Biological Forum – An International Journal **16(1): 197-204(2024)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Cultivation Practices Adopted in Gladiolus (*Gladiolus grandiflorus* L.) for Maximizing the Production

Itishree Pradhan, Sushree Sangeeta, Prachurjya Samantaray, Sukirti Mohanty*, Aradhana Nayak, Akanshya Pattanaik and Reshma Sahoo
Department of Floriculture and Landscaping,
Siksha O Anusandhan (Deemed to be University), Bhubaneswar (Odisha), India.

(Corresponding author: Sukirti Mohanty)*
(Received: 23 November 2023; Revised: 02 December 2023; Accepted: 26 December 2023; Published: 15 January 2024)
(Published by Research Trend)

ABSTRACT: The classic bulbous perennial gladiolus, or *Gladiolus grandiflorus* L., is native to South Africa and is a member of the Iridaceae family of flowers. It is a monocot plant with about 150 species currently recognized. Gladiolus can be cultivated in a broad variety of soil types, from light sandy to clay loam, and in a wide range of weather conditions. The natural proliferation of new corms and cormels is the usual method of propagation. Gladiolus flower output quality is influenced by planting depth and timing. For this crop, a 50:60:60 kg NPK fertilizer dose per acre combined with 10 MT FYM works well. Irrigation schedules can be made to prevent nutrients from seeping into deeper soil layers while also taking into account the rooting area. Using herbicides on crops, such as pre- and post-emergence treatments, allows for cost-effective weed management and boosts output. When it came to reducing the number of insect pests, neem seed kernel at 200 gm/L water plus *Trichogramma evanescense* at 0.5 gm/ 6 sq. m proved to be more effective than the other treatments. One of the main culprits of gladiolus yellowing and corm rot is the soil-borne fungus *Fusarium oxysporum* f.sp. gladioli. Depending on the cultivars and season, gladiolus spikes can be harvested 60–100 days after planting. Additionally, it has been found that GA3 delays the proteolysis linked to senescence and wilting. By preserving protein and cellular integrity, cytokinin can also postpone petal senescence. By enhancing membrane integrity and postponing the peroxidation of membrane lipids, postharvest treatment of cut flowers with benzyl adenine (BA) prolongs the vase life of the flowers. Gladiolus spike and corm yields are influenced by cultivar, corm size, planting density, and management techniques. As a result, some 80,000 spikes would be produced per acre. Depending on the cultivar, planting depth, and other factors, the yield of cormel varies between 1.5 and 2.5 quintals per acre.

Keywords: Gladiolus, Corms, Spike, flower, fertilizer, Gibberellic acid, yield, post harvest handling, shelf life.

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) is a classic bulbous perennial flower belongs to the family Iridaceae. with its origin from South Africa. The history of gladiolus cultivation dates back to 2000 years, when some species commonly known as 'corn lily' were grown in parts of Asia Minor. The word gladiolus is derived from the Latin word gladius meaning a sword, because of the sword like leaves, of this plant. Therefore it's also known as 'Sword lily'. Its wide variety of shades, erects spikes and large-sized blooms plus greater keeping quality makes it suitable to adorn for a room decoration and bouquet. It is monocot plant having approximately one hundred and fifty known species (Negi*et al*., 1982). It grows best on a site in sandy loam soil with bright sun. It is the only flower crop which was accepted in European countries when grown in open field conditions. Hence as a cut flower, it has great potentially for export to European countries during winter months to earn valuable foreign exchange for the country (Mahadik *et al*., 2017).

Its magnificent inflorescence with florets of dazzling colours, varying forms and sizes and long keeping quality makes it an attractive cut flower. The gladiolus is perfect for floral arrangements as well as gardens. The florets have a good keeping quality of cut spike because they open sequentially over an extended period of time. It works great in pots and looks great cut. It is also a great choice for beds and herbaceous borders.

Over 11660 hectares of gladiolus are planted nationwide, with an estimated 106 crore cut flowers produced (Kadam *et al*., 2014). It occupies fifth position in the international floriculture trade (Sharma and Sharma 1988). It is occasionally used for landscaping and is used commercially for cut flowers. Gladiolus came in third place among cut flowers in terms of area and production. The states of Uttar Pradesh, West Bengal, Odisha, Chhattisgarh, Haryana, and Maharashtra are the main producers of gladioli in the nation. According to Kadam *et al*. (2014), gladiolus is also grown in states like Uttarakhand, Karnataka, Andhra Pradesh, and Sikkim. Even though gladiolus is primarily a winter flower crop, it may be produced all year round in regions with temperate climates.

BOTANICAL DESCRIPTION

Gladiolus has a herbaceous stem with slender, linear leaves that are sheathed at the base and flattened at the sides. According to Hutchinson (1959), the flowers are actinomorphic, bisexual, have three stamens on their perianth, and an entirely inferior ovary. The term "corm" refers to the underground stem used by gladiolius as a propagation medium that stores nourishment. Until growth picks back up once the spring rains start, the corm can sustain the plant while it is dormant. Every year after being planted, gladiolus corms shrivel and die, yet on top of them, they develop a new daughter corm. On the upper surface of the daughter corm, from which the new plant emerges the next year, the buds form. Old leaves cover the corm; their bases are thin and dry. Husks are these papery leaves. The husks come together to form a point at the top by overlapping each other. Little new corms known as cormels or cormlets are formed from the base while the new daughter corm forms on top of the old one. The main way gladiolus are propagated are through these corms and cormels. Typically, cormels are categorized into three sizes: large, measuring more than 1.0 cm in diameter; medium, measuring 0.5 cm to less than 1.0 cm; and small, measuring less than 0.5 cm. The initiation of the flower spikes marks the beginning of the cormel development. Cormels form as the spikes reach full bloom. Following flowering, the cormels continue to enlarge as the photosynthates point downward (Hartmann *et al*., 1981).

