STUDIES ON WINTER ANNUALS FOR THEIR GROWTH, FLOWERING, FLOWER QUALITY AND YIELD UNDER HILL ZONE OF KARNATAKA

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CERTIFICATE

This is to certify that the thesis entitled **"STUDIES ON WINTER ANNUALS FOR THEIR GROWTH, FLOWERING, FLOWER QUALITY AND YIELD UNDER HILL ZONE OF KARNATAKA"** submitted in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE (HORTICULTURE) in FLORICULTURE AND LANDSCAPE ARCHITECTURE** to the College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga is a bonafide record of research work carried out by **Ms. SINDHU, K., ID NO. MH2TAH0190** (sindhukoghli44@gmail.com) during the period of study in this university under my guidance and supervision and no part of this thesis has previously formed the basis for the award of any other degree, diploma, associateship or any other similar titles.

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STUDIES ON WINTER ANNUALS FOR THEIR GROWTH, FLOWERING, FLOWER QUALITY AND YIELD UNDER HILL ZONE OF KARNATAKA

(SINDHU, K.)

ABSTRACT

The investigation entitled "Studies on winter annuals for their growth, flowering, flower quality and yield under hill zone of Karnataka" was carried out at Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, during 2019-20. The experiment was laid out in Randomized Completely Block Design (RCBD) with twelve treatments and three replications. The annuals *viz.*, *Calendula officinalis* L., *Callistephus chinensis* (L.) Nees, *Cosmos bipinnatus* L., *Chrysanthemum coronarium* L., *Gomphrena globosa* L., *Helichrysum bracteatum* L., *Lupinus hartwegii* Lindl., *Salvia splendens* L., *Lathyrus odoratus* L., *Dianthus barbatus* L., *Xerochrysum viscosum* Rx. Bayer, and *Zinnia elegens* L. are evaluated for their mean performance on growth, flowering, flower quality and yield parameters. The observations recorded on various growth and flowering parameters were subjected to statistical measures mean, range, standard error and coefficient of variation. The highest score for cut flower suitability was obtained in *Callistephus chinensis* (L.) Nees (5.00), *Gomphrena globosa* L. (5.00), *Helichrysum bracteatum* L. (5.00), followed by *Chrysanthemum coronarium* L. (4.76) and *Calendula officinalis* L. (4.22). The maximum score for loose flower suitability was obtained in *Callistephus chinensis* L. (5.00), *Chrysanthemum coronarium* L. (5.00), followed by *Calendula officinalis* L. (4.74) and *Gomphrena globosa* L. (4.66). The highest flower yield per plant was observed in *Chrysanthemum coronarium* L. (432.44 g) followed by *Calendula officinalis* L. (236.28 g) and *Callistephus chinensis* L. (174.25 g) are suited for flower purposes. In case of seed production, the highest average seed yield per plant was obtained in *Chrysanthemum coronarium* L. (79.13 g), *Calendula officinalis* L. (56.22 g), *Lathyrus odoratus* L. (52.65 g) and *Lupinus hartwegii* Lindl. (28.50 g) were recorded best of all winter annuals under study. The highest BC ratio was recorded in *Calendula officinalis* L. (12.88), *Chrysanthemum coronarium* L. (11.74), *Lathyrus odoratus* L. (9.55) and *Lupinus hartwegii* Lindl. (9.07) with the best suitability for commercialization.

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ಕರ್ನಾಟಕದ ಗುಡ್ಡಗಾಡು ಪ್ರದೇಶದಲ್ಲಿ ಚಳಿಗಾಲದ ವಾರ್ಷಿಕ ಹೂ ಗಿಡಗಳ ಬೆಳವಣಿಗೆ, ಹೂ ಬಿಡುವಿಕೆ, ಹೂವಿನ ಗುಣಮಟ್ಟ ಮತ್ತು ಇಳುವರಿಯ ಅಧ್ಯಯನ

(ಸಿಂಧು, ಕೆ.)

ಸಾರಾಂಶ

ಪ್ರಸ್ತುತ ಅಧ್ಯಯನವು ಕರ್ನಾಟಕದ ಗುಡ್ಡಗಾಡು ಪ್ರದೇಶದಲ್ಲಿ ಶೀತಕಾಲದ ವಾರ್ಷಿಕ ಹೂಗಿಡಗಳ ಬೆಳವಣಿಗೆ, ಹೂಬಿಡುವಿಕೆ, ಹೂವಿನ ಗುಣಮಟ್ಟ ಮತ್ತು ಇಳುವರಿಯ ಬಗ್ಗೆ ಕ್ಷೇತ್ರ ಸಂಶೋಧನೆಯನ್ನು ತೋಟಗಾರಿಕೆ ಮಹಾವಿದ್ಯಾಲಯ, ಮೂಡಿಗೆರೆಯ ಪುಷ್ಪ ಕೃಷಿ ಮತ್ತು ಉದ್ಯಾನ ವಿನ್ಯಾಸ ವಿಭಾಗದ ಪ್ರಾಯೋಗಿಕ ಬ್ಲಾಕ್‌ನಲ್ಲಿ ೨೦೧೯–೨೦೨೦ ಅವಧಿಯಲ್ಲಿ ಕೈಗೊಳ್ಳಲಾಗಿತ್ತು. ಪ್ರಸ್ತುತ ಅಧ್ಯಯನವು ಯಾದೃಚ್ಛಿಕ ಸಂಪೂರ್ಣ ಬ್ಲಾಕ್ ವಿನ್ಯಾಸದೊಂದಿಗೆ ೧೨ ಉಪಚಾರಗಳು ಮತ್ತು ಮೂರು ಪ್ರತಿಕೃತಿಗಳನ್ನು ಒಳಗೊಂಡಿತ್ತು. ಇದರಲ್ಲಿ ವಾರ್ಷಿಕ ಹೂಗಿಡಗಳಾದ *ಕೆಲೆಂಡುಲಾ ಅಫಿಷಿನಾಲಿಸ್* ಲಿ., *ಕ್ಯಾಲಿಸ್ಟೆಫಸ್ ಚೈನೆನ್ಸಿಸ್* (ಲಿ.) ನೀಸ್, *ಕಾಸ್ಮೋಸ್ ಬೈಪಿನ್ನಾಟಸ್* ಲಿ., *ಕ್ರೈಸಾಂಥೆಮಮ್ ಕೊರೊನೆರಿಯಮ್* ಲಿ., *ಗೊಂಫ್ರೆನಾ ಗ್ಲೋಬೊಸಾ* ಲಿ., *ಹೆಲಿಕ್ರೈಸಮ್ ಬ್ರಾಕ್ಟಿಯೆಟಮ್* ಲಿ., *ಲುಪಿನಸ್ ಹಾರ್ಟ್ವೆಗಿ* ಲಿಂಡಲ್., *ಸಾಲ್ವಿಯಾ ಸ್ಪ್ಲೆಂಡೆನ್ಸ್* ಲಿ., *ಲ್ಯಾಥೈರಸ್ ಒಡೋರೆಟಸ್* ಲಿ., *ಡೈಯಾಂಥಸ್ ಬಾರ್ಬಟಸ್* ಲಿ., *ಝಿನ್ನೀರೊಕ್ರೈಸಮ್ ವಿಸ್ಕೋಸಮ್ ಆರ್‌ಎಕ್ಸ್. ಬೇಯರ್* ಮತ್ತು *ಝಿನಿಯಾ ಎಲಿಗಾನ್ಸ್* ಲಿ. ಗಳ ಸರಾಸರಿ ಕಾರ್ಯಕ್ಷಮತೆಯನ್ನು ಬೆಳವಣಿಗೆ, ಹೂಬಿಡುವಿಕೆ, ಹೂವಿನ ಗುಣಮಟ್ಟ ಮತ್ತು ಇಳುವರಿಗಳಲ್ಲಿ ಮೌಲ್ಯಮಾಪನ ಮಾಡಲಾಯಿತು. ವಿವಿಧ ಬೆಳೆಗಳ ಬೆಳವಣಿಗೆ ಮತ್ತು ಹೂಬಿಡುವ ನಿಯತಾಂಕಗಳಲ್ಲಿ ದಾಖಲಾದ ಅವಲೋಕನಗಳನ್ನು ಸರಾಸರಿ, ಶ್ರೇಣಿ, ಪ್ರಮಾಣಿಕದೋಷ ಮತ್ತು ವ್ಯತ್ಯಾಸದ ಗುಣಾಂಕದಂತಹ ವಿವರಣಾತ್ಮಕ ಸಂಖ್ಯಾಶಾಸ್ತ್ರೀಯ ಕ್ರಮಗಳಿಗೆ ಒಳಪಡಿಸಲಾಯಿತು. ಹೂಗಿಡಗಳ ಗರಿಷ್ಠ ಸೂಕ್ತತೆ ಸೂಚ್ಯಂಕವು *ಕ್ಯಾಲಿಸ್ಟೆಫಸ್ ಚೈನೆನ್ಸಿಸ್* (ಲಿ.) ನೀಸ್, *ಗೊಂಫ್ರೆನಾ ಗ್ಲೋಬೊಸಾ* ಲಿ. ಮತ್ತು *ಹೆಲಿಕ್ರೈಸಮ್ ಬ್ರಾಕ್ಟಿಯೆಟಮ್* ಲಿ. ಗಳಲ್ಲಿ ೫ ನ್ನು ಹಾಗೂ *ಕ್ರೈಸಾಂಥೆಮಮ್ ಕೊರೊನೆರಿಯಮ್* ಲಿ., (೪.೭೬) ಮತ್ತು *ಕೆಲೆಂಡುಲಾ ಅಫಿಷಿನಾಲಿಸ್* ಲಿ. (೪.೨೨) ಕತ್ತರಿಸಿದ ಹೂಗಳಲ್ಲಿ ಹೊಂದಿದ್ದು ಆದರೆ ಬಿಡಿ ಹೂಗಳಿಗೆ *ಕ್ಯಾಲಿಸ್ಟೆಫಸ್ ಚೈನೆನ್ಸಿಸ್* (ಲಿ.) ನೀಸ್ ಮತ್ತು *ಕ್ರೈಸಾಂಥೆಮಮ್ ಕೊರೊನೆರಿಯಮ್* ಲಿ. ಗಳಲ್ಲಿ ೫ ಸೂಚ್ಯಂಕವನ್ನು ಹೊಂದಿದ್ದು *ಕೆಲೆಂಡುಲಾ ಅಫಿಷಿನಾಲಿಸ್* ಲಿ. ಮತ್ತು *ಗೊಂಫ್ರೆನಾ ಗ್ಲೋಬೊಸಾ* ಲಿ. ಕ್ರಮವಾಗಿ ೪.೭೪ ಮತ್ತು ೪.೬೬ ಹೊಂದಿದೆ. ವೀಕ್ಷಣೆಯಲ್ಲಿದ್ದ ವಾರ್ಷಿಕ ಹೂಗಿಡಗಳ ಅವಲೋಕನೆ ಮಾಡಿದಾಗ ಗರಿಷ್ಠ ಹೂವಿನ ಇಳುವರಿ *ಕ್ರೈಸಾಂಥೆಮಮ್ ಕೊರೊನೆರಿಯಮ್* ಲಿ. (೪೩೨.೪೪ ಗ್ರಾಂ./ಗಿಡಕ್ಕೆ), *ಕೆಲೆಂಡುಲಾ ಅಫಿಷಿನಾಲಿಸ್* ಲಿ., (೨೩೬.೨೮ ಗ್ರಾಂ./ ಗಿಡಕ್ಕೆ) ಮತ್ತು *ಕ್ಯಾಲಿಸ್ಟೆಫಸ್ ಚೈನೆನ್ಸಿಸ್* (ಲಿ.) ನೀಸ್ (೧೭೪.೨೫ ಗ್ರಾಂ./ಗಿಡಕ್ಕೆ) ದಾಖಲಾಗಿದ್ದು ಹೂವಿನ ಉದ್ದೇಶಗಳಿಗೆ ಸೂಕ್ತವಾಗಿದೆ. ಮುಂದುವರೆದು ಗರಿಷ್ಠ ಬೀಜದ ಇಳುವರಿ ಗಿಡಕ್ಕೆ *ಕ್ರೈಸಾಂಥೆಮಮ್ ಕೊರೊನೆರಿಯಮ್* ಲಿ., *ಕ್ಯಾಲೆಂಡುಲ ಅಫಿಷಿನಾಲಿಸ್* ಲಿ., *ಲ್ಯಾಥೈರಸ್ ಒಡೋರೆಟಸ್* ಲಿ. ಮತ್ತು *ಲುಪಿನಸ್ ಹಾರ್ಟ್ವೆಗಿ* ಲಿಂಡಲ್. ಗಳಲ್ಲಿ ಕ್ರಮವಾಗಿ ೭೯.೧೩ ಗ್ರಾಂ, ೫೬.೨೨ ಗ್ರಾಂ, ೫೨.೬೫ ಗ್ರಾಂ. ಮತ್ತು ೨೪.೫೦ ಗ್ರಾಂ. ದಾಖಲಾಗಿದ್ದು ಬೀಜೋತ್ಪಾದನೆಗೆ ಸೂಕ್ತವಾಗಿದೆ. *ಕ್ರೈಸಾಂಥೆಮಮ್ ಕೊರೋನರಿಮ್* ಲಿ. (೧೨.೪೪), *ಕ್ಯಾಲೆಂಡುಲಾ ಅಫಿಷಿನಾಲಿಸ್* ಲಿ. (೧೧.೭೪), *ಲ್ಯಾಥೈರಸ್ ಒಡೊರಟಸ್* ಲಿ. (೯.೫೫) ಮತ್ತು *ಲುಪಿನಸ್ ಹಾರ್ಟ್ವೆಗಿ* ಲಿಂಡಲ್. (೯.೦೭) ಗಳಲ್ಲಿ ಹೆಚ್ಚಿನ ಲಾಭ–ವೆಚ್ಚ ಅನುಪಾತ ದಾಖಲಾಗಿದ್ದು ವಾಣಿಜ್ಯೀಕರಣಕ್ಕೆ ಸೂಕ್ತವಾಗಿದೆ.

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INTRODUCTION

I INTRODUCTION

Floriculture is the ability and knowledge of growing flowers and other floricultural products to excellence. It includes the cultivation of flowers and ornamental crops from the time of planting to harvesting along with the production of planting materials through seeds, cuttings, budding, grafting, marketing of flowers and flower products. Flowers have always remained an integral part of human life's social fabric due to its essence and fragrance being essential on all social, cultural and religious functions of any society since time immemorial. (Francis *et al*. 2005). Floriculture is a profitable agribusiness venture throughout the world and is dynamic and fast-growing.

India is bestowed with several agro-climatic zones conducive for the production of sensitive and delicate floriculture products. During the decade after liberalization, the floriculture industry took giant steps in the export arena and is growing at the rate of 20 to 25 per cent in the domestic and international markets. As per National Horticulture Database, 2018-19, the area under floriculture production in India was 339 thousand hectares with an output of 1991 thousand tonnes loose of flowers and 867 thousand tonnes of cut flowers. India's total export of floriculture was 19726.57 MT worth of Rs. 571.38 Crores per 81.94 USD Millions in 2018-19. The major importing countries are the United States, Netherlands, United Kingdom, Germany, and United Arab Emirates.(Anonymus,2018)

Among the various fields of floriculture, seed production of annuals is considered profitable and has a tremendous scope in the future. In India, 90 per cent of seed production comes from three main centres, namely, Ludhiana, Bengaluru, and Kalimpong. The area of about 800 ha is under flower seed production and Punjab contributes about half of the area under seed production with estimated annual earnings of Rs.6 crores (Kumar, 2011)

The term "annual" when applied to herbaceous ornamentals, refers to plants that are grown for only one season. Ornamental annuals are the herbaceous plants that grow from seeds, produce flowers, set seeds, and complete their life cycle within one growing season of the year, having a short period of the lifespan. There are a vast number of species and varieties that show variations in height, growth habit, and also the shape, size, and color of flowers.

Most of the winter annuals are introduced by Britishers in India. These annuals can tolerate comparatively low temperatures and are comfortably grown in the winter season and bloom best during this season. Winter flowering annuals serve as essential components in any landscape plan (Brown, 2012). They beautify the surroundings and exhibit a more magnificent display of blooms with a diverse palette of colors. They provide high impact when used as mass plantings in raised beds or in-ground beds.

Apart from growing in beds of various size and shapes with one or more annuals (Howe and Waters, 1998), They are frequently used as bedding plants, garden plants, plants for rockery, window basket, cut flowers and herbaceous border in gardens (Love *et al*. 2009). However, few types are grown for cut flowers and also attractive foliage (Steven and Gast, 1992)

Annuals have the potential to thrive in almost all climate and soil type. The proper selection of annuals and their time of planting boost up the beautification in landscaping. Due to the wide variety of annual flowers available in winters, it becomes the site of attraction in the garden. Seed production of annuals has become one of the profitable constituents of the floriculture industry, some of these vibrant winter annuals are Antirrhinum, Calendula, China aster, Daisy, Helichrysum, Pansy, Petunia, Salvia, Sweet William, Verbena, Zinnia, etc.

The description of the seasonal annuals used in investigation and its landscape and commercial uses are as follows. Calendula (*Calendula officinalis* L., pot marigold), a member of the Asteraceae family, is an important aromatic ornamental plant indigenous to Europe (Khan, 2011) and is cultivated worldwide as outdoor seasonal annual. In addition to being used as a bedding plant or specialty cut flower in landscape horticulture, calendula is also used in cosmetics and pharmaceuticals (Warner and Erwin 2005; Ercetin *et al*. 2012). China aster [*Callistephus chinensis* (L.) Nees.] belongs to the family Asteraceae and is native of China. Among the annuals, China aster is ranked third for popularity, after Chrysanthemum and Marigold (Sheela, 2008). China aster is a free blooming half hardy, easy growing winter annual crop grown for cut flower as well as loose flower. (Dharmendra *et al*. 2019). It is estimated to be grown in 1,020 ha with a production of flower 800 million tonnes in India. (Kumari *et al*. 2017). In addition to its cultivation, China aster can be used in landscape gardening to provide mass aesthetic effect. *Cosmos bipinnatus* is also known as Mexican Aster, which belongs to the family Asteraceae. It is one of the most common flowering annuals, which can be seen in home gardens, window boxes, and as a loose flower. Garland chrysanthemum, botanically known as *Chrysanthemum coronarium* L., is an annual under the chrysanthemum group of flowers. It is more hardy, vigorous and grows taller. Its flowers are in various shades of yellow, white, having single or double forms (Desai, 1962). The growers are attracted towards annual chrysanthemum flowers as it's of short duration, to produce marketable attractive good keeping quality flowers. (Hawa *et al*. 2018). Bachelor's button (*Gomphrena globosa* L.) belongs to the family Amaranthaceae, which is half-hardy, used in beds, borders, rockeries, and pots. It is an annual ornamental plant that grows with varying height. (Ashwini *et al*. 2019) and is one of the important commercial flower crop grown for "loose flower" used for garland making. Though not fragrant, the flowers are very popular due to their attractive colour, light weight and good keeping quality. (Sendhil *et al*. 2019). *Helichrysum bracteatum*

commonly known as the strawflower is a flowering plant in the family *Asteraceae* native to Australia, with yellow, orange, pink, deep rose, red, wine, magneto, purple and white blooms. (Maryam, 2014). *Helichrysum* are producing worldwide as fresh and dried flowers, which retains the color for a longer time. The dwarf cultivars can be used as bedding plants.

Lupinus hartwegii is also known as lupine, which belongs to the Fabaceae family. They are hardy annuals and biennials, widely cultivated for a food source and as ornamentals. They are suitable for beds, borders, pots, and as cut flowers. Lupin is mainly grown as bedding plants and as specialty cut flower. *Salvia splendens*, the scarlet sage is a tender annual belongs to the family Lamiaceae. It can be grown throughout the year and are the most popular bedding plant. *Lathyrus odoratus*, Ornamental sweet pea, is a cool-season annual, belongs to the family Fabaceae. It is used in the landscape as ground cover, window boxes, and sometimes as cut flower for flower arrangements. *Dianthus barbatus* L. commonly called as Sweet William belongs to family Caryophyllaceae is a winter annual usually grown as bedding plant, in edges, and pots for landscaping and for cut flower production. (Sharma *et al*. 2015). *Xerochrysum viscosum* is produced worldwide as fresh and dried flowers, which belongs to the family Asteraceae. They have been commonly used in folk medicine as an herbal tea. *Zinnia elegans* are also known as youth and age, belong to the family Asteraceae. The graceful narrow-leaved or creeping zinnia is useful for naturalizing in rock gardens, containers, and hanging baskets and also as bedding or for mass plantings as edging or filler plants (Kessler, 2008).

