



内蒙古农业大学

Inner Mongolia Agricultural University



The resistance evaluation of sunflower against broomrape and a potential efficient way to control broomrape

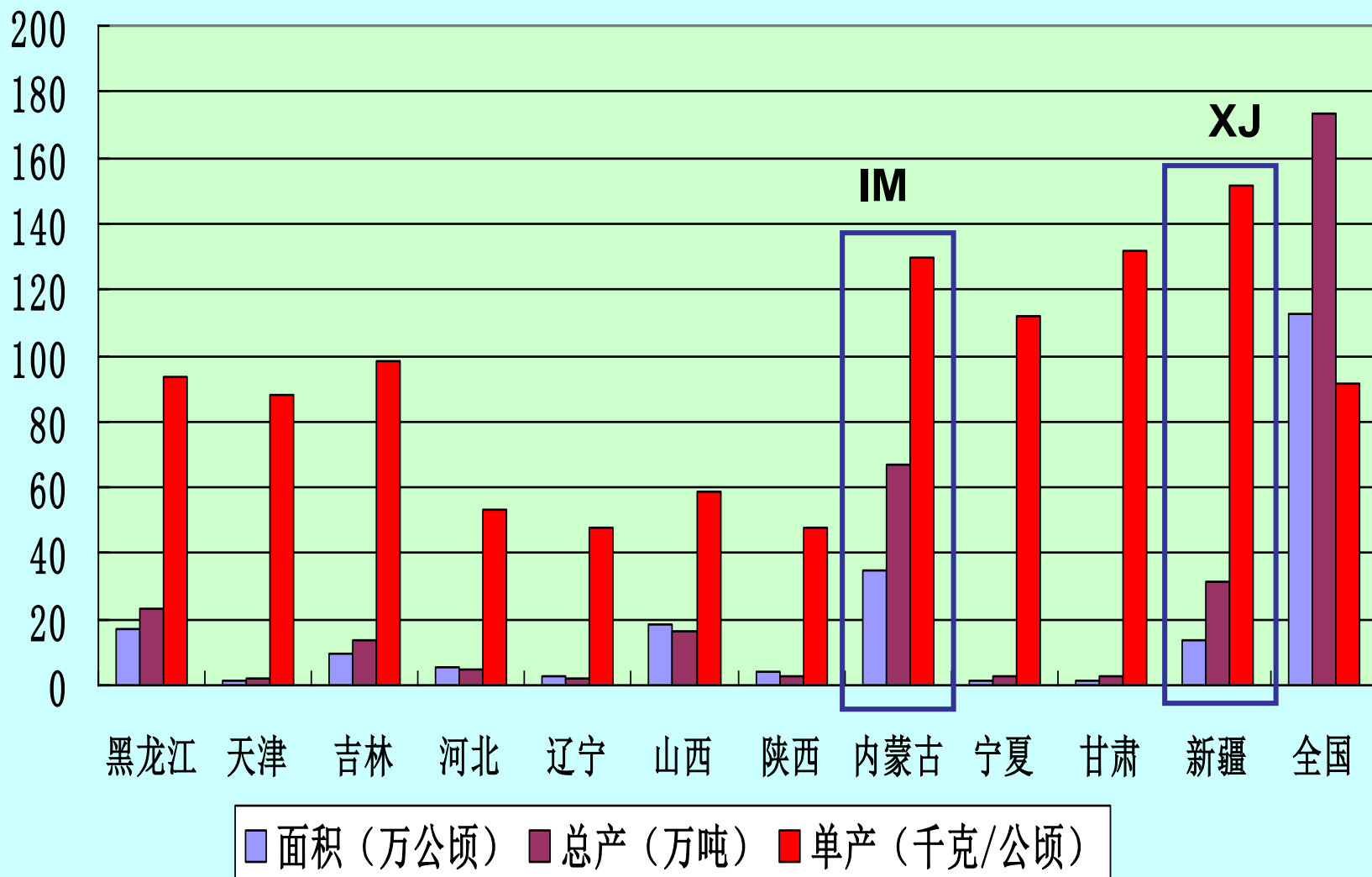
Jun Zhao

National Lab of Sunflower Pest and Disease control
China Special Oil Crops Research System (CARS-14)
Inner Mongolia Agri. Univ. China

Sunflower in China

- Sunflower is one of the important oil crops in the world, its planting areas in China is around 0.8 million hectares;
- Inner Mongolia is the biggest sunflower planting region, its planting areas is 0.43 million hecter, followed by Xinjiang, the planting area is 0.25 million hecter;
- Besides Innermongolia and Xinjiang, Heilongjiang、Jilin and Gasu are also the main regions for sunflower planting.

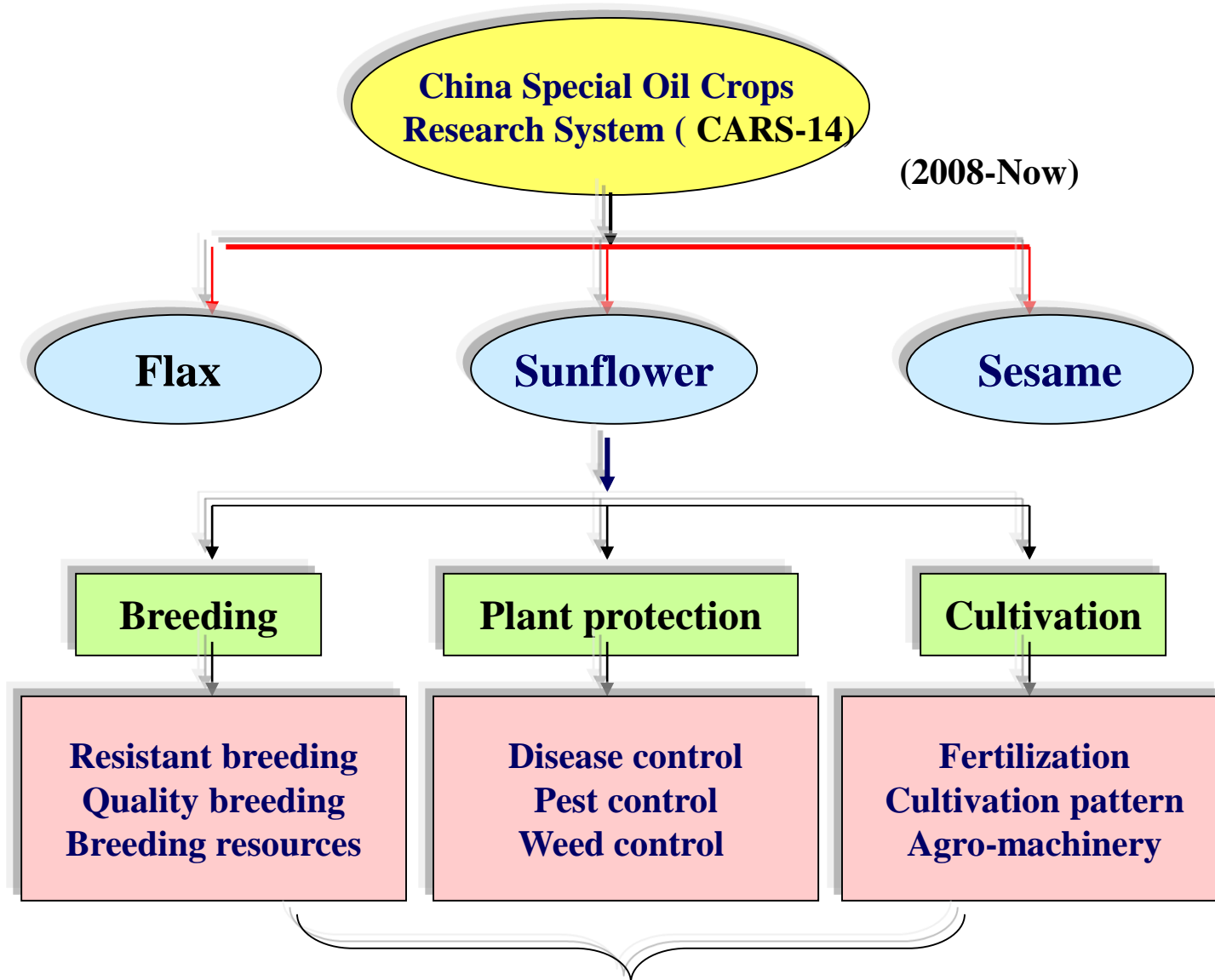
The planting area and yield of sunflower in China





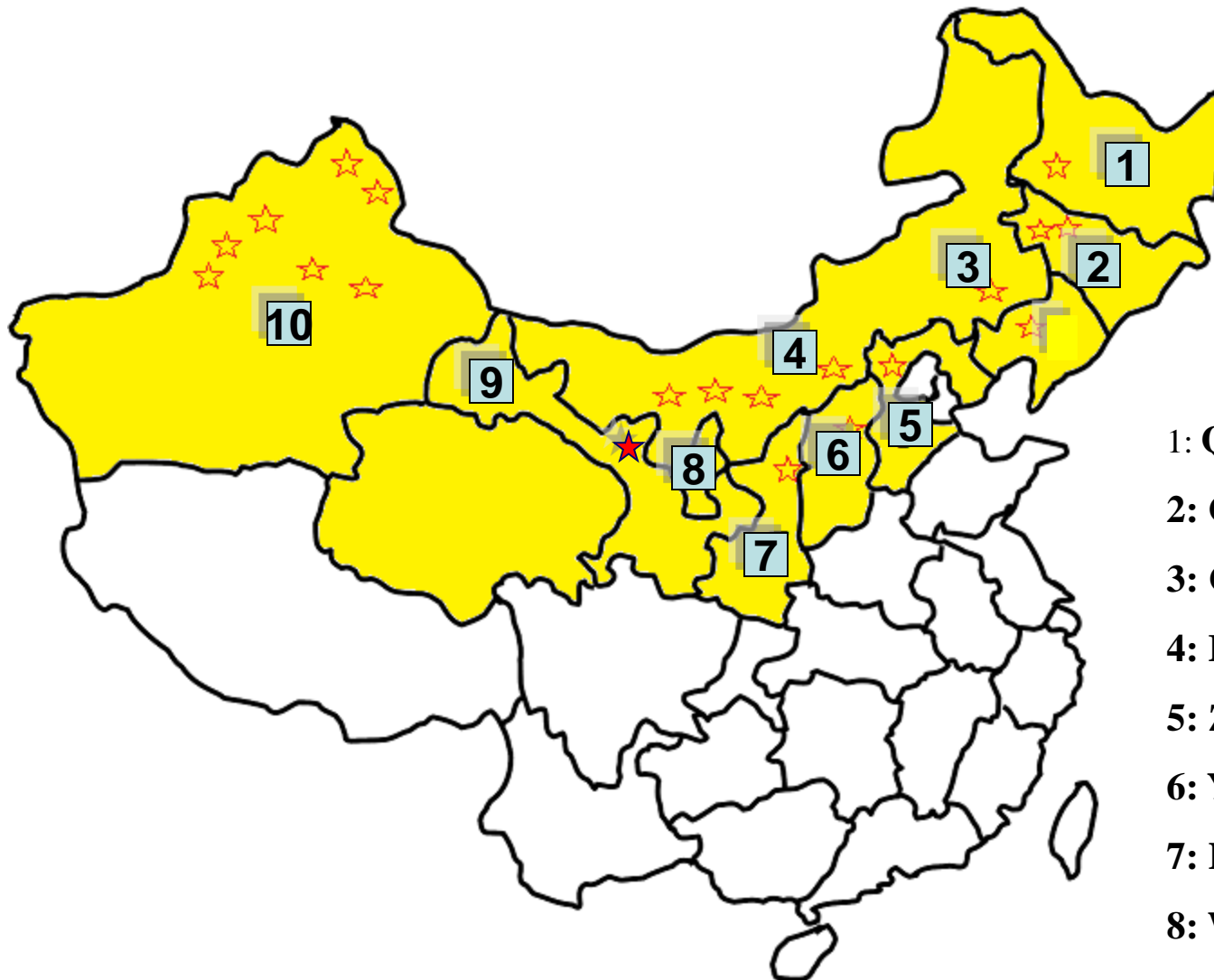


Sunflower research team in China



10 stations distributed in different provinces of China

Distribution of stations in China



Participants of China Oil Crop Research Team

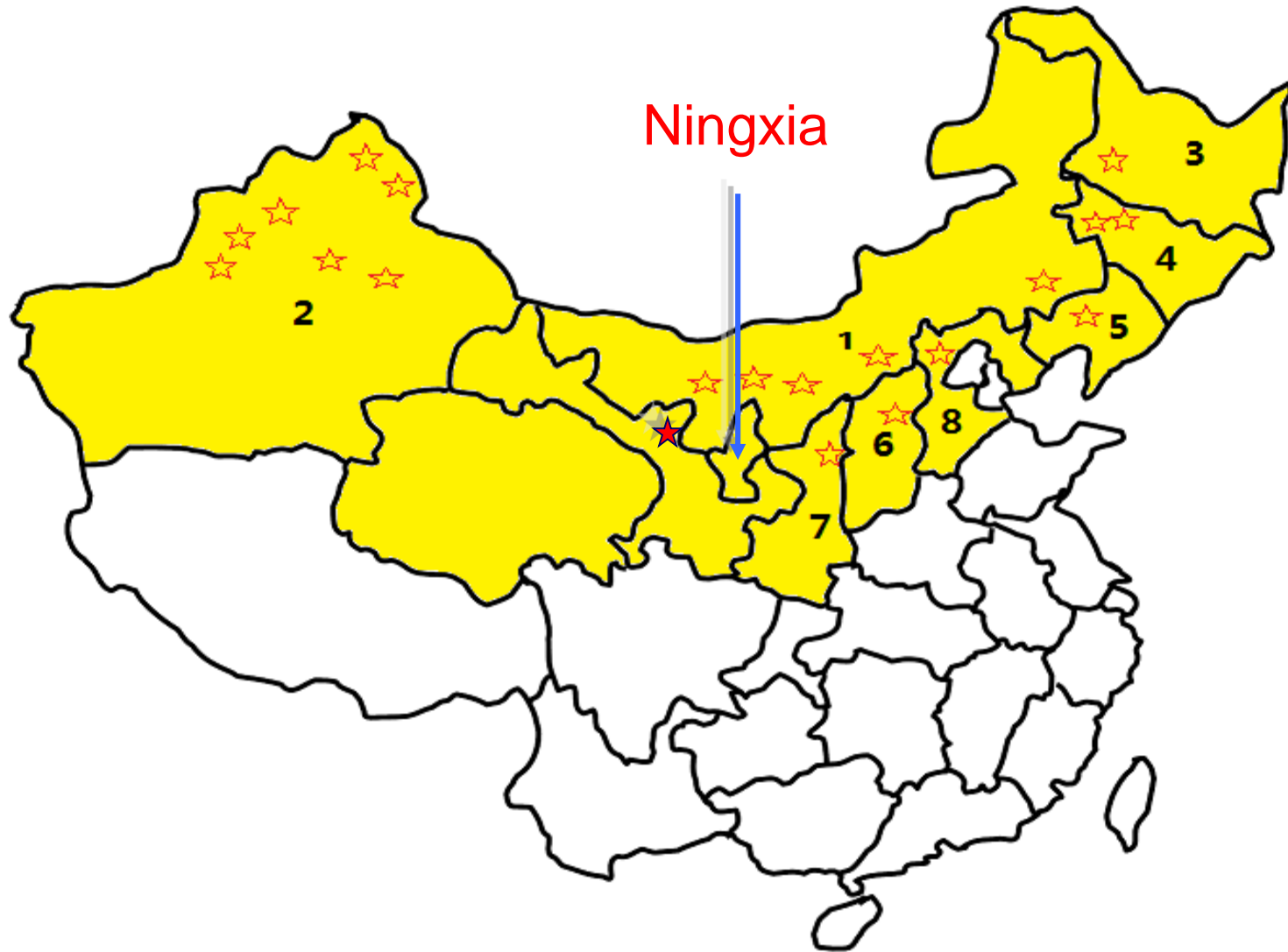


Sunflower Broomrape

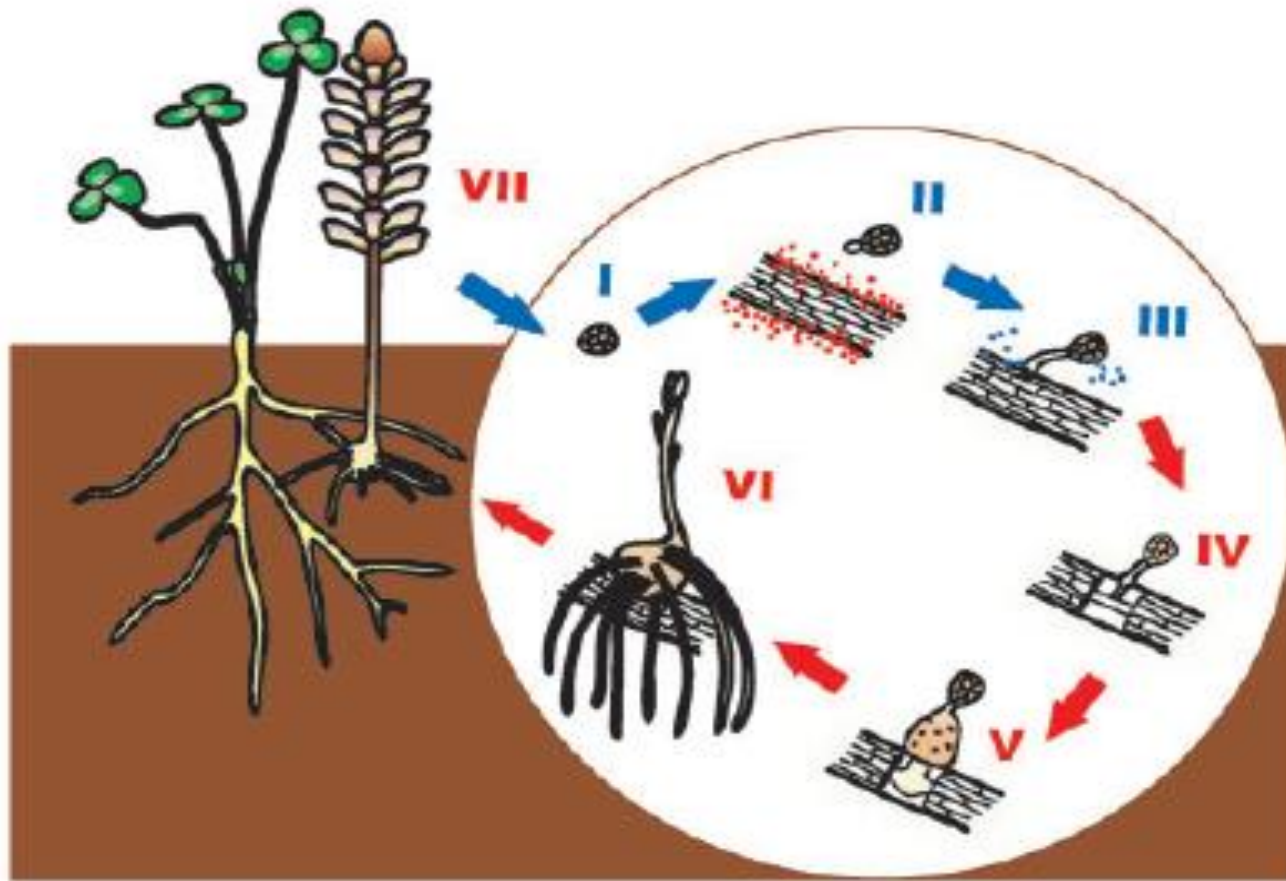
(*Orobanche cumana* Warll)

- Broomrape is a kind of parasitic seed plant, it is holo-parasites, which depend on hosts for nutrition completely.
- The hosts of broomrape include sunflower (*Helianthus annuus* L.), tomato (*Lycopersicon esculentum* Mill) and tobacco (*Nicotiana tabacum* L.).
- In China, broomrape appears in all the sunflower planting regions except Ningxia region.