TAXONOMIC POSITION

- Kingdom: Plantae
- Sub-kingdom: Tracheobionta
- Division: Magnoliophyta
- Class: Liliopsida
- Sub-class: Lilioideae
- Order: liliiales
- Family: Iridiaceae
- Sub-family: Crocoideae
- Tribe: Gladioleae
- Genus: Gladiolus
- Species: 226 species

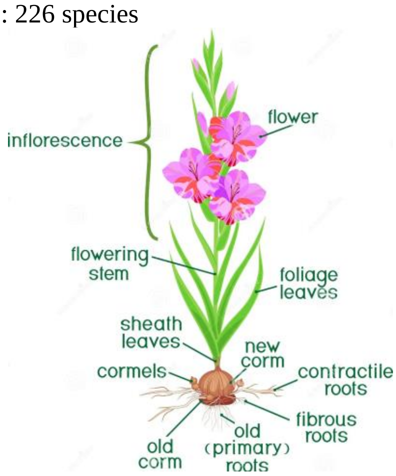

Fig. 1. Morphological representation of Gladiolus plant (Hartman *et al*., 1990).

ADAPHOCLIMATIC REQUIREMENTS

Gladiolus is extensively cultivated in numerous tropical and subtropical countries worldwide, thriving in a diverse range of climatic conditions. It can be successfully grown from low plains to elevations as high as 2500 m. The climatic factor plays a crucial role in the growth and development of gladiolus. Ideally, a mild climate is favorable for its cultivation, while excessively hot or cold conditions can be detrimental. Gladiolus thrives in sunny environments, requiring a minimum of 80% sunlight for optimal growth and flowering. However, it is essential to ensure the planting site is sheltered from strong winds, and constant humidity is discouraged to prevent pathogen attraction.

According to Shillo *et al*. (2005), high temperatures can indirectly harm gladiolus by affecting plant water balance. Direct damage from high temperatures occurs during the period from planting to the first leaf stage, with reduced soil moisture impeding plant development. The stages immediately after planting and just before spike sprouting are particularly sensitive. Khan *et al*. (2008) study yielded similar findings, indicating that planting in January significantly increased bulb survival percentages.

Gladiolus exhibits adaptability to a wide range of soils, from light sandy to clay loam, although it thrives best in deep (at least 30 cm), well-drained, friable soils enriched with organic matter and nutrients. The pH level should be slightly acidic within the range of 5.5-6.5. In light and sandy soils, the application of well-rotted organic manure is recommended, while in heavy soils, the addition of sandy soil can enhance soil texture (Begum *et al*., 2007).

PROPAGATION

Commercially, gladiolus propagation primarily relies on corms, serving the dual purpose of producing flowering spikes and generating additional corms. As a cormous plant, gladiolus undergoes natural multiplication through the formation of new corms and cormels (Hartman *et al*., 1990; Ziv & Lilien-kipnis 1990). In a typical cycle, a mother corm produces a new daughter corm each season, accompanied by several cormels. These cormels require three to four seasons to reach a size suitable for flowering.

Corms are typically categorized based on their diameter, with the size directly influencing the length of the floral stem (spike). Generally, corms with a diameter of 2.5 cm and above are preferred for planting to achieve optimal flowering, while smaller ones are used for corm multiplication. A medium-sized corm with a high crown is considered superior to a flat, larger corm. Therefore, selecting high-quality, appropriately sized corms free from pathogens is crucial for successful planting. Some flower growers also choose to import corms from European countries.

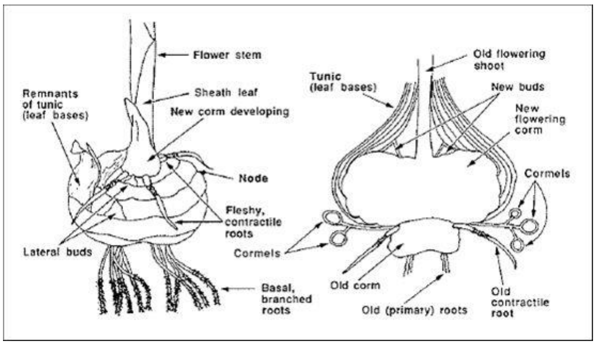

Fig. 2. Detailed structure of corm and cormal (Hartman *et al*., 1990).

The insufficient supply of planting material is attributed to the slow rate of multiplication and a high percentage of corm spoilage during storage (Singh & Dohare 1992). Additional challenges include the physiological dormancy of corms and cormels, lasting for 4–5 months, and the occurrence of corm rot during storage (Priyakumari & Sheela 2005). To address these issues, corms and cormels undergo treatment with a hot water solution before storage, effectively eliminating latent fungi, insects, and nematodes (Larson, 1992).