The selection of suitable flower crops is vital for proper growth, flowering, and seed production to gain desirable returns, which depends on prevailing environmental and geographical conditions. The hill conditions do not facilitate cut flower production in every corner; therefore, the alternative approach of seed production in such areas could be beneficial for the farmers. Depending on the plant species, the temperature, humidity, rainfall, photoperiod, and other climatic factors affect the plant growth and reproductive phase, in their own way, with different magnitude depending on the plant species. These factors may be beneficial to one species, at the same time, may have harmful effects on other species. Growing factors boost plant growth and flowering when the proper selection of species is followed and increases flower and seed yield. In recent years, the importance of ornamental plants has increased, particularly in countries, which are earning foreign exchange from the export of ornamental plants.

In the hill condition of Chikkamagaluru district of Karnataka, winter annual are generally planted during October-November. The climatic conditions vary from place to place in India and prevailing environmental conditions greatly influence the plant growth, flowering, and seed production; therefore, best-suited annuals cannot be

determined on a national scale. Therefore, there is a need to find out the suitable annuals for a particular zone for commercialization. In view of the importance of environmental conditions, the field experiment entitled 'Studies on winter annuals for their growth, flowering, flower quality and yield under hill zone of Karnataka' was carried to examine an applied possibility of species selection of various winter annuals with the following objectives:

1. To study the morphological parameters of winter annuals.
2. To study the flowering, flower quality, and yield parameters of winter annuals.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

Among the various fields in floriculture, the cut flower, loose flower, and seed production had emerged as a viable and profitable alternative, with a high potential to generate remunerative self-employment among small and marginal farmers. In Karnataka, winter annuals are grown during October-November. The winter trail present here is the part of an evaluation of annuals to broaden the winter palate of colors available to homeowners and landscapers in the hill zone of Karnataka. In this chapter, an attempt has been made to review the available literature on studies of winter annuals for growth, flowering, and seed production under the following heading.

2.1 Growth and flowering

2.2 Seed production

2.1 Growth and flowering

There are a wide range of colors available in *Centurea cyanus*, but it is mainly grown for its deep blue to purple and pink to rose flowers. (Bailey and Bailey, 1976a). Dwarf cultivars (50-60cm) of *Antirrhinum* L. are suited for bedding and potted flowering plants whereas tall ones (90-100cm) for cut flowers (Bailey and Bailey, 1976b).

In cosmos, paclobutrazol at 150ppm treatment resulted in the highest number of branches (15.00) per plant and the number of flowers (140.00) per plant and the lowest plant height (51.4 cm) and flower size (4.2 cm) compared with 10.73, 75.00, 72.5 cm and 6.5 cm, respectively, for these parameters in control (Mohd *et al*. 1988).

Bassappa *et al*. (1990) conducted a field trial of *Helichrysum bracteatum*. The results revealed that the highest flower yield (9.24 t/ha) was obtained from plots receiving N at 150 kg per ha + P_2O_5 at 100 kg per ha; the yield in the unfertilized control (4.48 t/ha).

Jana and Pal (1991) revealed that the nutrient elements, nitrogen and phosphorus deficiency showed maximum reduction in growth. The flower diameter increased significantly with higher levels of N and P in *Cosmos bipinnatus*. The maximum growth of the plants was obtained with the combined application of treatment 20g nitrogen, 10g Phosphorous and 10g potash per m^2. The further number of days required for flower bud opening in cosmos increased significantly with higher levels of nitrogen. The number of leaves in calendula plants was significantly increased with increasing levels of nitrogen, phosphorous, and potassium (Sigedar *et al*. 1991).

Florincescu and Zaharia (1995) studied the variability of ornamental characteristics in four cultivars of sweet pea *viz*. Royal Pink, Royal Mixed, Knee Hi and Zig Zag and three species of *Lathyrus viz. L. latifolius, L. tuberosus* and *L. odoratus*. The length of the flower stem and inflorescence was recorded greater in

L. odoratus. The number of flowers per inflorescence was greater in *L. latifolius* and the flower size was greater in *L. Odoratus*.

Kaur and Kumar (2001) have reported that nitrogen application at 30g/m^2 resulted in tallest plants (38.89cm), widest spread (48.27cm), more number of branches (51.41/plant), longer flower duration (58.68 days) and the maximum seed yield (39.75g/m^2) in *Iberis amara*.

Dubey *et al*. (2002) found that planting *Cosmos* in August month produced tallest plants with maximum spread and number of branches rather than planting in May or July month.

A study was conducted to determine the effect of spacing and nitrogen fertilizer application on *Chrysanthemum coronarium* Local White. Treatments comprised of three spacings (30x20, 30x30 and 30x40 cm) and four nitrogen rates (0, 50, 100 and 150 kg/ha). The number of branches, plant spread, main stem diameter, fresh weight of plant and dry weight of plant were significantly highest in the widest spacing (30x40 cm) and highest nitrogen rate (150 kg N/ha) (Karavadia and dhaduk, 2002)

Mili and Sable (2003) experimented to evaluate the effect of plant density and nitrogen levels on growth and flowering of *Calendula officinalis* L. The results of the study revealed that planting density (45 cm × 45 cm) and 100 kg N/ha showed the highest number of leaves, number of branches and leaf area per plant, flower diameter, the average weight of individual cut flower, cut flower and loose flower yield per plant, whereas the height of the plant was maximum at 30 cm × 30 cm and 100 kg N/ha.

Kim and Ahn (2003) evaluated accessions of *Dianthus* for growth and flower characteristics and interspecific cross-compatibility. They stated that seventeen species or ecotypes were grouped as three classes based upon their plant heights. With the exception *Dianthus chinensis* accessions 190, 191 and *D. tianschanicees*, which have 38, 34 and 20 petals respectively, most plants have flowers of 5 petals. The cross-compatibility was confirmed among species of *D. chinensis, D. arenarus, D. plumarius*. The fertility rate was highest (70%) in the cross between *D. plumarius* and *D. serotinus*. Chromosome numbers of *D. chinensis, D. barbatus,* and *D. knappii* were confirmed as 2n=30. The average number was 9 per cell and a significant difference in chloroplast number was not found among the species.

Nagaraju *et al.* (2004) studied the effect of dates of planting on flowering and flower quality of China aster (*Callistephus chinensis Nees.*) cv. Kamini. The results revealed that the maximum number of flowers per plant with larger sized flowers recorded in china aster cv. 'Kamini' when planting is done in May month. The days taken to first flower opening and 50 per cent flowering were recorded the minimum when planted in December and November rather than other months of the year. The number of flowers per plant has recorded the maximum in January planting.

Kelly *et al.* (2005) evaluated 210 pansy cultivars as bedding plants. The outstanding performance found in cultivars like 'Accord/Banner Black Beauty,' 'Nature Blue,' 'Nature Ocean,' 'Panola Clear Mixture,' 'Nature Pink shades,' 'Nature Beacon,' 'Panola Purple with Face,' 'Baby Bingo Lavender Blue,' 'Nature White,' 'Nature Yellow,' 'Iona Purple & Yellow With Blotch,' 'Bingo Red & Yellow,' 'Panola Yellow With Blotch,' 'Whiskers Yellow.' These cultivars were believed to perform well in the southern U.S, or areas of the world with a similar heat and cold hardiness zones.

A study was conducted to know the effect of planting time on growth and flower yield in *Gaillardia pulchella* Foug. by Patil *et al*. (2005). The results revealed that there were significant differences as flower yield was recorded highest (33.33 t/ha) from plants planted in January, followed by December, being the next best month.

Inaba and Ohshiro (2005) observed that the yield of cut flowers per plant decreased with an increase in planting density. However, the yield of cut flowers per square meter was significantly less in 4 plants per row than in 6 and 8 plants per row. The productivity was higher in raising seedlings without temporary planting than in the conventional method.

Singh and Martolia (2006) conducted a field experiment to find out the variation in various lupin (*Lupinus hartwegii* L.) germplasm. The results revealed that germplasm LHS 25 registered wide variation on plant height (24.83 cm to 95.53cm), plant spread (32.16 cm to 110.06 cm), and stem diameter (0.62 to 2.28 cm) was recorded. The rachis length varied from 7.52 cm (LHG 23) to 51.93 cm (LHG 34), and spike longevity in the field ranged from 8.00 (LHG 22) to 26.00 days (LHG 25). The wide variation in flower color with pure white and violet purple color flower of two or three color shades were also observed. Two genotypes (LHG 25 and LHG 26) exhibited double shades of red-purple and yellow color.

Singh and Jauhari (2006) recorded the maximum number of secondary branches/plant (21) in 'PSG 18' and number of leaves (2670.33) with 'PSG 12', whereas lines 'PSG 3' and 'PSG 1' resulted in the maximum number of nodes (28.33) and leaf area index (5.36), respectively. The maximum number of florets per spike and the number of open florets in the vase were recorded with 'PSG 6'. 'PSG 20' exhibited the maximum rachis length (12.55 cm) in snapdragon (*Antirrhinum majus* L.).

In *Coreopsis lanceolate* L., the first planting carried out in the first week of November resulted in tallest plants (94.47 cm) and more number of branches (20.32/plant). The plant spacing of 60x30 cm resulted in tallest plants (85.44), but the wider spacing of 60x60 cm produced vigorous plants with more branches (20.01/plant). In *Coreopsis tinctoria* L., the first planting carried out in first week of November produced the tallest plants (136.35 cm). The wider spread (86.72 cm) was recorded under the second planting carried out in the third week of November. The number of

branches (17.59/plant) was recorded as significantly higher under planting density of 60x60 cm in comparison to 15.80/plant recorded at 60x30 cm. (Dhatt and Kumar, 2007).

Kabir *et al*. (2007) revealed that black plastic mulch showed better performance with highest plant height (47 cm), number of leaves per plant (220), visible flower bud initiation (24 DAT) and the maximum number of flowers (178) followed by water hyacinth mulch and straw mulch respectively whereas the lowest were observed from control. Deep coloured flower (L* 48) was produced from black plastic mulch treated plants and light-coloured flower (L*61) from control in Dianthus (*Dianthus chinensis* L.).

Seghatoleslami and Mousavi (2009) studied the influence of sowing date and plant density on flower yield of pot marigold (*Calendula officinalis* L.). The results revealed that the latest sowing date had the highest flower yield. There was no significant difference between flower yield in sowing dates of 30th March and 14th April (105.8 and 112.5 g/m^2, respectively), but these yields were more than the sowing date of 30th April (80.7 g/m^2). The flower yield (125.4g/m^2) was recorded highest at 25 plants per m^2.

Baloch *et al*. (2009) studied the effects of different sowing dates on the flowering time of important ornamental annuals. They made investigations on six short-day plants (Zinnia, Sunflower, French marigold, African marigold, Cockscomb, and Cosmos) and ten long-day plants (Moss rose, Pansy, Snapdragon, Petunia, Pot marigold, Annual phlox, Cornflower, Oriental poppy, Flax and Annual verbena). They concluded that planting ornamental annuals early, flowered earlier as compared to late planting.

Basoli (2009) conducted an experiment on the effect of planting dates on growth and flowering of various cultivars of chrysanthemum. The planting was done at an interval of 15 days from April 9 to August 7. The longer cut stems with more number of flowers were obtained with early plantings. As the planting date was delayed gradual decrease in length of cut stem and number of flowers per stem was observed. Morteza *et al*. (2009) obtained the maximum number of flowering stems per plant (7.11) in valerian (*Valeriana officinalis* L.) when planted in August 10 as compared to late planting, i.e., September 1 and September 20.

Parmar *et al*. (2012) evaluated the effect of bio fertilizers and nitrogenous fertilizer on growth, flowering, and yield of annual chrysanthemum. They revealed that application of 175 kg N/ha + *Azospirillum* + *Azotobactor* produced significantly maximum plant height (96.23 cm), number of branches per plant (50.59), plant spread (79.08 cm in North-South direction and 78.79 cm in East-West direction), the minimum days for first flower initiation (37.00 days), the maximum number of flowers per plant

(161.28), maximum flower yield per plant (569.55 g) as well as per hectare (22.56 t) was recorded in the same treatment. The treatment 150 Kg N/ha+ *Azospirillum* produced flowers with the maximum shelf life (4.33 days).

The experiment was conducted to know the effect of NP fertilizers on the growth and flower production of Zinnia (*Zinnia elegans* L.) by Baloch *et al*. (2010). The results revealed that the treatment with highest NP rate of 50+20 g/1.5 m^2 took minimum days for the emergence of a first flower bud (50.66 days), opening of first flower (59.66 days), life of flower (7.33days), the highest number of branches per plant (11.33), flowers per plant (12.66) and plant height (68.22 cm) which was on par with the treatment NP at the rate of 50+10 g/1.5 m^2.

Kumar (2011) evaluated F_1 hybrids of pansy and stated that the maximum plant height (37.49cm) and plant spread (36.99cm) were recorded in A-12. The Accession A-13 with a plant spread of 35.08 cm can be used for exhibition purposes, and Accession A-8 with a spread of 24.86 cm can be used for bedding purposes. The maximum number of flowers (91.16/plant) was recorded in Accession A-11. The longer flowering duration (96.16 days) was recorded from Accession A-5 followed by Accession A-12 (95.83 days).

Blanchard and Runkel (2011) stated that thermal tolerance varied considerably among different genera of annual bedding plants. The flower developmental rate had an asymmetrical response to temperature, and the estimated T_{min} varied among species and ranged from 1.1 °C in French marigold (*Tagetes patula* L.) to 9.9 °C in angelonia (*Angelonia angustifolia* Benth.). T_{opt} and T_{max} were only observed for 8 to 10 species with the temperature range tested. T_{opt} ranged from 19.1 °C in Dahlia (*Dahlia* × *hybrida* Cav.) to 28.0 °C in blue salvia (*Salvia farinacea* Benth.), whereas T_{max} ranged from 30.3 °C in Snapdragon (*Antirrhinum majus* L.) to 31.7 °C in moss rose (*Portulaca grandiflora* Hook.).

Rani *et al*. (2011) made a study on seed production of flowering annuals under poplar based agroforestry system. The Benefit-Cost ratio of growing flowers for seed production ranged from 1.15 to 5.31 under three-year-old poplar canopy and 1.68 to 5.51 in an open environment. Among the crops studied, *Coreopsis tinctoria, Coreopsis lanceolata, Phlox drumondii*, and *Gaillardia pulchella* showed better performance than the other crops in both conditions.

The varietal evaluation of French marigold (*Tagetes patula* Linn.) was carried out by Raghuvanshi and Sharma (2011) stated that the cultivar Safari Queen recorded maximum plant height (35.80 cm), flower yield per square meter (8.27 kg). The Plant spread (30.37 cm) was recorded the maximum in cv harmony Boy. The cultivar Bonanza Bolero recorded maximum values for three traits viz. leaf area (34.58 cm^2), flower diameter (5.26 cm), and 1000-seed weight (2.60g). The maximum duration of

flowering was recorded in cv. Safari Tangerine (39.67 days) and the cultivar 'Cupid on Varied Orange' resulted in highest 100- loose flower weight. The maximum carotene content of 3747.50 µg/g was obtained in cv. Honey Comb, which was on par with cv. 'Hero Harmony' (3745.83µg/g).

Berimavandi *et al*. (2011) investigated on effect of plant density and sowing dates in *Calendula officinalis* L. revealed that the maximum plant dry weight (35.67 g), flower number per plant (25.88), branch number per plant (9.44), flower dry weight (3.72 g), and amount of essential oil per 100 g dried flower (0.16 ml) were obtained at the 20 plants per m^2, while the maximum of flower dry weight (132.07 g), and amount of essential oil (0.19 ml), both per area unit were obtained at the 60 plants per m^2.

Balaj *et al.* (2011) studied the effect of bedding plants (*Tagetes erecta* and *Antirrhinum majus)* in urban landscape architecture. The results revealed that the species (*Tagetes erecta* and *Antirrhinum majus*) have a very good blooming due to favourable climatic conditions in Kosovo, which affected the growth, quality, and color of the flowers. Hybrids of species of flowers like Tagetes and Antirrhinum have demonstrated high decorative value and long period with flowers, good growing, leaves, and flowers of different colors (white, red, yellow, pink). There is variability among cultivars in terms of the number of flowers and blooming period. In all varieties, blooming begins in May with a various number of flowers (2 to 4) per plant. The maximum blooming (the largest number of flowers) is achieved in July and August, while the blooming ends in late of October.

Shafique *et al.* (2011) performance of various Snapdragon (*Antirrhinum majus* L.) cultivars as cut flowers in Punjab, Pakistan. The studies revealed that Maryland White Yellow, Potomac Orange Dark, Mary land golden bronze, Maryland pink true, and Apollo cinnamon cultivars of snapdragon performed well for vegetative growth and produced good quality flower spike and proved their superiority over the other cultivars.

Sharma (2012) revealed that among the different treatments, GA_3@20 mg/l was found to be the best for maximizing seedling emergence percentage (88.00 %), plant height (27.30 cm), plant spread (27.75 cm), earliest first flowering (101.20 days), number of flowers per plant (133.33), number of capsules per plant (58.29). The planting done on 2nd November was found to be the best for maximizing plant height (28.54 cm), plant spread (28.59 cm), earliest first flowering (100.30), number of flowers per plant (138.69), number of capsules per plant (68.01), in pansy (*Viola* × *wittrockiana* Gams.).

Airadevi (2012) revealed that among the different treatment combination of *Azospirillum* + PSB + 50% vermicompost equivalent to RDN + 50% recommended NPK recorded significantly higher plant height (87.00 cm), number of branches/plant

(39.61), plant spread (35.77 cm), total dry matter production (22.77 g/plant) and early flower bud initiation (25.13 days after transplanting), flower diameter (5.60 cm), vase life of cut flowers (8.53 days), shelf life of loose flower (42.06 hrs) in Annual chrysanthemum.

Sainath *et al*. (2012) carried out an experiment to assess the effect of different plant growth regulators on growth, quality, yield, and yield components in annual chrysanthemum (*Chrysanthemum coronarium* L.). The results indicated significantly higher plant height (97.28 cm), number of branches (27.32), leaf area (4497.24 cm^2/plant), dry weight (0.747 g/plant) and maximum flower yield per plant (498.6 g) in GA3 @ 200 ppm followed by all other treatments.

The branching pattern as influenced by pinching time in garland chrysanthemum (*Chrysanthemum coronarium* L.) was evaluated by Dorajeerao and Mokashi (2012) and concluded that early pinching at 20 days after sowing recorded significantly maximum plant height (117.58cm) at the final stage, the highest number of leaves (259.24), leaf area per plant (1315.0 cm^2), number of branches (39.58), plant spread (29.14 cm) and stem girth (13.69 mm).

The effect of plant spacing on yield and quality of garland chrysanthemum (*Chrysanthemum coronarium* L.) conducted by Dorajeerao *et al*. (2012). The study revealed that the flower yield per ha (8.41 t) was the highest at spacing level (30 x 30) which was at par with 30 x 40 level (7.42 t). The number of flowers per plant (65.1) was highest at 60 x 60 level. The quality parameters, *viz.* mean flower diameter, hundred flower weight as well as thousand seed weight increased with increasing levels of spacing from 30 x 30 to 60 x 60 and found to be non-significant.

Mittal (2013) evaluated the winter annuals for flower and seed production. The results of the study revealed that the winter annuals *viz. Agrostemma githago, Eschscholtzia californica, Chrysanthemum coronarium, Centurea cyanus, Antirrhinum majus, Delphinium ajacis, Mathiola incana, Molucella laevis* were found best suited for flowering. In case of seed production, *Calendula officinals, Lupinus hartwegii, Eschscholtzia californica, Chrysanthemum coronarium, Centurea cyanus* were recorded best of all winter annuals under study. *Chrysanthemum coronarium, Centurea cyanus, Calendula officinalis, Delphinium ajacis* recorded highest benefit-cost ratio with the best suitability for commercialization among the farmers.

