pharmaceutical properties (Dwiyani et al., 2023). The papery colourful bracts surrounding the true flowers enable excellent colour retention after drying, making globe amaranth one of the most important commercial dried flower species.

Despite their considerable commercial importance, the production of both marigold and globe amaranth continues to face several challenges. The availability of superior cultivars with stable flowering behaviour, improved flower quality, and enhanced resistance to biotic and abiotic stresses remains limited. Environmental stresses such as drought, salinity, and temperature fluctuations adversely affect plant growth, flower yield, and pigment accumulation, while post-harvest deterioration during harvesting, transportation, and storage reduces market value (Ma et al., 2020; Babaei et al., 2021; Dalavi et al., 2025). Furthermore, increasing consumer demand for high-quality flowers, natural pigments, and environmentally sustainable production systems necessitates continuous improvement in breeding strategies, biotechnology, precision cultivation, nutrient management, and post-harvest technologies (Saputra et al., 2025; Venkatesan and Ramesh Kumar, 2025).

Marigold and globe amaranth are reviewed together because both are commercially important ornamental crops with expanding applications in floriculture, natural pigment extraction, pharmaceutical products, and landscape horticulture (Udchachon et al., 2021; Dwiyani et al., 2023). Although both crops share common production objectives, including enhanced flower quality, increased productivity, improved stress tolerance, and greater post-harvest longevity, their technological advancement has followed different pathways. Marigold has experienced substantial progress in hybrid breeding, male sterility systems, molecular breeding, mutation breeding, and tissue culture (Sindhuja et al., 2018; Venkatesan and Ramesh Kumar, 2025), whereas production improvement in globe amaranth has relied more heavily on cultivation optimization, plant growth regulation, germplasm evaluation, and post-harvest technologies (Kumar et al., 2023; Akbar and Sahare, 2024; Saputra et al., 2025). Therefore, a comparative review of these two crops provides a comprehensive understanding of their complementary technological developments and identifies future opportunities for sustainable ornamental crop production.

This review summarizes recent advances in the production technologies of marigold and globe amaranth, with emphasis on genetic improvement, breeding strategies, biotechnology, tissue culture, cultivation practices, nutrient management, pest and disease management, and post-harvest technologies. It further discusses the major production constraints, technological limitations, and future research directions for improving productivity, flower quality, resource-use efficiency, and the sustainable commercialization of these economically important ornamental crops.

2 Origin of Marigold and Gomphrena

Marigold (*Tagetes* spp.) is native to South and Central America, particularly Mexico, and belongs to the family Asteraceae (Compositae) (Shafiee et al., 2023). From Mexico, it spread to different parts of the world during the early sixteenth century. The genus *Tagetes* was named after Tages, an Etruscan demigod associated with wisdom and beauty. The genus comprises approximately 33 species, of which *Tagetes erecta* (African marigold), *Tagetes patula* (French marigold), and *Tagetes minuta* are the most widely cultivated (Figure 1). Marigold plants are generally erect, vigorous, and fast-growing, with heights ranging from 30 to 90 cm. Their flowers vary in colour from deep orange and golden yellow to bright yellow and lemon yellow, with flower diameters typically ranging from 4 to 6 cm (Udchachon et al., 2021).

Gomphrena (*Gomphrena globosa* L.) is native to Central America, particularly Guatemala and Panama, and belongs to the family Amaranthaceae (Akbar and Sahare, 2024). The genus *Gomphrena* comprises approximately 120–140 species of annual and perennial herbs distributed across the Americas, Australia, and the Indo-Malayan region, with *G. globosa* being the most widely cultivated ornamental species (Figure 2). In Brazil alone, about 46 species have been documented across diverse ecosystems, including cerrado savannas, open grasslands (*campo limpo*), rocky highland grasslands (*campo rupestre*), and caatinga vegetation, whereas relatively few species occur in forest habitats (Vieira et al., 1994). Most species are herbaceous or shrubby and possess specialized