought stress, J. Plant Physiol., 166 (11): 1207-1217.

[19] Wang Y C, Gu W R, Ye L F, et al. Physiological mechanisms of delaying leaf senescence in maize treated with compound mixtures of DCPTA and CCC [J]. Journal of Northeast Agricultural University (English Edition), 2015, 22 (3): 1-15.