Panhwar *et al*. (2013) revealed that the maximum flower yield and quality parameters like the number of flowers per plant, flower diameter, and flower age of Zinnia were recorded at a spacing of 30 cm and 40 cm. The maximum number of seeds, germination rate, and uniformity of *Zinnia elegans* L. was recorded at closer spacing (20,30cm).

The studies on growth and yield parameters of different genotypes of china aster

(*Callistephus chinensis* L. Nees) conducted by Munikrishnappa *et al*. (2013) revealed that the maximum loose flower yield (37.91 t / ha) was recorded in Phule Ganesh White and it was lowest Mixed Variety Local (9.97 tonnes). The number of cut flowers per plant (55.43) and the maximum number of cut flowers (40.76 lakh/ha) was recorded in Phule Ganesh Violet.

Maryam (2014) investigated the impact of nitrogen and phosphorous efficiency on the growth and flowering of *Helichrysum bracteatum*. The application of nitrogen fertilizer significantly improved the height of plants (35.0cm), the number of branches (7.00), wet (22.75 g), and dry weight (7.45 g) of plants in strawflowers. The phosphorus obtained the maximum number of flowers (16.80), and Interaction between nitrogen and phosphorus lay to increase the number of branches (6.51), number of flowers (15.37), and wet (20.65 g) and dry weight (6.70 g) of plants.

Hemalatha *et al*. (2014a) revealed that among the different treatment combinations the treatment T4 (30 cm × 30 cm and 120 % RDF) recorded the maximum height of plant (69.17cm), number of branches per plant (12), plant spread (43.83 sq. cm), maximum fresh weight (117.76 g, 14.13 g) and dry weight (79.11 g, 9.06 g) of shoot and root respectively. With regards to post-harvest life, oven and microwave oven drying took less time (2 min) for drying, better color, and good keeping quality in bachelor's button (*Gomphrena globosa* L.).

Hemalatha *et al*. (2014b) studied the biomass, yield, and economics of bachelor's button (*Gomphrena globosa* L.) revealed that the maximum fresh weight and dry weight of root (14.13 g, 9.05 g), maximum fresh weight and dry weight of shoot (117.76 g, 79.11 g) maximum weight of flowers per plant (117.68 g). per square meter (1295.42 g), per hectare (12.91 t), maximum number of flowers per plant (193.10), per square meter (2176.67), per hectare (21.76 lakhs), with regards to economics maximum net returns (Rs 1,85,571/ha) and the cost-benefit ratio (1:3.51) were recorded by spacing 30 × 30 cm and application of 120 per cent of recommended dosage of fertilizers.

Sushma *et al*. (2014) studied the influence of pinching and cycocel on growth and flower yield of annual chrysanthemum and revealed that the pinching at 30 and 45 days after transplanting had recorded more reduction in plant height whereas, pinching at 30 days after transplanting recorded the maximum number of branches per plant, plant spread, the number of flowers per plant, flower yield per plant and flower yield per hectare. The foliar application of cycocel (1000 ppm) recorded an increasing number of branches per plant, diameter of stem, plant spread, number of flower per plant, flower yield per plant, and flower yield per hectare.

In *Dianthus barbatus* L., the September 17th planting resulted in increased plant height (63.54 cm), plant spread (33.32 cm), stem length (56.30 cm), earliest flowering (71.15 days), duration of flowering (41.98 days), number of flowers per stem

(central and side; 109.42 and 27.58), number of capsules per plant (373.75), number of seeds per capsule (40.85), 1,000 seed weight (0.90 g) and seed yield per plant (10.75 g) (Sharma *et al*. 2015).

An investigation was conducted by Waded *et al*. (2015) to evaluate the genotypes, to know the effect of spacing and growth regulators in annual chrysanthemum. Among the six genotypes studied, the maximum plant height (103.00 cm) was recorded in genotype AACS-2. Whereas, the genotype Sarpan White had maximum plant spread N-S and E-W direction (39.80 cm and 44.85 cm respectively), number of branches per plant (29.15), and leaf area per plant (4669.52 cm^2). The treatment combination of 60 x 30 cm spacing with GA_3 @ 200 ppm spray had results in the highest plant height (109.60 cm) and early flowering (38.67 days).

Munikrishnappa *et al*. (2015) stated that the early flowering (52.25 days) and maximum duration of flowering (39.4) were noticed in the genotype Sarpan Yellow whereas, the highest flower yield per plant (194.50 g), flower yield per hectare (10.80 t) were obtained in Haryana collection. The treatment combination of 60 x 60 cm, cycocel @ 1000 ppm resulted in the maximum duration of flowering, more number of flowers per plant (102.40), the shelf life of flowers (75.90 hr.) and flower yield per plant (302.08 g). The treatment combination of 60 x 30 cm, cycocel @ 1000 ppm produced the highest flower yield per hectare (13.78 t) in annual chrysanthemum (*Chrysanthemum coronarium* L.).

Ahmad *et al*. (2016) evaluated the macronutrient application effects on *Calendula officinalis* L. They revealed that the application of 200–100–100 kg ha^{-1} NPK resulted in highest plant height (41.3 cm) earliest flowering (61.3 d), maximum number of flowers per plant (50.5 flowers), flower diameter (47.1 mm), seed yield per plant (14.1 g), harvest Index (23.9%). While 200–200–200 kg ha^{-1} NPK increased stomatal conductance (4.35 mmol m^{-2} s^{-1}), photosynthetic rate (9.9 μmol m^{-2} s^{-1}), leaf P (0.64%), and flower weight (0.99 g). The maximum leaf area was recorded in plants fertilized with 150–150–150 g m^{-2} NPK (35.3 cm^2).

Rai and Chaudhary (2016) evaluated the china aster cultivars under the mid-hill conditions of Himachal Pradesh. The results revealed that maximum plant height (102.25 cm) and flower head diameter (6.82 cm) was noted in Phule Ganesh Violet. Arka Shashank recorded the maximum number of primary branches (19.00) and stalk length (32.60 cm) and also the minimum number of days to first flower opening (77.25 days) and days to 50 per cent flowering (92.45 days). The highest number of harvests of loose flower (7.25) and the number of flowers per plant (19.60) was observed in Phule Ganesh White. Phule Ganesh Purple recorded maximum weight of flowers per plant (174.42 g) and individual flower weight (5.30 g). Based on these findings, Phule Ganesh Purple was found to be most suitable for loose flower production, and Arka Shashank was found ideal for cut flower production.

Agrawal and Dorajeerao (2016) assessed the effect of planting geometry and nitrogen levels on growth, yield, and quality of goldenrod (*Solidago canadensis* L.). The study revealed that an application of 300 kg per ha nitrogen and 45 cm × 30 cm spacing recorded maximum plant height (70.95cm), number of leaves (95.54), leaf area (7.55dm^2) and number of suckers (9.37). The highest number of panicles per plot (111.08) was registered by the highest dose of nitrogen (300 kg ha^{-1}) and closer spacing (30 cm × 15 cm). The number of marketable panicles per plot (55.99) was recorded maximum with 300 kg per ha of nitrogen and 30 cm × 30 cm spacing.

Sharma *et al.* (2017) studied on effect of different planting dates and climatic conditions on growth, flowering of candytuft (*Iberis amara*) and reported that the maximum plant height (34.81 cm), plant spread (33.23 cm), number of side stems/plant (6.25), earliest visible flower bud formation (55.43 days), flowering (77.80 days), duration of flowering (41.80 days), number of flower clusters/stem (15.46) were recorded with September 17 planting.

The experiment was conducted to evaluate china aster (*Callistephus chinensis* L. Nees) F_1 hybrids and parents for growth, flower quality, yield, and post-harvest life by Pratiksha *et al*. (2017). The results of the study revealed that hybrid-8 recorded the highest number of leaves per plant (312.47), number of branches (23.19), number of flowers per plant (93.66), highest weight of flowers per plant (293.00 gm) and flower yield per hectare (24.68 tonnes). Hybrid-4 recorded maximum plant height (73.16 cm) and the longest (28.92 days) duration of flowering.

An experiment was laid out to study the influence of Spacing and NPK Fertilization on yield and economics of Sweet William (*Dianthus barbatus*) by Azharuddin *et al*. (2017) and observed that among the different treatment combinations number of flower stalks per plant, per meter square and hectare per year were maximum in S2N1P1K (30x30 cm and 10:10:10 g NPK/ m^2) levels (9.70, 31.03 and 98233.33 respectively). The number of flowers per plot per year at S2N1P2K (30x30 cm and 10:15:10 g NPK/m^2) levels (30.03) is on par with that of S2N1P1K. The benefit-cost ratio and net returns were maximum (1:2.75 and Rs.72, 004 /ha, respectively) in S2N1P1K (30x30 cm and 10:10:10g NPK/m^2).

Bajad *et al*. (2017) demonstrated the effect of planting time and mulching materials on flower yield and quality in china aster. The results revealed that planting of mid-March obtained best results for plant height (107.70 cm), plant spread (55.54 cm), number of flowers per plant (72.54), however, the number of days taken for flower bud formation (108.24 days), flower diameter (5.47 cm), duration of flowering (55.90 days), were recorded to be best in mid of June. The silver plastic mulch obtained the best results for the plant height (84.48 cm), plant spread (48.39 cm), number of flowers per plant (47.89), flowering duration (51.53 days), flower diameter (4.73 cm), fresh weight (291.67 g), flower yield per plant (134.73 g) and minimum days

are taken for flower bud formation (115.91 days).

Sharma *et al*. (2018) analyzed the different plant spacing and strains of gomphrena and stated that closest spacing of 20cm x 15cm gave best results for plant height (59.10 cm), earlier visible flower bud stage (52.00 days), flower yield per square meter (1,253.13 g). However, plant spread (44.88 cm), number of flowers per plant (72.11), flower diameter (2.31 cm), duration of flowering (96.55days), weight of flower per plant (65.79 g) were recorded maximum with 20 x 30 cm spacing. Among strains, GGM gave the best results for plant height (54.65 cm), weight of flowers per plant (57.00 g), flower yield per square meter (1,253.13 g).

Hawa *et al*. (2018) noticed that among different planting times, the maximum number of flowers per plant was recorded in 15th October planting (95.28). Whereas, under different pinching intervals, the maximum number of flowers per plant was noticed in single pinching at 30 days after transplanting (97.52). The maximum flower yield per hectare was recorded in 15th October planting (15.45 t) and single pinching at 30 days after transplanting (16.84 t) in annual chrysanthemum.

Priya (2018) studied the comparison of selected seasonal ornamentals for growth, flowering, and yield parameters for dry flower purposes. The seasonals such as *Lagurus ovatus, Helichrysum bracteatum, Bromus rubens and Briza maxima* were recorded best for yield parameters of all winter annuals. The maximum score for overall acceptability was obtained in *Lagurus ovatus* (5), followed by *Helichrysum bracteatum* (4.66). The maximum cost-benefit ratio as dry flower was obtained in *Helichrysum bracteatum* (1.11), followed by *Limonium sinuatum* (1.06) based on the yield parameters, shelf life, overall acceptability, and cost-benefit ratio seasonal annuals viz. *Lagurus ovatus* (Bunny tail grass), *Helichrysum bracteatum* (Paper flower), *Briza maxima* (Quaking grass), *Bromus rubens* (Broom grass), *Limonium sinuatum* (Statice) and *Moluccella laevis* (Bells of Ireland) can be recommended to be used as dry flowers.

Ashwini *et al*. (2019) evaluated the bachelor's button (*Gomphrena globosa* L.) genotypes for growth and yield parameters. The results revealed that genotype AGS-10 recorded maximum plant height (132.17 cm), maximum plant spread (121.67 cm), number of leaves per plant (4140.83), leaf area per plant (1200.78 cm^2), leaf area index (0.4447), number of primary branches per plant (16.53) and number of secondary branches per plant (106.93) were observed in the genotype AGS-1, whereas, maximum stalk length was recorded in AGS-5 (20.73 cm) genotype. The genotype 'AGS-13' took a minimum number of days to flower bud initiation (9.67 days), and Genotype AGS-1 flowered for a maximum period of 87.67 days. The maximum flower yield (13.75 t/ha) was recorded in AGS-1.

Dharmendra *et al*. (2019) studied the performance of different varieties of china aster (*Callistephus chinensis* L. Nees) for the North-eastern dry zone of Karnataka. The

genotype Phule Ganesh Violet expressed highest plant height (69.40 cm), plant spread (33.36 cm), number of leaves (192.05), number of primary branches (22.05), number of secondary branches (38.60) and leaf area(42.28cm^2), followed by Phule Ganesh white at 120 days after transplanting. The genotype Phule Ganesh White expressed the highest flower diameter (6.35 cm) and yield per plant(214.67g). The genotype Poornima showed the highest number of flowers per plant (68.53), followed by Arka Archana (66.67). The overall study revealed that the genotype Phule Ganesh Violet found promising for the North-eastern dry zone.

Bhattarai *et al*. (2019) studied the influence of growing conditions on initiation to wilting of flowers of winter annuals. The results revealed that *Calendula officinalis* showed earliness in flower bud initiation (23.25 DAT), flower bud differentiation (32.88 DAT), blooming (35.50 DAT) and wilting (43.00 DAT) under the open condition and the late flowering was found in *Antirrhinum majus* (74.67 DAT), whereas, the delayed wilting was observed in *Helichrysum bracteatum* (94.30 DAT) under both conditions. The shortest period for wilting of flowers was recorded in *Eschscholtzia californica* (2.00 days) under protected conditions, while, *Helichrysum bracteatum* required the maximum period (21. 84 days) from blooming to wilting.

2.2 Seed production

Shivkumar (2000) studied on effect of plant nutrition, plant density and seed maturity on seed yield and quality in marigold. The results revealed that significantly higher yield of good quality seed (579.7 kg/ha) was noticed with the application of 270:72:72 kg NPK per hectare with 60x30 cm spacing (55555 plants/ha) and also it recorded the highest net returns per hectare (Rs. l, 17,863). The seeds harvested at 28 days after flower opening recorded maximum 1000 seed weight (3.19 seed germination (83%), seedling length (11.92 cm), and vigor index (988) as compared to the seeds obtained from either delayed or early harvested heads.

In *Coreopsis lanceolate* L., the seed yield decreased as the planting was delayed beyond first week of November, which was recorded as the highest *viz*., 90.32g per m^2 under first planting, followed by 76.97g per m^2 under second planting in third week of November. In *Coreopsis tinctoria* L., the maximum seed yield (98.68 g/m^2) was recorded under the second planting carried out in the third week of November. The seed yield (83.97g/m^2) was recorded as significantly higher under a planting density of 60 cm x 60 cm in comparison (81.31g/m^2) at 60x30 cm (Dhatt and Kumar, 2007).

Seghatoleslami and Mousavi (2009) stated that the three sowing dates viz. 30th March, 14th April, and 30th April recorded the significant difference of seed yield of 276.5, 198.5, and 167.8 g per m^2, respectively. The seed yield was highest at 25 plants per m^2 (233.6 g/m^2) in pot marigold (*Calendula officinalis* L.).

Dhami and Rao (2010) studied the effect of bio fertilizers on seed quality

attributes of African marigold cv. Pusa Narangi Gainda and stated that treatment comprising of *Azotobacter* + PSB + Vermicompost gave the highest values of seed attributes like germination per cent (87.88%), seedling length (10.26 cm), dry weight of the seedling (13.06 mg), Vigour index I (901.76) and Vigour Index II (1147.97) while the minimum values were recorded in control.

The varietal evaluation of French marigold (*Tagetes patula* Linn.) was carried out by Raghuvanshi and Sharma (2011) stated that the cultivar Safari Queen recorded maximum seed yield per plant (0.54g), and seed yield per square meter (9.06g). The cultivar Bonanza Bolero recorded maximum values for 1000-seed weight (2.60g).

The important early flowering winter annuals for seed production such as Pansy, Petunia, Poppy, Helichrysum, Delphinium, Stock, Sweet alyssum and Nemesia are sown in the nursery is in the last week of September to the first week of October and transplanting is carried out from last week of October to the first week of November. The mid-season annuals like Calendula, Gazania, Ice plant, Dimorphotheca, Candytuft, Gamolepis, Verbena, Phlox, *Coreopsis lanceolata*, Nasturtium, Sweet William, and Sweet Sultan are transplanted from second to the third week of November. The crops, which take a longer duration to come to flower, are classified under late-season groups that are transplanted from the end November to the first fortnight of December, for example, *Coreopsis tinctoria*, Gaillardia and Monarda, etc. (Kumar *et al*. 2011).

Sainath *et al*. (2012) noticed GA_3 @ 200 gave the best results for the number of seeds (265.33) per flower and seed yield (500.00 kg/ha) and the seed quality parameters like thousand seed weight (2.14 g/plant), germination percentage (67.67%), seedling length (10.60 cm), Vigour index (717) and dry weight (36.37 mg) were also higher in treatment of GA_3 @ 200 ppm in annual chrysanthemum (*Chrysanthemum coronarium* L.).

Sharma (2012) noticed that the number of capsules per plant (58.29), the number of seeds per capsule (45.98), seed yield (2.84 g) was recorded best with the treatment GA_3@20 mg/l. The planting done on 2nd November was found to be the best for maximizing the number of capsules per plant (68.01), number of seeds per capsule (53.24), seed yield (3.64 g) in pansy (*Viola* × *Wittrockiana* Gams.).

The study on effects of location and the application of different mineral fertilizers in pot marigold (*Calendula officinalis* L.) conducted by Jevdovic *et al*. (2013) revealed that the variant with 400 kg NPK ha^{-1} recorded the highest seed yield (672.84 kg ha-1), highest total seed germination (91.84%), 1,000 seed weight (6.83 g).

Munikrishnappa *et al*. (2015) revealed that the cultivar Haryana collection recorded the highest seed yield per hectare (656.05 kg) whereas, the treatment combination of 60 cm x 30 cm, GA_3 @ 200 ppm produced maximum seed yield per hectare (443.77 kg) in annual chrysanthemum (*Chrysanthemum coronarium* L.).

A field experiment conducted by Dhatt (2015) stated that planting time significantly affected plant growth and seed yield. The optimum transplanting time for *Coreopsis lanceolata* and *Mathiola incana* was 20th October and resulted in maximum seed yield (77.12 g/m^2 and 20.25 g/m^2, respectively). The highest yield of 105.62 g/m^2 was obtained from 20th November planting in *G. aristata*. Early planting of *V. tricolor* and *V. hybrida* on 20th October resulted in more number of branches, and the maximum seed yield.

The effect of different planting dates and climatic conditions on growth, flowering of candytuft (*Iberis amara* L.) was studied by Sharma *et al*. (2017). The results of the study revealed that the number of silliqua per plant (3467.72), seed yield per plant (10.25 g), and 1,000 seed weight (2.18 g) was recorded with September 17th planting. However, the earliest siliqua formation (157.58 days) was observed on December 1st, planted crop.

Sharma *et al*. (2018) revealed that the maximum seed yield per plant (3.34g) was obtained with a spacing of 20 cm x 30 cm. The seed yield per meter square (83.34g) was maximum in the closest spacing of 20 cm x 15 cm. Among the different strains, GGM gave the best results for seed yield per plant (3.57g) and seed yield per meter square (75.14 g) in *Gomphrena globosa* L.

MATERIAL AND METHODS

III MATERIAL AND METHODS

The field experiment was conducted on 'Studies on winter annuals for their growth, flowering, flower quality and yield under hill zone of Karnataka.' It was carried out at the experimental farm of the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga during 2019-20.

The details of the experimental site, materials used, the methodology adopted and the statistical analysis adopted for conducting the research and observations recorded during the investigations have been described in this chapter.

3.1 Geographical location of the experimental site

The experiment was carried out in an open field in the experimental block of the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere. It is situated in the Western Ghats and represents the typical hill zone (Zone-9 and Region V) of Karnataka and lies at 13^{o} 25' North latitude and 75^{o} 25' East longitude with an altitude of 980 above mean sea level (MSL).

3.2 Climate and soil

Mudigere is cool and pleasant throughout the year. The area receives a total annual rainfall during the year is 3446.10 mm, mainly distributed for six to eight months from April to November with the peak period of rainfall from June to August. The average annual maximum temperature is 28.92 °C and the minimum temperature is 18.83 °C. The average annual maximum relative humidity is 79.78 per cent and the minimum relative humidity is 58.68 per cent. The meteorological data for the period of experimentation was obtained from the meteorological observatory of Zonal Agricultural and Horticultural Research Station (ZAHRS), Mudigere, and the same is presented in Appendix-I.

