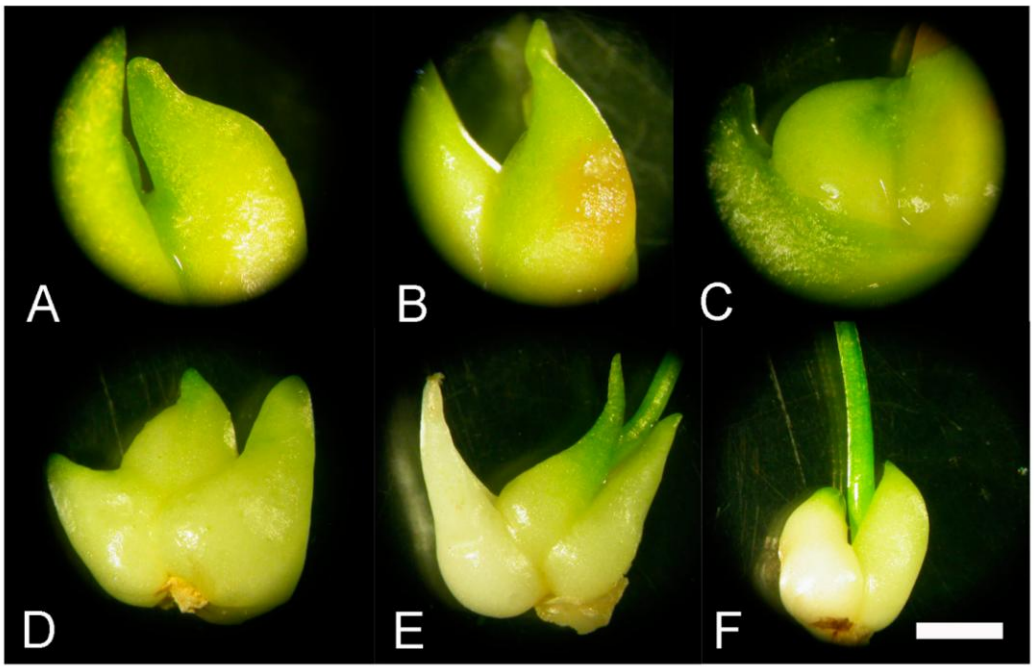

Figure 2 Sprouting of bulbs cultured *F. meleagris* bulbs cultured on medium with 10 μM GA3 and GA inhibitors (Adopted from Marković et al., 2020)

Image caption: (A,B) Bulbs grown for five weeks at 24 °C on culture medium supplemented with GA3 inhibitors: ancymidol (A) and paclobutrazol (B); (C) Bulb grown for five weeks at 7 °C on culture medium supplemented with and GA3. (D-F) Bulbs cultured on medium with GA3 after one (D), two (E) and five weeks (F) at 24 °C; Scale bars = 5 mm (Adopted from Marković et al., 2020)

3.3 Regulatory effects of light-temperature interaction on peimine accumulation

As an important secondary metabolite in *F. thunbergii*, peimine synthesis and accumulation are influenced not only by genetic factors but also by external environmental conditions such as light and temperature. Light provides the material basis for the synthesis of peimine and other secondary metabolites by affecting photosynthesis and carbon source supply, whereas temperature influences the formation and accumulation of active ingredients by regulating enzyme activity, respiratory metabolism, and growth processes. Existing studies have shown that light conditions not only regulate the growth of *F. thunbergii*, but also strongly affect the accumulation of steroidal alkaloids, including peimine. In field and shade-house experiments, shading generally increased the total active ingredient content in *F. thunbergii* bulbs by approximately 11%~21%, even though it reduced biomass (Liu et al., 2025a). Under the combined effects of shading and optimized potassium supply, the contents of peimine and related steroidal alkaloids, including imperialine, peiminine, and cyclopamine, were significantly higher than those under full light. Despite a certain yield penalty, the total alkaloid accumulation per unit area was still increased.

The effects of light and temperature on peimine accumulation are usually not independent, but rather show coordinated regulation. Appropriate light is conducive to dry matter accumulation, while suitable low temperature or a relatively large diurnal temperature difference may reduce respiratory consumption and promote the accumulation of active ingredients in bulbs. Within a certain range, mild environmental stress may also activate plant defense responses and secondary metabolic pathways, thereby promoting the synthesis of alkaloid components. Transcriptomic and metabolomic analyses have shown that shading under sufficient potassium supply can upregulate key genes and pathways involved in steroidal alkaloid biosynthesis, including farnesyl pyrophosphate synthase and multiple transcription factors, thereby linking changes in light microclimate with the molecular regulation of peimine synthesis (Liu et al., 2025a). These findings indicate that low to moderate light is not only an ecological environmental factor, but may also act as a quality-regulating “signal,” promoting the diversion of carbon flow from growth expansion toward secondary metabolism and thereby increasing peimine concentration.