LAND PREPARATION AND PLANTING

♦ **Ploughing.** The initial ploughing, done two months prior to planting, reaches a depth of 30 cm and is left untouched. Approximately 2-3 weeks before the actual planting, a second ploughing takes place, followed by rolling to achieve a finely textured soil. The field is then divided into smaller sections to ensure uniform leveling of the land and facilitate irrigation. Drainage channels are also incorporated to efficiently remove any excess water.

♦ **Spacing and Plant Population.** The most common way to plant gladiolus is in ridges and furrows, with a 30 cm spacing between ridges and a 15 cm spacing between corms inside the ridge. The size of the plot and the ease of intercultural activities can be taken into consideration while determining the length of the ridges. Alternatively, rather than planting in pre-formed ridges, planting can be done on the surface and then covered with earth. In this situation, additional earthing up at a later time becomes necessary. For planting in an area of one acre, 80000 corms would be needed based on the recommended spacing.

♦ **Time of Planting.** Normally, gladiolus is cultivated during the winter season. Nevertheless, in areas with mild climate, it can be planted throughout the year, except for the summer months when the risk of sunburn is high. Implementing a staggered approach to planting corms enables a constant yield of flower spikes. Continuous year-round planting provides farmers with the opportunity to harvest three gladiolus crops in a span of two years. However, the current plan assumes a single crop cycle per year with staggered planting.

The timing of planting significantly influences the growth and quality of gladiolus, as emphasized by Khan *et al*. in 2008. Proper planting schedules, satisfying consumer demands, contribute to enhanced vegetative growth and improved quality of gladiolus, as note by Zubair *et al*. (2006). Planting schedules vary due to differences in photoperiods, temperatures, and light intensity. Talia and Traversa (1986) reported that optimal-sized gladiolus corms were obtained from plantings in February and March. Maximum spikes per plant were achieved from April to May plantings, while the highest number of corms per tuberose plant was observed in March and April plantings (Mukhopadhyay and Banker 1981).

With early planting, days to sprouting were 20 and with late planting, days to sprouting were 12 (Arora and Sandhu 1987). The same result was also observed by Hong *et al*. (1989), who reported that a delay in planting decreased the number of days to sprouting. Ko *et al*. (1994) mentioned that earlier planting produced larger corms and longer stems.

♦ **Depth of Planting.** Corms and cormels are placed in rows with their bases down and covered with soil during planting. Shallow corm planting tends to yield more cormels but may lead to lodging in regions with strong winds. The recommended depth for planting is ideally in the range of 7-10 cm. Various factors, including the size of corms and cormels, planting depth, and timing, play a crucial role in influencing the quality of gladiolus flower production (Arora and Khanna 1990).

Fig. 3. Gladilous field in ridge and furrow system of planting (Khan *et al.,* 2008).

CULTURAL PRACTICES

♦ **Fertilizer Application.** The application of organic manure is crucial for both flowering and corm development in gladiolus. However, excessive use of manure resulted tall and slender flower spikes. The assumed manurial dosage includes 10 metric tons of Farm Yard Manure (FYM), along with 50:60:60 kilograms of Nitrogen (N), Phosphorus (P), and Potassium (K) per acre. Additionally, 5 kilograms of Zinc have been considered in this application. This balanced approach to organic manure application aims to promote healthy growth without negatively affecting the structure of the flower spikes.

Vermicompost serves as an excellent organic matter source, providing both macro- and micronutrients to plants while enhancing the physical, chemical, and biological properties of the soil (Sinha and Sunil 2009). Growers often opt for the supplementary and complementary use of both organic manures and inorganic chemical fertilizers as an alternative approach for sustainable production and to preserve soil health (Singh and Pandey 2006). This combined use aims to ensure a balanced and comprehensive nutrient supply to plants while promoting overall soil fertility and resilience.

Insufficient and unbalanced application of inorganic fertilizers, coupled with limited use of organic manures, can have negative impacts on plant growth and yield (Singh *et al*., 2011). Prolonged reliance on chemical fertilization has been associated with reduced yield, degradation of soil health, water pollution, and an increase in disease and pest infestations, (Okwuagwu *et al*., 2003). To promote optimal yield and produce quality, it is essential to provide plants with a balanced combination of both organic manures and inorganic fertilizers in adequate amounts.

Cultivars that exhibit rapid growth, resulting in large plants and flower spikes, tend to respond more positively to fertilizer applications compared to those with lower vigour, producing smaller plants and spikes, as observed by Woltz (2001). Interestingly, smaller corms have a greater fertilizer requirement than larger corms, primarily due to their reliance on stored reserves and, in part, the increased feeding capacity of the extensive root system produced by larger corms (Pal, 2000).

Potassium is a crucial nutrient essential for the growth and development of the gladiolus crop. Plants that receive potassium supplementation tend to display enhanced vegetative and reproductive growth (Yasin *et al*., 2018).

♦ **Growth Regulator.** Changes in the carbohydrate status of the petals are associated with the senescence process in cut flowers, which is regulated by hormones (Mayak *et al.,* 1972). Gibberellic acid or cytokinin can be used to prevent or postpone petal senescence (Reid and Serek 1997). Furthermore, wilting and proteolysis associated with senescence have been observed to be delayed by GA3 (Eason, 2002). By preserving proteins and cellular integrity, cytokinin can also help postpone petal senescence (Whitehead, 1994).