Distribution of sunflower broomrape in China



Life cycle of *Orobanche cumana* Warll



Adapted from Yoneyama K, *et.al.* Plant & Cell Physiology, 2010, 51(7):1095-1103.



**Wulanchabu
Inner Mongolia**



A le tai
Xinjiang



Different biotypes of sunflower broomrape



Ongoing studies on sunflower broomrape

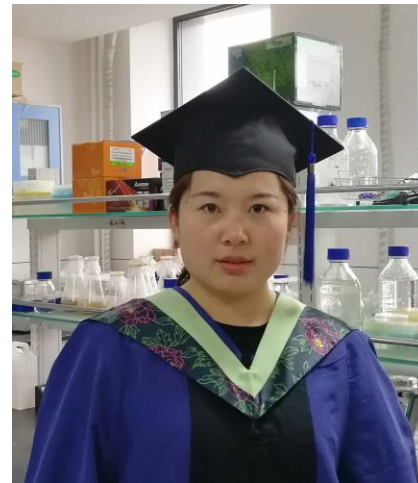
- Set up the parasitic system of broomrape under lab condition
- Identify the race type of sunflower broomrape in China
- Evaluation the resistance level of different sunflower varieties against broomrape
- Analysis genetic diversity within and among different sunflower broomrape populations
- Unravel resistant mechanism of sunflower against broomrape
- Integrated control on sunflower broomrape

1

Screening resistant varieties against broomrape under lab condition



Dongsheng Xu



Shenghua Shi

Petri dish system



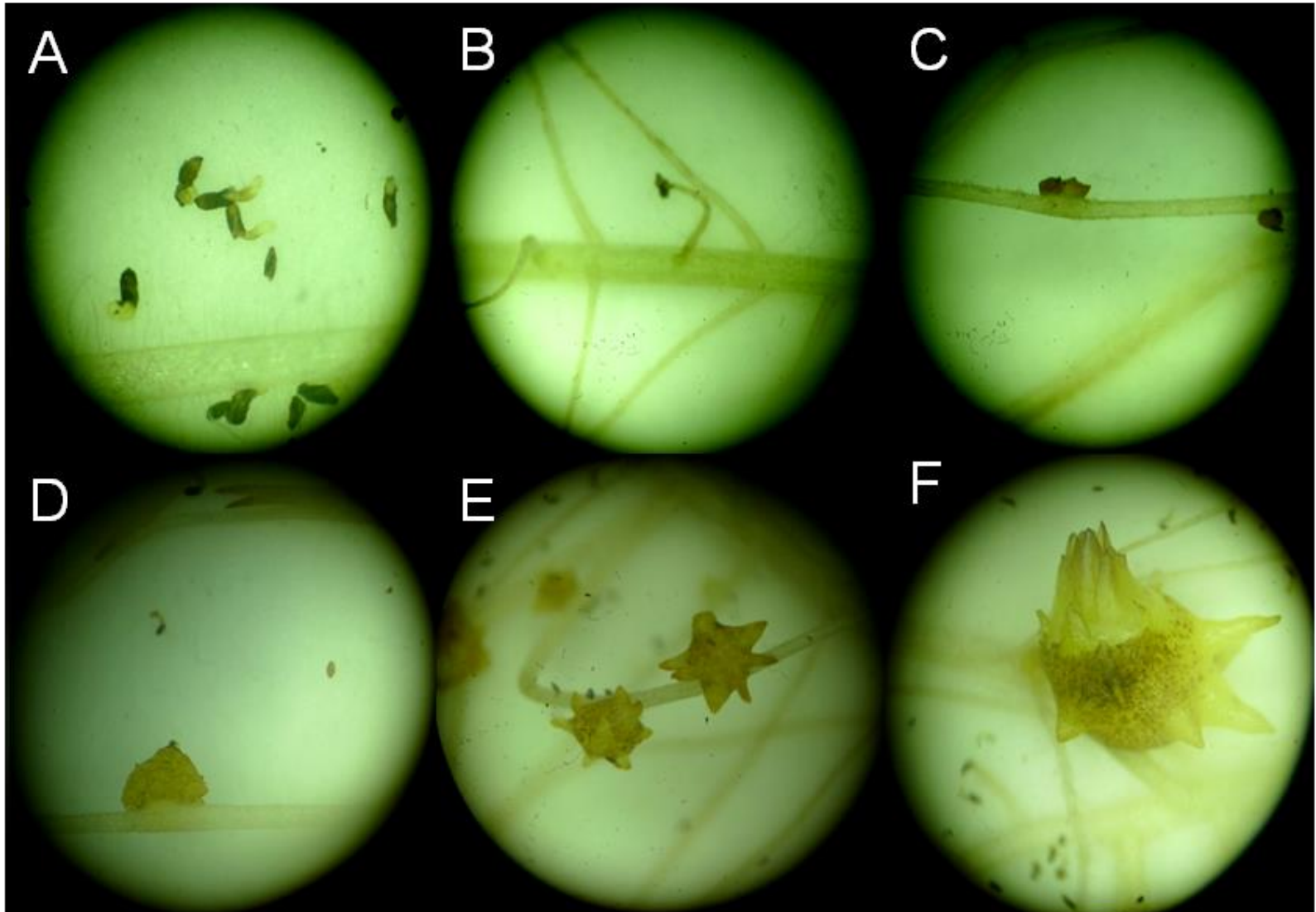
**Dissect parasitic stage
of broomrape**

Screen the resistance varieties

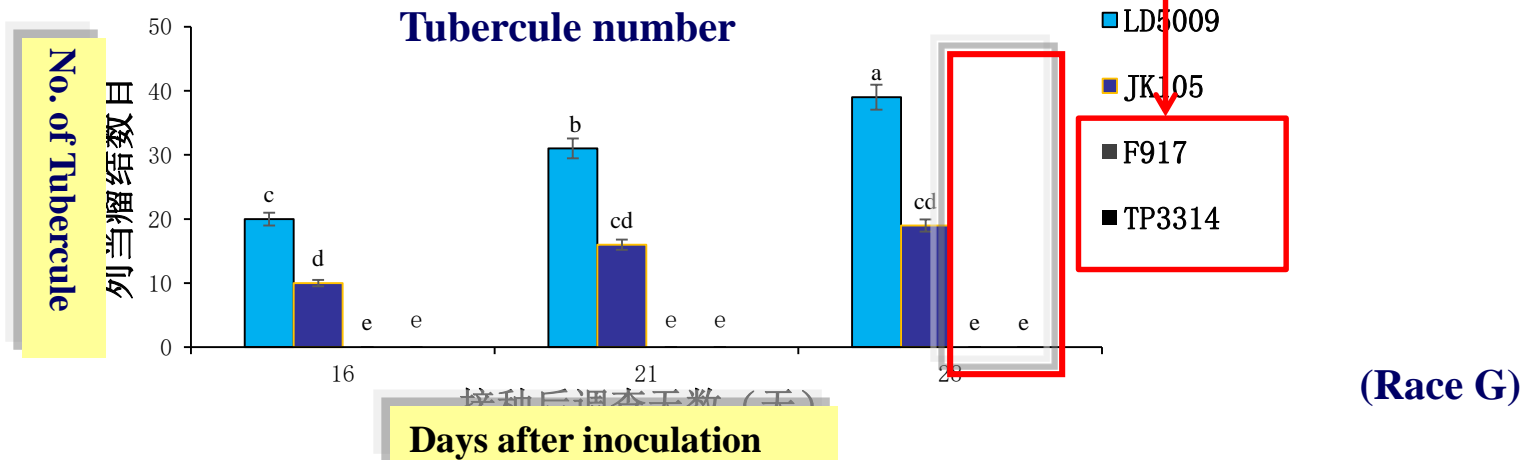
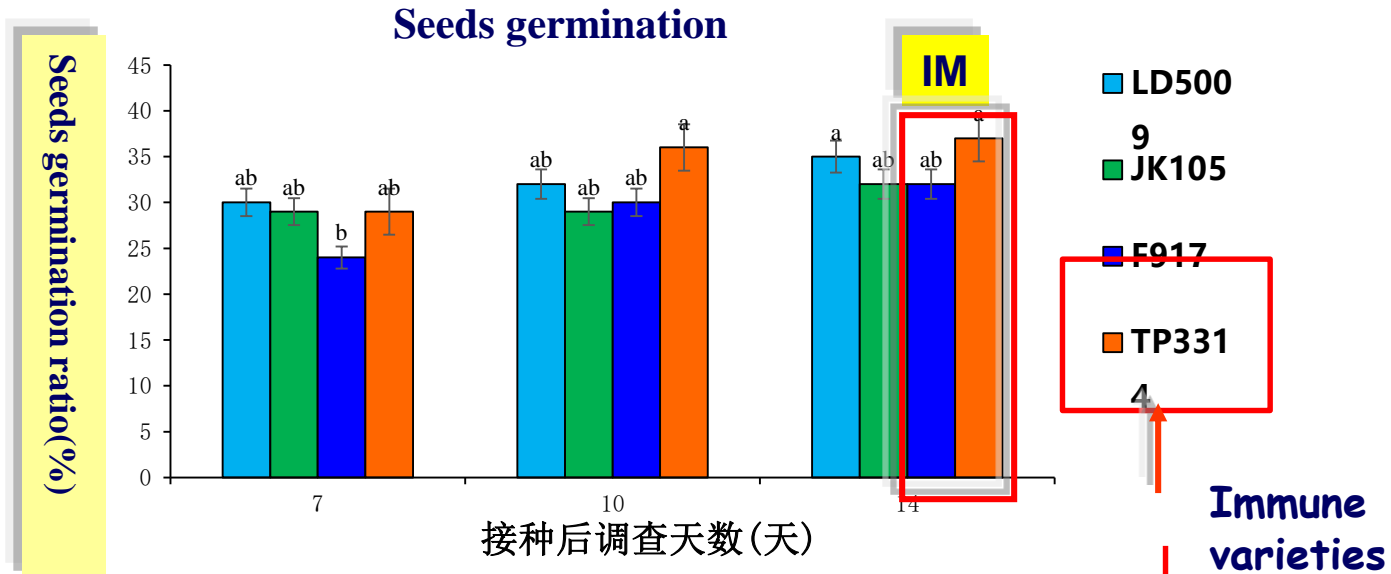
Unravel resistance mechanism



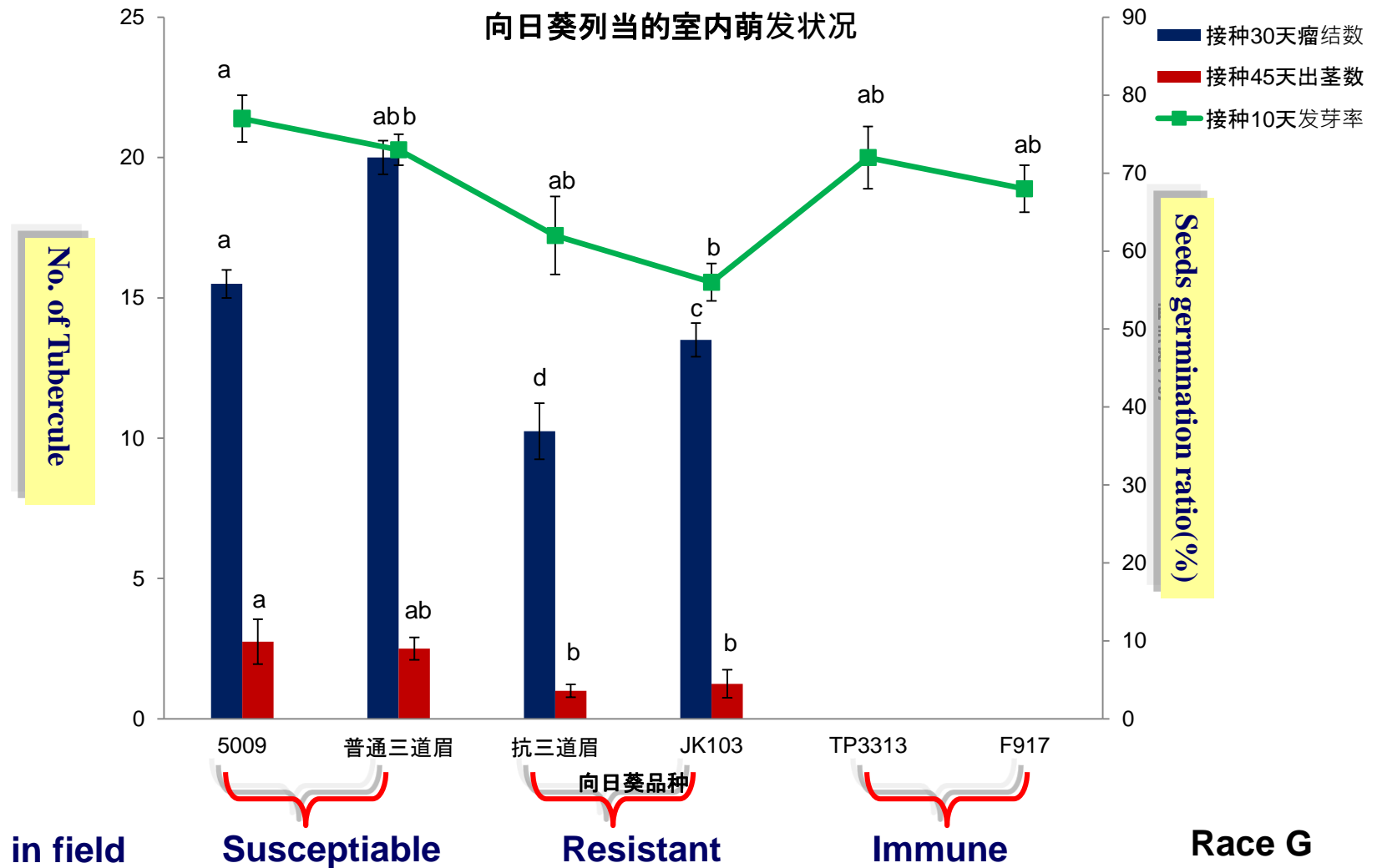
Dissecting the parasitic process of broomrape



