

## Effect of the bulbil orientation and arched back on garlic growth

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### Abstract

The garlic plant, bolting rate, the weight of garlic bolt and garlic bulb were researched by planting the Jin xiang garlic. Based on arched back of garlic is consistent, bulbil direction upward 90o(SDUT90), bulbil tilted 60o(marked as SDUT60), bulbil tilted 30o(SDTU30), bulbil flat (SDT0), bulbil direction down toward 30o(SDDT30), bulbil direction down toward 60o(SDDT60), bulbil direction down toward 90o(SDDT90), bulbil direction upward 90o and the random arched back (RDUT90). The results showed that the time of garlic unearthed was short with the garlic bud vertical orientation. Moreover, the survive rate of garlic was better with the garlic bud vertical orientation.

### Keywords

Garlic; Bulbil direction; Arched back; Production.

### 1. Introduction

At present, the planting requirement for garlic is that the bulbil direction should be faced upward and arched back should be in a consistent direction[1]. Therefore, there are three mechanical planting methods for garlic[2,3]: firstly, garlic hole was conducted by hole press method, then bulb seeds were pressed the hole with bulb seeding direction and arched back in a random state. Secondly, planting mechanism (power system, seed collector, system for correcting sprouts facing upwards, ransport system). The problem of garlic seeds direction upwards was solved using this technology before bulbils were seeded. However, it cannot solve the upright requirement of the bulbil direction and the consistent arched back direction in the soil[4,5]. Thirdly, garlics were planted by manual planting, which can guarantee the consistency of single-seed planting and garlic arched back direction. But the labor intensity is high and the planting efficiency is relatively lower than that of pure mechanical sowing [6-8].

Compared with the garlic plant height, sprouting rate, and bulb weight of garlic by setting the garlic bulbil direction( upward, downward, and random). Jin et al found that the bulbil direction had no effect on the survival rate of garlic during planting. However, the emergence time of garlic was prolonged, the seedlings were weak and uneven, the later matured plants were shorter, and the bulb weight was lighter with the bulbil directions were downwards or random[9]. Liu et al reported that the garlic with bulbil tilted 45° and bulbil flat (the plant height, pseudostem length, length of garlic bolting, the fresh weight of garlic bolting, bolting rate, fresh weight of single garlic, cross diameter of garlic ) were not discriminated compare with bulbil upward, and bulbil inverted 45° was not beneficial to garlic growth by setting bulbil upward, bulbil tilted 45°, bulbil flat, bulbil inverted 45°[10]. The above literature provides important agricultural support for the design of garlic planting machines, but the classification of garlic arched back directions is not detailed. Furthermore, it was not considered that arched back effected on plant height, garlic bolting, and bulb production.

In this study, garlic growth was conducted by considering bulbil seeding direction and consistent arched back, then the height of garlic shoot branches, bolting rate, the weight of garlic bolt and garlic bulb was discussed. It will provide a more comprehensive agricultural support for the research of the garlic sowing machine.

## 2. Materials and methods

Jinxiang No. 3 white skin garlic was selected as garlic seeds. A single weight of garlic seed was 3g-5g, these garlic seeds were divided into eight groups and 70 seeds/group. The soil texture was loam. The garlic seeds were planted on October 2nd, 2021 and harvested on May 17th, 2022. Prior to plowing the ground, 5kg of potassium sulfate compound fertilizer and one bag of carbendazim were applied, subsequently the land was raked. The garlic seeds were planted at a depth of 20-30 mm, row spacing was 130 mm and plant spacing was 50 mm. Each group was marked and watered thoroughly during garlic seeds growth. The plastic film was covered after five days later. The edges of the film were pressed into the soil with tree branches to prevent wind damage when the film is removed during the covering process.