The Physio-chemical characteristics of the soil were determined by taking the composite soil samples from 0-15 and 15-30 cm soil depth before transplanting. The soil of the experiment site was low in organic carbon, available phosphorus and medium in available potassium, available nitrogen and the same has presented in Appendix-II.

3.3. Plant material

The study was conducted with 12 winter annuals *viz*., *Calendula officinalis* L. (pot marigold), *Callistephus chinensis* (L.) Nees (China aster), *Cosmos bipinnatus* Baill. (Mexican aster), *Chrysanthemum coronarium* L. (annual chrysanthemum), *Gomphrena globosa* L. (globe amaranth), *Helichrysum bracteatum* Andr. (helichrysum or paper flower), *Lupinus hartwegii* Lindl. (lupine), *Salvia splendens* L. (salvia), *Lathyrus odoratus* L. (sweet pea), *Dianthus barbatus* L. (Sweet William), *Xerochrysum*

viscosum (Seiber ex DC.) R.J. Bayer (golden everlasting) and *Zinnia elegens* Jacq. (zinnia). Open-pollinated seeds of nine species for raising seedlings were procured from the experimental farm of the Department of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. However, the seeds of gomphrena, salvia, and Chinese pink were procured from Indo-American Hybrid Seeds Pvt. Ltd. Bengaluru.

3.4 Nursery raising

Nursery raising of twelve different annuals were undertaken in pro trays. The pro trays were filled with coco peat and seeds were sown at one seed per cell. Seeds were covered with coco peat and the trays were placed one above the other and covered with a polythene sheet until germination starts. After six days, pro trays with germinated seeds were placed individually on the raised beds inside the shade net. Watering was done daily using a hand sprayer. Carbendazim at 2g per liter of water was sprayed as a preventive measure twice at ten and thirty days age of seedling. 19:19:19 at 0.2 per cent at 30 days age of seedling. Seedlings were transplanted at 45 days age.

3.5 Cultivation practices

3.5.1 Field preparation

The experiment was conducted under open field conditions. For field preparation, the soil was dug up to a depth of 30 cm, pulverized well, and well-decomposed FYM (farmyard manure) at the rate of 5 kg per m^2 was mixed in the soil. At the same time, fertilizers were also mixed in the soil. Fertilizers like nitrogen, phosphorus, and potassium were applied at the rate of 20 g each per m^2. The full doses of phosphorus and potassium and half dose of nitrogen were applied as basal dose at the time of bed preparation. The remaining half dose of the nitrogen was applied after 30 days after transplanting. After the application of fertilizers and manures, flatbeds were prepared for planting the crop.

3.5.2 Transplanting

The transplanting of uniform size seedlings was done at a spacing of 30 cm × 30 cm from plant to plant and row to row accommodating nine plants per square meter area in case of *Callistephus chinensis* (L.) Nees (China aster), *Chrysanthemum coronarium* L. (annual chrysanthemum), *Helichrysum bracteatum* Andr. (helichrysum or paper flower), *Gomphrena globosa* L. (globe amaranth), *Lupinus hartwegii* Lindl. (lupin), *Lathyrus odoratus* L. (sweet pea), at 25 cm × 25 cm in case of *Calendula officinalis* L. (pot marigold), *Dianthus barbatus* L. (Sweet William), *Cosmos bipinnatus* (Mexican aster), at 20 cm × 20 cm in case of *Salvia splendens* L. (salvia), *Xerochrysum viscosum* (Seiber ex DC.) R.X. Bayer (golden everlasting), *Zinnia elegens* Jacq. (zinnia). Transplanting was done on 3rd December 2019. After transplanting, light irrigation was done.

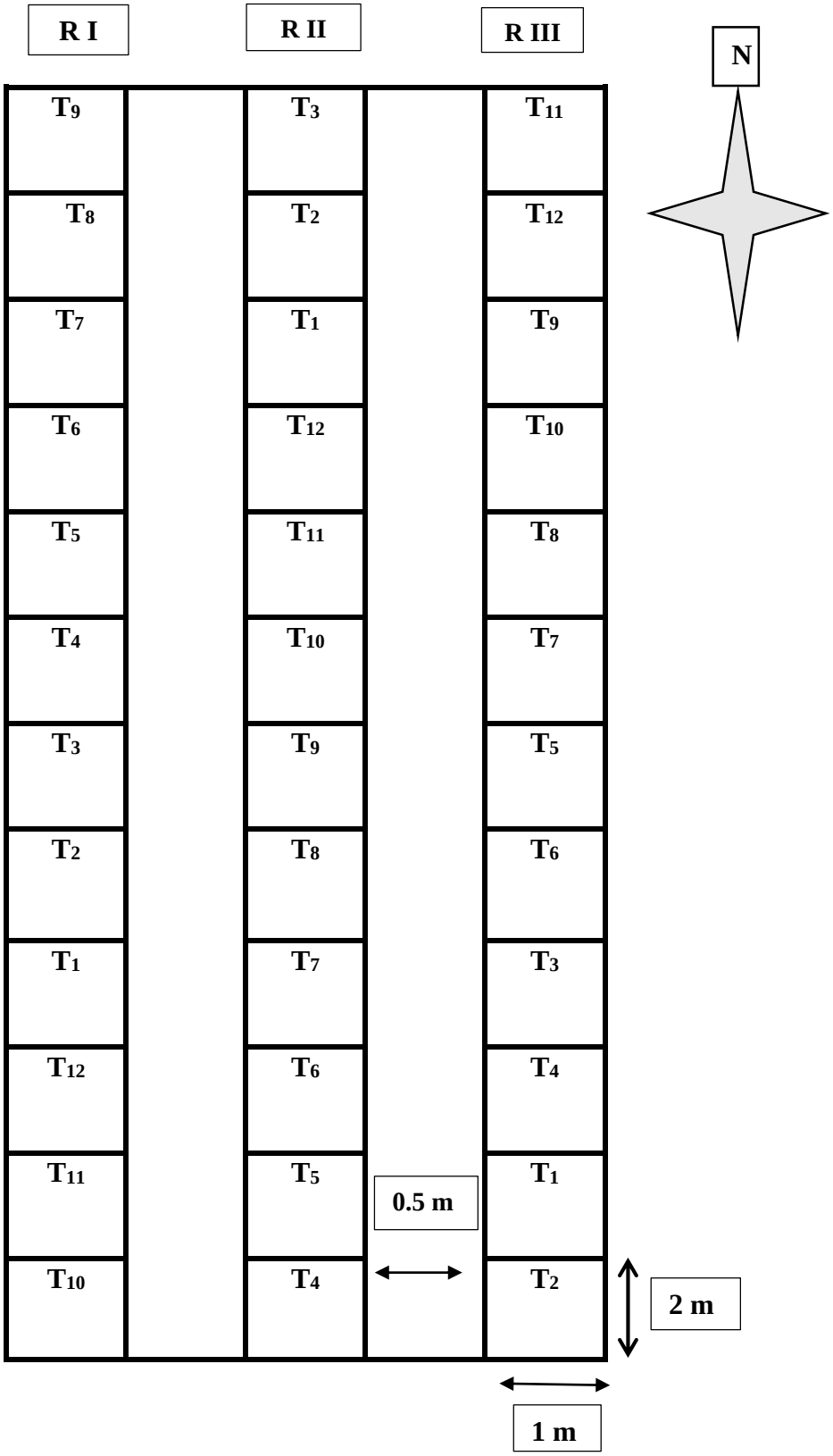


Fig. 1. Layout of the experimental plot

Plate 1. View of nursery raising

3.5.3 Intercultural operations

Throughout the experiment from transplanting until termination of the investigation, the field was irrigated depending on the requirement. Other intercultural operations like; hoeing and weeding, removal of dried, dead and diseased leaves and shoots, spraying against insect pests and diseases, staking in case of sweet pea, were done depending on the requirement.

3.5.4 Pinching

Pinching was done in case of *Calendula officinalis* L. (Pot marigold), *Callistephus chinensis* (L.) Nees (China aster), *Cosmos bipinnatus* L. (Mexican aster), *Chrysanthemum coronarium* L. (annual chrysanthemum), *Helichrysum bracteatum* Andr. (helichrysum or paper flower), *Xerochrysum viscosum* (Seiber ex DC.) R.X. Bayer (Golden everlasting) and *Zinnia elegens* Jacq. (Zinnia) to produce multi-stemmed plants. The pinching was performed at the fourth node stage by removing the apical growing portion of the plant.

3.6 Experimental details

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments in each replication were allotted using the random number table. The plan and layout of the experiment are shown in Fig.1. The study was conducted on twelve winter annuals planted on the same date. The details of the studies conducted were as follows:

3.6.1 Design and Experimental layout

Statistical Design	Randomized Complete Block Design (RCBD)
Crop	12 winter annuals
Number of replications	03
Number of treatments	12
Planting method	Flat bed
Plot size	2.0 × 2.0 m
Planting date	03-12-2020

3.6.2 Winter annuals

The details of the plant species used in the experiment.

Treatments	Common name	Scientific Name	Family
T_1	Calendula	*Calendula officinalis* L.	Asteraceae
T_2	China aster	*Callistephus chinensis* (L.) Nees	Asteraceae
T_3	Cosmos	*Cosmos bipinnatus* L.	Asteraceae
T_4	Annual chrysanthemum	*Chrysanthemum coronarium* L.	Asteraceae
T_5	Gomphrena	*Gomphrena globosa* L.	Amaranthaceae
T_6	Helichrysum	*Helichrysum bracteatum* Andr.	Asteraceae
T_7	Lupin	*Lupinus hartwegii* Lindl.	Fabaceae
T_8	Salvia	*Salvia splendens* L.	Lamiaceae
T_9	Sweet pea	*Lathyrus odoratus* L.	Fabaceae
T_{10}	Sweet William	*Dianthus barbatus* L.	Caryophyllaceae
T_{11}	Xerochrysum	*Xerochrysum viscosum* R.X. Bayer	Asteraceae
T_{12}	Zinnia	*Zinnia elegens* Jacq.	Asteraceae

3.7 Collection of experimental data

Five plants were selected randomly from each treatment and were tagged for recording various morphological, flowering, flower quality and yield at different stages of crop growth.

3.7.1 *Calendula officinalis* L. (pot marigold)/ *Callistephus chinensis* (L.) Nees (China aster)/ *Cosmos bipinnatus* Baill. (Mexican aster)/ *Chrysanthemum coronarium* L. (annual chrysanthemum)/ *Helichrysum bracteatum* Andr. (helichrysum or paper flower)/ *Dianthus barbatus* L. (Sweet William) / *Xerochrysum viscosum* (Seiber ex DC.) R.J. Bayer (golden everlasting)/ *Zinnia elegens* Jacq. (zinnia).

3.7.1.1 Plant height (cm)

The height of the plants was recorded from the base of the plant to the tip of the

30 days after transplanting

View of experimental plot at full bloom stage

Plate 2. Overall view of the experimental plot at different growth stages

longest leaf in centimeters and average was worked out and expressed in centimeters.

3.7.1.2 Plant spread (cm)

The plant spread of the plants was recorded as the average distance between the outermost side leaves in East to West direction, and the distance between the outermost side leaves in North to South direction and expressed in centimeters.

3.7.1.3 Number of leaves per plant

Number of leaves produced were recorded by counting the number of leaves and average was worked out.

3.7.1.4 Leaf length (cm)

The leaf length was recorded from the base to tip of the leaf from the five randomly selected tagged plants using scale and it was expressed in centimeters.

3.7.1.5 Leaf breadth (cm)

The breadth of five leaves from the middle of the leaf was recorded using a scale. The average was worked out and expressed in centimeters.

3.7.1.6 Leaf area (cm^2)

The leaves from five randomly selected plants from each treatment were used for estimation of leaf area at peak vegetative growth stage. The leaf area was computed by disc method and was expressed as cm^2 per plant.

3.7.1.7 Fresh weight (g)

The fresh weight of the plant was weighed on a common electric balance at peak flowering stage and expressed in grams.

3.7.1.8 Dry matter accumulation in different plant parts (g) at peak flowering stage

The dry weight of the shoot and root was weighed on a common electric balance after drying the sample in hot air oven until the sample attains a constant weight and expressed in grams.

3.7.1.9 Total dry matter production /plant (g) at peak flowering stage

The total dry weight of the plant was weighed on a common electric balance after drying the whole plant sample in hot air oven until the sample attains constant weight at peak flowering stage and expressed in grams.

3.7.1.10 Days to first flower bud initiation (FBI)

The number of days taken from the date of transplanting to the date of appearance of first flower bud initiation was counted as days taken to flower bud emergence from all the tagged plants and average was worked out.

3.7.1.11 Days taken for 50 per cent flowering

The number of days required for 50 per cent of the plants was done by counting the days from the first flower in each plot to 50 per cent flower buds that have been opened in each plot.

3.7.1.12 Days to marketable flower harvest

The number of days required for peak flowering stage and when the flowers attain the full size depending on the species.

3.7.1.13 Duration of flowering

The days were counted from the date of flowering to the stage when 60-70 per cent flowers faded on plant.

3.7.1.14 Days taken for flower senescence in the plant (from FBI to wilting of flowers)

Days taken for flower senescence in the plant is recorded in the tagged flowers by counting the number of days from blooming to reach the wilting of flowers.

3.7.1.15 Diameter of the flower (cm)

The diameter of the flower was measured at the point of maximum breadth. This was done by using digital Vernier calipers, and average diameter in cm was computed.

3.7.1.16 Number of petals per flower

The number of petals in flower recorded from the five randomly selected tagged plants and average was worked out.

3.7.1.17 Petal length (cm)

The length of the petal from randomly selected five flowers from each tagged plant was recorded using a scale, and the average was worked out and expressed in centimeters.

3.7.1.18 Petal breadth (cm)

The breadth of the petal from randomly selected five flowers from each tagged plant was recorded using scale and the average was worked out and expressed in centimeters.

3.7.1.19 Petiole length (cm)

The length of randomly selected five flowers petiole from each tagged plant was recorded using measuring scale and average was worked out and expressed in centimeters.

3.7.1.20 Stalk length (cm)

Stalk length was recorded at peak flowering using measuring scale and the average was worked out from five stems from each treatment and expressed in

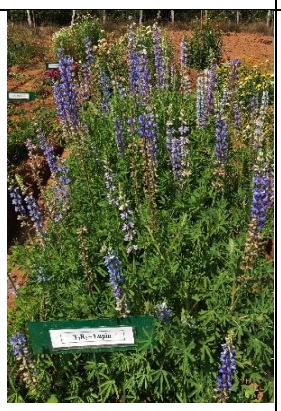
			
Calendula officinalis L.	*Callistephus chinensis* (L.) Nees	*Cosmos bipinnatus* L.	*Chrysanthemum coronarium* L.
			
Gomphrena globosa L.	*Helichrysum bracteatum* Andr.	*Lupinus hartwegii* Lindl.	*Salvia splendens* L.
			
Lathyrus odoratus L.	*Dianthus barbatus* L.	*Xerochrysum viscosum* Rx. Bayer	*Zinnia elegans* L.

Plate 3: General view of different winter annuals during flowering

centimeters.

3.7.1.21 Shelf life (days)

The shelf life of the flowers was counted from the date of harvest to the day they remain fresh and presentable form. The harvested flowers are placed in a polythene cover and are observed daily up to the senescence of flowers. The vase life was expressed in terms of days from the date of harvest until the senescence of petals.

3.7.1.22 Vase life (days)

The flower stems are harvested from the selected tagged plants. Soon after harvest, flowers are kept in a bucket containing fresh water to remove the field heat. Then the stalks are cut again to uniform stem length. The flower stalks are placed in a conical flask containing 500ml of tap water. The flowers were observed daily up to the senescence of flowers. Falling off the petals from the flowers was considered as the end of the vase life of flowers. The vase life was expressed in terms of days from the date of harvest until the senescence of petals.

3.7.1.23 Number of flowering stems per plant

Number of flowering stems per plant are recorded by counting the number of stems bearing the flower buds and average was worked out.

3.7.1.24 Number of flowers per plant.

Number of flowers per plant are counted from the five randomly selected tagged plants average was worked out.

3.7.1.25 Flower yield per plant (g)

The total flowers are harvested at peak flowering stage from the five randomly selected tagged plants individually and are weighed on the common electric balance and expressed in grams.

3.7.1.26 Flower yield per plot (kg)

The total flowers are harvested at peak flowering stage from all the plants in the plot and are weighed on the common electric balance and expressed in Kilograms

3.7.1.27 Seed yield per plant (g)

Seed yield per plant was computed from five randomly selected tagged plants by weighing the threshed seeds on a common electric balance and was expressed in grams

3.7.1.28 Seed yield per plot (Kg)

Seed yield per plot was computed by collecting and weighing the threshed seeds of the whole plot on a common electric balance and expressed in Kilograms

3.7.2 *Lupinus hartwegii* Lindl. (lupin) / *Salvia splendens* L. (salvia) / *Lathyrus odoratus* L. (sweet pea) / *Gomphrena globosa* L. (globe amaranth)

These annuals are the spike bearing types. Hence, All the observations recorded in case of Calendula were recorded. Besides, the following observations were also recorded.

3.7.2.1 Number of spikes per plant

Total number of stems produced after pinching of the plant was counted at the time of peak flowering stage

3.7.2.2 Number of florets/flowers per spike

Total number of florets per spike was counted at the time of peak flowering stage

3.8 Statistical analysis

The present investigation was undertaken to evaluate 12 species of winter annuals for various parameters. The observations recorded on different growth, flowering and yield parameters were subjected to descriptive statistical measures as mean, range, standard error, and coefficient of variation (Gomez and Gomez, 1984). Observations were recorded from five randomly selected plants of each treatment and replication. The data comprising the calculated average values of each observation were subjected to computerized statistical analysis.

3.9. Biochemical analysis

3.9.1 Chlorophyll content in leaf

The chlorophyll content of leaf was analyzed by collecting the healthy and fully matured second leaf from the middle of the plant at peak vegetative growth stage. Chlorophyll-a, chlorophyll-b and total chlorophyll contents of leaf tissue were determined by using Dimethyl sulfoxide (DMSO) as suggested by Shoaf and Lium (1976).

The fresh and fully matured leaves from the plant were brought to the laboratory in an ice box from the research field. A known weight of the sample (100 mg) was cut into small pieces and incubated in 7.0 ml of dimethyl sulfoxide at 65 °C for 120 minutes. After the incubation period, the supernatant was collected by decanting and leaf tissue was discarded. Then the volume of the supernatant was made up to 10 ml using DMSO. The absorbance of the extract was measured at 645 nm and 663 nm using dimethyl sulfoxide as blank in a spectrophotometer (VISISCAN 167).

The total chlorophyll content was calculated by using formulae given below

$$\text{Chlorophyll} - 'a' = [12.7\ (A663) - 2.69(A645)] \times \frac{V}{100 \times W \times a} \quad \text{(mg/g fr. wt.)}$$

$$\text{Chlorophyll} - 'b' = [22.9(A645) - 4.68\ (A663) \times \frac{V}{100 \times W \times a} \quad \text{(mg/g fr. wt.)}$$

$$\text{Total chlorophyll} = [20.2(A645) + 8.02(A663)] \times \frac{V}{100 \times W \times a} \text{ (mg/g fr. wt.)}$$

Where,

A= Absorbance at specific wavelengths (645 nm and 663 nm) V= Volume of the extract (10 ml)

W= Fresh weight of the sample (100 mg)

a = Path length of the light in the cuvette (1 cm)

3.10 Consumer preference

Consumer preference of winter annuals was carried out based on various attributes like flower color, cut flower suitability, loose flower suitability and overall acceptability. The score has been given using a 1-5 hedonic scale, and the same is presented in Appendix-III.

3.11 Economics

For calculating Benefit-Cost ratio of different winter annuals, the cost of fertilizer (urea, single super phosphate, muriate of potash) and the cost of FYM was taken at the current existing rates. The labour cost, including fertilizer application, irrigation and plant protection, weeding, *etc*., during the cropping period, were worked out. Wherein, some annuals which are suitable for loose flower production are utilized for flower harvest and marketing. Only the 1st harvest is being used for flower marketing rest of flowers are utilized for seed production. The yield of flowers and seeds of annuals flower and seed production, obtained were taken into consideration for working out the economics (Appendix-IV). Based on the total cost of cultivation and the gross return obtained, the net return and benefit-cost ratio (BCR) were worked out and were computed for 800-meter square area.