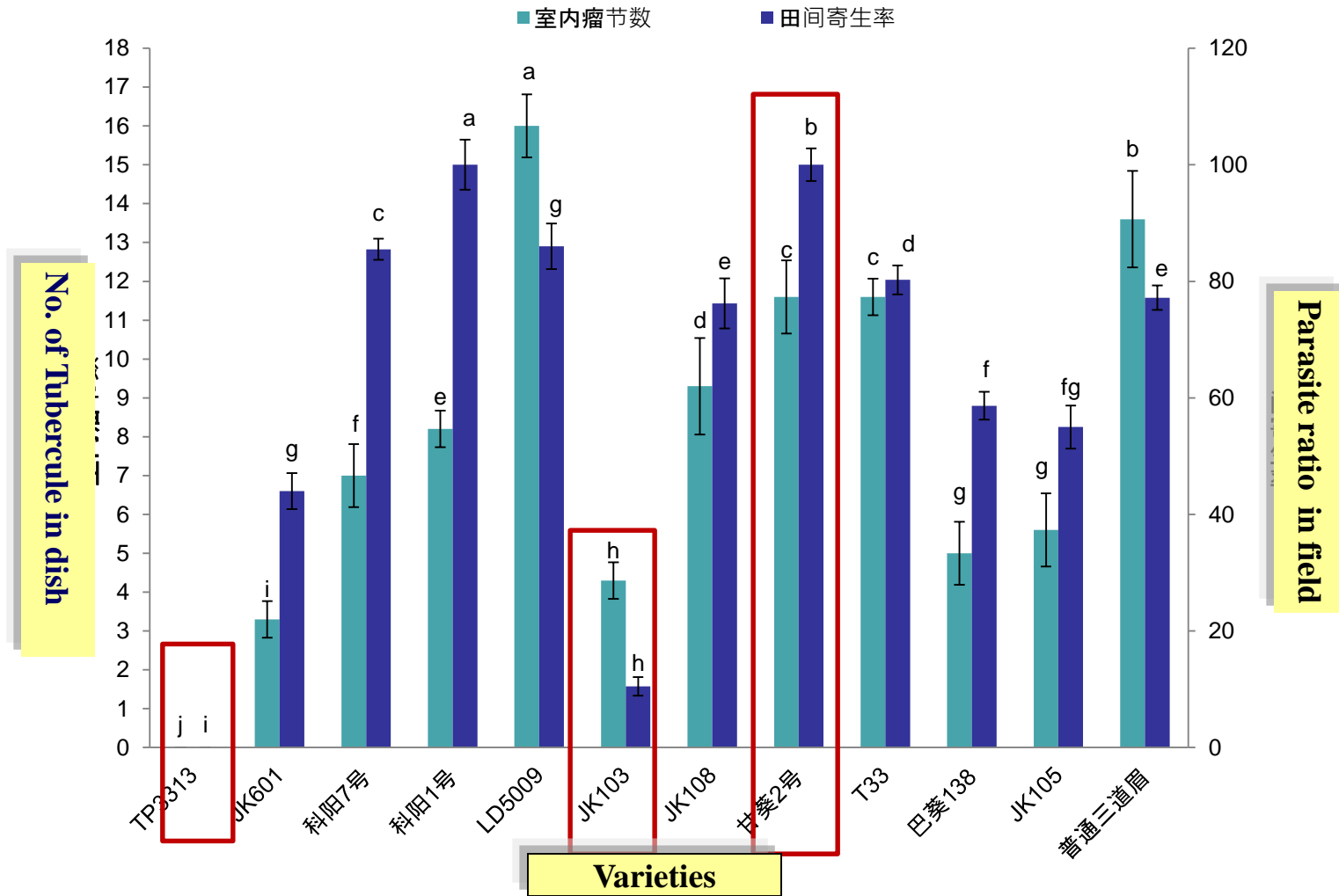
Seeds germination rate can not be used as resistant evaluation criteria



Seeds germination rate can not be used as resistant evaluation criteria



Comparison on the resistance level of different varieties under both field and lab condition



Set up the resistance evaluation criteria for petri dish system

| Resistant level | Tubercule number per dish |
|------------------------|---------------------------|
| Immun (I) | $X=0$ |
| High resistance (HR) | $1 \leq X \leq 5$ |
| Middle resistance (MR) | $5 < X \leq 10$ |
| Susceptible (S) | $10 < X \leq 15$ |
| High susceptible (HR) | $15 < X$ |

**Note: Tubercule number count 35 dpi ,
10 plants/variety, 3 repeats.**

Sunflower varieties information

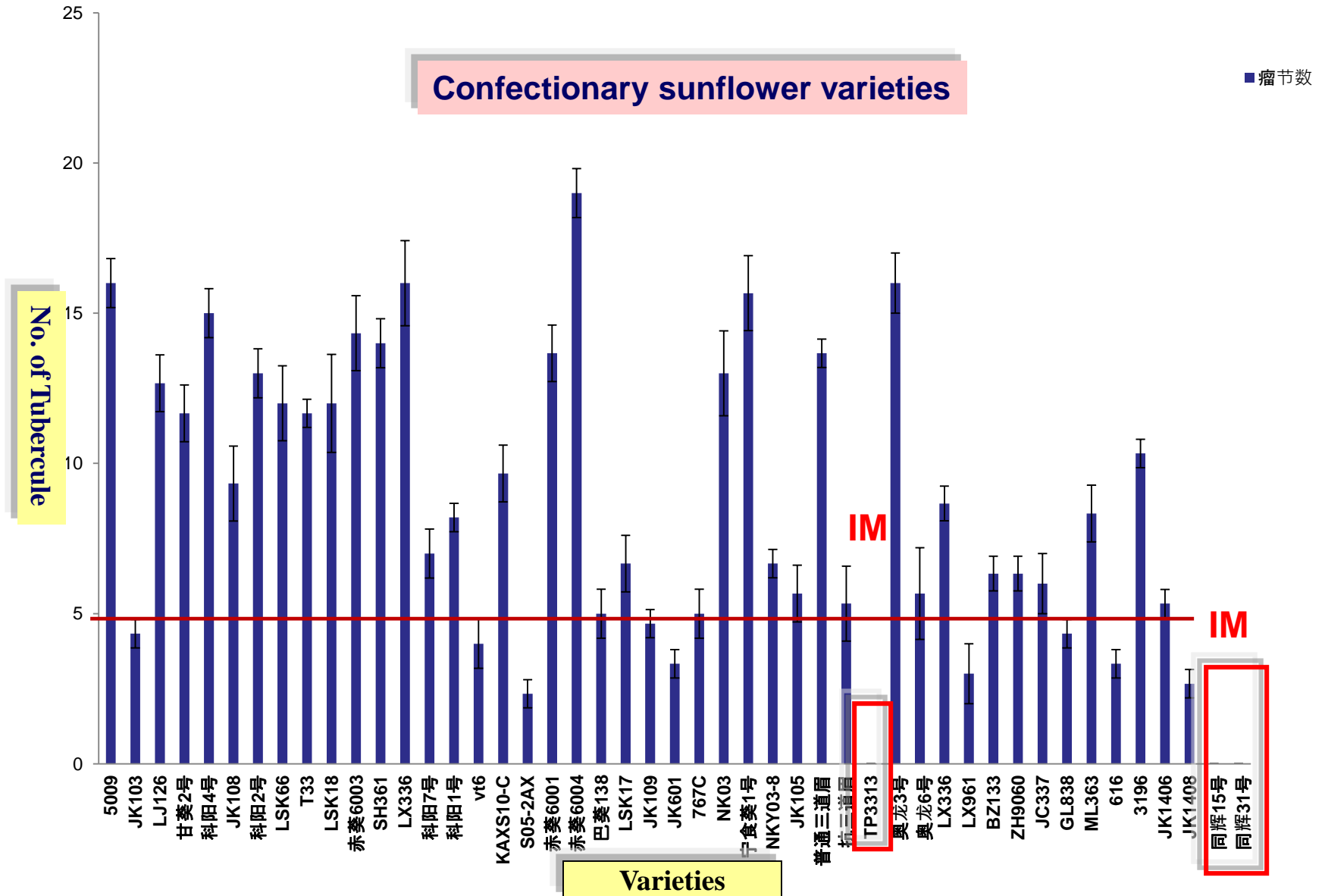
| 编号 | 品种名称 | 来源 | 编号 | 品种名称 | 来源 |
|----|----------|--------------|----|-----------|-------------------|
| 1 | LD5009 | 北京凯福瑞种业公司 | 41 | 3196 | 山西省农业科学院作物科学研究所 |
| 2 | JK103 | 吉林白城农科院 | 42 | 616 | 山西省农业科学院作物科学研究所 |
| 3 | LJ126 | 内蒙古巴彦淖尔市杭锦后旗 | 43 | GL838 | 山西省农业科学院作物科学研究所 |
| 4 | 甘葵2号 | 黑龙江甘南县向日葵研究所 | 44 | JK1406 | 山西省汾阳市省农科院经济作物研究所 |
| 5 | 科阳4号 | 内蒙古农牧科学院 | 45 | JK1408 | 山西省汾阳市省农科院经济作物研究所 |
| 6 | JK108 | 吉林白城农科院 | 46 | 同辉15号 | 甘肃同辉种业有限责任公司 |
| 7 | 科阳2号 | 内蒙古农牧科学院 | 47 | 同辉31号 | 甘肃同辉种业有限责任公司 |
| 8 | LSK66 | 黑龙江省农科院 | 48 | F53 | 辽宁省农科院作物所 |
| 9 | T33 | 内蒙古农牧业科学院 | 49 | 赤CY102 | 内蒙古赤峰市农科院 |
| 10 | LSK18 | 黑龙江省农科院 | 50 | S67 | 北京得农种业赤峰分公司 |
| 11 | 赤葵6003 | 内蒙古赤峰市农科院 | 51 | 法国1 | 国家向日葵产业技术体系 |
| 12 | SH361 | 内蒙古三瑞种业公司 | 52 | 赤KY11-52 | 内蒙古赤峰市农科院 |
| 13 | LX336 | 国家向日葵产业技术体系 | 53 | 赤CY101 | 内蒙古赤峰市农科院 |
| 14 | 科阳7号 | 内蒙古农牧科学院 | 54 | 赤KY11-46 | 内蒙古赤峰市农科院 |
| 15 | 科阳1号 | 内蒙古农牧科学院 | 55 | 新葵杂5号 | 新疆农业科学院 |
| 16 | vt6 | NDSU | 56 | F917 | 内蒙古萨福沃农业发展有限公司 |
| 17 | KAXS10-C | 国家向日葵产业技术体系 | 57 | 油A6 | 国家向日葵产业技术体系 |
| 18 | S05-2AX | 国家向日葵产业技术体系 | 58 | YS1408-10 | 国家向日葵产业技术体系 |
| 19 | 赤葵6001 | 内蒙古赤峰市农科院 | 59 | vt33 | NDSU |
| 20 | 赤葵6004 | 内蒙古赤峰市农科院 | 60 | vt24 | NDSU |

Sunflower varieties information

| 编号 | 品种名称 | 来源 | 编号 | 品种名称 | 来源 |
|----|---------|-------------|----|-----------|---------------|
| 21 | 巴葵138 | 内蒙古巴彦淖尔市农科院 | 61 | vt35 | NDSU |
| 22 | LSK17 | 黑龙江省农科院 | 62 | vt37 | NDSU |
| 23 | JK109 | 吉林白城农科院 | 63 | vt27 | NDSU |
| 24 | JK601 | 吉林白城农科院 | 64 | vt29 | NDSU |
| 25 | 767C | 国家向日葵产业技术体系 | 65 | vt46 | NDSU |
| 26 | NK03 | 内蒙古农科院 | 66 | vt41 | NDSU |
| 27 | 宁食葵1号 | 国家向日葵产业技术体系 | 67 | vt13 | NDSU |
| 28 | NKY03-8 | 国家向日葵产业技术体系 | 68 | vt7 | NDSU |
| 29 | JK105 | 吉林白城农科院 | 69 | vt11 | NDSU |
| 30 | 普通三道眉 | 新疆北屯农十师农科院 | 70 | vt1 | NDSU |
| 31 | 抗三道眉 | 新疆北屯农十师农科院 | 71 | vt42 | NDSU |
| 32 | TP3313 | 内蒙古三瑞种业公司 | 72 | tex6 | NDSU |
| 33 | 奥龙3号 | 内蒙古奥隆种业公司 | 73 | vt43 | NDSU |
| 34 | 奥龙6号 | 内蒙古奥隆种业公司 | 74 | 赤CY106 | 内蒙古赤峰市农科院 |
| 35 | LX336 | 金裕种业 | 75 | LKZ13-1 | 黑龙江省农科院 |
| 36 | LX961 | 金裕种业 | 76 | LKZ14-4 | 黑龙江省农科院 |
| 37 | JC337 | 金裕种业 | 77 | 伊葵杂3号 | 新疆农业科学院 |
| 38 | ZH9060 | 正和种业 | 78 | YS1408-24 | 国家向日葵产业技术体系 |
| 39 | BZ133 | 正和种业 | 79 | 临葵4号 | 山西省农业科学院小麦研究所 |
| 40 | ML363 | 内蒙古蒙龙种业科技公司 | 80 | 矮大头 | 河北东秦种业有限公司 |

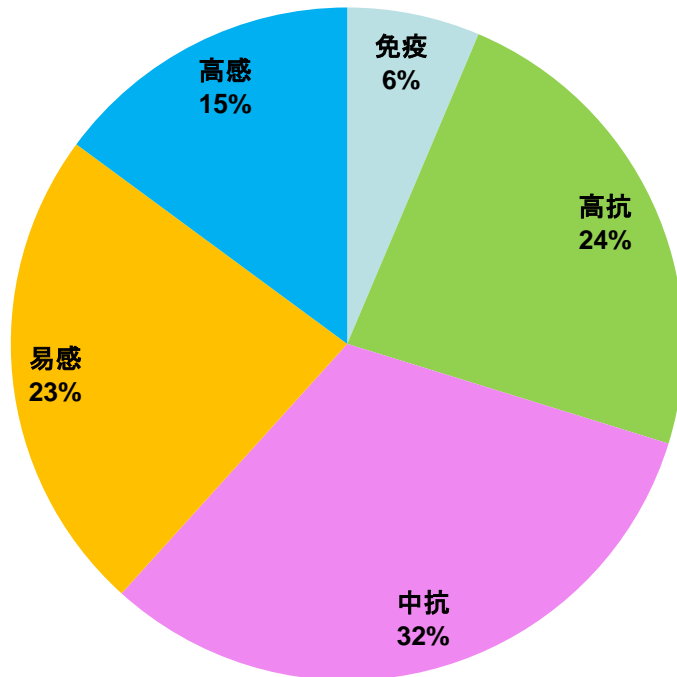
80 sunflower varieties

Screening the resistance varieties of sunflower



Screening results of confectionary sunflower varieties

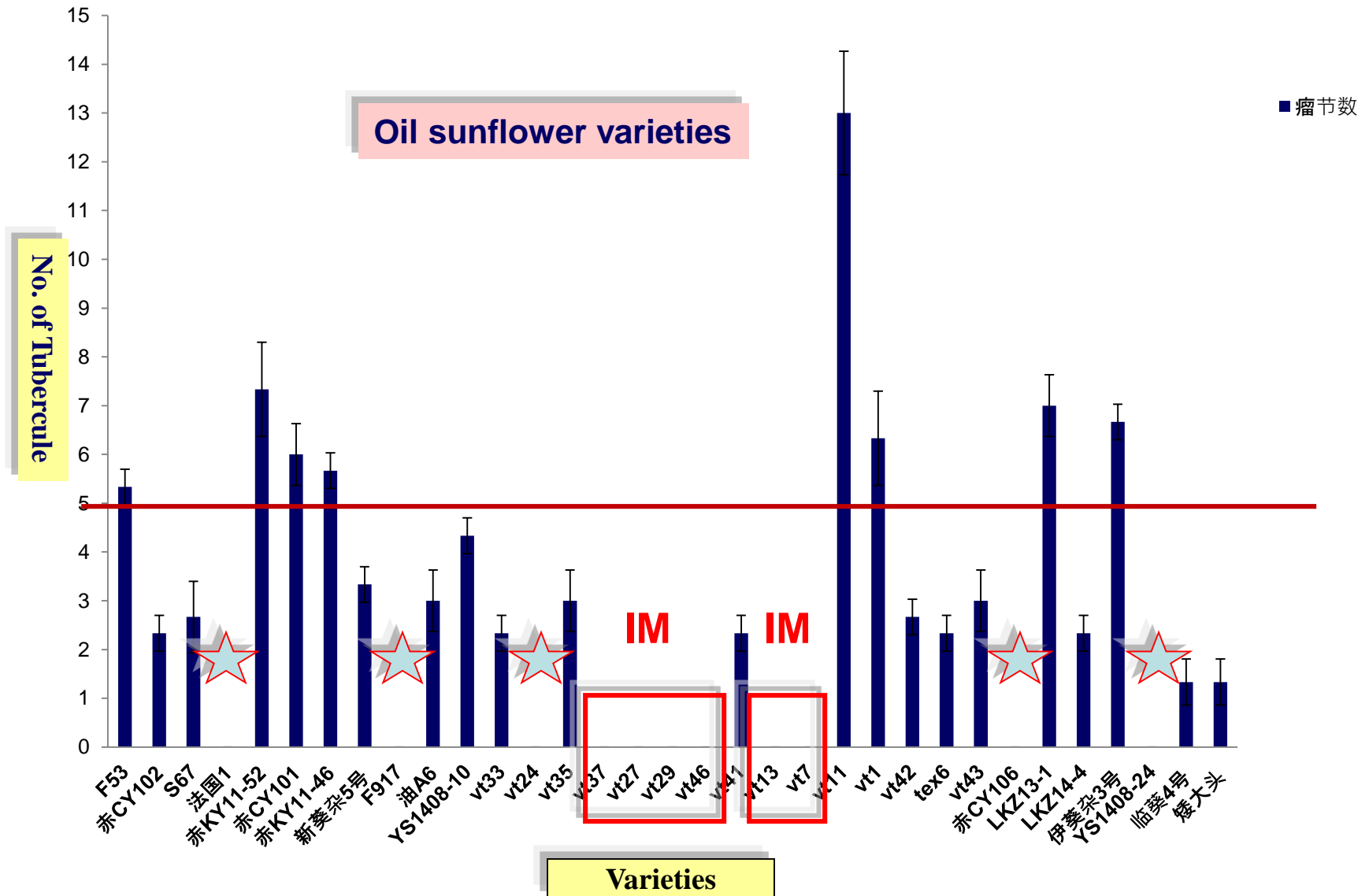
Confectionary varieties : 47 in total



IM (3 varieties) : TP3313、同辉15号、同辉31号。

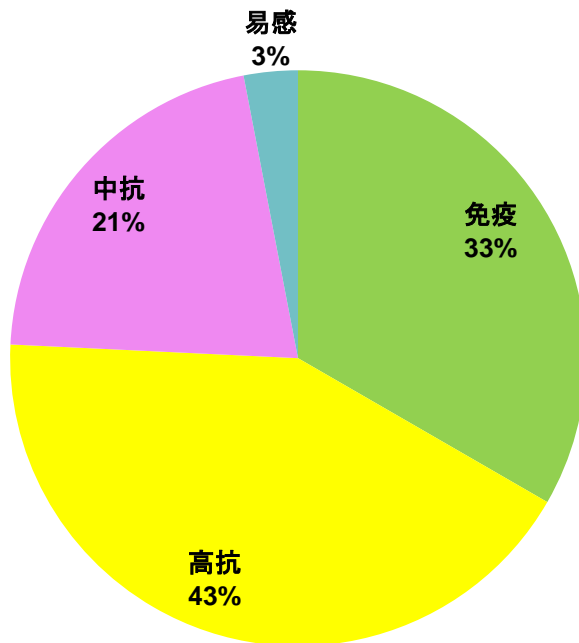
HR (11 varieties) : JK103、JK601、JK109、Bakui138 ect.。

Screen the resistance varieties of sunflower



Screening results of Oil sunflower varieties

Oil sunflower varieties : 33 in total



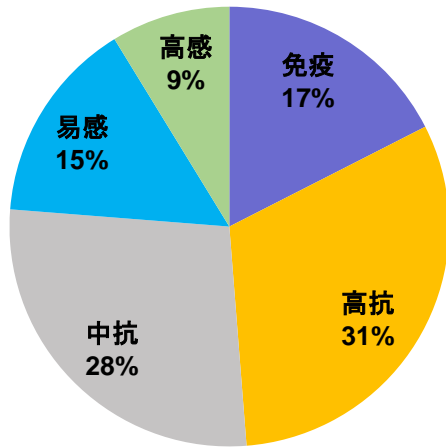
IM (11 varieties) : France 1, F917, vt24, ChiCY106 ect.