In order to differentiate, Based on arched back of garlic is consistent, bulbil direction upward  $90^\circ$  (marked as SDUT90), bulbil tilted  $60^\circ$  (marked as SDUT60), bulbil tilted  $30^\circ$  (marked as SDTU30), bulbil flat (marked as SDT0), bulbil direction down toward  $30^\circ$  (marked as SDDT30), bulbil direction down toward  $60^\circ$  (marked as SDDT60), bulbil direction down toward  $90^\circ$  (marked as SDDT90), bulbil direction upward  $90^\circ$  and the random arched back (marked as RDUT90) during garlic planting, as shown in Fig.1.

The emergence of garlic was observed and the emergence rate was measured among the eight groups. To obtain the height of plant growth, the plant height was measured using a tape measure, bolting rate and garlic weight were recorded by digital electronic weightgraph. Finally, the fresh weight of garlic bolting was also measured after its harvested.

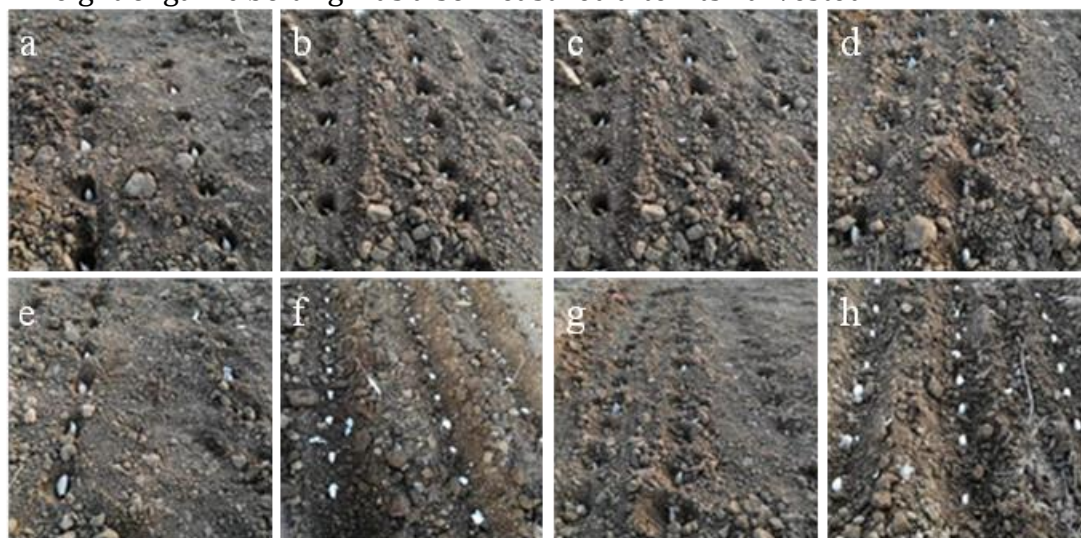


Fig.1 Unconsistent and consistent arched back of the garlic under different bulbil angels: (a) SDUT90, (b) RDUT90, (c) SDUT60, (d) SDUT30, (e) SDT0, (f) SDDT30, (g) SDDT60, (h) SDDT90, respectively.

## 2.1. Result

### 2.1.1. Effect arched back of bulbil on garlic emergence rate

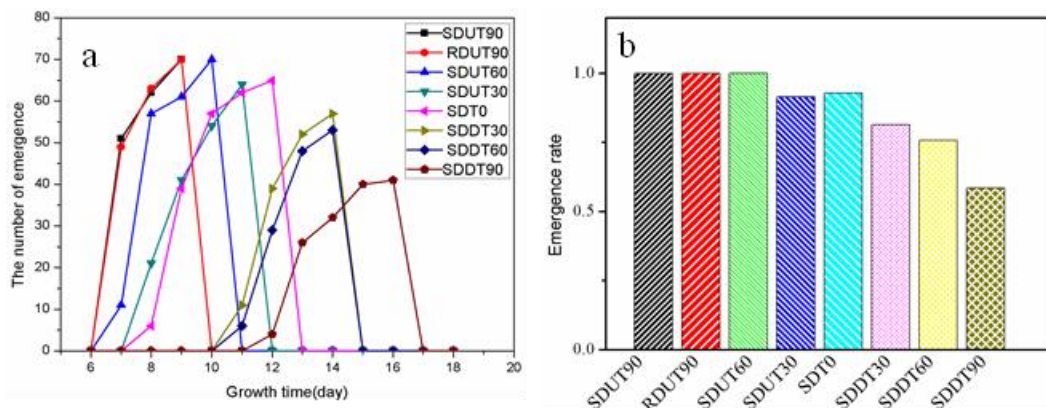


Fig. 2 Unconsistent and consistent arched back of bulbil effect on garlic growth under different bulbil angels: (a) the number of emergence, (b) emergence rate.