Cut flowers treated with benzyl adenine (BA) after harvesting are known to have longer-lasting blooms due to increased membrane integrity, delayed membrane lipid peroxidation, and decreased ion leakage (Elanchezhian and Srivastava 2000). The amount of carbs in flowers has also been linked to how long cut flowers last (Mayak and Halevy 1981).

♦ **Irrigation.** Adequate soil moisture is crucial at the time of planting to eliminate the need for watering until sprouting. The frequency of irrigation is significantly influenced by the soil type and prevailing weather conditions. In warmer weather, it is recommended to irrigate twice a week, whereas during winter, this frequency can be reduced to once a week. After the harvest of flowers, it is advisable to decrease the amount of watering. Providing irrigation at least 4-7 days before lifting the corms, depending upon weather conditions, facilitates the easy and effective lifting of both corms and cormels.

To achieve high-quality flowers, providing sufficient water when needed. Optimal irrigation practices can be determined by considering the rooting area while being cautious to prevent nutrient leaching into deeper soil layers (Raina *et al*., 1999, 2002, 2011). Drip irrigation is often preferred over other methods due to its high water-application efficiency, minimizing losses from surface evaporation and deep percolation. The frequent application of water through drip irrigation helps maintain manageable concentrations of salts in the rooting zone, (Mantell *et al*., 1985). Howell (1972) mentioned that water requirements are lower in heavy soils because they can store water for a longer duration.

♦ **Weeding.** In the ridges and furrows system, earthing up or hilling can be performed when the shoots reach approximately 20 cm in height. This helps in keeping the plants upright and prevents the exposure of corms. For surface planting systems, earthing up is typically done at the fourth leaf stage of the plants. Weeding is generally conducted at the two-leaf and four-leaf stages. The practice of close planting can eliminate the need for staking, but weeding and staking activities may be undertaken as deemed necessary throughout the growth period.

The application of herbicides, including both pre-emergence and post-emergence treatments on crops, is an effective strategy for economic weed control, leading to increased productivity (Taj *et al*. 1986).

Iqbal and Cheema (2008) observed a reduction of 75% to 88% in purple nutsedge (*Cyperus rotundus*) compared to the untreated control when using S-metolachlor as a pre-emergent herbicide. Similarly, Cheema *et al*. (2003) reported a 58% to 71% inhibition of *Cyperus rotundus* with reduced rates of S-metolachlor compared to the control. In contrast, Maqbool *et al*. (2001) found that while Pendimethalin and S-metolachlor were both applied as pre-emergent herbicides, Pendimethalin was not effective against *Cyperus rotundus*, whereas S-metolachlor effectively controlled this weed.

According to Marwat *et al*. (2008), Pendimethalin has been found to be highly effective in controlling *Melilotus indica*. Shehzad *et al*. (2012) reported that various herbicides, including pendimethalin, were successful in effectively managing *Melilotus indica*. Zubair *et al*. (2009) mentioned that pre-emergence applications of Stomp were also effective in controlling *Melilotus indica*.

♦ **Staking.** Staking or providing support for gladiolus flower stalks is essential to prevent them from bending or becoming deformed during summer storms. This practice ensures that the plants remain upright despite high winds and rains, and it also helps in suppressing weed growth. For light soils, it is necessary to mound up or "earth up" the soil around the plants. In situations where spikes grow longer or the stems are not strong enough to withstand lodging or mild wind impacts, additional support is provided using strong stakes, typically around 1.5 meters in height (Safeena *et al*., 2014).

PROBLEM ASSOCIATED WITH SPROUTING AND FLOWERING

One of the main obstacles to the commercial cultivation of gladiolus is its dormancy, which prevents it from being produced all year round to provide a consistent supply of flowers and corms to the markets. According to Priyakumari and Sheela (2005) the dormancy of the corms and cormels is major problem in sprouting which leads to no flowering. Dormancy is influenced by temperature when corms are stored: A greater temperature increases dormancy, whereas a lower temperature decreases it (Denny, 1936). Loss of sprouting or corm dormancy may be induced by water stress as well as by high temperature, or both (Zieslin and Geller 1983). Corms cured for long periods at high temperatures (25-27 °C) produced less vigorous plants and inferior flowers because of dehydration (Magie, 1968). Apte (1960); Post (1952) also mention the specific effect which temperature has on winter flowering and they state that flower failure in glasshouse grown gladioli in winter is due to a combination of low light intensities, short days and high temperature. Corm and cormels are typically planted in order to propagate gladiolus. The size of the corm utilised during planting directly affects the cormel, corm, and gladiolus flower production. Smaller sizes of the corms are poor yielder, and larger sized corms add in cost of cultivation (Singh, 1992). Pereira *et al*. (2009) mentioned that gladioli are quite susceptible to water shortage, resulting in uneven, shorter, and low quality flower stems. Fusarium is one of the most common, abundant, and significant genera of microfungi that are carried by soil. Corms and cormels is greatly affected by Fusarium corm rot and high percentage of spoilage of corms during storage (Sinha and Roy 2002; Riaz *et al*., 2010).