HR (14 varieties) : ChiCY102, S67, Xinkuiza 5 ect.

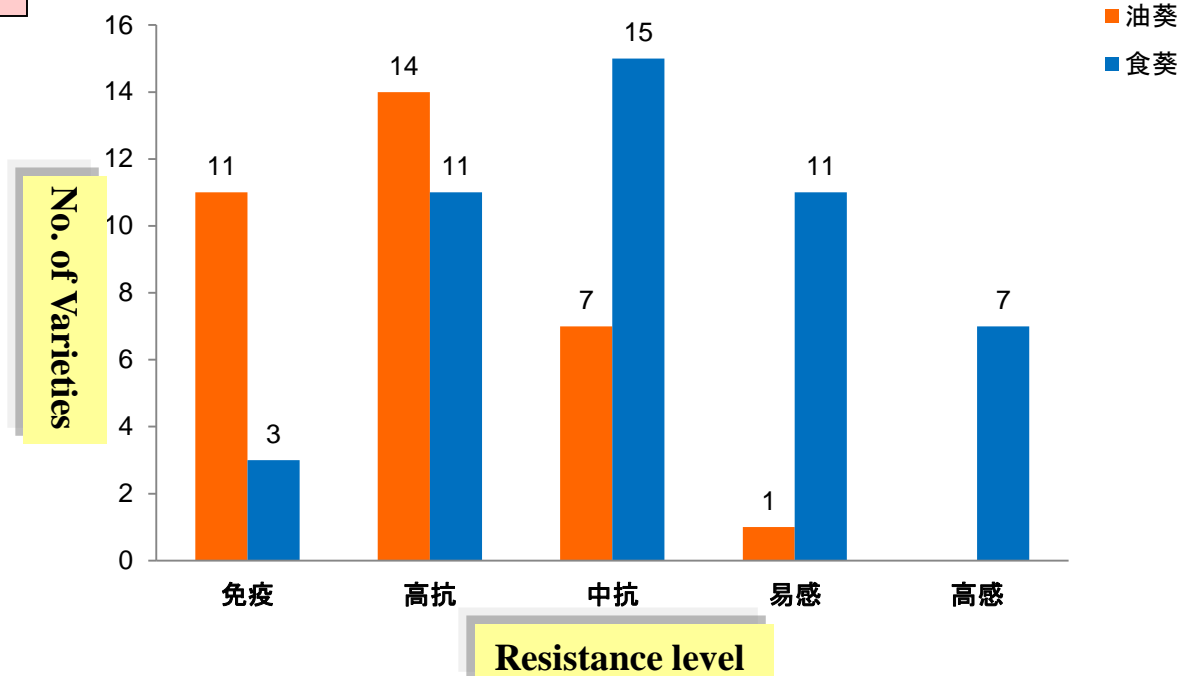
Comparison screening results between Confectionary and Oil sunflower varieties

Resistance classification of 80 varieties

(80份)



不同向日葵品种抗性鉴定结果 (80份)

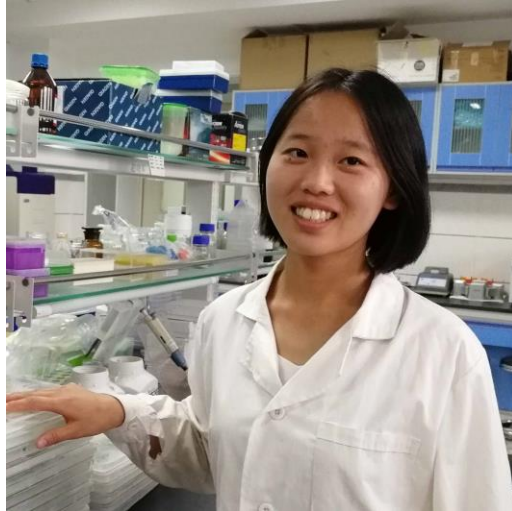


Conclusion

- Petri dish system can be used as a fast and accurate way to screen sunflower resistance level under lab condition;
- Tubercule, instead of seed germination rate, can be used as criteria to evaluate the resistant level of sunflower varieties;
- In general, oil sunflower varieties showed higher resistance to broomrape compared with confectionary sunflower varieties.

2

A potential efficient way to control sunflower broomrape in China



Huiqing Liu (IMAU)



Xili Zhang (Sunrise Company)

The control ways for sunflower broomrape

- **Generate immune or high resistance sunflower varieties;**
- **Combined planting herbicide resistant variety with spraying herbicide;**
- **Using bio-control agent in soil against broomrape;**
- **Using trap-crops to reduce broomrape seeds in soil**

.....

A potential blocking agent (Target 1) is coming.....

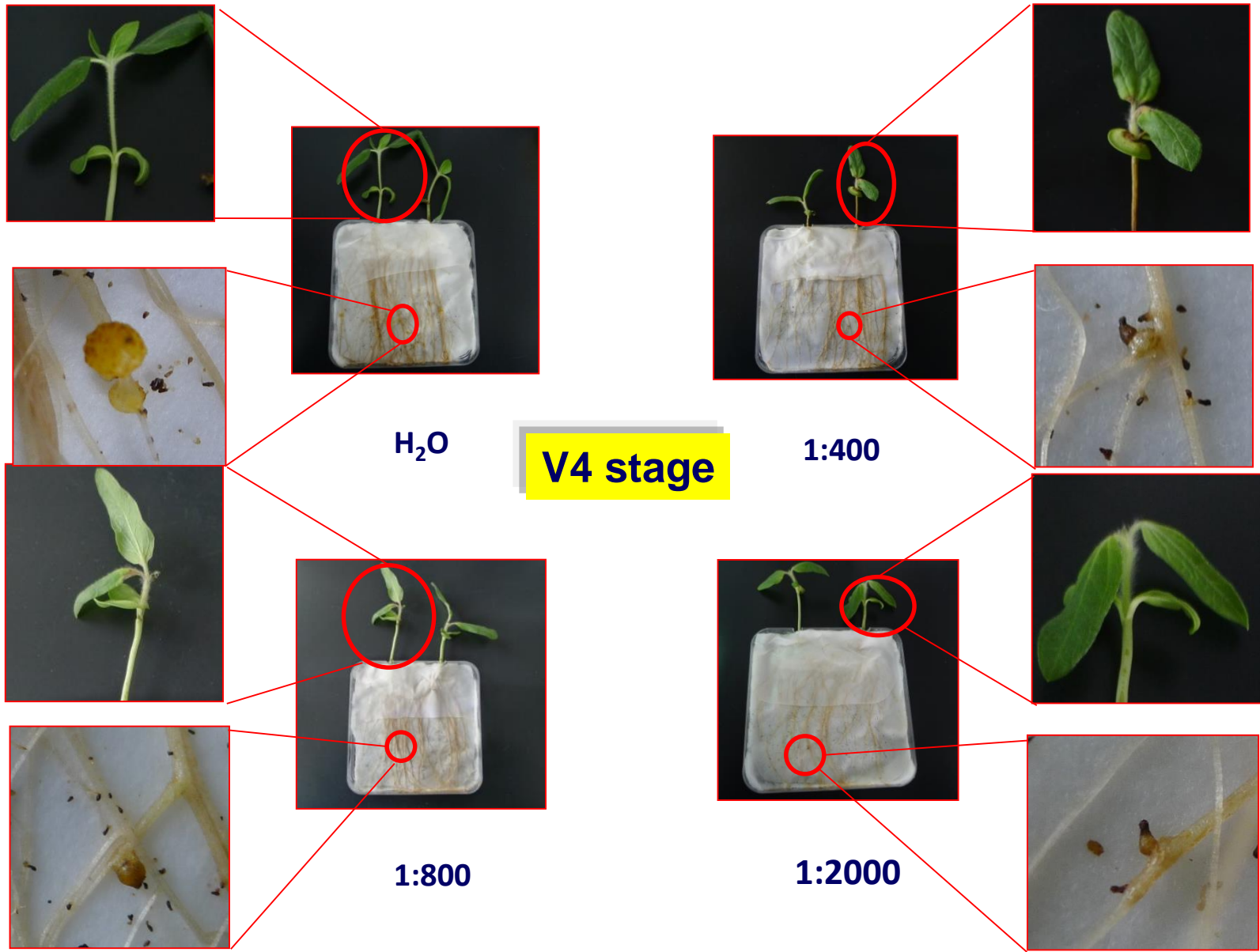
About blocking agent---Target 1

- A kind of mixture of chemical and nutrient;
- It could block the parasite of broomrape on sunflower roots;
- It does have dramatically blocking effect on the early stage of parasite of broomrape;

.....

Synthesized by **Tsinghua University**

Spraying Target 1 on leaves **before** tubercule formation





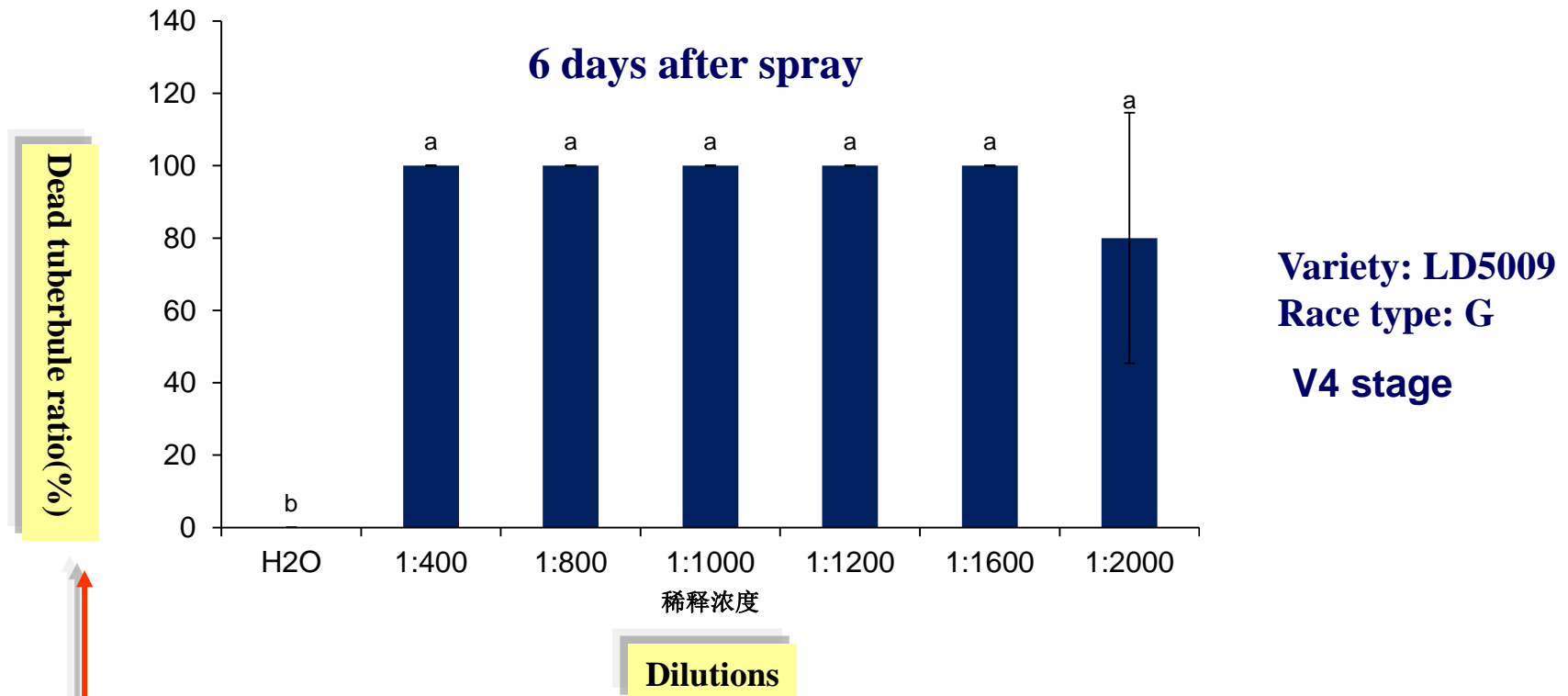
CK



Target 1

Spraying Target1 on leaves before tubercule formation

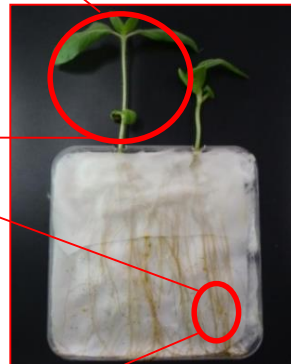
6 days after spray



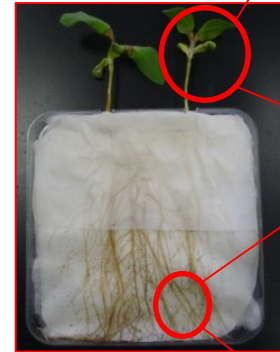
$$\text{Dead tubercule (\%)} = \frac{\text{No.of dead tubercule}}{\text{No.Total tubercule}} \times 100\%$$

- 4.3 -- Inoculate broomrape seeds
- 4.16 -- Spay Target 1 on leave
- 4.21-- Calculate tuburcule

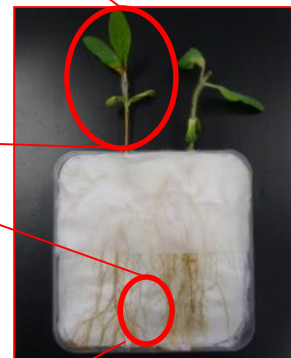
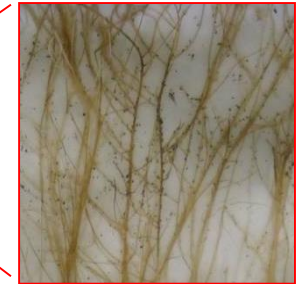
Watering with Target 1 before tubercule formation