Fig.2 shows unconsistent and consistent arched back of bulbil effect on garlic growth under different bulbil angels. It can be seen from Fig. 2 that garlic emergence rate was high due to upward and consistent arched back of bulbil. Under the same consistent arched back of bulbil, the emergence rate of garlic was increased by the upward arched back exceed 60°. Furthermore, consistent arched back of bulbil was evident beneficial to enhance the emergence rate of garlic with conformity arched back direction.

### 2.1.2. Effect arched back of bulbil on garlic plant growth and bolting rate

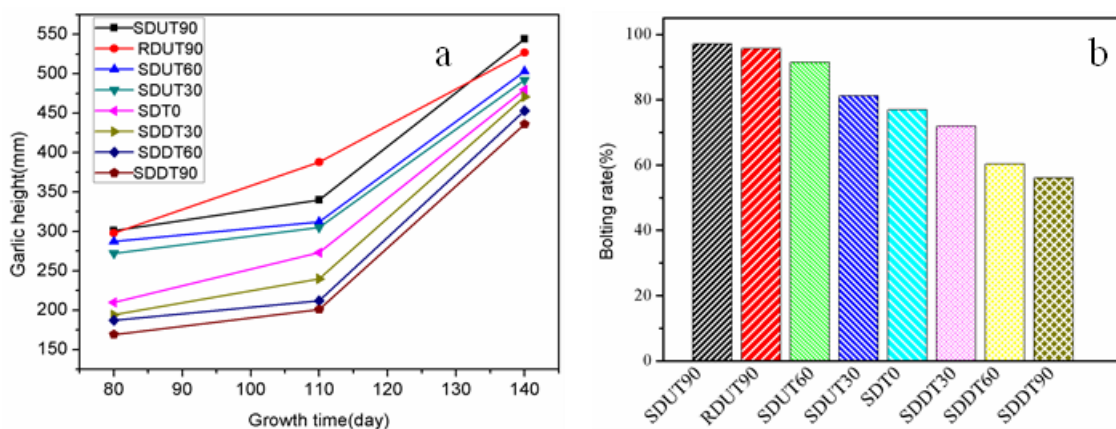


Fig. 3 Unconsistent and consistent arched back of bulbil effect on garlic growth under different bulbil angels: (a) garlic plant height, (b) bolting rate

Fig.3 shows that garlic plant height and bolting rate of the different groups with different arched back. For the tracking measurement of plant height, ten garlic plants were randomly selected from each of the eight groups, based on the orientation of the bulbil and arched back direction. From Fig.3a, it can be seen that the orientation of the bulbil and arched back direction during sowing had a significant impact on the growth of garlic during the seedling and emergence stage. Compared to garlic plants with the bulbil upward, germination leaves and emergence of the bulbil downwards was slow and weak. Meanwhile, it had a longer emergence period and uneven emergence. During the seedling stage, the leaves grew slowly and emerged later. Specifically, the height of garlic plants (bulb direction and consistent arched back of garlic, bulbil direction (SDUT90) ) were 3.2% higher than those with bulbil direction upward 90° and the random arched direction(RDUT90), at 140 days. It can be deduced that arched back direction of bulbil had some impact on the garlic plant, but the effect was not obvious. As for bolting rate of garlic, it can be seen from Fig.3b that bolting rate of consistent arched back



orientation with bulbil direction upward  $90^\circ$  (SDUT90) was highest among these groups. The bolting rate was 1.5% higher than that of the bulbil upwards at a  $90^\circ$  and arched back random.