PESTS AND DISEASES

The plant is susceptible to attacks from aphids, thrips, cutworms, mites, loopers, and seed corm maggots, leading to significant damage. Gladiolus is also prone to various diseases such as Fusarium rot, spongy rot, neck rot, leaf spot, and viral infections. The application of Sevin/Malathion and Chlorpyriphos at a concentration of 0.2% has proven to be effective in controlling these pests. To manage fungal diseases, the use of fungicides like Dithane M-45, Captan, Bavistin, etc., is recommended. In the case of viral infections, affected plants should be promptly uprooted and destroyed as a preventive measure.

The combination of Neem seed kernel at a concentration of 200 gm/L water along with *Trichogramma evanescense* at 0.5 gm/6 sq. m demonstrated superior efficacy in reducing the population of insect pests compared to other treatments. Following closely in effectiveness was Neem oil at 3 ml/L water in combination with *Trichogramma evanescense* at 0.5 gm/6 sq. m, applied at a 7-day interval. Thus, among the various management approaches evaluated, the use of Neem seed kernel @ 200 gm/L water with *Trichogramma evanescense* @ 0.5 gm/ 6 sq. m, as well as Neem oil @ 3ml/L water + *Trichogramma evanescense*@ 0.5 gm/ 6 sq. m at a 7-day interval, were identified as effective strategies to combat insect pest infestations in gladiolus.

Fusarium oxysporum f. sp. gladioli, a soil-borne fungus, is a primary factor leading to yellowing and corm rot in gladiolus, as indicated by studies conducted by Buxton (1955); Nelson *et al*. (1981); Dallavalle *et al*. (2002). Chen *et al*. (1994) reported *Fusarium oxysporum* and *F. solani* as the agents responsible for root rot in gladiolus from Shanghai, China. These same fungal species were identified by Tandon and Bhargava (1963), as well as Sarabhoy and Agarwal (1983), as the causative organisms behind yellowing and corm rot issues in gladiolus.

HARVESTING AND POST- HARVESTING

The harvesting period for gladiolus spikes typically ranges from 60 to 120 days after planting, depending on factors such as the variety, corm size during planting, and the prevailing season. Optimal harvesting occurs when the spikes are in the tight bud stage, displaying one to five florets with coloration, and the plant has at least four leaves, facilitating the development of corms and cormels. For instance, if corms are planted in September, the harvesting of spikes would commence from November/December and extend through January/February. The frequency of harvesting should be adjusted based on factors such as plant/spike growth, market demand, and prices. Corms are lifted post-maturity, typically when approximately 25% of the cormel sturns brown color, and the leaves start turning yellow and drying. The process of corm maturity takes about one and a half to two months after flowering.

Fig. 4. Gladiolus spike ready for harvesting for local market (Rubinstein, 2000).

The harvesting time for gladiolus spikes ranges from 60 to 100 days after planting, and this duration is influenced by factors such as the specific cultivar and the time of the year (Jenkins, 1963; Jenkins *et al.*, 1970).

Fig. 5. Gladiolus spike ready for harvesting for distant market (Rubinstein, 2000).

POST HARVEST HANDLING

♦ **Vase life.** Calcium concentration significantly influenced the vase life of gladiolus spikes. The calcium increases the self-life of cut flowers by preventing the cellular membrane from deteriorating (Torre *et al*., 1999; Rubinstein, 2000) by preventing free radicals from damaging the cell membrane (Agarwal *et al*., 2005; Sairam *et al*., 2011; Singh *et al*., 2013). Gerbera, rose, and gladiolus flowers undergo calcium treatment to prolong vase life (Gerasopoulos & Chebli 1999; Ahmad *et al*., 2011; Capdeville *et al*., 2005; Sairam *et al*., 2011).

By storing the spike at 4°C for 48 hrs with cellophane wrapped enhanced vase life compared to newspaper wrapping in, due to decline water loss and a buildup of more relative humidity inside the cellophane packages (Beura and Singh 2003).

The $Al_2(SO_4)_3$ increases the vase life as well as the fresh weight (percentage of initial) of the cut flowers by preventing micro-organisms growth in xylem vessels of the cut flower stems and maintained uptake of water and becomes more effective when sucrose are mixed with it (Pun and Ichimura 2003).

YIELD. The production of spikes and corms in gladiolus is influenced by factors such as the cultivar, corm size, planting density, and management practices. Consequently, the yield per acre is estimated to be approximately 80,000 spikes. Cormel yield ranges from 1.5 to 2.5 quintals per acre, depending on factors like variety and planting depth. Although cormels can be sold at a rate upto Rs. 300 per kg, in the present scheme, earnings from cormels have not been considered, as sustained sale of cormels may not be possible considering the existing area and likely area expansion under gladiolus.

CONCLUSIONS

This review paper summarises the scientific cultivation practise of Gladiolus to maximise the yield and quality of the flowers keeping in view about environment sustainability, as this occupies a promising position in the cut flower market both in national and inter-national market.

FUTURE SCOPE

The cultivation practise discussed in this paper can be used commercially to increase the production and productivity by the farmers. Along with this, further research can be taken up in form of organic trial aiming at the good production pace.

Acknowledgement. The authors are thankful to Siksha O Anusandhan (Deemed to be university), Bhubaneswar for providing facility to collect relevant literature to compile and form this scientific bulletin for relevance to the farmers.

Conflict of Interest. None.