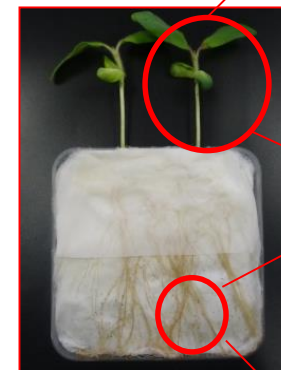
H₂O



1:400



1:800



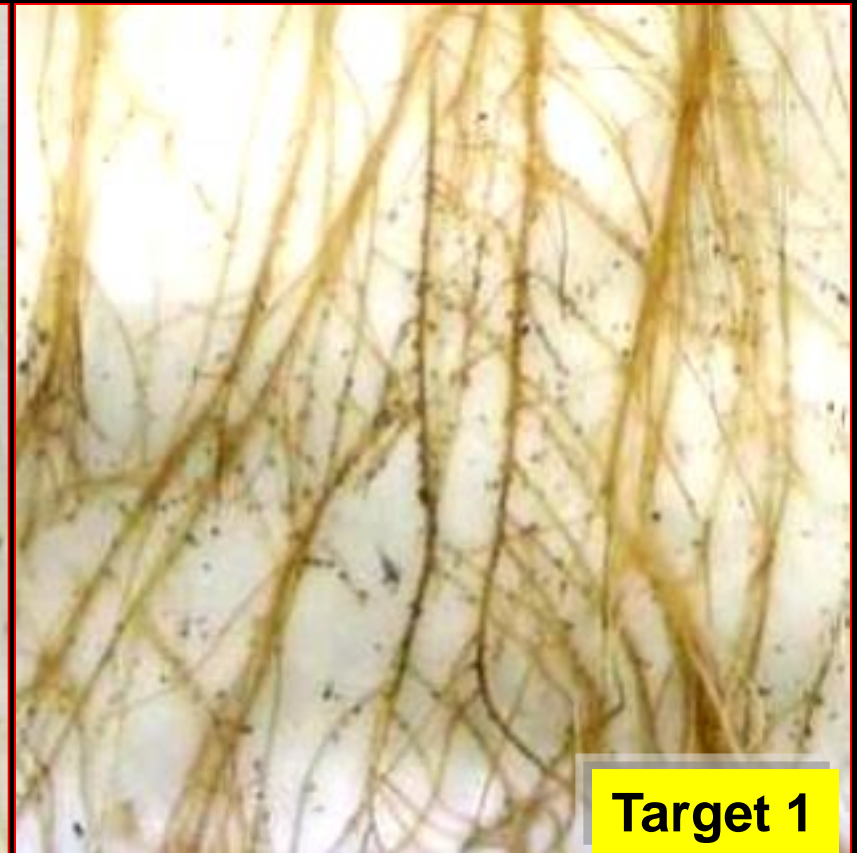
1:2000



Watering with Target 1 before tubercule formation

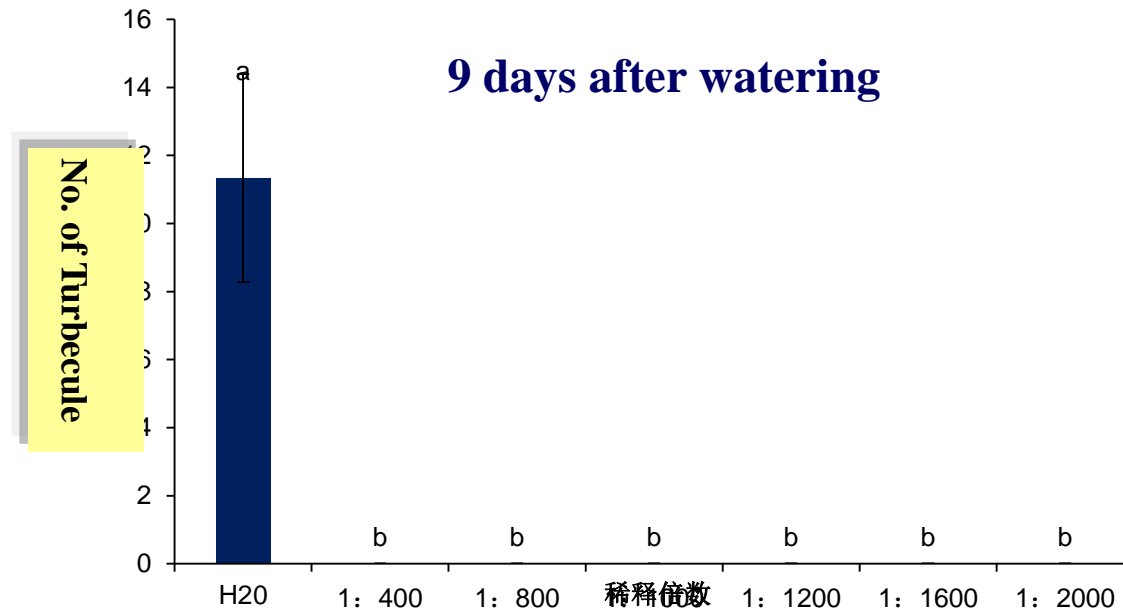


CK



Target 1

Watering with Target 1 before tubercule formation



Variety: LD5009
Race type: G

V4 stage

4.9 -- Inoculate broomrape seeds

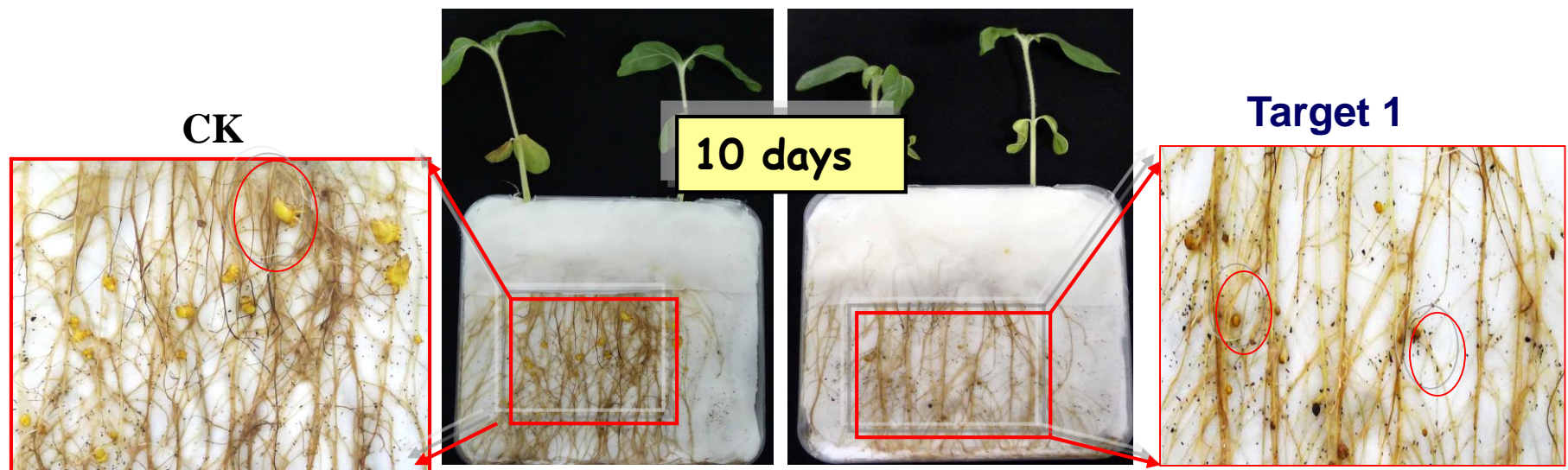
4.19 – watering target 1 in petri dish

4.27-- Calculate tubercule

Spraying Target 1 after tubercule formation

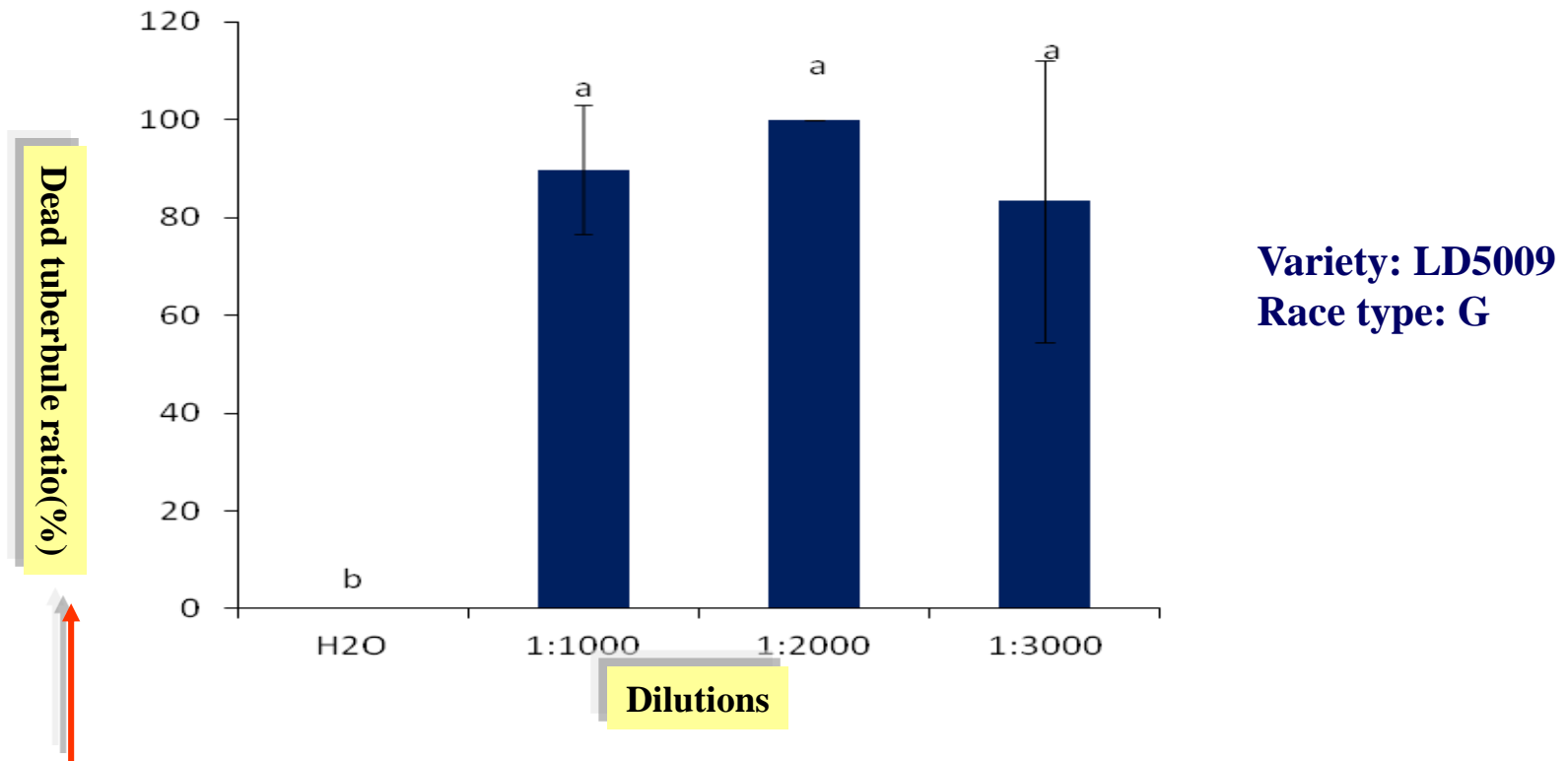


Spraying target 1 on leaves **after** tubercule formation



Spraying Target 1 on leaves after tubercule formation

14 days after spray

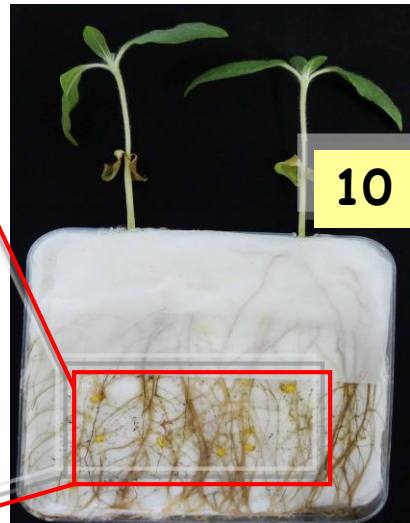


$$\text{Dead tubercule (\%)} = \frac{\text{No.of dead tubercule}}{\text{No.Total tubercule}} \times 100\%$$

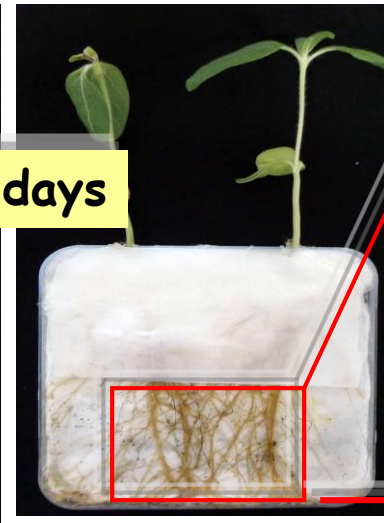
- 5.19-- Inoculate seeds
- 6.1-- Spay Target 1 on leave
- 6.14-- Calculate tubercule