3.11.1 Gross return

The gross income was worked out based on the prevailing market rate of the flowers and seeds.

3.11.2 Net return

The net return was calculated based on gross return and cost of cultivation and expressed in per 800meter square area

The net return was calculated by using the following formula

Net return = Gross returns – Cost of cultivation

3.11.3 Benefit Cost Ratio (BCR)

The cost-benefit ratio for different winter annuals was worked out based on the price of inputs used for cultivation and price of marketable produce in the local market

by using formula and expressed in a ratio.

$$\text{Benefit: Cost ratio} = \frac{\text{Net returns (Rs/ha)}}{\text{Cost of cultivation (Rs/ha)}}$$

EXPERMENTAL RESULTS

IV EXPERIMENTAL RESULTS

The study entitled "Studies on winter annuals on growth, flowering, flower quality and yield under hill zone of Karnataka" was carried out in the experimental farm of Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere. Experimental data obtained during the course of an investigation of twelve winter annuals for various parameters have been critically evaluated. The results of the study have been presented in this chapter.

4.1 Growth, flowering, flower quality and yield parameters of winter annuals

A perusal of data presented in Table 1 describes the mean performance of *Calendula officinalis* L. for various recorded observations. It is evident from the data that the mean plant height was 67.30 cm and it ranged from 53.20-71.00 cm. The mean plant spread (N-S) was 42.77 cm and it ranged from 35.50-53.00 cm and mean plant spread (E-W) was 43.08 cm with a range of 32.00-56.00 cm. Mean leaf length and leaf breadth was 13.10 cm and 4.43 cm with a range of 11.00-14.60 cm and 3.50-5.10 cm, respectively. The average number of leaves was 143.92, with a mean leaf area of 3568.00 cm^2, which ranged from 104.00-167.00 and 2984.33-3905.20 cm^2. Fresh weight varied from 155.00-217.50 g with a mean of 182.84 g and the total dry matter production at peak flowering stage ranged from 36.50-45.20 g with a mean of 41.23 g. Total chlorophyll was 3.18 mg/g of fresh weight. The average number of days taken for flower bud initiation was 25.42 and ranged from 23.00-29.60. The average days taken for 50 per cent flowering 43.68 and the average days taken for marketable flower harvest was 38.75. Respective ranges for these characters were 41.00-46.00 and 43.00-38.75. The average duration of flowering was 64.50 days and it ranged from 61.00-70.00 days. The average number of days taken for flower senescence in plant was 7.12, which ranged from 5.60-8.40 days. The average number of flowering stems per plant and the average number of flowers per plant was 28.10 and 139.80. Respective ranges for these characters are 23.00-32.00 and 96.00-162.00. The diameter of the flower ranged from 4.60-6.12 cm with a mean size of 5.29 cm. The average number of petals per flower, petal length, and petal breadth was 62.54, 2.24 cm, and 0.38 cm, respectively, and ranges are 49.00-74.00, 1.90-3.10 cm, and 0.30-0.46 cm, respectively. The average petiole length and stalk length was 5.63 cm and 39.62 cm, which ranged from 3.40-6.50 cm and 32.00-43.00 cm, respectively. The average shelf and vase life was 2.34 and 3.55 days. Respective ranges for these parameters was 1.50-2.60 days and 2.85-4.00 days. The average flower yield per plant and plot was 236.28 g and 8.23 kg, which ranged from 182.00-278.00 g per plant and 7.40-10.30 kg per plot. Seed yield per plant and per plot ranged from 41.00-83.00 g and 1.30-2.35 g, with an average yield of 56.22 g and 1.68 kg, respectively. In this species, the least variability was found in leaf length (cm) with a minimum coefficient of variation, *i.e.*,

Table 1. Evaluation of Pot marigold (*Calendula officinalis* L.) for growth, flowering, flower quality and yield parameters.

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	67.30	53.20	71.00	0.67	1.71
Plant spread (N-S) (cm)	42.77	35.50	53.00	0.76	3.08
plant spread (E-W) (cm)	43.08	32.00	56.00	0.68	2.74
Leaf length (cm)	13.10	11.00	14.60	0.12	1.54
Leaf breadth (cm)	4.43	3.50	5.10	0.11	4.32
Number of leaves	143.92	104.00	167.00	2.98	3.59
Leaf area (cm^2)	3568.00	2984.33	3905.20	293.01	14.22
Fresh weight (g)	182.84	155.00	217.50	18.36	17.39
Total dry matter production (g)	41.23	36.50	45.20	2.54	10.67
Total Chlorophyll (mg/g of fresh weight)	3.18	2.87	3.64	0.23	12.78
Days taken for flower bud initiation	25.42	23.00	29.60	2.10	14.30
Days taken for 50% flowering	43.68	41.00	46.00	1.45	5.77
Days taken for marketable flower harvest	38.75	35.00	43.00	2.32	10.38
Duration of flowering (days)	64.50	61.00	70.00	2.78	7.48
Days taken for flower senescence	7.12	5.60	8.40	0.82	19.88
Number of flowering stems/spikes/plant	28.10	23.00	32.00	2.67	16.44
Number of flowers/spikes/plant	139.80	96.00	162.00	21.90	27.13
Diameter of flower (cm)	5.29	4.60	6.12	0.44	14.55
Number of petals per flower	62.54	49.00	74.00	7.29	20.19
Petal length (cm)	2.24	1.90	3.10	0.43	33.49
Petal breadth (cm)	0.38	0.30	0.46	0.05	21.05
Petiole length (cm)	5.63	3.40	6.50	1.12	34.58
Stalk length (cm)	39.62	32.00	43.00	3.82	16.69
Shelf life (days)	2.34	1.50	2.60	0.43	31.83
Vase life (days)	3.55	2.85	4.00	0.35	17.31
Flower yield (loose flowers) (g/plant)	236.28	182.00	278.00	28.42	20.83
Flower yield per plot (kg)	8.23	7.40	10.30	1.04	21.92
Seed yield per plant (g)	56.22	41.00	83.00	13.43	41.38
Seed yield per plot (kg)	1.68	1.30	2.35	0.34	34.64
Germination Percentage	86.60	73.00	95.20	6.88	13.76

1.54. There was the highest variability in seed yield per plant with a maximum coefficient of variation, *i.e.*, 41.38.

The data presented in Table 2. exhibits the mean performance of *Callistephus chinensis* (L.) Nees for various parameters. Data shows that the mean plant height was 45.21 cm and it ranged from 36.00-48.50 cm. The mean plant spread (N-S) was 31.11 cm and it ranged from 28.00-36.00 cm and mean plant spread (E-W) was 32.32 cm with a range of 29.50-39.00 cm. Leaf length ranged from 3.60-7.50 cm with a mean of 6.58 cm and mean leaf breadth was 5.09 cm, which ranged from 4.10-6.20 cm. The average number of leaves was 141.53, with a mean leaf area of 3746.28 cm^2, which ranged from 124.00-162.00 and 3425.44 - 4002.60 cm^2, respectively. Mean fresh weight and total dry matter production at peak flowering stage was 161.96 g and 38.42 g, which ranged from 144.00-175.00 g and 32.50-41.50 g, respectively. Total chlorophyll was 4.32 mg/g of fresh weight. The average number of days taken for flower bud initiation ranged from 40.00-47.00 days, and the average days taken was 43.22. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 59.44 and 50.13 days. Respective ranges for these characters were 57.00-64.00 and 45.00-54.00 days. The average of duration of flowering was 43.87 days, and it ranged from 37.00-52.00 days. Days taken for flower senescence in plant ranged from 11.50-17.00 days, and its mean value was 14.84 days. The average number of flowering stems per plant and the average number of flowers per plant ranged from 12.00-19.00 and 22.00-46.00. Respective mean values for these parameters were 15.36 and 31.25. The diameter of the flower ranged from 5.50-7.80 cm with a mean size of 6.48 cm. The number of petals per flower, petal length, and petal breadth ranged from 57.00-104.00, 1.40-3.10, and 0.30-0.80 cm, respectively, and the mean values for these parameters are 88.20, 2.52, and 0.61 cm. The average petiole length and stalk length was 7.84 and 42.67 cm, which ranged from 5.80-9.60 and 29.00-54.00cm, respectively. The average shelf and vase life was 4.68 and 8.10 days. Respective ranges for these parameters was 4.00-5.50 and 7.00-10.50 days. Flower yield per plant and plot ranged from 152.00-215.00 g and 5.10-7.50 kg, with their average yield of 174.25 g and 6.19 kg. Seed yield per plant and per plot ranged from 18.00-38.00 g and 0.66-1.60 kg, respectively, and their mean values are 25.33 g and 0.98 kg, respectively. The average germination percentage of seeds was 57.82, with the range of 47.50-63.00. This species had the highest variability in seed yield per plot with a maximum coefficient of variation of 54.80, and the least variability was found in plant height with the minimum coefficient of variation, *i.e.*, 1.94.

Table 2. Evaluation of China aster [*Callistephus chinensis* (L.) Nees] for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	45.21	36.00	48.50	0.51	1.94
Plant spread (N-S) (cm)	31.11	28.00	36.00	0.66	3.70
plant spread (E-W) (cm)	32.32	29.50	39.00	0.37	2.01
Leaf length (cm)	6.58	3.60	7.50	0.08	2.06
Leaf breadth (cm)	5.09	4.10	6.20	0.11	3.79
Number of leaves	141.53	124.00	162.00	6.13	7.51
Leaf area (cm^2)	3746.28	3425.44	4002.60	169.71	7.85
Fresh weight (g)	161.96	144.00	175.00	9.28	9.93
Total dry matter production (g)	38.42	32.50	41.50	2.96	13.35
Total Chlorophyll (mg/g of fresh weight)	4.32	3.98	4.86	0.27	10.95
Days taken for flower bud initiation	43.22	40.00	47.00	2.04	8.18
Days taken for 50% flowering	59.44	57.00	64.00	2.28	6.65
Days taken for marketable flower harvest	50.13	45.00	54.00	2.67	9.24
Duration of flowering (days)	43.87	37.00	52.00	4.38	17.28
Days taken for flower senescence	14.84	11.50	17.00	1.69	19.77
Number of flowering stems/spikes/plant	15.36	12.00	19.00	2.03	22.84
Number of flowers/spikes/plant	31.25	22.00	46.00	7.45	41.31
Diameter of flower (cm)	6.48	5.50	7.80	0.69	18.32
Number of petals per flower	88.20	57.00	104.00	15.60	30.64
Petal length (cm)	2.52	1.40	3.10	0.56	38.50
Petal breadth (cm)	0.61	0.30	0.80	0.16	44.38
Petiole length (cm)	7.84	5.80	9.60	1.11	24.43
Stalk length (cm)	42.67	29.00	54.00	7.31	29.68
Shelf life (days)	4.68	4.00	5.50	0.44	16.23
Vase life (days)	8.10	7.00	10.50	1.20	25.69
Flower yield (loose flowers) (g/plant)	174.25	152.00	215.00	20.40	20.28
Flower yield per plot (kg)	6.19	5.10	7.50	0.70	19.63
Seed yield per plant (g)	25.33	18.00	38.00	6.36	43.50
Seed yield per plot (kg)	0.98	0.66	1.60	0.31	54.80
Germination Percentage	57.82	47.50	63.00	5.16	15.46

A perusal of data presented in Table 3. describes the mean performance of *Cosmos bipinnatus* L. for various recorded observations. It is evident from the data that the mean plant height was 32.05 cm and it ranged from 26.00-39.00 cm. The mean plant spread (N-S) was 24.93 cm and it ranged from 22.50-31.00 cm, and mean plant spread (E-W) was 23.99 cm with a range of 20.60-29.00 cm. The mean leaf length and leaf breadth was 5.38 cm and 4.78 cm, with a range of 4.50-6.40 cm and 3.30-5.10 cm, respectively. The average number of leaves was 76.17, with a mean leaf area of 589.10 cm^2, which ranged from 59.00-84.00 and 599.20-622.00 cm^2. Fresh weight varied from 61.00-89.40 g with a mean of 72.45 g and the total dry matter production at peak flowering stage ranged from 21.80-32.60 g with a mean of 26.84 g. Total chlorophyll was 2.46 mg/g of fresh weight. The average number of days taken for flower bud initiation was 18.65 and ranged from 17.00-25.00. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 25.72 and 24.94. Respective ranges for these characters were 22.00-28.00 and 23.00-28.00. The average of duration of flowering was 35.18 days, and it ranged from 31.00-42.00 days. The average number of days taken for flower senescence in plant was 5.47, which ranged from 4.50-6.00 days. The average number of flowering stems per plant and the average number of flowers per plant was 12.95 and 46.64. Respective ranges for these characters are 9.00-18.00 and 33.00-65.00. The diameter of the flower ranged from 3.80-5.20 cm with a mean size of 4.42 cm. The average number of petals per flower, petal length, and petal breadth was 17.90, 1.91 cm, and 1.42 respectively, and ranges are 14.00-23.00, 1.60-2.20cm, and 1.10-1.60 respectively. The average petiole length and stalk length was 4.85 and 17.23 cm, which ranged from 3.80-6.20 cm and 12.00-20.50 cm, respectively. The average shelf and vase life was 0.98 and 1.75 days. Respective ranges for these parameters was 0.75-1.40 and 1.50-2.20 days. The average flower yield per plant and per plot was 38.36 g and 1.08 kg, which ranged from 27.00-51.50 gm and 0.85-1.45 kg. Seed yield per plant and plot ranged from 4.20-8.90 gm, and 0.09-0.21 kg, respectively, and their mean values are 5.98 gm and 0.16 kg, respectively. The average germination percentage of seeds was 54.00, with the range of 74.00-87.00. In this species, the least variability was found in plant spread (N-S) with a minimum coefficient of variation, *i.e.*, 1.96. There was the highest variability in seed yield per plant with the maximum coefficient of variation, *i.e.*, 42.62.

Table 3. Evaluation of Mexican aster (*Cosmos bipinnatus* L.) for growth, flowering, flower quality, and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	32.05	26.00	39.00	0.57	3.10
Plant spread (N-S) (cm)	24.93	22.50	31.00	0.28	1.96
plant spread (E-W) (cm)	23.99	20.60	29.00	0.59	4.23
Leaf length (cm)	5.38	4.50	6.40	0.08	2.67
Leaf breadth (cm)	4.78	3.30	5.10	0.26	9.46
Number of leaves	76.17	59.00	84.00	1.96	4.47
Leaf area (cm^2)	583.10	559.50	622.00	19.60	5.82
Fresh weight (g)	72.45	61.00	89.40	8.65	20.67
Total dry matter production (g)	26.84	21.80	32.60	3.14	20.25
Total Chlorophyll (mg/g of fresh weight)	2.46	1.88	2.78	0.29	20.45
Days taken for flower bud initiation	18.65	17.00	25.00	3.29	30.60
Days taken for 50% flowering	25.72	22.00	28.00	1.88	12.63
Days taken for marketable flower harvest	24.94	23.00	28.00	1.55	10.75
Duration of flowering (days)	35.18	31.00	42.00	3.44	16.93
Days taken for flower senescence	5.47	4.50	6.00	0.49	15.38
Number of flowering stems/spikes/plant	12.95	9.00	18.00	2.66	35.52
Number of flowers/spikes/plant	46.64	33.00	65.00	9.53	35.41
Diameter of flower (cm)	4.42	3.80	5.20	0.41	16.14
Number of petals per flower	17.90	14.00	23.00	2.67	25.80
Petal length (cm)	1.91	1.60	2.20	0.17	15.73
Petal breadth (cm)	1.42	1.10	1.60	0.16	19.57
Petiole length (cm)	4.85	3.80	6.20	0.71	25.32
Stalk length (cm)	17.23	12.00	20.50	2.64	26.56
Shelf life (days)	0.98	0.75	1.40	0.21	37.17
Vase life (days)	1.75	1.50	2.20	0.23	22.31
Flower yield (loose flowers) (g/plant)	38.36	27.00	51.50	7.13	32.19
Flower yield per plot (kg)	1.08	0.85	1.45	0.19	29.96
Seed yield per plant (g)	5.98	4.20	8.90	1.47	42.62
Seed yield per plot (kg)	0.16	0.09	0.21	0.04	39.03
Germination Percentage	54.00	74.00	87.00	3.76	12.05

The data presented in Table 4. exhibit the mean performance of *Chrysanthemum coronarium* L. for various parameters. Data shows that the mean plant height was 111.01 cm and it ranged from 96.00-119.00 cm. The mean plant spread (N-S) was 44.82 cm and it ranged from 39.00-48.50 cm, and mean plant spread (E-W) was 45.21 cm with a range of 42.50-51.20 cm. Leaf length ranged from 7.00-11.20 cm with a mean of 9.45 cm, and mean leaf breadth was 3.90 cm, which ranged from 3.20-4.30 cm. The average number of leaves was 215.19, with a mean leaf area of 2850.85 cm^2, which ranged from 186.00-262.00 and 2614.20-3281.50 cm^2. Mean fresh weight and total dry matter production at peak flowering stage was 376.49 g and 85.75 g, which ranged from 327.00-434.00 g and 74.00-106.20 g, respectively. Total chlorophyll was 3.52 mg/g of fresh weight. The average number of days taken for flower bud initiation ranged from 39.00-46.00, and average days taken was 42.20. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 53.95 and 58.33. Respective ranges for these characters were 49.00-57.00 and 54.00-61.00. The average of duration of flowering was 66.90 days, and it ranged from 64.00-72.00 days. Days taken for flower senescence in plant ranged from 7.50-9.00 days, and its mean value was 8.26 days. The average number of flowering stems per plant and an average number of flowers per plant ranged from 54.00-61.00 and 128.00-176.00. Respective mean values for these parameters were 40.85 and 159.25. The diameter of the flower ranged from 4.10-5.70 cm with a mean size of 5.01 cm. The number of petals per flower, petal length, and petal breadth ranged from 17.00-31.00, 1.70-2.60 cm, and 0.90-1.30, respectively, and mean values for these parameters are 22.60, 2.10 cm, and 1.10 cm. The average petiole length and stalk length was 6.49cm and 65.44, which ranged from 4.50-7.80cm and 52.00-74.00cm, respectively. The average shelf and vase life was 2.85 and 5.12 days. Respective ranges for these parameters was 2.10-3.40 and 4.20-6.00 days. Flower yield per plant and per plot ranged from 315.00-504.00 g and 12.00-15.50 kg with their average yield of 13.45 g and 13.45 kg. Seed yield per plant and per plot ranged from 76.00-81.15 g, and 2.50-3.10 kg, respectively, and their mean values are 79.13 g and 2.83 kg, respectively. The average germination percentage of seeds was 89.87, with the range of 84.00-93.00. This species had the highest variability in the number of petals per flower with a maximum coefficient of variation, *i.e*., 32.78, and the least variability was found in plant spread (N-S) with the minimum coefficient of variation, *i.e*., 1.04.