REFERENCES

Agarwal, S., Sairam, R. K., Srivastava, G. C., Tyagi, A. and Meena, R. C. (2005). Role of ABA, salicylic acid, calcium and hydrogen peroxide on antioxidant enzymes induction in wheat seedlings. *Plant Science*, *169*(3), 559-570.

Ahmad, K., Mostafa, A. and Roya, K. (2011). Post-harvest evaluation of vase life, stem bending and screening of cultivars of cut gerbera (*Gerbera jamesonii* Bolus ex. Hook f.) flowers. *African Journal of Biotechnology*, *10*(4), 560-566.

Apte, S. S. (1960). New approach to an old problem -early flowering of gladiolus. The Gladiolus, New Eng. *Glad. Soc. Y.B.*, *35*, 123-130.

Arora, J. S. and Sandhu, G. S. (1987). Effect of two planting dates on the performance of fifteen gladiolus cultivars. *Punjab. Hort. J*., *27*(4), 243-249.

Arora, J. S. and Khanna, K. (1990). Studies on corm production in gladiolus as affected by cormel sizes. *Indian Journal of Horticulture*, *47*, 442-446.

Begum, R. A., Rahman, M. N., Mondol, A., Rahman, M. J. and Khan, F. N. (2007). Effect of different moisture regimes on the growth and quality of gladiolus. *International Journal of Sustainable Crop Production*, *2*(5), 43-45.

Beura**,** S**.** and Singh, R. **(**2003**)**. Effect of storage temperature and wrapping material on postharvest life of gladiolus cultivar Her Majesty. *Journal of Ornamental Horticulture New Series*, *6*(4), 322-327**.**

Buxton, E. W. (1955). Fusarium diseases of gladiolus. *Transactions of the british mycological society*, *38*(3), 193- 201.

Capdeville, G. D., Maffia, L. A., Finger, F. L. and Batista, U. G. (2005). Pre-harvest calcium sulfate applications affect vase life and severity of graymold in cut roses. *Scientia Horticulturae*, *103*, 329-338.

Cheema, Z. A., Khaliq, A. and Hussain, R. (2003). Reducing herbicide rate in combination with Comparison between conventional and organic weed management: growth and yield of leek (*Allium porrum* L.). *39*(2), 81-88.

Chen, L. Z., Gan, X. B., Song, J. Y. and Gu, W. (1994). A study on gladiolus root rot. *J. Shanghai Agric. College*, *12*, 240-246.

Dallavalle, E., Aulerio, A. Z. D., Verardi, E. and Bertaccini, A. (2002). Detection of RAPD polymorphism in Gladiolus cultivars with different sensitivities to *Fusarium oxysporum* f. sp. gladioli. *Plant Molecular Biology Reporter*, *20*, 1-6.

Denny, F. E. (1936). Storage temperatures for shortening the rest period of gladiolus corms. Contributory Boyce Thompson Institute, *8*, 137-140.

Eason, J. R. (2002). *Sandersonia aurantiaca*: an evaluation of post-harvest pulsing solutions to maximize cut flower quality. *New Zealand Journal of Crop and Horticultural Science*, *30*, 273–279.

Elanchezhian, R. and Srivastava, G. C. (2000). Effect of growth regulators on senescence of chrysanthemum flowers. *Indian Journal of Plant Physiology*, *6*, 233–243.

Gerasopoulos, D. and Chebli, B. (1999). Effects of pre and postharvest calcium applications on the vase life of cut gerberas. *The Journal of Horticultural Science and Biotechnology*, *74*, 78-81.

Hartmann, H. T., Kester, D. E. and Davis, F. T. (1990). Plant propagation: Principles and practices. Prentice-Hall, Int. Inc. Eng. Cliffs, New Jersey. pp. 443-445

Hartmann, H.T., Flocker, W. J. and Kofrank, A. M. 1981. Ornamental grown from bulbs, corms, tubers and rhizomes. *Plant Sci. Growth, Dev. & Utilization of Cultiv Plants*, 429-453.

Hong, Y. P., Goo, D. H. and Huh, K. Y. (1989). Studies on corm formation in gladiolus gandavensis. The effect of planting date of cormels on corm production, dormancy and flowering of the corm in the next generation. *Res. Rep. Rural Dev. Adm. Hort. Manual*, *31*(4), 54-59.

Howell, E. A. (1972). Growing season care. In: The World of the Gladiolus unknown: book, N. Amer. Gladiolus Coun. Edgewood Press, Edgewood, MD, 52–53.

Hutchinson, J. (1959). Families of flowering plants. Macmillan & Co. Ltd. St. Martins St., London.Pp-792.

Iqbal, J. and Cheema, Z. A. (2008). Purple nutsedge (*Cyperus rotundus* L.) Management in cotton with combined application of sorgaab and S-metolachlor. *Pak. J. Bot*., *40*(6), 2383-2391.

Jenkins, J. M. (1963). Characteristics of commercial gladiolus varieties. North Amer. *Gladiolus Council. Bullet*, *75*, 37-38.

Jenkins, J. M., Milholland, R. D., Lilly, J. P. and Beute, M. K. (1970). Commercial gladiolus production in North Carline. N. C. *Agric. Ext. Circ*., *44*, 1-34.

Kadam, J. J., Agale, R.C., Rite, S. C. and Pandav S. M. (2014). Exploration of fungicides and phyto extract against *Fusarium oxysporum* sp. Gladioli causing corm rot of gladiolus. *Discovery Agriculture*, *2*(9), 61-64.