Watering with Target 1 after tubercule formation

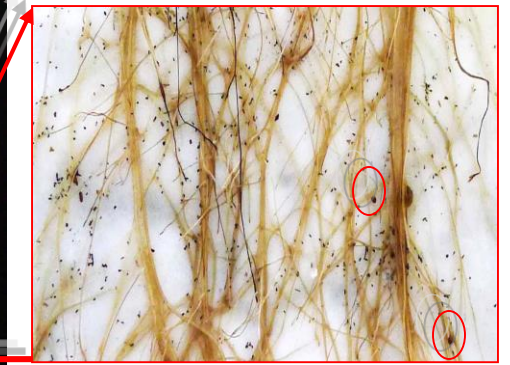
CK



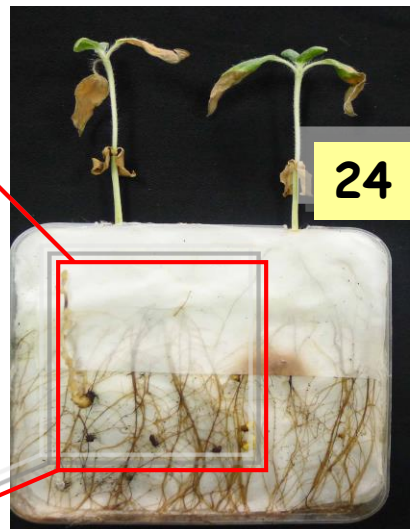
10 days



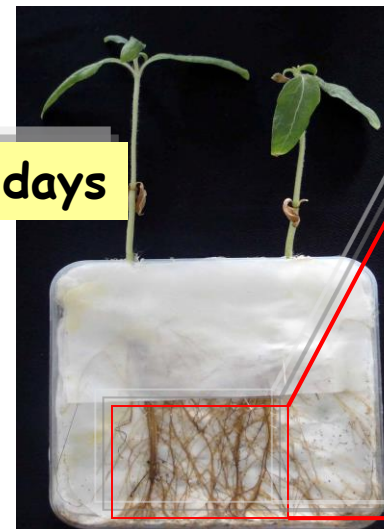
Target 1



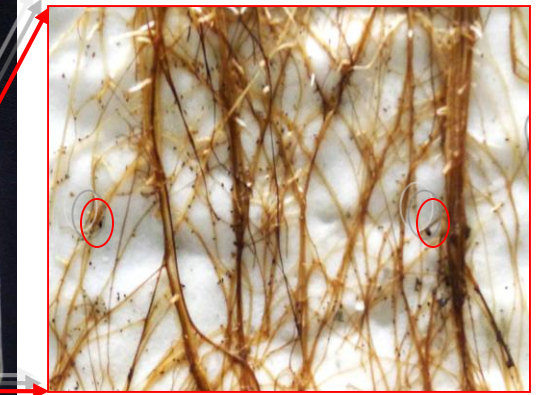
CK



24 days

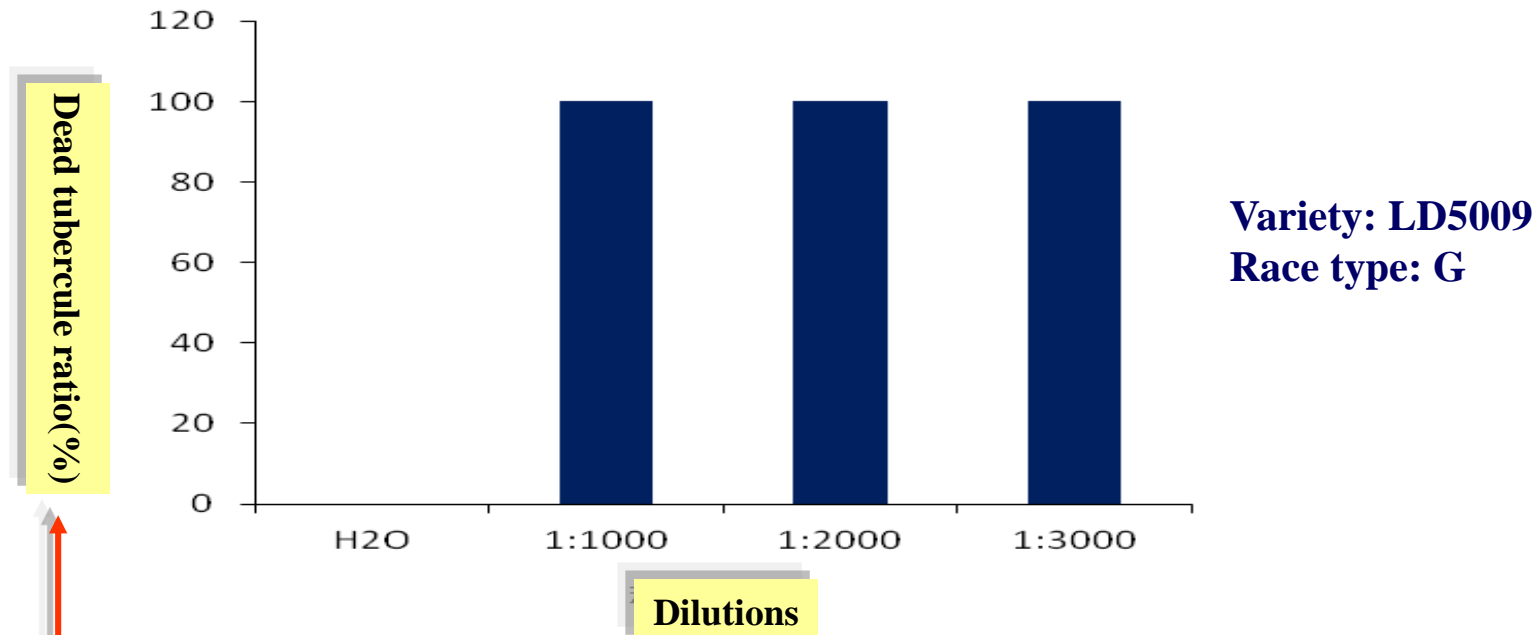


Target 1



Watering with Target 1 after tubercule formation

14 days after watering



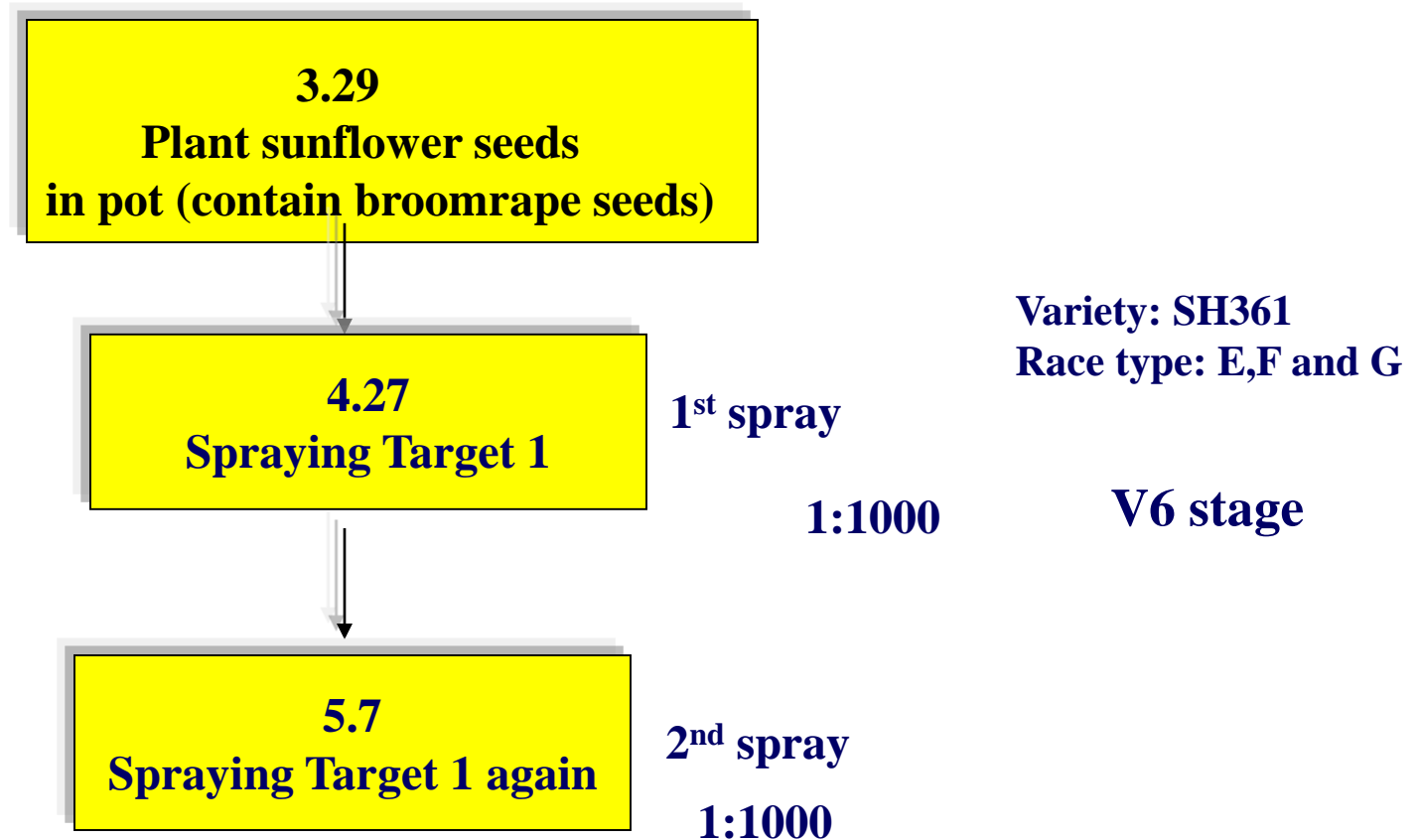
$$\text{Dead tubercule (\%)} = \frac{\text{No.of dead tubercule}}{\text{No.Total tubercule}} \times 100\%$$

5.19-- Inoculate seeds

6.1-- Water Target 1 on root

6.14-- Calculate tubercule

Test the blocking effects of Target 1 in greenhouse



Performed in greenhouse of Sunrise Seeds Company

Test the blocking effects of Target 1 in greenhouse

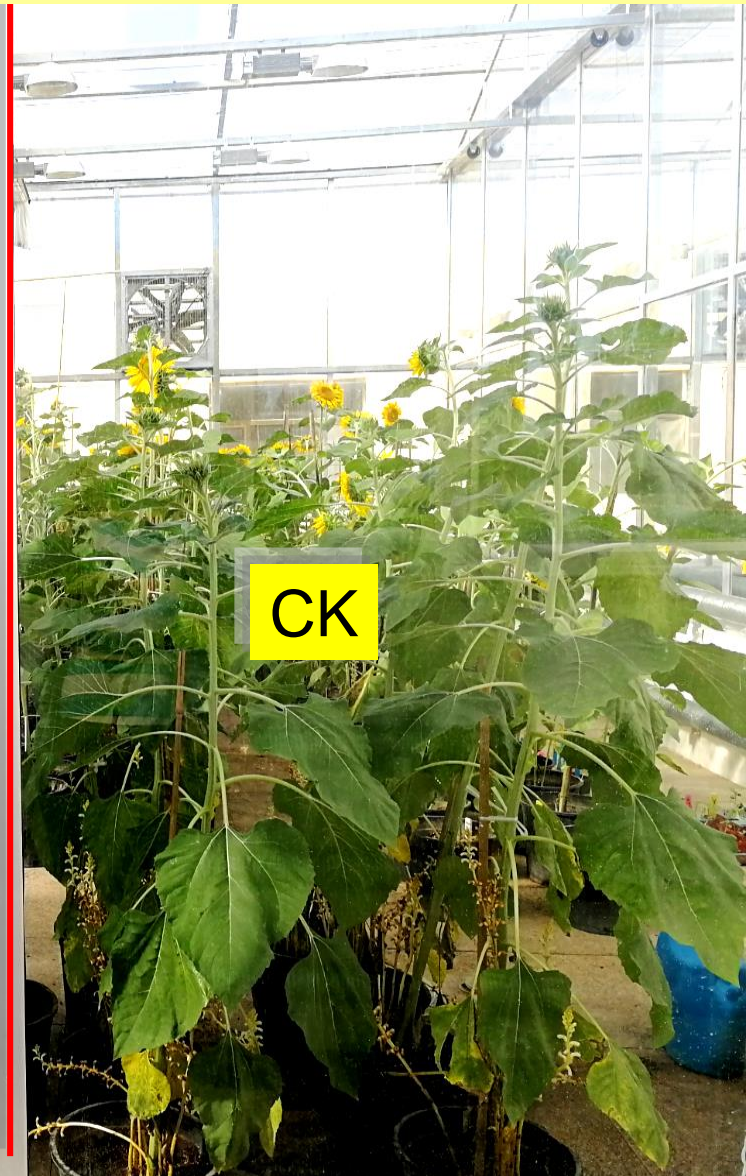
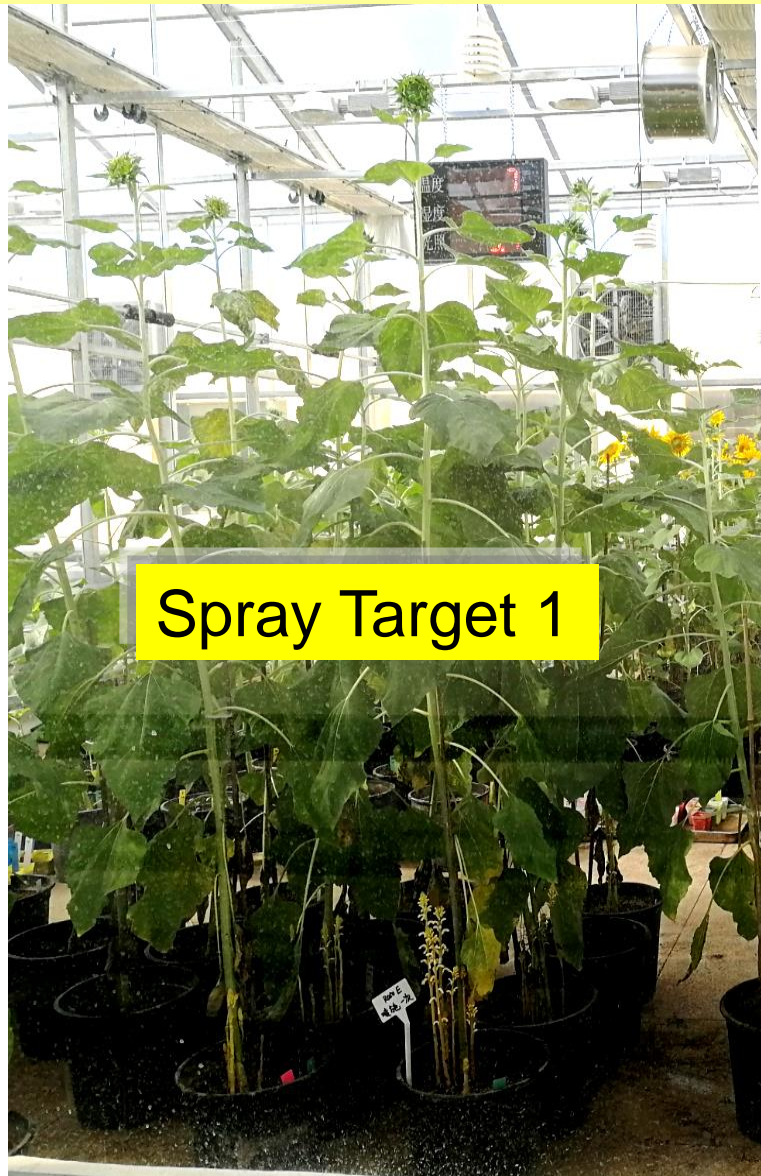


Photo on May 25 (28 days after spray)

Test the blocking effects of Target 1 in greenhouse

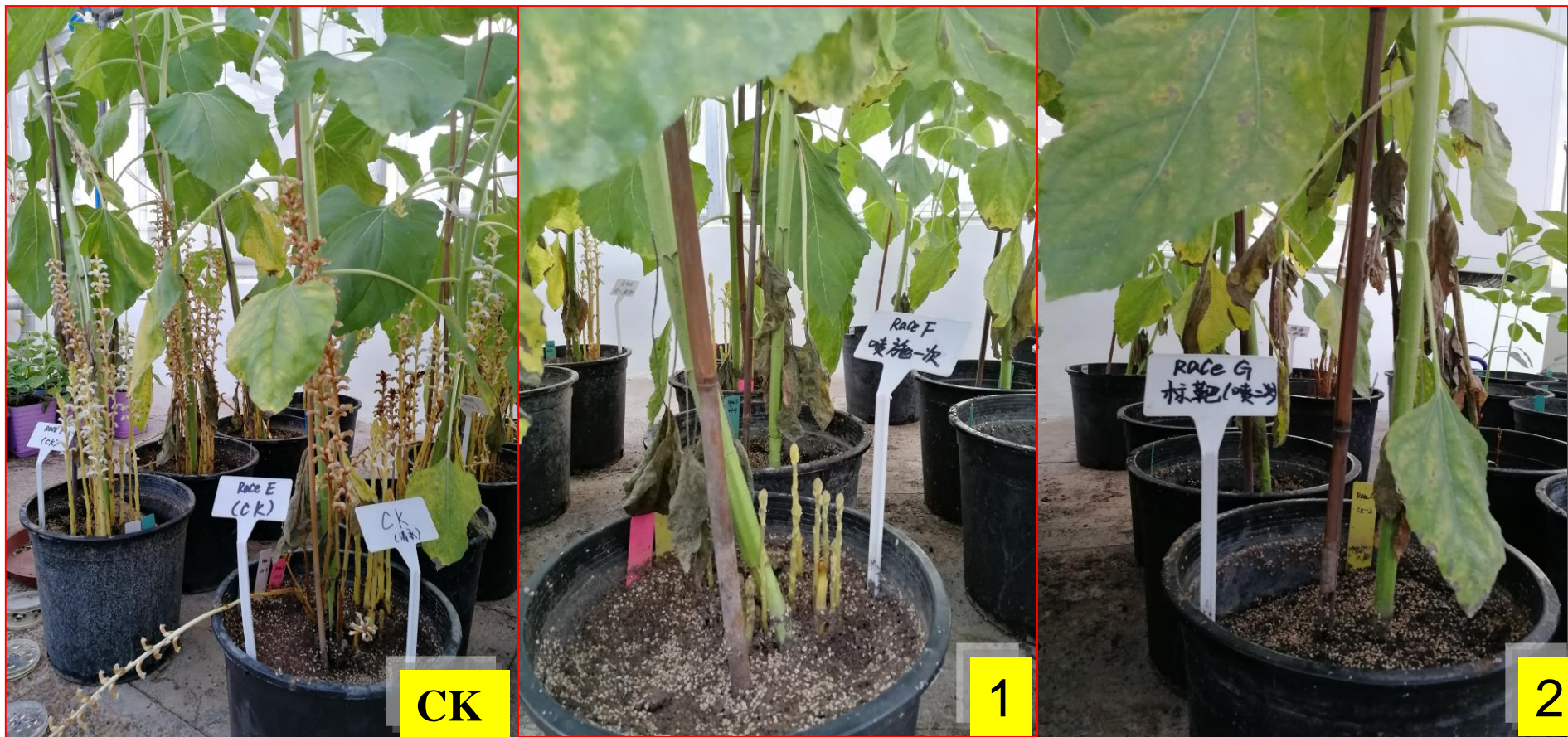
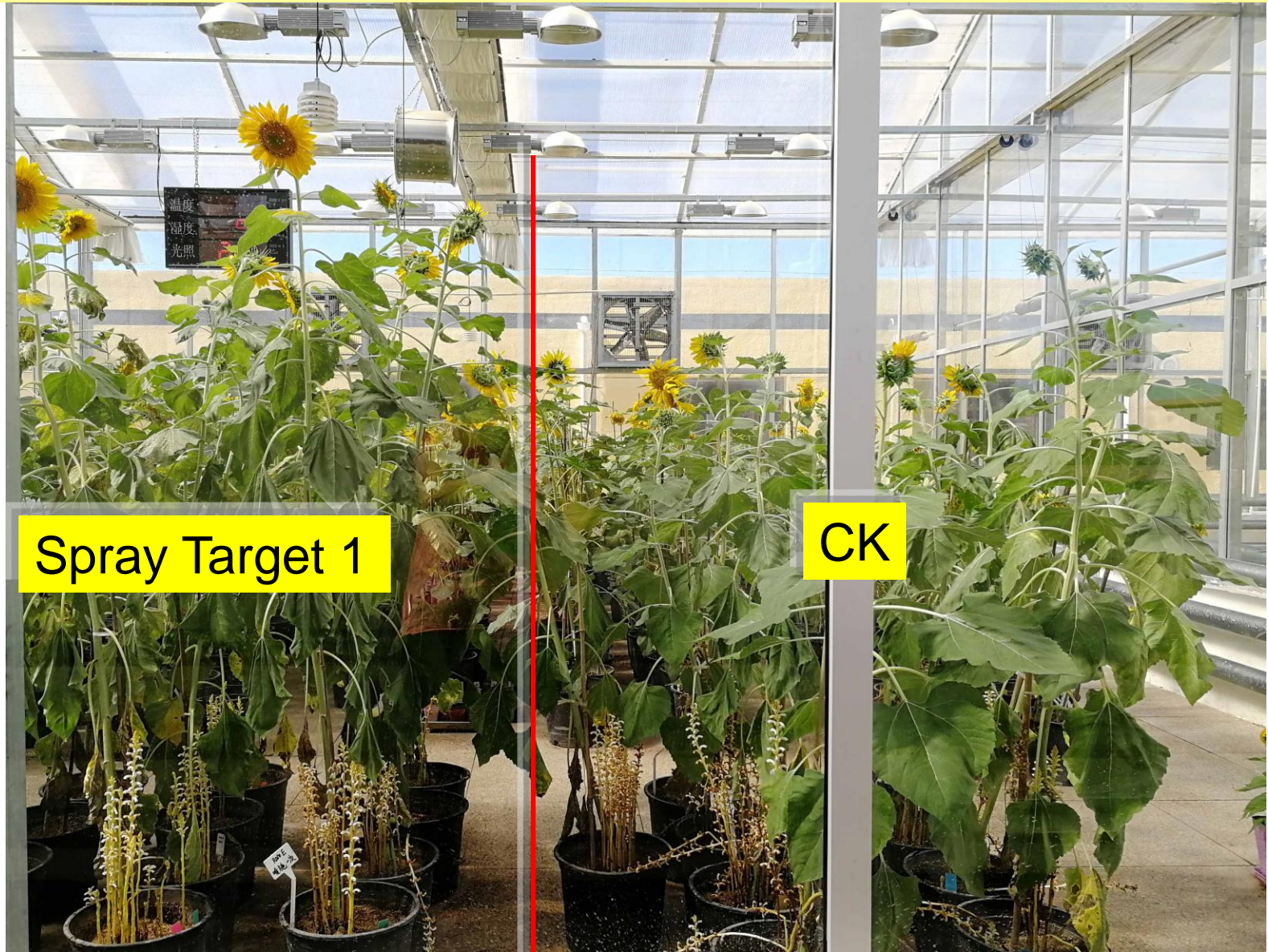


Photo on May 25 (28 days after spray)

Test the blocking effects of Target 1 in greenhouse



Spray Target 1

CK

Photo on June 13 (43 days after spray)