Table 4. Evaluation of Annual Chrysanthemum (*Chrysanthemum coronarium* L.) for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	111.01	96.00	119.00	0.79	1.23
Plant spread (N-S) (cm)	44.82	39.00	48.50	0.27	1.04
plant spread (E-W) (cm)	45.21	42.50	51.20	0.67	2.56
Leaf length (cm)	9.45	7.00	11.20	0.09	1.63
Leaf breadth (cm)	3.90	3.20	4.30	0.03	1.54
Number of leaves	215.19	186.00	262.00	3.84	3.09
Leaf area (cm^2)	2850.85	2614.20	3281.50	215.68	13.10
Fresh weight (g)	376.49	327.00	434.00	31.15	14.33
Total dry matter production (g)	85.75	74.00	106.20	10.26	20.73
Total Chlorophyll (mg/g of fresh weight)	3.52	3.05	3.80	0.24	11.63
Days taken for flower bud initiation	42.20	39.00	46.00	2.04	8.38
Days taken for 50% flowering	53.95	49.00	57.00	2.50	8.02
Days taken for marketable flower harvest	58.33	54.00	61.00	2.18	6.49
Duration of flowering (days)	66.90	64.00	72.00	2.56	6.62
Days taken for flower senescence	8.26	7.50	9.00	0.43	9.08
Number of flowering stems/spikes/plant	40.85	31.00	46.00	4.93	20.89
Number of flowers/spikes/plant	159.25	128.00	176.00	15.64	17.01
Diameter of flower (cm)	5.01	4.10	5.70	0.47	16.41
Number of petals per flower	22.60	17.00	31.00	4.28	32.78
Petal length (cm)	2.10	1.70	2.60	0.26	21.82
Petal breadth (cm)	1.10	0.90	1.30	0.12	18.18
Petiole length (cm)	6.49	4.50	7.80	1.01	26.99
Stalk length (cm)	65.44	52.00	74.00	6.80	18.01
Shelf life (days)	2.85	2.10	3.40	0.39	23.60
Vase life (days)	5.12	4.20	6.00	0.52	17.59
Flower yield (loose flowers) (g/plant)	432.44	315.00	504.00	59.19	23.71
Flower yield per plot (kg)	13.45	12.00	15.50	1.05	13.57
Seed yield per plant (g)	79.13	76.00	81.15	1.59	3.47
Seed yield per plot (kg)	2.83	2.50	3.10	0.18	10.76
Germination Percentage	89.87	84.00	93.00	2.94	5.66

A perusal of data presented in Table 5. describes the mean performance of *Gomphrena globosa* L. for various recorded observations. It is evident from the data that the mean plant height was 54.02 cm and it ranged from 49.00-61.00 cm. The mean plant spread (N-S) was 41.24 cm and it ranged from 37.00-46.50 cm and the mean plant spread (E-W) was 44.10 cm with a range of 38.00-47.00 cm. Mean leaf length and leaf breadth was 8.38 cm and 1.59 cm with a range of 6.20-9.60 cm and 1.20-2.20 cm, respectively. The average number of leaves was 85.49, with a mean leaf area of 1429.76 cm^2, which ranged from 71.00-112.00 and 1183.00-1805.20 cm^2. Fresh weight varied from 92.00-144.00 g with a mean of 109.53 g, and the total dry matter production at peak flowering stage ranged from 28.00-43.00 g with a mean of 33.50 g. Total chlorophyll was 2.51 mg/g of fresh weight. The average number of days taken for flower bud initiation was 51.88 and ranged from 49.00-57.00. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 63.16 and 60.07. Respective ranges for these characters were 58.00-66.00 and 56.00-64.00. The average of duration of flowering was 59.72 days and it ranged from 55.00-68.00 days. The average number of days taken for flower senescence in plant was 15.45, which ranged from 13.00-17.00 days. The average number of flowering stems per plant and the average number of flowers per plant was 28.14 and 51.33. Respective ranges for these characters are 21.00-36.00 and 38.64. The diameter of the flower ranged from 2.10-3.40 cm with a mean size of 2.57 cm. The average number of petals per flower, petal length, and petal breadth was 53.85, 0.56 cm, and 0.82 cm, respectively and ranges are 46.00-66.00, 0.40-0.70 cm, and 0.70-0.96 cm, respectively. The average petiole length and stalk length was 11.46 cm and 34.25 cm, which ranged from 7.40-14.00 cm and 27.00-42.00 cm, respectively. The average shelf and vase life was 3.15 and 4.38 days. Respective ranges for these parameters was 2.40-3.90 and 3.80-5.50 days. The average flower yield per plant and plot was 1.72 g and 10.90 kg, which ranged from 44.00-67.00 g and 1.30-2.10 kg. Seed yield per plant and plot ranged from 7.50-17.40 g, and 0.21-0.52 kg, respectively, and their mean values are 10.90 g and 0.38 kg, respectively. The average germination percentage of seeds was 42.76, with the range of 36.00-53.00. In this species, the least variability was found in plant height with a minimum coefficient of variation, *i.e.*, 0.67. The highest variability in seed yield per plant with the maximum coefficient of variation, *i.e.*, 51.66.

Table 5. Evaluation of Globe Amaranth (*Gomphrena globosa* L.) for growth, flowering, flower quality, and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	54.02	49.00	61.00	0.21	0.67
Plant spread (N-S) (cm)	41.24	37.00	46.50	0.50	2.09
plant spread (E-W) (cm)	44.10	38.00	47.00	0.46	1.83
Leaf length (cm)	8.38	6.20	9.60	0.11	2.33
Leaf breadth (cm)	1.59	1.20	2.20	0.04	4.65
Number of leaves	85.49	71.00	112.00	1.70	3.45
Leaf area (cm^2)	1429.76	1183	1805.2	190.79	23.11
Fresh weight (g)	109.53	92.00	144.00	17.24	27.26
Total dry matter production (g)	33.50	28.00	43.00	4.77	24.66
Total Chlorophyll (mg/g of fresh weight)	2.51	2.14	2.86	0.21	14.36
Days taken for flower bud initiation	51.88	49.00	57.00	2.57	8.57
Days taken for 50% flowering	63.16	58.00	66.00	2.58	7.09
Days taken for marketable flower harvest	60.07	56.00	64.00	2.31	6.66
Duration of flowering (days)	59.72	55.00	68.00	4.15	12.05
Days taken for flower senescence	15.45	13.00	17.00	1.24	13.89
Number of flowering stems/spikes/plant	28.14	21.00	36.00	4.35	26.74
Number of flowers/spikes/plant	51.33	38.00	64.00	7.51	25.35
Diameter of flower (cm)	2.57	2.10	3.40	0.42	28.05
Number of petals per flower	53.85	46.00	66.00	6.16	19.82
Petal length (cm)	0.56	0.40	0.70	0.09	26.96
Petal breadth (cm)	0.82	0.70	0.96	0.08	15.99
Petiole length (cm)	11.46	7.40	14.00	2.05	31.00
Stalk length (cm)	34.25	27.00	42.00	4.34	21.93
Shelf life (days)	3.15	2.40	3.90	0.43	23.81
Vase life (days)	4.38	3.80	5.50	0.56	22.15
Flower yield (loose flowers) (g/plant)	52.33	44.00	67.00	7.36	24.35
Flower yield per plot (kg)	1.72	1.30	2.10	0.23	23.34
Seed yield per plant (g)	10.90	7.50	17.40	3.25	51.66
Seed yield per plot (kg)	0.38	0.21	0.52	0.09	41.36
Germination Percentage	42.76	36.00	53.00	5.21	21.09

The data presented in Table 6. exhibit the mean performance of *Helichrysum bracteatum Andr.* for various parameters. Data shows that the mean plant height was 92.84 cm and it ranged from 78.00-108.00 cm. The mean plant spread (N-S) was 32.12 cm and it ranged from 23.00-36.00 cm and mean plant spread (E-W) was 34.03 cm with a range of 31.00-39.00 cm. Leaf length ranged from 8.50-18.30 cm with a mean of 15.47 cm and mean leaf breadth was 2.87 cm, which ranged from 1.50-3.40 cm. The average number of leaves was 94.75, with a mean leaf area of 1835.24 cm^2, which ranged from 84.00-112.00 and 1712.10-2052.50 cm^2. Mean fresh weight and total dry matter production at peak flowering stage was 268.45 g and 55.81 g, which ranged from 216.00-304.00 g and 42.10-63.50 g, respectively. Total chlorophyll was 1.56 mg/g of fresh weight. The average number of days taken for flower bud initiation ranged from 35.00-43.00, and average days taken was 37.90. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 54.82 and 51.22. Respective ranges for these characters were 49.00-58.00 and 46.00-55.00. The average of duration of flowering was 64.20 days, and it ranged from 59.00-72.00 days. Days taken for flower senescence in plant ranged from 17.00-24.50 days, and its mean value was 64.20 days. The average number of flowering stems per plant and an average number of flowers per plant ranged from 7.62 and 21.82. Respective mean values for these parameters were 5.00-12.00 and 12.00-38.00. The diameter of the flower ranged from 5.10-6.30 cm with a mean size of 5.96 cm. The number of petals per flower, petal length, and petal breadth ranged from 121.00-183.00, 0.60-1.05 cm, and 0.25-0.75 cm, respectively, and mean values for these parameters are 148.64, 0.87 cm, and 0.47 cm. The average petiole length and stalk length was 5.01 cm and 73.28 cm, which ranged from 3.80-6.80 cm and 62.00-79.00 cm, respectively. The average shelf and vase life was 3.71 and 14.85 days. Respective ranges for these parameters was 3.00-4.80 days. Flower yield per plant and per plot ranged from 56.00-87.00 g and 1.55-1.92 kg, with their average yield of 73.57 g and 1.7 kg. Seed yield per plant and per plot ranged from 2.80-10.50 g and 0.36-1.90 kg, respectively, and their mean values are 7.12 g and 0.90 kg, respectively. The average germination percentage of seeds was 64.20, with the range of 42.50-76.00. This species had the highest variability in seed yield per plot with the maximum coefficient of variation, *i.e.*, 96.33, and the least variability was found in plant spread (E-W) with the minimum coefficient of variation, *i.e.*, 1.25.

Table 6. Evaluation of Paper flower (*Helichrysum bracteatum* Andr.) for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	92.84	78.00	108.00	1.47	2.75
Plant spread (N-S) (cm)	32.12	23.00	36.00	0.34	1.81
plant spread (E-W) (cm)	34.03	31.00	39.00	0.25	1.25
Leaf length (cm)	15.47	8.50	18.30	0.49	5.53
Leaf breadth (cm)	2.87	1.50	3.40	0.07	4.33
Number of leaves	94.75	84.00	112.00	2.46	4.50
Leaf area (cm^2)	1835.24	1712.10	2052.50	108.95	10.28
Fresh weight (g)	268.45	216.00	304.00	26.77	17.27
Total dry matter production (g)	55.81	42.10	63.50	6.87	21.33
Total Chlorophyll (mg/g of fresh weight)	1.56	1.30	2.06	0.25	27.76
Days taken for flower bud initiation	37.90	35.00	43.00	2.56	11.69
Days taken for 50% flowering	54.82	49.00	58.00	2.91	9.21
Days taken for marketable flower harvest	51.22	46.00	55.00	2.70	9.12
Duration of flowering (days)	64.20	59.00	72.00	3.97	10.71
Days taken for flower senescence	21.88	17.00	24.50	2.44	19.33
Number of flowering stems/spikes/plant	7.62	5.00	12.00	2.20	50.10
Number of flowers/spikes/plant	21.82	12.00	38.00	8.15	64.71
Diameter of flower (cm)	5.96	5.10	6.30	0.43	12.59
Number of petals per flower	148.64	121.00	183.00	18.21	21.22
Petal length (cm)	0.87	0.60	1.05	0.14	27.37
Petal breadth (cm)	0.47	0.25	0.75	0.15	54.33
Petiole length (cm)	5.01	3.80	6.80	0.91	31.57
Stalk length (cm)	73.28	62.00	79.00	5.64	13.33
Shelf life (days)	3.71	3.00	4.80	0.55	25.83
Vase life (days)	14.85	11.00	18.20	2.09	24.42
Flower yield (loose flowers) (g/plant)	73.57	56.00	87.00	9.19	21.62
Flower yield per plot (kg)	1.70	1.55	1.92	0.11	11.45
Seed yield per plant (g)	7.12	2.80	10.50	2.27	55.27
Seed yield per plot (kg)	0.90	0.36	1.90	0.50	96.33
Germination Percentage	64.20	42.50	76.00	10.86	29.31

A perusal of data presented in Table 7. describes the mean performance of *Lupinus hartwegii* Lindl. for various recorded observations. It is evident from the data that the mean plant height was 63.70 cm and it ranged from 48.00-71.00 cm. The mean plant spread (N-S) was 34.20 cm, and it ranged from 23.00-38.20 cm, and mean plant spread (E-W) was 36.48 cm with a range of 27.00-41.50 cm. Mean leaf length and leaf breadth was 5.42 cm and 1.32 cm with a range of 4.50-7.00 cm and 0.90-1.70 cm, respectively. The average number of leaves was 108.03, with a mean leaf area of 4166.40 cm^2, which ranged from 75.00-133.00 and 3852.00-4329.50 cm^2. Fresh weight varied from 226.00-337.00 g with a mean of 293.25 g, and the total dry matter production at peak flowering stage ranged from 35.30-51.60 g with a mean of 45.17 g. Total chlorophyll was 2.01 mg/g of fresh weight. The average number of days taken for flower bud initiation was 65.83 and ranged from 62.00-72.00. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 79.35 and 76.32. Respective ranges for these characters were 74.00-83.00 and 73.50-81.00. The average of duration of flowering was 61.50 days, and it ranged from 52.00-73.00 days. The average number of days taken for flower senescence in plant was 4.05, which ranged from 3.50-4.80 days. The average number of spikes per plant and the average number of flowers per spike was 23.50 and 128.73. Respective ranges for these characters are 16.00-34.00 and 88.00-167.00. The diameter of the flower ranged from 1.20-2.15 cm with a mean size of 1.80 cm. The average number of petals per flower, petal length, and petal breadth was 5.00, 1.66 cm, and 0.87 cm, respectively, and ranges are 5.00-5.00, 1.30-2.10 cm, and 0.70-1.10 cm respectively. The average petiole length and stalk length was 0.82 cm and 61.15 cm, which ranged from 0.60-1.20 cm and 47.00-68.40 cm, respectively. The average shelf and vase life was 1.75 and 3.15 days. Respective ranges for these parameters was 1.50-2.20 days. The average flower yield per plant and per plot was 66.05 g and 1.10 kg, which ranged from 47.00-85.00 g and 0.90-1.40 kg. Seed yield per plant and per plot ranged from 17.30-47.80 g and 0.55-0.96 kg, respectively, and their mean values are 28.50 g and 0.69 kg, respectively. The average germination percentage of seeds was 89.78, with the range of 76.00-97.00. In this species, the least variability was found in plant height with a minimum coefficient of variation, *i.e.*, 0.98. There was the highest variability in seed yield per plant with a maximum coefficient of variation, *i.e.*, 58.90.

Table 7. Evaluation of Lupine (*Lupinus hartwegii* Lindl.) for growth, flowering, flower quality, and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	63.70	48.00	71.00	0.36	0.98
Plant spread (N-S) (cm)	34.20	23.00	38.20	0.38	1.93
plant spread (E-W) (cm)	36.48	27.00	41.50	0.38	1.81
Leaf length (cm)	5.42	4.50	7.00	0.24	7.52
Leaf breadth (cm)	1.32	0.90	1.70	0.02	2.65
Number of leaves	108.03	75.00	133.00	23.96	16.89
Leaf area (cm^2)	4166.40	3852.00	4329.50	157.24	6.54
Fresh weight (g)	293.25	226.00	337.00	34.13	20.16
Total dry matter production (g)	45.17	35.30	51.60	5.01	19.21
Total Chlorophyll (mg/g of fresh weight)	2.01	1.90	2.18	0.09	7.43
Days taken for flower bud initiation	65.83	62.00	72.00	3.11	8.20
Days taken for 50% flowering	79.35	74.00	83.00	2.73	5.97
Days taken for marketable flower harvest	76.32	73.50	81.00	2.36	5.35
Duration of flowering (days)	61.50	52.00	73.00	6.14	17.30
Days taken for flower senescence	4.05	3.50	4.80	0.39	16.61
Number of flowering stems/spikes/plant	23.50	16.00	34.00	5.41	39.86
Number of flowers/spikes/plant	128.73	88.00	167.00	22.84	30.73
Diameter of flower (cm)	1.80	1.20	2.15	0.30	29.00
Number of petals per flower	5.00	5.00	5.00	0.00	0.00
Petal length (cm)	1.66	1.30	2.10	0.23	24.46
Petal breadth (cm)	0.87	0.70	1.10	0.12	23.75
Petiole length (cm)	0.82	0.60	1.20	0.19	40.30
Stalk length (cm)	61.15	47.00	68.40	7.08	20.04
Shelf life (days)	1.75	1.50	2.20	0.23	22.31
Vase life (days)	3.15	2.70	4.60	0.74	40.81
Flower yield (loose flowers) (g/plant)	66.05	47.00	85.00	10.97	28.77
Flower yield per plot (kg)	1.10	0.90	1.40	0.15	24.05
Seed yield per plant (g)	28.50	17.30	47.80	9.69	58.90
Seed yield per plot (kg)	0.69	0.55	0.96	0.14	33.90
Germination Percentage	89.78	76.00	97.00	6.89	13.30

The data presented in Table 8 exhibits the mean performance of *Salvia splendens* L. for various parameters. Data shows that the mean plant height was 30.72 cm and it ranged from 22.00-38.50 cm. The mean plant spread (N-S) was 30.82 cm and it ranged from 25.00-41.50 cm, and mean plant spread (E-W) was 31.62 cm with a range of 27.50-34.60 cm. Leaf length ranged from 4.70-8.10 cm with a mean of 6.89 cm, and mean leaf breadth was 5.00 cm, which ranged from 4.25-6.20 cm. The average number of leaves was 134.87, with a mean leaf area of 2452.36 $cm^{2,}$ which ranged from 88.00-162.00 and 2165.22-2605.80 cm^2. Mean fresh weight and total dry matter production at peak flowering stage was 162.76 g and 28.20 g, which ranged from 146.20-194.50 g and 23.30-37.50 g, respectively. Total chlorophyll was 3.82 mg/g of fresh weight. The average number of days taken for flower bud initiation ranged from 42.50-53.00, and average days taken was 46.24. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 65.43 and 59.26. Respective ranges for these characters were 60.50-69.50 and 54.50-63.00. The average of duration of flowering was 42.11 days, and it ranged from 36.00-49.50 days. Days taken for flower senescence in plant ranged from 11.50-16.00 days, and its mean value was 13.22 days. The average number of flowering spikes per plant and an average number of flowers per spike ranged from 12.00-21.00 and 76.00-122.00. Respective mean values for these parameters were 15.78 and 97.46. The diameter of the flower ranged from 0.90-1.42 cm with a mean size of 1.18 cm. The number of petals per flower, petal length, and petal breadth ranged from 2.00-2.00, 2.30-4.10 cm, and 1.10-1.60 cm, respectively, and mean values for these parameters are 2.00, 3.23 cm, and 1.32 cm. Average petiole length and stalk length was 0.67 cm and 19.10 cm, which ranged from 0.35-0.80 cm and 14.50-27.00 cm, respectively. The average shelf and vase life was 1.70 and 2.76 days. Respective ranges for these parameters was 1.00-2.10 and 2.00-3.50 days. Flower yield per plant and per plot ranged from 34.00-66.00 g and 1.25-1.80 kg with their average yield of 54.44 g and 1.55 kg. Seed yield per plant and per plot ranged from 1.30-3.70 g and 0.05-0.08 kg, respectively, and their mean values are 2.14 g and 0.06 kg, respectively. The average germination percentage of seeds was 8.50, with the range of 6.20-13.00. This species had the highest variability in seed yield per plant with the maximum coefficient of variation, *i.e.*, 63.19 and the least variability was found in leaf length with the minimum coefficient of variation, *i.e.*, 0.38.