Khan, F. U., Jhon, A. Q., Khan, F. A. and Mir, M. M. (2008). Effect of planting time on flowering and bulb production of tulip conditions in Kashmir. *Indian Journal of Horticulture*, *65*(1), 0972-8538.

Ko, J. Y., Kim, S. K., Um, N. Y., Han, J. S. and Lee, K. K. (1994). Planting times and corm grades of gladiolus gandavensis for retarding culture in high land.RDA Journal of Agricultural Science, *36*(1), 430-434.

Larson (1992). Introduction to floriculture. Acad. Press, London. *2*, 147.

Magie, R. O. (1968). Disease control relative to new methods of harvesting, curing and storing of gladiolus corms. *North Amer. Gladiolus Council Bull*, *95*, 83-87.

Mahadik, M. K., Chopde, N. and Lokhande, S. (2017). Growth, yield and quality of gladiolus vary by nitrogen and potassium fertility levels. *Int. J Chem. Studies*, *5*(5), 2163-2166.

Mantell, A., Frenkel, H. and Meiri, A. (1985). Drip irrigation of cotton with saline sodic water. *Irrigation Science*, *6*, 95–106.

Maqbool, M. M., Tanveer, A., Ali, A., and Ahmed, R. (2001). Effect of sowing method and herbicides and weeds and yield of cotton (*Gossipium hirsutum*). *Pak. J. Bot*., *33*(4), 383-387.

Marwat, K. B., Saeed, M., Hussain, Z., Gul, B., and Rashid, H. U. (2008). Study of various herbicides for weed control in wheat under irrigated conditions, *Pak. J. Weed Sci. Res*., *14*(1-2), 1-8.

Mayak, S., Halevy, A. H. and Kats, M. (1972). Correlative changes in phytohormones in relation to senescence process in rose petals. *Physiol. Plant*, *27*, 1–4.

Mayak, S. and Halevy, A. H (1981). Senescence and post-harvest physiology of cut flowers. Part II. *Horticultural Reviews*, *3*, 59–143.

Mubhopadhayay, A. and Banker, G. J. (1981). Effect of time of planting on growth, flowering and bulb production in tuberose cv. “single”. *Indian Agriculturist (India)*

Negi, S. S., Sharma, T., Raghava, S. P. S. and Shrinivasan, V. R. (1982). Variability studies in gladiolus. *Indian Journal of Horticulture*, *39*, 269-272.

Nelson, P. E., Hort, R. K. and Woltz, S. S. (1981). Fusarium diseases of ornamental plants. In: Nelson P.E., Tonson J.A., Cook R.J. (eds), Fusarium: diseases, biology, taxonomy, Pemsylvania State University Press, 121-128.

Okwuagwu, M. I., Alleh, M. E., and Osemwota, I. O. (2003). The effects of organic and inorganic manure on soil properties and yield of okra in Nigeria. *African Crop Science Conference*, *6*, 390-393.

Pal, P. R. (2000). Effect of nitrogen, phosphorus and plant density on growth and yield of flower in (*Jasminum auriculatum* L.) Var. Single. *South India Horticulture*, *32*(3), 140-146.

Pereira, J. R. D., Carvalho, J. A., Paiva, P. D. O., Silva, D. J. S., Souza, A. M. G. and Souza, K. J. (2009). Crescimento e produção de hastes florais de gladíolocultivado sob diferentestensões de água no solo. *Ciência e Agrotecnologia*, *33*(4), 965-970.

Post, K. (1952). Florist Crop Production and Marketing. *Orange Judd. Pub. Co. New York.*

Priyakumari, I. and Sheela, V. L. (2005). Micropropagation of gladiolus cv. 'Peach Blossom' through enhanced release axillary buds. *Journal of Tropical Agriculture*, *43*, 47-50.

Pun, U. K. and Ichimura, K. (2003). Role of sugars in senescence and biosynthesis of ethylene in cut flowers. *Japan Agricultural Research Quarterly, 4*, 219-224.

Raina, J. N. (2002). Drip irrigation and fertigation: Prospects and retrospects in temperate fruit production. In: Enhancement of Temperate Fruit Production (K.K. Jindal and D.R. Gautam, Eds.), 296-301, Directorate of Research, University of Horticulture and Forestry, Nauni, Solan, India.

Raina, J. N., Sharma, T. and Suman, S. (2011). Effect of drip fertigation with different fertilizers on nutrient distribution in soil, leaf nutrient content and yield of apricot (*Prunus aremeniaca* L.). *Journal of the Indian Society of Soil Science*, *59*(3), 268-277.

Raina, J. N., Thakur, B. C. and Verma, M. L. (1999). Effect of drip irrigation and polyethylene mulch on yield, quality and water use efficiency of tomato (*Lycopersicon esculentum*). *Indian Journal of Agricultural Sciences*, *69*, 430-433.

Reid, M. S. and Serek, M. (1997). Use of growth regulators for improving the post-harvest quality of ornamentals. *Perishables Handling*, *92*, 7-8.

Riaz, T., Khan, S. K. and Javaid, A. (2010). Screening of gladiolus germplasm for agronomic performance and resistance against corm rot disease. *African Journal of Biotechnology*, *9*, 6701-6707.