### 2.1.3. Effect bulbil and arched towards on the weight of garlic sprouts and garlic

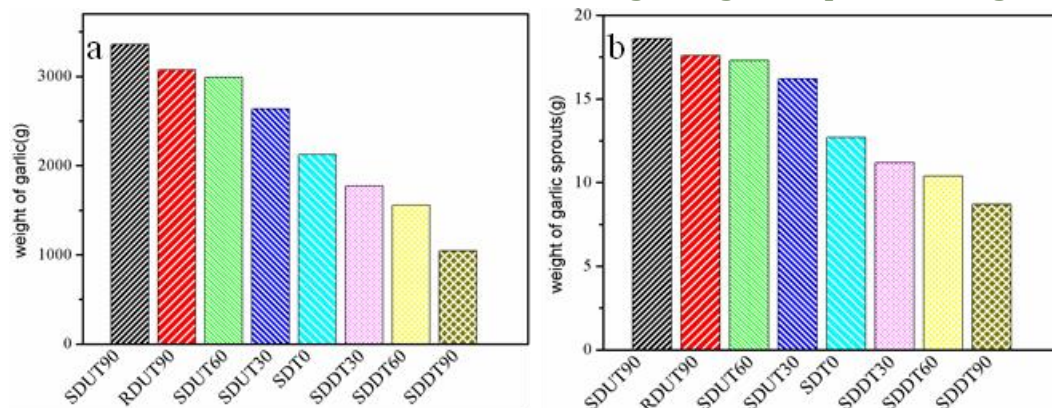


Fig. 4 (a) the weight of garlic sprout, (b) the weight of garlic

Fig. 4 shows the weight of garlic sprouts and garlic. As for Fig.4a, the weight of garlic sprouts and garlic of arched back orientation consistent with bulbil direction upward  $90^\circ$  (SDUT90) were highest among these eight groups. The weight of garlic sprouts and garlic with bulbil upward  $90^\circ$  and consistent with arched back (SDUT90) were 9.3% higher than those with bulbil direction upward  $90^\circ$  and the random arched direction (RDUT90). Compared with bulbil upward  $60^\circ$  and arched back (SDUT60), it was also high 12.4%. Furthermore, it also was high 58% than that of SDT0. Compared with SDDT90, the weight of garlic (SDUT90) was high 221.4%. Fig.4b shows that the fresh weight of a single garlic sprout was 5.7% higher than that of bulbil direction upward  $90^\circ$  and the random arched direction (RDUT90). It is beneficial to increase the production of the plant with consistent arched back and bulbil upward orientation. Because garlic plants have opposite leaves, the plants in the same row do not block each other when the arched backs are facing the same, photosynthesis and ventilation conditions are better than those with random arched backs, resulting in the highest yield of garlic shoots and bulbs.

### 3. Conclusion

The emergence is fast and strong and the emergence rate of garlic is 100%, with the bulbil upwards exceeded  $60^\circ$  during sowing. By contrast, the emergence of seedlings is uneven and the sprouting leaves are slowly and weakly unearthed, resulting in a longer emergence period, due to bulbil upwards less than  $60^\circ$ . The bulbil orientation has a significant impact on the height of garlic plants. The less vertically the scales are oriented, the shorter the garlic plant. The arched back has a certain effect on the height of garlic plants.

The bulbil orientation has a significant impact on the bolting rate and yield of garlic. The less vertically bulbil are oriented, the lower the bolting rate and yield of garlic. The orientation of the arched back has no significant effect on the garlic bolting rate, but it has a certain impact on the garlic bolt yield, which is 5.7% higher than the garlic bolt yield with a random orientation of the arched back.

The orientation of the bulb has a significant impact on garlic yield. The less vertically the bulb is oriented, the smaller the garlic head and the lower the yield. The arched back also has a significant impact on the yield of garlic. The arched back orientation is consistent, the yield of garlic is 9.3% higher than that of the random of arched back.

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