Test the blocking effects of Target 1 in greenhouse

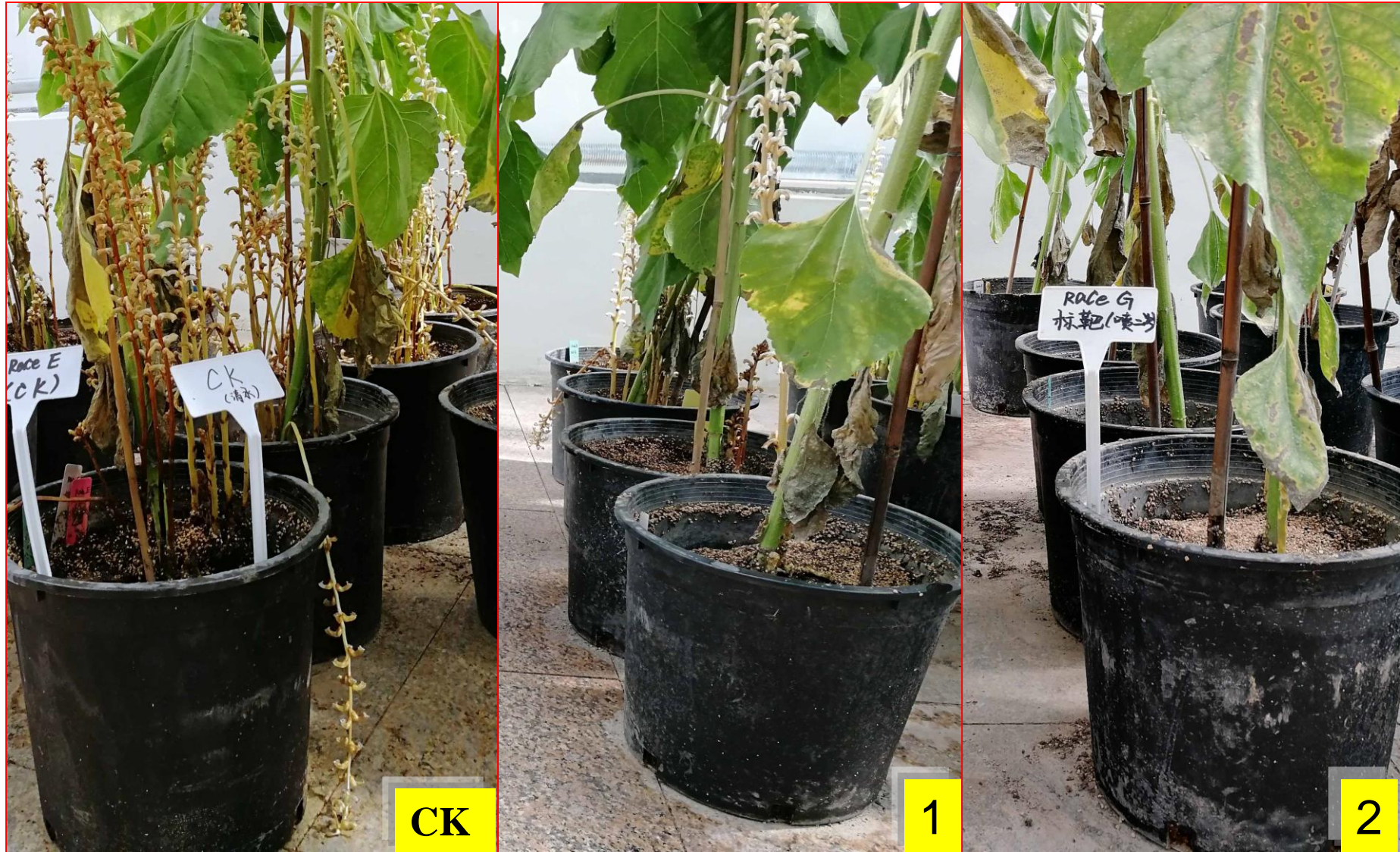
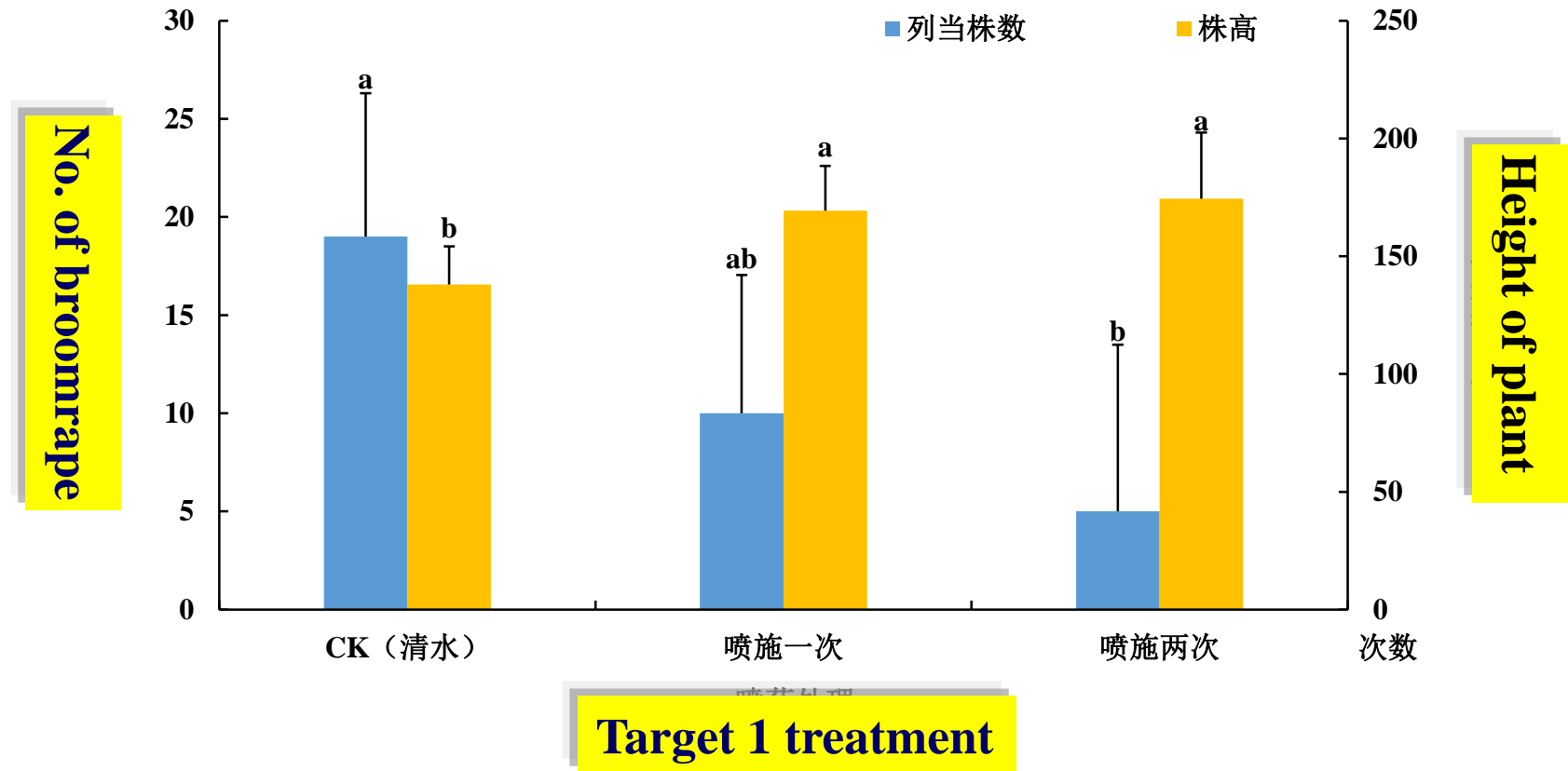


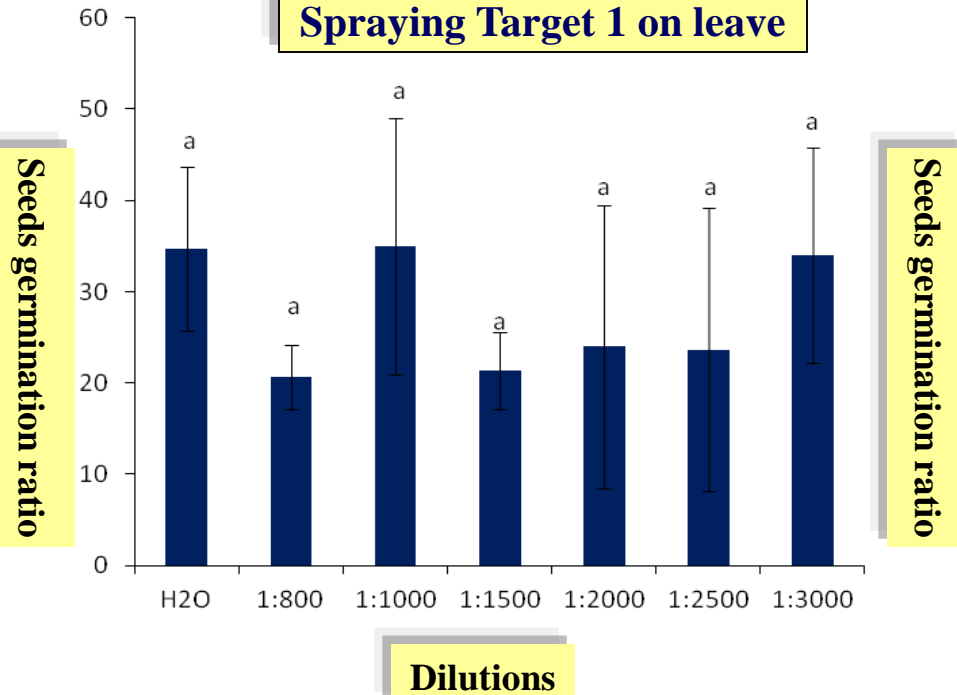
Photo on June 13 (43 days after spray)

The block effects of Target 1 under greenhouse condition

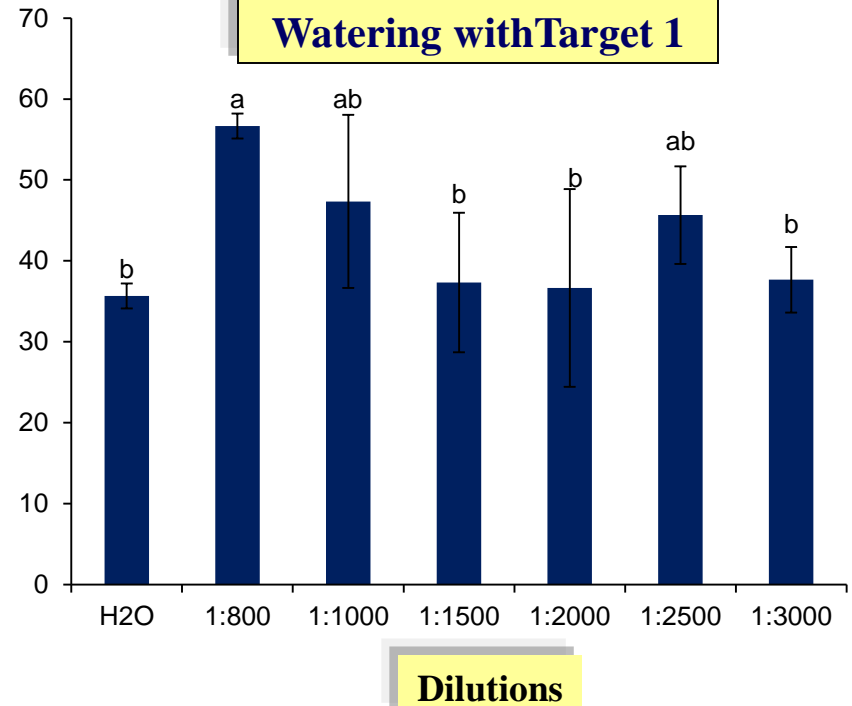


Target 1 does not have effects on broomrape seeds germination

Spraying Target 1 on leave



Watering with Target 1



5.20—Plant sunflower seeds

6.2-- Inoculate seeds

6.2– Spray or Water with target 1

6.9-- Calculate tubercule

Conclusion

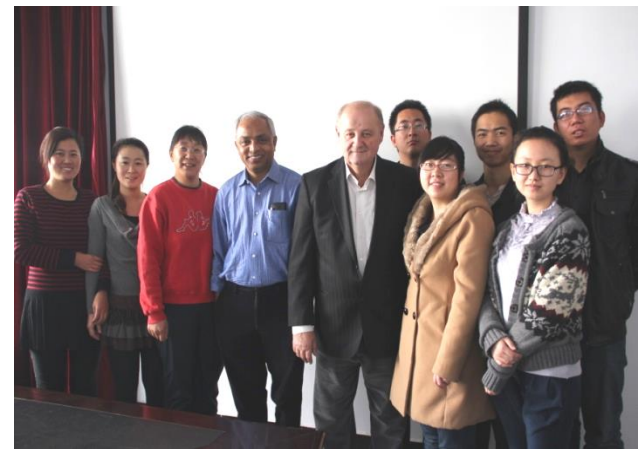
- **Both spraying and watering with Target 1 could block the parasite of broomrape on sunflower;**
- **The optimized dilution is between 1:1000-1:3000 under lab and greenhouse condition;**
- **There has side effects of high concentration of Target 1 on sunflower young leaves;**
- **The period of preserving effects is around one month.**
- **Target 1 does not have effects on the seeds germination of broomrape.**



DraganSkoric



Stephane Munous



kristina Subbaro



Francine Gover

**Academic
communication**



Jan C.C.



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Acknowledgement



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**Sunflower Research
Institute of Agritec Co.,
Ltd.**

Funded by China Special Oil Crop Research System (CARS-14)

International Symposium on Confection Sunflower Technology and Production

Date: Aug. 8-10, 2018

Location: Wuyuan, Inner Mongolia, China

Goal: Symposium will host over 100 leading experts on on confectionary sunflower breeding, pest resistance, as well as marketing and production.

Hosted by:

**Sanrui Agritec Co., Ltd,
Municipal government of Wuyuan
Inner Mongolia Agri. Univ.**

Detail register information :

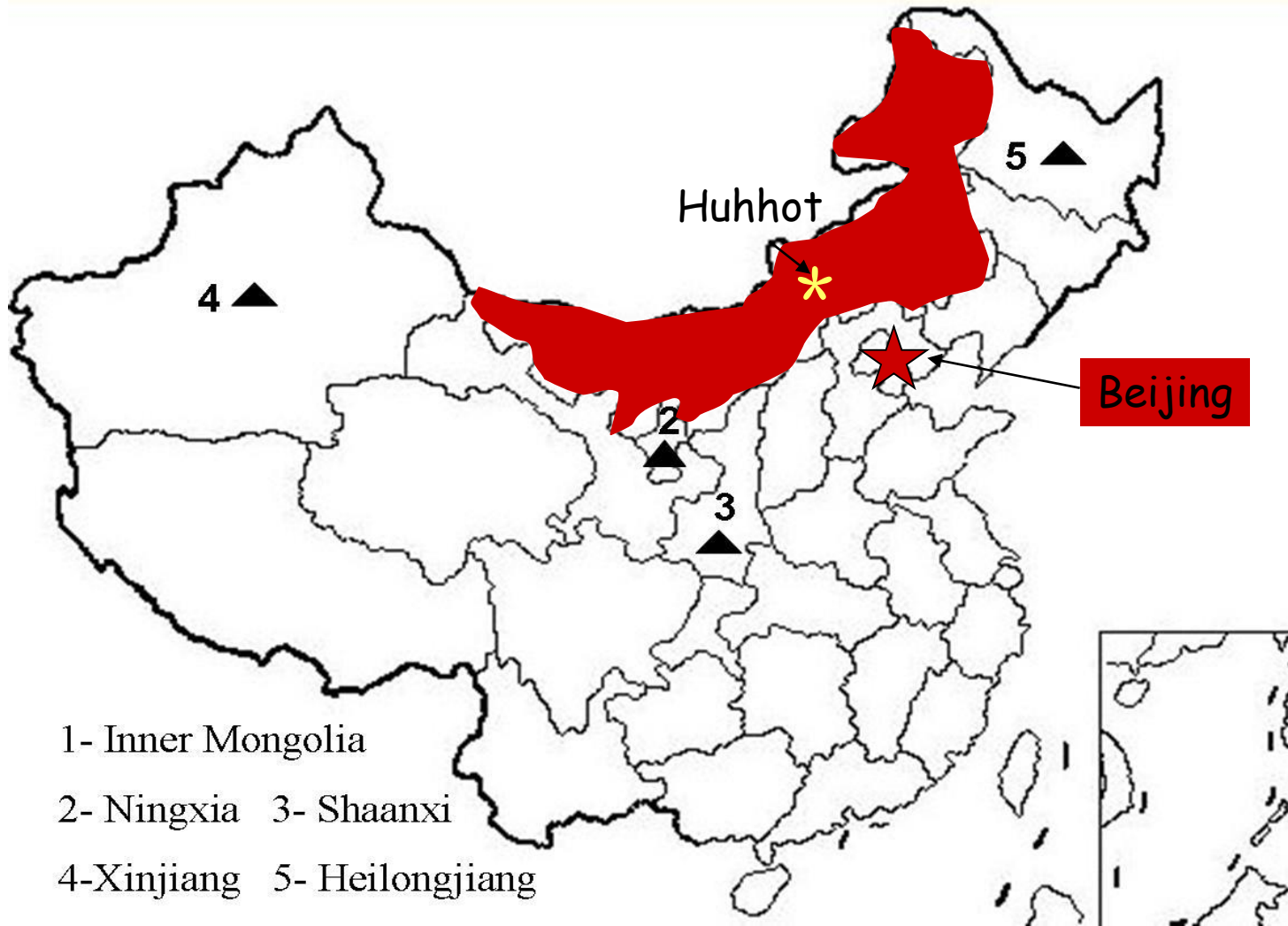
<http://isasunflower.org> (ISA)

The Coming Future.....

We are planing to host following meeting:

- 1. 5th International Sunflower Broomrape Syposium, 2022**
- 2. International Sunflower Congress, 2024**

Location of Inner Mongolia



About Inner Mongolia.....