Rubinstein, B. (2000). Regulation of cell death in flower petals. *Plant Molecular Biology*, *44*, 303-318.

Safeena, S. A., Thangam, M., Devi, S. P., Desai A. R., Arunachalam, V., Gupta, M. J. and Singh, N. P. (2014). Ready reckoner on cultivation of gladiolus.

Sairam, R. K., Vasanthan, B. and Arora, A. (2011). Calcium regulates gladiolus flower senescence by influencing antioxidative enzymes activity. *Acta Physiologiae Plantarum*, *33*(5), 1897-1904.

Sarabhoy, A. K. and Agarwal D. K. (1983). Two new diseases of ornamental plants: Fusarium rot and *Mamnalaria* species. *Current Science (Bangalore)*, *52*, 821-822.

Sharma, S. C. and Sharma, A. N. (1988). Commercial cultivation of gladiolus in: *J. Parkash and R. Bhandary (Eds), Floriculture technology trades and trends, Oxford publishing Co. Pvt. Ltd. New Delhi,* 199-202.

Shehzad. M. A., Maqsood, Haq, MAnwar-ul and Niaz, A. (2012). Efficacy of various herbicides against weeds in wheat (*Triticum aestivum* L.). *African Journal of Biotechnology*, *11*, 791-799.

Shillo R. and Halevy, A. H. (2005). The effect of various environmental factors on flowering of gladiolus. *Scientia Horticulturae*, *4*(2), 147-155.

Singh, A. P. and Dohare, S. R. (1992). Maximization of corms and cormel production in Gladiolus. *In. Prakash J, Bhandary*, 205-208.

Singh, S. (1992). Gladiolus Cultivation. Associated Publication Company, New Dehli, India.

Singh, J., Singh, M., Jain, A., Bhardwaj, S., Singh, A., Singh, D. K., Bhushan, B. and Dubey, S. K. (2013). An introduction of plant nutrients and foliar fertilization: a review "Precision farming: a new approach". *Daya Publishing Co., New Delhi*, 252-320.

Singh, S. R., Zargar, M. Y., Najar, G. R., Peer, F. A. and Ishaq, M. I. (2011). Integrated use of organic and inorganic fertilizers with bioinoculants on yield, soil fertility and quality of apple (*Malus domestica*). *Journal of the Indian Society of Soil Sci*ence, *59*(4), 362-367.

Singh, V. and Pandey, M. (2006). Effect of integrated nutrient management on yield of and nutrient uptake by onion and on soil fertility. *Journal of Indian Society of Soil Sci*ence, *54*, 365-367.

Sinha, P. and Roy, S. K. (2002). Plant regeneration through In vitro cormel formation from callus culture of *Gladiolus primulinus* Baker. *Plant Tissue Cult*ure, *12*, 139-145.

Sinha, R. and Sunil, H. (2009). The emerging coeffective and sustainable technology of 21st century for multiple uses of land management to safe and sustainable food production. *Environmental Research Journal*, *3*(2-3), 10-19.

Taj, F. H., Khattak, A. and Jan, T. (1986). Chemical weed control in wheat. *Sarhad J. Agric*., *2*, 15 21.

Talia, M. C. and Traversa, E. (1986). The effect of time of planting and size of cormels of gladioli on the yield of corms for forced flower production. *Abst. Orn. Hort*, *14*(3), 34.

Tandon, R. N. and Bhargava S. N. (1963). Fusarium rot of gladiolus. *Current Sci.*, *32*, 377.

Torre, S., Borochov, A. and Halevy, A. (1999). Calcium regulation of senescence in roses. *Physiologia Plant*, *107*, 214-219.

Whitehead, C. H. (1994). Ethylene sensitivity and flower senescence. In: Scott RJ, Stead AD (eds), Molecular and cellular aspects of plant reproduction. Cambridge University Press, Cambridge, 269–285.

Woltz, S. S. (2001). The world of gladiolus, NAGC, IJSA: 143-9.

Yasin, N. A., Zaheer, M. M., Khan, W. U., Ahmad, S.R., Ahmad, A., Ali, A. and Akram, W. (2018). The beneficial role of potassium in Cd-induced stress alleviation and growth improvement in *Gladiolus grandiflora* L., *International Journal of Phytoremediation*, *20*(3), 274-283.

Zhang, Z. H. and Guo, W. M. (1998). Regulation of 6-BA on membrane permeability of cut chrysanthemum in vase periods. *Adv. Hortic.*, *2*, 697–701.

Zieslin, N. and Geller, Z. (1983). Studies with Liatrisspicata Willd. 1. Effect of Temperature on Sprouting, Flowering and Gibberellin Content. *Annals of Botany*, *52*, 849-853.

Zubair, M., Wazir, F. K., Akhtar, S. and Ayub, G. (2006). Planting dates affect floral characteristics of gladiolus under the soil and climatic conditions of Peshawar. *Pakistan Journal of Biological Science*, *9*(9), 1669-1676.

How to cite this article: Itishree Pradhan, Sushree Sangeeta, Prachurjya Samantaray, Sukirti Mohanty, Aradhana Nayak, Akanshya Pattanaik and Reshma Sahoo (2024). Cultivation Practices Adopted in Gladiolus (*Gladiolus grandiflorus* L.) for Maximizing the Production. *Biological Forum – An International Journal, 16*(1): 197-204.