Table 8. Evaluation of Salvia (*Salvia splendens* L.) for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	30.72	22.00	38.50	0.35	1.97
Plant spread (N-S) (cm)	30.82	25.00	41.50	0.52	2.91
plant spread (E-W) (cm)	31.62	27.50	34.60	0.18	1.01
Leaf length (cm)	6.89	4.70	8.10	0.02	0.38
Leaf breadth (cm)	5.00	4.25	6.20	0.06	2.23
Number of leaves	134.87	88.00	162.00	1.72	2.21
Leaf area (cm^2)	2452.36	2165.22	2605.80	143.68	10.15
Fresh weight (g)	162.76	146.20	194.50	15.87	16.89
Total dry matter production (g)	28.20	23.30	37.50	4.65	28.57
Total Chlorophyll (mg/g of fresh weight)	3.82	3.35	4.20	0.25	11.31
Days taken for flower bud initiation	46.24	42.50	53.00	3.39	12.68
Days taken for 50% flowering	65.43	60.50	69.50	2.63	6.97
Days taken for marketable flower harvest	59.26	54.50	63.00	2.51	7.33
Duration of flowering (days)	42.11	36.00	49.50	3.95	16.24
Days taken for flower senescence	13.22	11.50	16.00	1.40	18.38
Number of flowering stems/spikes/plant	15.78	12.00	21.00	2.70	29.59
Number of flowers/spikes/plant	97.46	76.00	122.00	13.37	23.76
Diameter of flower (cm)	1.18	0.90	1.42	0.15	22.23
Number of petals per flower	2.00	2.00	2.00	0.00	0.00
Petal length (cm)	3.23	2.30	4.10	0.52	27.91
Petal breadth (cm)	1.32	1.10	1.60	0.15	19.34
Petiole length (cm)	0.67	0.35	0.80	0.16	41.60
Stalk length (cm)	19.10	14.50	27.00	3.97	35.98
Shelf life (days)	1.70	1.00	2.10	0.35	35.78
Vase life (days)	2.76	2.00	3.50	0.43	27.18
Flower yield (loose flowers) (g/plant)	54.44	34.00	66.00	10.25	32.61
Flower yield per plot (kg)	1.55	1.25	1.80	0.16	17.96
Seed yield per plant (g)	2.14	1.30	3.70	0.78	63.19
Seed yield per plot (kg)	0.06	0.05	0.08	0.01	28.87
Germination Percentage	8.50	6.20	13.00	2.25	45.85

A perusal of data presented in Table 9 describes the mean performance of *Lathyrus odoratus* L. for various recorded observations. It is evident from the data that the mean plant height was 91.68 cm and it ranged from 71.50-110.00 cm. The mean plant spread (N-S) was 29.60 cm and it ranged from 25.60-35.50 cm, and mean plant spread (E-W) was 32.47 cm with a range of 28.50-38.00 cm. Mean leaf length and leaf breadth was 4.53 cm and 2.21 cm with a range of 4.20-5.60 cm and 1.90-2.40 cm, respectively. Average number of leaves was 221.54 with a mean leaf area of 1544.52 cm^2, which ranged from 169.00-254.00 and 1450.00-1602.00 cm^2. Fresh weight varied from 53.50-78.40 g with a mean of 64.92 g and the total dry matter production at peak flowering stage ranged from 14.10-17.60 g with a mean of 15.97 g. Total chlorophyll was 2.18 mg/g of fresh weight. The average number of days taken for flower bud initiation was 40.25 and ranged from 38.00-44.00. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 57.05 and 55.68. Respective ranges for these characters were 55.00-61.00 and 52.00-58.00. The average of duration of flowering was 38.66 and it ranged from 36.00-43.00 days. The average number of days taken for flower senescence in plant was 6.82, which ranged from 5.50-9.00 days. The average number of flowering stems per plant and the average number of flowers per plant was 19.57 and 59.92. Respective ranges for these characters are 13.00-32.00 and 47.00-85.00. The diameter of the flower ranged from 2.30-3.10 cm with a mean size of 2.78 cm. The average number of petals per flower, petal length, and petal breadth was 5.00, 2.58 cm, and 1.63 cm, respectively, and ranges are 5.00-5.00, 1.40-3.20 cm, and 1.20-1.80 cm respectively. The average petiole length and stalk length was 1.45 cm and 12.74 cm, which ranged from 0.70-2.70 cm and 10.20-16.50 cm, respectively. The average shelf and vase life was 1.59 and 2.74 days. Respective ranges for these parameters was 1.00-2.20 days and 2.10-3.50 days. The average flower yield per plant and per plot was 36.80 g and 1.10 kg, which ranged from 26.40-57.00 g and 0.76-1.36 kg. Seed yield per plant and per plot ranged from 31.60-64.20 g and 0.76-1.36 kg, respectively, and their mean values are 52.65 g and 1.57 kg, respectively. The average germination percentage of seeds was 91.20, with the range of 83.00-96.20. In this species, the least variability was found in plant spread (E-W) with the minimum coefficient of variation, *i.e.*, 0.76. The highest variability in petiole length with the maximum coefficient of variation, *i.e.*, 75.15.

Table 9. Evaluation of Sweet Pea (*Lathyrus odoratus* L.) for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	91.68	71.50	110.00	0.64	1.21
Plant spread (N-S) (cm)	29.60	25.60	35.50	0.27	1.55
plant spread (E-W) (cm)	32.47	28.50	38.00	0.14	0.76
Leaf length (cm)	4.53	4.20	5.60	0.04	1.67
Leaf breadth (cm)	2.21	1.90	2.40	0.06	4.98
Number of leaves	221.54	169.00	254.00	4.66	3.65
Leaf area (cm^2)	1544.52	1450.00	1602.00	47.63	5.34
Fresh weight (g)	64.92	53.50	78.40	7.26	19.37
Total dry matter production (g)	15.97	14.10	17.60	1.02	11.04
Total Chlorophyll (mg/g of fresh weight)	2.18	1.55	2.60	0.32	25.49
Days taken for flower bud initiation	40.25	38.00	44.00	1.89	8.12
Days taken for 50% flowering	57.05	55.00	61.00	1.98	6.00
Days taken for marketable flower harvest	55.68	52.00	58.00	1.86	5.79
Duration of flowering (days)	38.66	36.00	43.00	2.19	9.80
Days taken for flower senescence	6.82	5.50	9.00	1.10	27.89
Number of flowering stems/spikes/plant	19.57	13.00	32.00	6.22	55.04
Number of flowers/spikes/plant	59.92	47.00	85.00	12.54	36.26
Diameter of flower (cm)	2.78	2.30	3.10	0.24	15.23
Number of petals per flower	5.00	5.00	5.00	0.00	0.00
Petal length (cm)	2.58	1.40	3.20	0.59	39.63
Petal breadth (cm)	1.63	1.20	1.80	0.22	23.01
Petiole length (cm)	1.45	0.70	2.70	0.63	75.15
Stalk length (cm)	12.74	10.20	16.50	1.92	26.08
Shelf life (days)	1.59	1.00	2.20	0.35	37.75
Vase life (days)	2.74	2.10	3.50	0.41	25.83
Flower yield (loose flowers) (g/plant)	36.80	26.40	57.00	10.10	47.54
Flower yield per plot (kg)	1.10	0.76	1.36	0.18	27.99
Seed yield per plant (g)	52.65	31.60	64.20	10.54	34.68
Seed yield per plot (kg)	1.57	1.25	1.90	0.19	20.71
Germination Percentage	91.20	83.00	96.20	4.13	7.85

The data presented in Table 10 exhibits the mean performance of *Dianthus chinensis* L. for various parameters. Data shows that the mean plant height was 25.81 cm and it ranged from 24.00-33.40 cm. The mean plant spread (N-S) was 26.29 cm and it ranged from 19.10-31.50 cm, and mean plant spread (E-W) was 26.99 cm with a range of 21.00-29.50 cm. Leaf length ranged from 7.60-14.10 cm with a mean of 12.57 cm and mean leaf breadth was 1.50 cm, which ranged from 1.20-1.80 cm. The average number of leaves was 77.84 with a mean leaf area of 782.27 cm^2, which ranged from 65.00-96.00 and 705.05-922.50 cm^2. Mean fresh weight and total dry matter production at peak flowering stage was 92.74 g and 20.52 g, which ranged from 76.70-119.30 g and 15.40-23.80 g, respectively. Total chlorophyll was 3.51 mg/g of fresh weight. The average number of days taken for flower bud initiation ranged from 33.00-42.00, and average days taken was 36.56. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 61.77 and 54.43. Respective ranges for these characters were 59.00-64.00 and 51.00-60.00. The average of duration of flowering was 57.98, and it ranged from 52.00-66.00 days. Days taken for flower senescence in plant ranged from 7.00-9.50 days and its mean value was 8.23 days. The average number of flowering spikes per plant and the average number of flowers per spike ranged from 36.00-52.00 and 142.00-178.00. Respective mean values for these parameters were 43.75 and 165.26. The diameter of flower ranged from 2.10-2.90 cm with a mean size of 2.58 cm. The number of petals per flower, petal length, and petal breadth ranged from 5.00-5.00, 1.10-1.80 cm, and 1.20-1.60 cm, respectively, and mean values for these parameters are 5.00, 1.47cm and 1.34. The average petiole length and stalk length was 6.25 cm and 25.87 cm, which ranged from 4.10-7.60 cm and 14.50-32.00 cm, respectively. The average shelf and vase life was 1.48 and 2.95 days. Respective ranges for these parameters was 1.10-2.30 and 2.00-4.10 days. Flower yield per plant and per plot ranged from 29.30-72.40 gm and 0.80-1.30 kg with their average yield of 45.84 gm and 1.12 kg. Seed yield per plant and per plot ranged from 1.86-3.50 g and 0.07-0.13 kg respectively, and their mean values are 2.46 g and 0.09 kg, respectively. The average germination percentage of seeds was 0.00. This species had the highest variability in flower yield per plant with the maximum coefficient of variation, *i.e.*, 50.68 and the least variability was found in leaf breadth with the minimum coefficient of variation, i.e., 0.38.

Table 10. Evaluation of Sweet William (*Dianthus chinensis* L.) for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	25.81	24.00	33.40	0.38	2.57
Plant spread (N-S) (cm)	26.29	19.10	31.50	0.29	1.89
plant spread (E-W) (cm)	26.99	21.00	29.50	0.25	1.60
Leaf length (cm)	12.57	7.60	14.10	0.30	4.10
Leaf breadth (cm)	1.50	1.20	1.80	0.00	0.38
Number of leaves	77.84	65.00	96.00	1.02	2.27
Leaf area (cm^2)	782.27	705.05	922.50	70.23	15.55
Fresh weight (g)	92.74	76.70	119.30	13.38	24.98
Total dry matter production (g)	20.52	15.40	23.80	2.59	21.89
Total Chlorophyll (mg/g of fresh weight)	3.51	3.30	3.86	0.18	8.69
Days taken for flower bud initiation	36.56	33.00	42.00	2.76	13.09
Days taken for 50% flowering	61.77	59.00	64.00	1.47	4.12
Days taken for marketable flower harvest	54.43	51.00	60.00	2.81	8.94
Duration of flowering (days)	57.98	52.00	66.00	4.17	12.45
Days taken for flower senescence	8.23	7.00	9.50	0.72	15.19
Number of flowering stems/spikes/plants	43.75	36.00	52.00	4.63	18.31
Number of flowers/spikes/plants	165.26	142.00	178.00	11.65	12.21
Diameter of flower (cm)	2.58	2.10	2.90	0.24	16.41
Number of petals per flower	5.00	5.00	5.00	0.00	0.00
Petal length (cm)	1.47	1.10	1.80	0.20	23.93
Petal breadth (cm)	1.34	1.20	1.60	0.13	16.82
Petiole length (cm)	6.25	4.10	7.60	1.09	30.11
Stalk length (cm)	25.87	14.50	32.00	5.69	38.10
Shelf life (days)	1.48	1.10	2.30	0.41	48.03
Vase life (days)	2.95	2.00	4.10	0.61	36.07
Flower yield (loose flowers) (g/plant)	45.84	29.30	72.40	13.41	50.68
Flower yield per plot (kg)	1.12	0.80	1.30	0.16	24.81
Seed yield per plant (g)	2.46	1.86	3.50	0.52	36.76
Seed yield per plot (kg)	0.09	0.07	0.13	0.02	38.49
Germination Percentage	0.00	0.00	0.00	0.00	0.00

A perusal of data presented in Table 11. describes the mean performance of *Xerochrysum viscosum* R.J. Bayer for various recorded observations. It is evident from the data that the mean plant height was 27.69 cm and it ranged from 19.50-33.60 cm. The mean plant spread (N-S) was 36.94 cm and it ranged from 26.00-41.50 cm, and mean plant spread (E-W) was 35.45 cm with a range of 28.00-38.00 cm. Mean leaf length and leaf breadth was 10.10 cm and 2.51 cm with a range of 7.40-12.50 cm and 1.70-3.10 cm, respectively. The average number of leaves was 41.66, with a mean leaf area of 384.28 cm^2, which ranged from 19.00-58.00 and 322.05-504.10 cm^2. Fresh weight varied from 118.00-194.00 g with a mean of 147.20 g, and the total dry matter production at peak flowering stage ranged from 29.20-46.80 g with a mean of 35.27 g. Total chlorophyll was 1.45 mg/g of fresh weight. The average number of days taken for flower bud initiation was 39.10 and ranged from 32.00-44.00. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 53.84 and 51.50. Respective ranges for these characters were 51.000-57.00 and 47.00-54.00. The average of duration of flowering was 46.20 days, and it ranged from 42.00-49.00 days. The average number of days taken for flower senescence in plant was 17.75, which ranged from 16.00-21.00 days. The average number of flowering stems per plant and the average number of flowers per plant was 9.20 and 18.68. Respective ranges for these characters are 5.65-13.20 and 13.20. The diameter of the flower ranged from 3.10-4.30 cm with a mean size of 3.68 cm. The average number of petals per flower, petal length, and petal breadth was 27.32, 0.82 cm, and 0.50 cm, respectively, and ranges are 22.00-35.00, 0.70-1.00cm, and 0.30-0.70 cm respectively. The average petiole length and stalk length was 6.05 cm and 22.50 cm, which ranged from 4.60-7.10 cm and 17.00-31.40 cm, respectively. The average shelf and vase life was 1.89 and 6.72 days. Respective ranges for these parameters was 1.20-3.00 and 4.50-8.40 days. The average flower yield per plant and per plot was 32.52 g and 0.85 kg, which ranged from 21.80-39.60 g and 0.60-1.10 kg. Seed yield per plant and per plot ranged from 0.20-0.40 g and 0.05-0.10 kg respectively, and their mean values are 0.32 g and 0.08 kg, respectively. The average germination percentage of seeds was 61.60, with the range of 46.00-69.50. In this species, the least variability was found in leaf breadth with the minimum coefficient of variation, *i.e*., 0.46. There was the highest variability in the number of flowers per plant with the maximum coefficient of variation, *i.e*., 68.69.

Table 11. Evaluation of Golden everlasting [*Xerochrysum viscosum* (Seiber ex DC) R.J. Bayer] for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	27.69	19.50	33.60	0.60	3.74
Plant spread (N-S) (cm)	36.94	26.00	41.50	0.49	2.30
plant spread (E-W) (cm)	35.45	28.00	38.00	0.17	0.82
Leaf length (cm)	10.10	7.40	12.50	0.18	3.00
Leaf breadth (cm)	2.51	1.70	3.10	0.01	0.46
Number of leaves	41.66	19.00	58.00	0.96	3.99
Leaf area (cm^2)	384.28	322.05	504.10	59.92	27.01
Fresh weight (g)	147.20	118.00	194.00	23.64	27.81
Total dry matter production (g)	35.27	29.20	46.80	5.77	28.32
Total Chlorophyll (mg/g of fresh weight)	1.45	1.25	1.68	0.13	14.94
Days taken for flower bud initiation	39.10	32.00	44.00	3.63	16.10
Days taken for 50% flowering	53.84	51.00	57.00	1.74	5.60
Days taken for marketable flower harvest	51.50	47.00	54.00	2.25	7.58
Duration of flowering (days)	46.20	42.00	49.00	2.14	8.02
Days taken for flower senescence	17.75	16.00	21.00	1.63	15.87
Number of flowering stems/spikes/plants	9.20	5.65	13.20	2.19	41.25
Number of flowers/spikes/plants	18.68	6.40	32.00	7.41	68.69
Diameter of flower (cm)	3.68	3.10	4.30	0.35	16.33
Number of petals per flower	27.32	22.00	35.00	3.93	24.94
Petal length (cm)	0.82	0.70	1.00	0.09	19.36
Petal breadth (cm)	0.50	0.30	0.70	0.12	40.00
Petiole length (cm)	6.05	4.60	7.10	0.75	21.44
Stalk length (cm)	22.50	17.00	31.40	4.49	34.57
Shelf life (days)	1.89	1.20	3.00	0.56	51.36
Vase life (days)	6.72	4.50	8.40	1.16	29.84
Flower yield (loose flowers) (g/plant)	32.52	21.80	39.60	5.45	29.03
Flower yield per plot (kg)	0.85	0.60	1.10	0.14	29.41
Seed yield per plant (g)	0.32	0.20	0.40	0.06	33.07
Seed yield per plot (kg)	0.08	0.05	0.10	0.02	33.27
Germination Percentage	61.60	46.00	69.50	7.80	21.93

The data presented in Table 12 exhibits the mean performance of *Zinnia elegens* Jacq. for various parameters. Data shows that the mean plant height was 32.57 cm and it ranged from 24.50-39.80 cm. The mean plant spread (N-S) was 23.76 cm and it ranged from 19.30-30.50 cm, and mean plant spread (E-W) was 25.63 cm with a range of 21.00-28.50 cm. Leaf length ranged from 3.00-5.80 cm with a mean of 4.91 cm, and mean leaf breadth was 3.57 cm, which ranged from 2.20-3.90 cm. The average number of leaves was 63.55 with a mean leaf area of 447.44 cm^2, which ranged from 47.00-81.00 and 379.00-486.30 cm^2. Mean fresh weight and total dry matter production at peak flowering stage was 89.96 g and 17.28 g, which ranged from 75.60-118.40 g and 14.40-22.80 g, respectively. Total chlorophyll was 3.76 mg/g of fresh weight. The average number of days taken for flower bud initiation ranged from 20.00-26.00, and the average days taken was 22.48. Average days taken for 50 per cent flowering and average days taken for marketable flower harvest was 36.12 and 31.10. Respective ranges for these characters were 32.00-39.00 and 29.00-34.00. The average of duration of flowering was 33.50, and it ranged from 30.00-39.00 days. Days taken for flower senescence in plant ranged from 8.00-11.00 days and its mean value was 9.18 days. The average number of flowering stems per plant and the average number of flowers per plant ranged from 12.00-17.00 and 18.00-43.00. Respective mean values for these parameters were 13.81 and 27.55. The diameter of flower ranged from 4.10-5.40 cm with a mean size of 4.88 cm. The number of petals per flower, petal length, and petal breadth ranged from 14.00-26.00, 1.30-1.70 cm, and 0.70-1.20 cm, respectively, and mean values for these parameters are 18.32, 1.51 cm and 0.98 cm. The average petiole length and stalk length was 3.71 cm and 22.30 cm, which ranged from 3.10-4.70 cm and 17.50-28.00, respectively. The average shelf and vase life was 1.76 and 3.05 days. Respective ranges for these parameters was 1.20-2.30 days. Flower yield per plant and per plot ranged from 27.50-62.40 g and 1.20-1.62 kg with their average yield of 41.25 g and 1.40 kg. Seed yield per plant and per plot ranged from 3.10-4.70 g and 0.18-0.33 kg respectively, and their mean values are 3.70 g and 0.25 kg, respectively. The average germination percentage of seeds was 75.60, with the range of 64.00-83.00. This species had the highest variability in the number of flowers per plant with the maximum coefficient of variation, *i.e.*, 49.02, and the least variability was found in plant spread (E-W) with the minimum coefficient of variation, *i.e.*, 1.09.

Table 12. Evaluation of Zinnia (*Zinnia elegens* Jacq.) for growth, flowering, flower quality and yield parameters

Parameters	Mean	Min	Max	SE	CV (%)
Plant height (cm)	32.57	24.50	39.80	0.62	3.30
Plant spread (N-S) (cm)	23.76	19.30	30.50	0.43	3.12
plant spread (E-W) (cm)	25.63	21.00	28.50	0.16	1.09
Leaf length (cm)	4.91	3.00	5.80	0.05	1.85
Leaf breadth (cm)	3.57	2.20	3.90	0.06	2.77
Number of leaves	63.55	47.00	81.00	0.93	2.54
Leaf area (cm^2)	447.44	379.00	486.30	34.32	13.29
Fresh weight (g)	89.96	75.60	118.40	14.22	27.38
Total dry matter production (g)	17.28	14.40	22.80	2.76	27.67
Total Chlorophyll (mg/g of fresh weight)	3.76	3.62	3.80	0.07	3.32
Days taken for flower bud initiation	22.48	20.00	26.00	1.81	13.93
Days taken for 50% flowering	36.12	32.00	39.00	2.11	10.14
Days taken for marketable flower harvest	31.10	29.00	34.00	1.50	8.34
Duration of flowering (days)	33.50	30.00	39.00	2.78	14.39
Days taken for flower senescence	9.18	8.00	11.00	0.92	17.42
Number of flowering stems/spikes/plant	13.81	12.00	17.00	1.60	20.06
Number of flowers/spikes/plant	27.55	18.00	43.00	7.80	49.02
Diameter of flower (cm)	4.88	4.10	5.40	0.40	14.10
Number of petals per flower	18.32	14.00	26.00	3.85	36.40
Petal length (cm)	1.51	1.30	1.70	0.12	13.29
Petal breadth (cm)	0.98	0.70	1.20	0.15	26.06
Petiole length (cm)	3.71	3.10	4.70	0.50	23.32
Stalk length (cm)	22.30	17.50	28.00	3.06	23.80
Shelf life (days)	1.76	1.20	2.30	0.32	31.27
Vase life (days)	3.05	2.00	4.10	0.61	34.43
Flower yield (loose flowers) (g/plant)	41.25	27.50	62.40	10.73	45.07
Flower yield per plot (kg)	1.40	1.20	1.62	0.12	15.05
Seed yield per plant (g)	3.70	3.10	4.70	0.50	23.56
Seed yield per plot (kg)	0.25	0.18	0.33	0.04	30.20
Germination Percentage	75.60	64.00	83.00	5.87	13.46

4.2 Consumer preference

All the winter annuals are not suitable for loose flower, cut flower, and seed production. So, here the attempt has been made to know the various attributes of seasonal annuals like flower color, cut flower suitability, and loose flower suitability and overall acceptability. The score has been given using a 1-5 hedonic scale, and the same is presented in Appendix-III. Table no. 13 shows the consumer preference in which the maximum score for flower color was obtained in *Dianthus barbatus* (5.00), followed by *Salvia splendens* (4.90) and *Helichrysum bracteatum* (4.82). The highest score for cut flower suitability among the annuals was obtained in *Callistephus chinensis* (5.00), *Gomphrena globosa* (5.00), *Helichrysum bracteatum* (5.00), followed by *Chrysanthemum coronarium* (4.76) and *Calendula officinalis* (4.22). The maximum score for loose flower suitability was obtained in *Callistephus chinensis* (5.00), *Chrysanthemum coronarium* (5.00), followed by *Calendula officinalis* (4.74) and *Gomphrena globosa* (4.66). The maximum score for overall acceptance was obtained in *Callistephus chinensis* (5.00), *Chrysanthemum coronarium* (5.00), followed by *Gomphrena globosa* (4.92), and *Calendula officinalis* (4.88).