- Square: 118.3 million hectares
- Population: 24.7 million
- Altitude: 1100-1300 meters
- Main minority: Mongolia minority
- Main crops: Maize, Oat, Potato, Sunflower. ...



Grassland





Kubuqi Desert



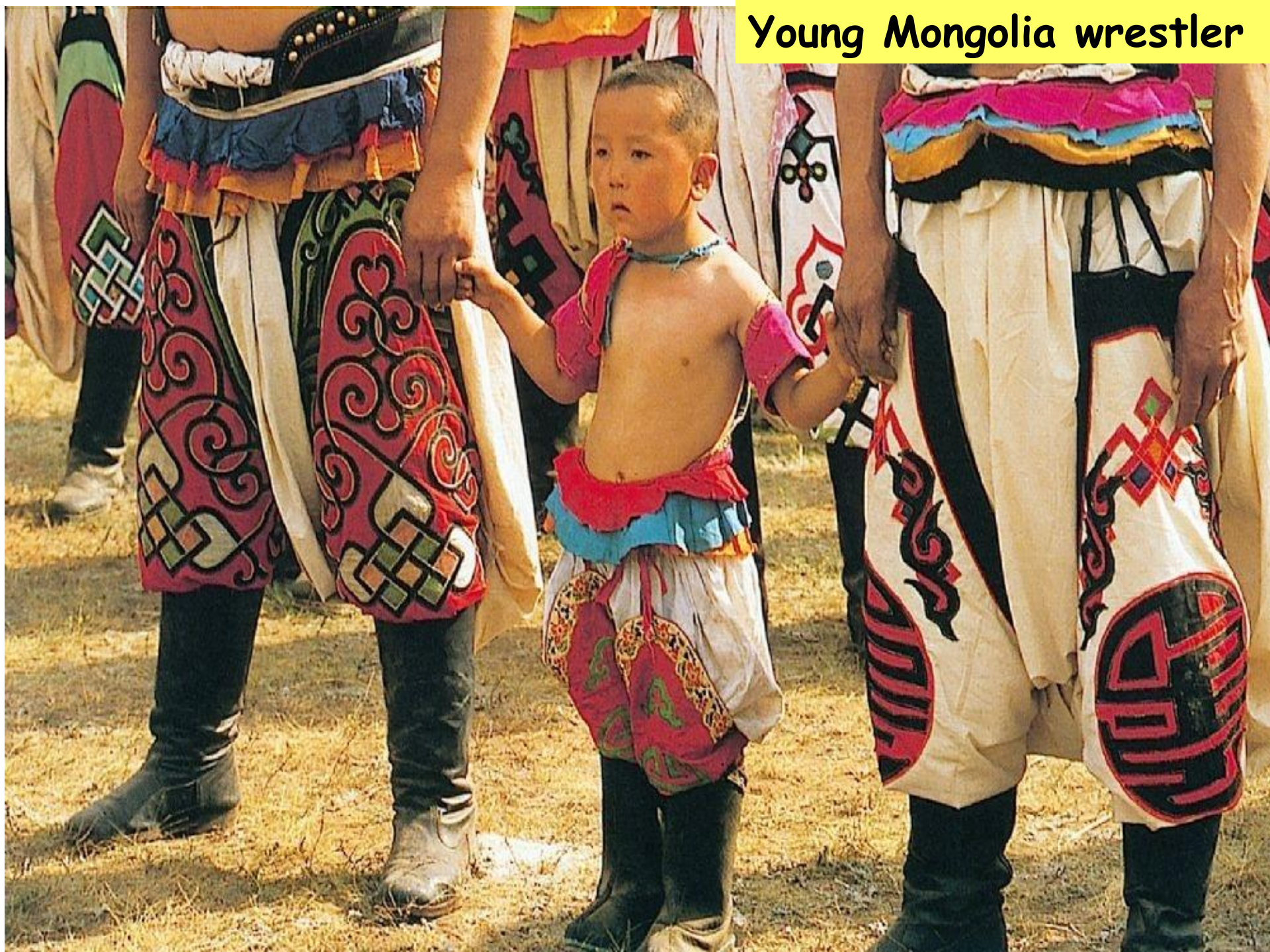
Rapeseed flower



Ao bao



Young Mongolia wrestler



The Cultural of Inner Mongolia.....

nopic.com/HI



The Cultural of Inne Mongolia.....



The Cultural of Inne Mongolia....

Lamp



Sunflower

Oat



Potato



HUAWEI P9
LEICA DUAL CAMERA

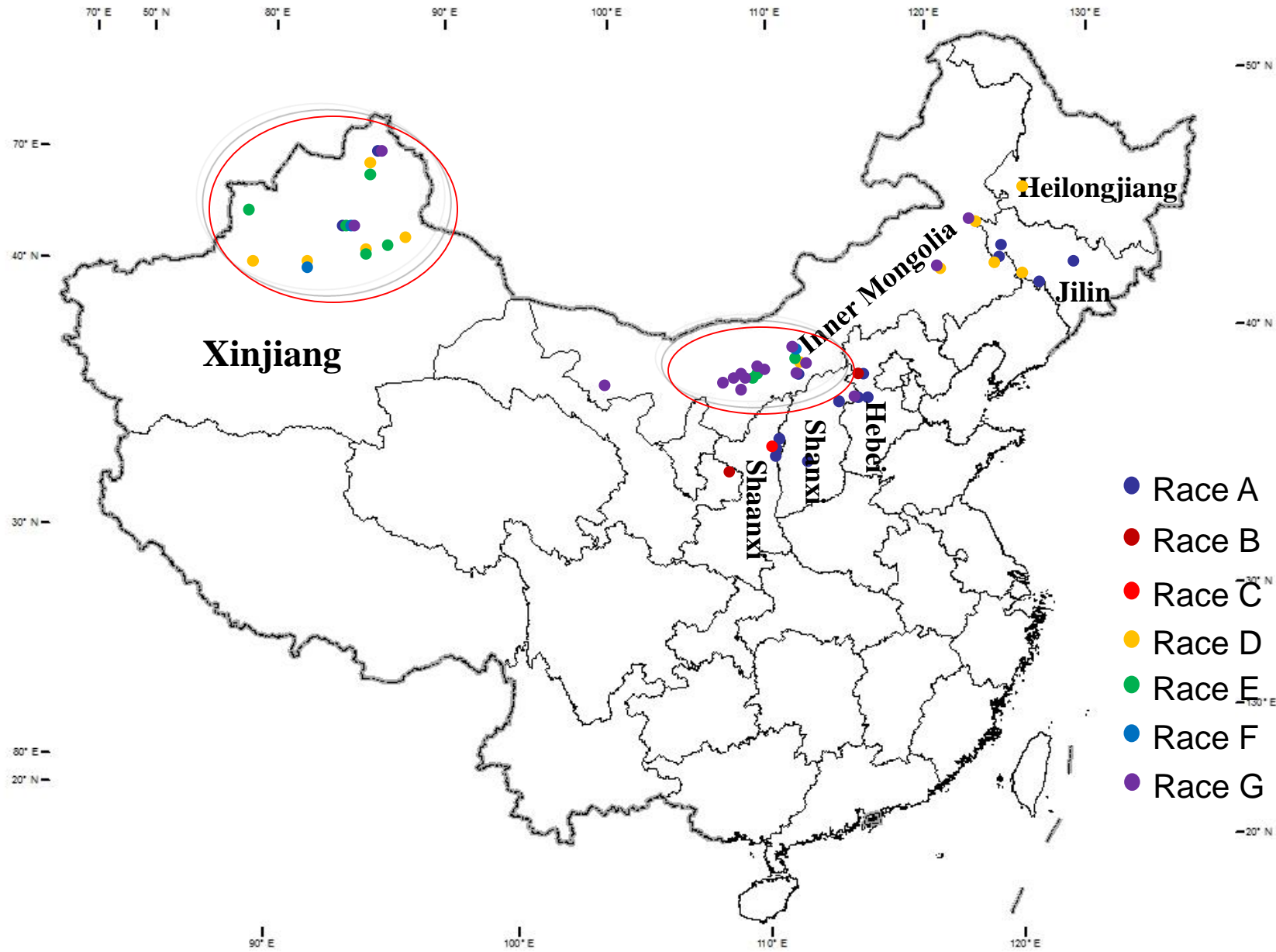


Welcome you to Inner Mongolia

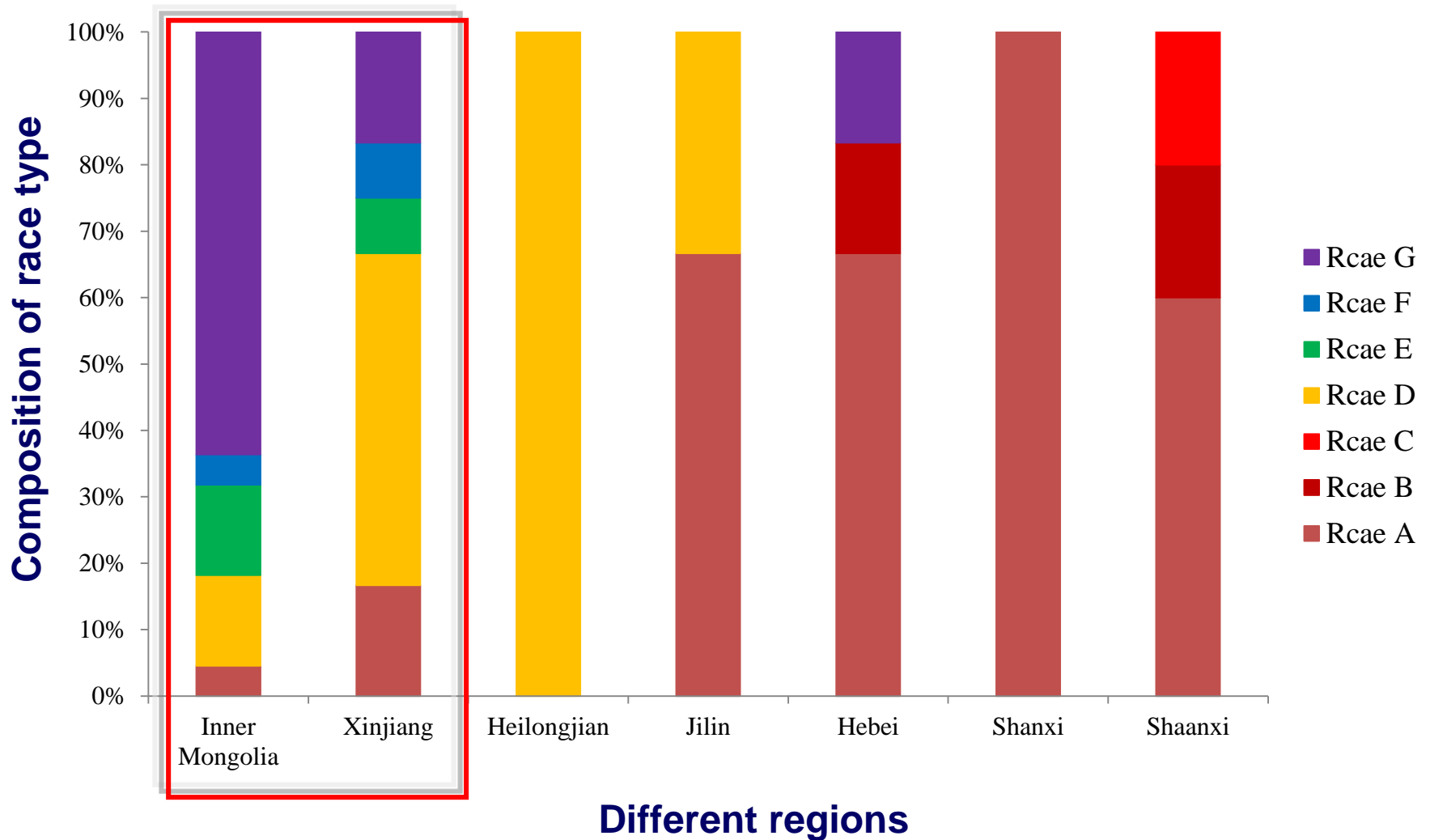
The infected area in Inner Mongolia region

| Location | Distribution | Infected area (万亩) | | | Severity |
|----------|----------------------------------|--|--|--|--|
| | | Inner Area | Flood area | Total | |
| 磴口县 | 白脑包镇、双河镇、新华镇 | 0.1503 | 0.8 | 0.9503 | 1级: 0.1503万亩 2级: 0.5万亩 3级: 0.3万亩 |
| 杭锦后旗 | 套海镇、天吉泰镇、复兴镇、胜丰镇、隆兴昌镇、和胜乡、塔尔湖镇 | 0.9 | 2.1 | 3 | 1级: 1.8万亩 2级: 0.75万亩 3级: 0.3万亩 4级: 0.15万亩 |
| 临河区 | 头道桥镇、二道桥镇、蛮会镇 | 0.0332 | 0.04 | 0.0732 | 1级: 0.0732万亩 |
| 五原县 | 巴镇、渡口镇 | 0 | 0.6 | 0.6 | 1级: 0.6万亩 |
| 乌拉特前旗 | 乌拉山镇、西小召镇、先锋镇、额尔登布拉格苏木、西山咀林场、新安镇 | 5.565 | 6.975 | 12.54 | 1级: 2.25万亩 2级: 7.16万亩 3级: 3.13万亩 |
| 乌拉特中旗 | 德岭山镇、乌加河镇 | 1.1 | 0 | 1.1 | 1级1.1万亩 |
| 乌拉特后旗 | 白脑包镇、双河镇、新华镇 | 0 | 0 | 0 | |
| 合计 | | 7.7485 (516.5 hm²) | 10.515 (701 hm²) | 18.2635 (1217.6 hm²) | |

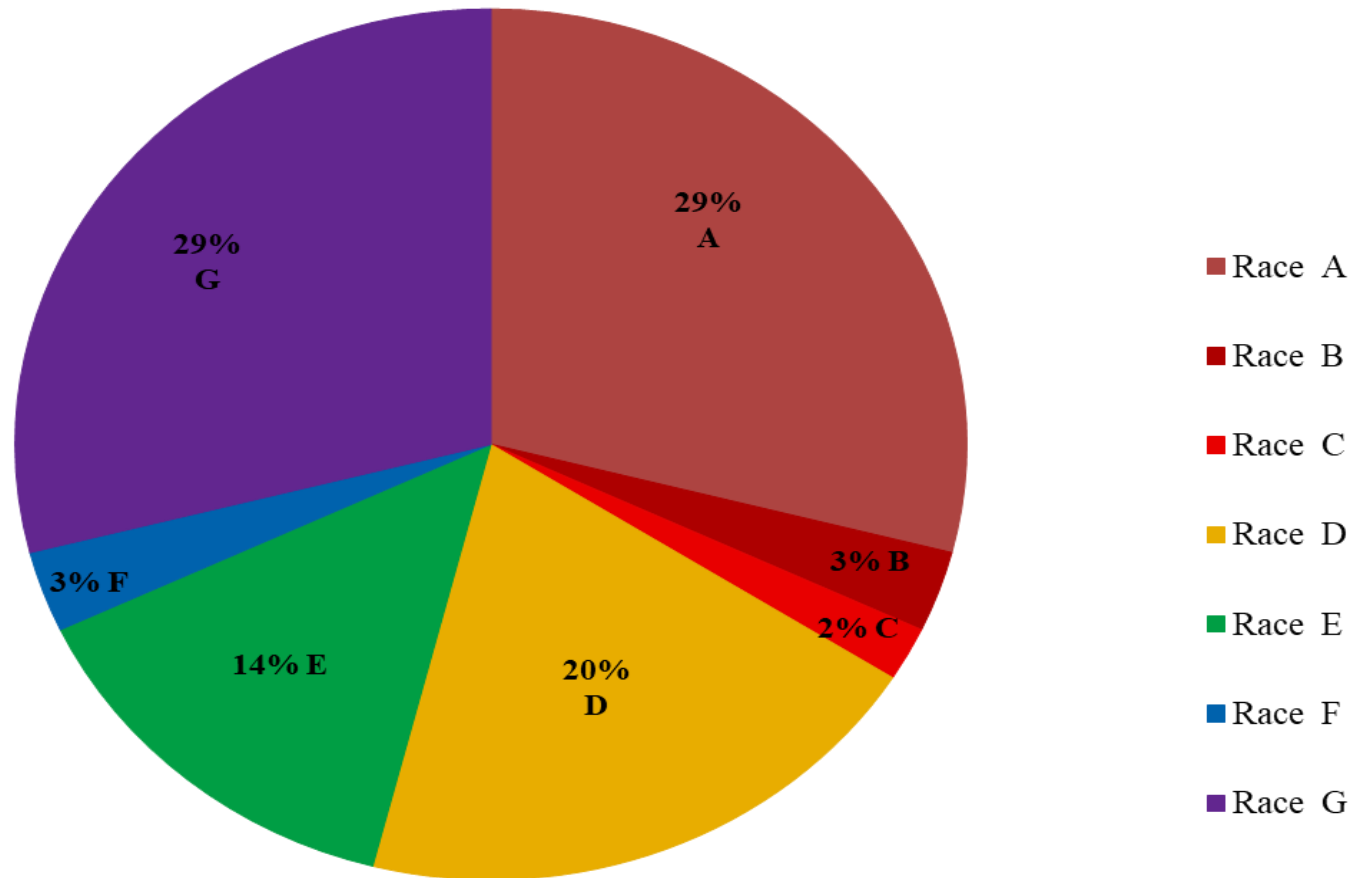
Race distribution pattern of broomrape in China



The race composition in different regions of China



The frequency of different race type of Sunflower broomrape in China



Dominant race type: **A (29%)** , **D (20%)** and **G(29%)**