Supplementary Material

Table S1. Main cytological characteristics of anther development in fertile and sterile lines.

Development Stage	Fertile line (Ningqi No.1)	sterile line (Ningqi No.5)
Ar	The anthers of fertile line and sterile line were rectangular, and the anther wall layer was not differentiated	
Sp	The anther wall of fertile and sterile lines differentiated into epidermis, endothecium, middle layer,and tapetum. The nucleus of pollen mother cells in the pollen sac is large and thick. There was no difference in wall layer and pollen mother cell between fertile line and sterile line.	
Pm	With the enlargement of the pollen sac cavity, the tapetum cells separated from the anther wall layer and closely adhered to the pollen mother cells to sink into the pollen sac. Pollen mother cells are in meiosis	With the enlargement of the pollen sac cavity, the tapetal cells did not separated from the anther wall layer, but adhered to the middle layer. With the enlargement of the pollen sac cavity, the pollen mother cells recessed into the cavity.
Te	The connection between the cells of tapetum is loose, the plasma wall is separated, the cell edge is not clear, and there are granule bodies in the cells. There are clearly visible tetrads in the pollen sac, and the callose wall around the tetrads is thick.	Tapetal cells are tightly connected, still clinging to the middle layer, with large and dense cells, and other parietal cells have vacuolization. There are clearly visible tetrads in the pollen sac cavity and thin callose outside the tetrads.
Po	There are only 3 layers of anther wall, and the tapetum is completely degraded. Epidermal cells are large and contain clearly visible nuclear material. The fibrous layer is obviously thickened on the endothecium, and the cells in the middle layer are smaller, and there is also degradation. The microspores in the middle of the anther are round and plump, and deeply colored.	Anther wall layer still has 4 layers, thinner than fertile line. The epidermal cells contain large vacuoles, the nuclei are squeezed to the edge, the endothecium is not thickened by the fibrous layer, the middle layer cells are small, the tapetal cells contain multinuclei, the cells are large and dense, and the cell edges are unclear.

Table S2. List of primers used in this study.

GENE	Primer	Useless
DYT1-F	ATTGTGTAAGATTGGGGAG	Realtime PCR
DYT1-R	AACAGAGGCACTAATAAGAAT	Realtime PCR
MS1-F	ACTTAACCGGTCATCAGGTCATG	Realtime PCR
MS1-R	CGATATCCATCGGTATTCGACTC	Realtime PCR

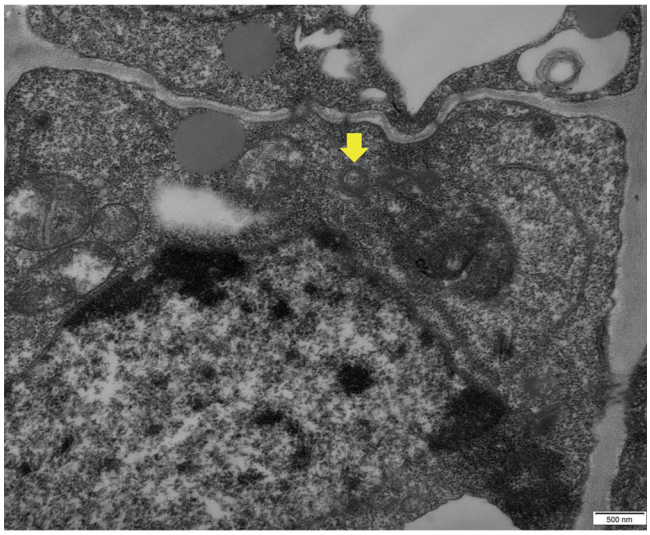

Figure S1. Fzo in pollen mother cell at Pm stage.

In the ultrastructural observation, we found abnormal mitochondrial morphology in pollen mother cells – Fzo at Pm stage.

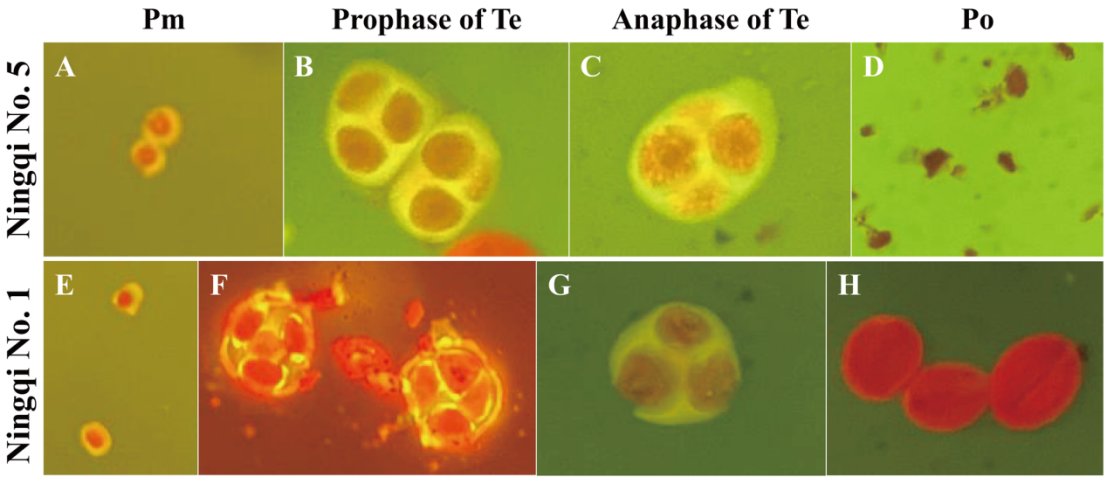

Figure S2. Callose development in Ningqi No.5 and Ningqi No.1 at different development stages: red is nuclear material, yellow is callose.(A, E), There was no significant change in callose in Pm stage in Ningqi No.1 and Ningqi No.5; B, There are clearly visible tetrads in the pollen sac cavity and thin callose outside the tetrads at prophase of Te stage in Ningqi No.5; C, Callose is not degraded at anaphase of Te stage in Ningqi No.5; D, At the Po stage, no microspore was found in Ningqi No.5; F, There are clearly visible tetrads in the pollen sac, and the callose wall around the tetrads is thick at prophase of Te stage in Ningqi No.1; G, Callose began degradation and becomes thin at anaphase of Te stage in Ningqi No.1; H, At the Po stage, round and deeply colored microspores can be seen in Ningqi No.1.