4.3 Benefit-Cost Ratio of winter annuals

A perusal of data presented in Table 14 exhibits the cost of cultivation and the Benefit-Cost Ratio of winter annuals. The cost of flower and seed production (for 800 m^2) was calculated for different annual crops. The details of the cost of cultivation and Net returns are presented in Appendix IV. It is evident from the data that the maximum Benefit-Cost Ratio was recorded in *Calendula officinalis* (12.88), followed by *Chrysanthemum coronarium* (11.74), *Lathyrus odoratus* (9.55) and *Lupinus hartwegii* (9.07). The minimum Benefit-Cost Ratio was recorded in Salvia splendens (0.18)

Table 13. Consumer preference of annuals

Sl no.	Winter annuals	Flower color	Cut flower suitability	Loose flower suitability	Overall acceptance
1.	*Calendula officinalis* L.	4.52	4.22	4.74	4.88
2.	*Callistephus chinensis*(L.) Nees	4.66	5.00	5.00	5.00
3.	*Cosmos bipinnatus* Baill.	3.05	1.20	4.09	2.95
4.	*Chrysanthemum coronarium* L.	4.55	4.76	5.00	5.00
5.	*Gomphrena globosa* L.	4.08	5.00	4.66	4.92
6.	*Helichrysum bracteatum* Andr.	4.82	5.00	3.25	4.05
7.	*Lupinus hartwegii* Lindl.	4.00	4.05	1.00	3.16
8.	*Salvia splendens* L.	4.90	3.14	1.00	3.02
9.	*Lathyrus odoratus* L.	3.84	2.88	1.00	2.58
10	*Dianthus barbatus* L.	5.00	2.06	1.00	3.22
11	*Xerochrysum viscosum* Rx. Bayer	3.47	4.00	3.42	2.63
12	*Zinnia elegens* Jacq.	3.26	3.57	2.00	3.84

Table 14. Benefit-Cost Ratio of winter annuals.

Annuals	Total Cost (Rs.)	Total yield of seeds (kg)	Sale price (Rs.)	Total yield of flowers (kg)	Sale price (Rs.)	Gross Returns (Rs.)	Net Returns (Rs.)	B-C Ratio
Calendula officinalis L.	19,681.41	503.73	500/kg	1075.20	20/kg	2,73,369.00	2,53,687.59	12.88
Callistephus chinensis(L.) Nees	27,099.77	39.72	6000/kg	389.76	30/kg	2,50,012.80	2,22,913.03	8.22
Cosmos bipinnatus Baill.	17,861.41	76.54	500/kg	-	-	38,270.00	20,408.59	1.14
Chrysanthemum coronarium L.	19,516.41	406.72	550/kg	555.12	45/kg	2,48,676.40	2,29,159.99	11.74
Gomphrena globosa L.	19,981.41	67.80	600/kg	159.52	30/kg	45,465.60	25,484.19	1.27
Helichrysum bracteatum Andr.	19,081.41	63.79	600/kg	163.52	30/kg	43,179.60	24,098.19	1.26
Lupinus hartwegii Lindl.	23,761.41	399.00	600/kg	-	-	2,39,400.00	2,15,638.59	9.07
Salvia splendens L.	19,381.41	19.17	1200/kg	-	-	23,004.00	3,623	0.18
Lathyrus odoratus L.	17,881.41	471.74	400/kg	-	-	1,88,696.00	1,70,814.59	9.55
Dianthus barbatus L.	23,161.41	71.68	650/kg	-	-	46,592.00	23,430.59	1.01
Xerochrysum viscosum Rx.	19,981.41	13.02	2.5/g	162.60	30/kg	37,428.00	17,446.59	0.87
Zinnia elegens Jacq.	22,661.41	74.00	2.0/kg	-	-	1,48,000.00	1,25,338.59	5.53

DISCUSSION

V DISCUSSION

In the present investigation, an attempt has been made to evaluate and study the winter annuals for growth, flowering, flower quality and yield parameters. The results have been discussed critically pertaining to the findings where ever possible, the results obtained during the investigation are discussed in this chapter.

5.1 Mean performance and parameters of variability

5.1.1 Pot marigold (*Calendula officinalis* L.)

The variability estimates in parameters were high, moderate, and low. In this annual, substantial variations were recorded for these parameters *viz*. flower yield per plot (7.40-10.30 kg), number of flowers per plant (96.00-162.00), shelf life (1.50-2.60 days), petal length (1.90-3.10 cm), petiole length (3.40-6.50 cm), seed yield per plant (41.00-83.00 g) and seed yield per plot (1.30-2.35 kg) and petal breadth (0.30-0.46 cm). Seghatoleslami and Mousavi (2009) stated that the planting on 30th March recorded a seed yield of 276.5 g per m^2 and was highest at 25 plants per m^2 (233.6 g /m^2). Kumar *et al*. (2011) reported that the seed yield of an open-pollinated variety of calendula is around 160-170 kg per acre. Among the winter annuals under study, the highest BCR (Fig 6.) was recorded in calendula because of the higher seed yield, which might be due to the genetic and favorable climatic conditions prevailing in the Mudigere region. The parameters mentioned above, which had higher variations, need the scope of improvement through fine-tuning of production technology along with the cultural practices, nutrition, breeding, etc. On the contrary, plant height, plant spread (N-S and E-W), number of leaves per plant, leaf length, leaf breadth, total dry matter production at peak flowering stage, days taken for 50 per cent flowering, duration of flowering, days taken for marketable flower harvest recorded the least variability with petite values of coefficient of variation. Ranges of these parameters were 53.20-71.00 cm, 35.50-53.00 cm and 32.00-56.00 cm, 104.00-167.00, 11.00-14.60 cm, 3.50-5.10 cm, 36.50-45.20 g, 41.00-46.00 days, 61.00-70.00 days and 35.00-43.00 days, respectively. These slender ranges of variations indicate a minimum probability of improvement through production technology and environmental manipulation. Bhattarai *et al*. (2019) stated that *Calendula officinalis* L. recorded earliness in flower bud initiation, flower bud differentiation, blooming, and wilting under the open condition. A modest range of variations was found in days taken for FBI (23.00-29.60), germination percentage (73.00-95.20), leaf area (2984.33-3905.20 cm^2), fresh weight (155.00-217.50 g), diameter of flower (4.60-6.12 cm), number of flowering stems per plant (23.00-32.00), stalk length (32.00-43.00 cm), vase life (2.85-4.00 days), days taken for flower senescence (5.60-8.40), number of petals per flower (49.00-74.00) and flower yield per plant (182.00-278.00 g).

5.1.2 China aster (*Callistephus chinensis* L. Nees)

The estimates of variation in parameters were high, moderate, and low. Here, considerable variations were found in these characters *viz*. number of flowering stems per plant (12.00-19.00), petiole length (5.80-9.60 cm), vase life (7.00-10.50 days), stalk length (29.00-54.00 cm), number of petals per flower (57.00-104.00), petal length (1.40-3.10 cm), number of flowers per plant (22.00-46.00), seed yield per plant (18.00-38.00 g), petal breadth (0.30-0.80 cm), and seed yield per plot (0.66-1.60 kg). These parameters recorded a wide range of variations and have a better scope of improvement through the sophistication of cultural practices. Nagaraju *et al*. (2004) revealed that the maximum number of flowers per plant with larger sized flowers recorded in china aster cv. 'Kamini' when planting is done in May. On the other hand, it is evident from the data that plant height (36.00-48.50 cm), plant spread N-S and E-W (28.00-36.00 and 29.50-39.00 cm), leaf length (3.60-7.50 cm), leaf breadth (4.10-6.20 cm), number of leaves (124.00-162.00), leaf area (3425.44-4002.60 cm^2), days taken for 50 per cent flowering (57.00-64.00), days taken for flower bud initiation (40.00-47.00) and days taken for marketable flower harvest (45.00-54.00) recorded least variability with low coefficient of variation. This constricted range of variation clearly indicates the constancy of observations with the least chances of improvement through production technology and environmental manipulation. A moderate range of observations were found in characters *viz*. fresh weight (144.00-175.00 g), total chlorophyll (3.98-4.86 mg/g of fresh weight), total dry matter production (32.50-41.50 gm), germination percentage (47.50-63.00), shelf life (4.00-5.50 days), duration of flowering (37.00-52.00 days), diameter of flower (5.50-7.80 cm), flower yield per plot (5.10-7.50 kg), days taken for flower senescence (11.50-17.00), and flower yield per plant (152.00-215.00 g). The increased flower yield per plant was because of increased flower weight and the number of flowers per plant. The shelf life of china aster (4.00-5.50 days), which was highest among the annuals which show its suitability as a loose flower. The similar results were in china aster by Munikrishnappa *et al*. (2013) and Zosiamliana *et al*. (2012).

5.1.3 Mexican aster (*Cosmos bipinnatus* L.)

The estimates of variation in parameters were high, moderate, and low. In this winter annual, significant variations were recorded for various characters *viz*. stalk length (12.00-12.50 cm), flower yield per plot (0.85-1.45 kg), days taken for flower bud initiation (17.00-25.00), flower yield per plant (27.00-51.50 g), number of flowers per plant (33.00-65.00), number of flowering stems per plant (9.00-18.00), shelf life (0.75-1.40 days), seed yield per plant (4.20-8.90 g) and seed yield per plot (0.09-0.21 kg). This data shows the scope of improvement through the refinement of production technology, including breeding practices, environmental manipulation, cultural practices, etc. due to high variations on observations. In *Coreopsis tinctoria* L.,

the maximum seed yield (98.68 g/m^2) was recorded under planting carried out in the third week of November. The seed yield of 83.97 g per m^2 was recorded under a planting density of 60 cm x 60 cm in comparison to 81.31 g per m^2 recorded at 60 cm x 30 cm. (Dhatt and Kumar, 2007). On the contrary, the parameters *viz*. plant height, plant spread N-S and E-W, leaf length, leaf breadth, number of leaves, leaf area, days taken for 50 per cent flowering, days taken for marketable flower harvest, and germination percentage recorded less variability with the minimum coefficient of variation. Ranges for these parameters were 26.30-39.00 cm, 22.50-31.00 and 20.60-29.00 cm, 4.50-6.40 cm, 3.30-5.10 cm, 59.00-84.00, 559.50-622.00 cm^2, 22.00-28.00 days, 23.00-28.00 days, 74.00-87.00, respectively. These slender ranges of variations clearly indicate the steadiness of observations with the minimum probability of improvement through production technology and environment manipulation. The days taken for flower bud initiation (17.00-25.00) and days taken for 50 per cent flowering (22.00-28.00) was recorded minimum in cosmos when compared to other seasonals under study. This may be due to the storage of carbohydrates through maximum photosynthates under high temperature and high light intensity, which triggered the early initiation of bud. A moderate range of observations were found in parameters *viz*. days taken for flower senescence (4.50-6.00), petal length (1.60-2.20 cm), diameter of flower (3.80-5.20 cm), duration of flowering (31.00-42.00 days), petal breadth (1.10-1.60 cm), total dry matter production (21.80-32.60 g), fresh weight (61.00-89.40 g), vase life (1.50-2.20 days), petiole length (3.80-6.20 cm) and number of petals per flower. In cosmos, the maximum growth of plants was obtained with combined application of 20 g nitrogen, 10 g phosphorus, and 10 g potash per m^2 (Jana and Pal, 1991).

5.1.4. Annual chrysanthemum (*Chrysanthemum coronarium* L.)

The variability estimates in parameters were high, moderate, and low. In this winter annual, substantial variations were recorded in these characters *viz*. total dry matter production (74.00-106.20 g), number of flowering stems per plant (31.00-46.00), number of petals per flower (17.00-31.00), vase life (4.20-6.00 days), petal length (1.70-2.60 cm), flower yield per plant (315.00-504.00 g), petal breadth (0.90-1.30 cm), petiole length (4.50-7.80 cm) and stalk length (52.00-74.00 cm). These parameters recorded a wide range of variations and have a better scope of improvement through the sophistication of cultural practices. The higher flower yield (35786.92 kg/ha) was recorded with the application of a higher nitrogen level (150 kg/ha) in Annual chrysanthemum (Karavadia and Dhaduk, 2002**).** In contrast, it is evident from the data that plant height (96.00-119.00 cm), plant spread N-S and E-W (39.00-48.50 and 42.50-51.20 cm), leaf length (7.00-11.20 cm), leaf breadth (3.20-4.30 cm), number of leaves (186.00-262.00), leaf area (2614.20-3281.50 cm^2), days taken for marketable flower harvest (54.00-61.00 days), duration of flowering (64.00-72.00 days), seed yield

per plant (76.00-81.15 g) and germination percentage (84.00-93.00) recorded least variability with low coefficient of variation. This constricted range of variation indicates constancy of observations with the least chances of improvement. The duration of flowering (64.00-72.00 days) was maximum in annual chrysanthemum, which might be due to the genetic characteristic of the plant. The branching pattern as influenced by pinching time in garland chrysanthemum (*Chrysanthemum coronarium* L.) was evaluated by Dorajeerao and Mokashi (2012) and concluded that early pinching at 20 DAS recorded significantly higher plant height, the maximum number of leaves (259.24), number of branches (39.58), plant spread (29.14 cm). A moderate range of observations were found in parameters *viz*. leaf area (2614.20-3281.50 cm^2), fresh weight (327.00-434.00 gm), total chlorophyll (3.05-3.80 mg/g of fresh weight), days taken for FBI (39.00-46.00), days taken for 50 per cent flowering (49.00-57.00), shelf life (2.10-3.40 days), flower yield per plot (12.00-15.50 kg), number of flowers per plant (128.00-176.00), and diameter of flower (4.10-5.70 cm). This annual recorded the highest flower yield per plant (315.00-504.00 g) and seed yield per plant (76.00-81.15 g) compared to other annuals under study. This may be due to genetic nature, growing situation and environmental conditions of the plant which led the good vegetative growth, inturn the more number of branches and flower heads leading to the higher flower and seed yield.

5.1.5 Globe amaranth (*Gomphrena globosa* L.)

The estimates of variation in parameters were high, moderate, and low. Here, considerable variations were found in these characters *viz*. Flower yield per plant (44.00-67.00 g), total dry matter production (28.00-43.00 g), number of flowers per plant (38.00-64.00), number of flowering stems per plant (21.00-36.00), petal length (0.40-0.70 cm), fresh weight (92.00-144.00 g), diameter of flower (2.10-3.40 cm), petiole length (7.40-14.00 cm), seed yield per plant (7.50-17.40 g) and seed yield per plot (0.21-0.52 kg). The parameters mentioned above, which had higher variations with the maximum coefficient of variation, need a scope of improvement through fine-tuning of production technology along with the cultural practices, nutrition, breeding, etc. Hemalatha *et al*. (2014) stated that the maximum number of flowers per plant, per square meter, per hectare, with regards to economics maximum net returns and the cost-benefit ratio were recorded by spacing 30 cm × 30 cm and application of 120 per cent of recommended dosage of fertilizers in *Gomphrena*. Dorajeerao (2016) revealed that the highest number of panicles per plot was registered by the highest dose of nitrogen (300 kg ha^{-1}) and closer spacing (30 cm × 15 cm) in goldenrod (*Solidago canadensis* L.). On the other hand, it is evident from data that observations like plant height, plant spread N-S and E-W, leaf length, leaf breadth, number of leaves, days taken for flower bud initiation, days taken for 50 per cent flowering, days taken for marketable flower harvest and duration of flowering recorded least variation with the

minimum coefficient of variation. Ranges for these parameters are 49.00-61.00 cm, 37.00-46.50 and 38.00-47.00 cm, 6.20-9.60 cm, 1.20-2.20 cm, 71.00-112.00, 46.00-57.00 days, 58.00-66.00 days, 56.00-64.00 days and 55.00-68.00 days, respectively. These slender ranges of variations clearly indicate the steadiness of observations with a minimum probability of improvement through production technology and environment manipulation. A moderate range of observations were found in parameters *viz*. Leaf area (1183.00-1805.20 cm^2), total chlorophyll (2.14-2.86 mg/g of fresh weight), days taken for flower senescence (13.00-17.00), number of petals per flower (46.00-66.00), petal breadth (0.70-0.96 cm), stalk length (27.00-42.00 cm), shelf life (2.40-3.90 days), vase life (3.80-5.50 days), flower yield per plot (1.30-2.10 kg) and germination percentage (36.00-53.00).

5.1.6 Paper flower (*Helichrysum bracteatum* L.)

The variability estimates in parameters were high, moderate, and low. In this winter annual, significant variations were recorded for various characters *viz*. Vase life (11.00-18.20 days), shelf life (3.00-4.80 days), petal length (0.60-1.05 cm), total chlorophyll (1.30-2.06 mg/g of fresh weight), germination percentage (42.50-76.00), petiole length (3.80-6.80 cm), number of flowering stems per plant (5.00-12.00), petal breadth (0.25-0.75 cm), seed yield per plant (2.80-10.50 g), number of flowers per plant (12.00-38.00) recorded a wide range of variations with the highest coefficient of variation and have a better scope of improvement through modification of cultural practices. The vase life (11.00-18.20 days) was recorded highest among the annuals under study; this may be due to the strong genetic characteristic of *Helichrysum***.** Kumar *et al*. (2011) reported that the seed yield of an open-pollinated variety of *Helichrysum bracteatum* is 80-90 kg/acre. The parameters *viz*. plant height (78.00-108.00 cm), Plant spread N-S and E-W (23.00-36.00 and 31.00-39.00 cm), leaf length (8.50-18.30 cm), leaf breadth (1.50-3.40 cm), number of leaves (84.00-112.00), leaf area (1712.10-2052.50 cm^2), days taken for 50 per cent flowering (49.00-58.00), days taken for marketable flower harvest (46.00-55.00), and duration of flowering (59.00-72.00 days) recorded least variability with petite values of coefficient of variation. This constricted range of variation indicates constancy of observations with the least chances of improvement. According to vishnuswarup (1995) plants of *Helichrysum* are 75.00-90.00 cm tall, with flower size of about 7.00 cm and days taken for flowering is about 105-120. Reticent variability was evident in parameters *viz*. Fresh weight (216.00-304.00 g), total dry matter production at peak flowering stage (42.10-63.50 g), days taken for FBI (35.00-43.00), diameter of flower (5.10-6.30 cm), number of petals per flower (121.00-183.00), stalk length (62.00-79.00 cm), days taken for flower senescence (17.00-24.50), flower yield per plant (56.00-87.00 g) and flower yield per plot (1.55-1.92 kg) recorded moderate coefficient of variation. The days taken for flower senescence in plant was maximum in helichrysum when compared to other

annuals under study. This may be due to the genetic and morphological characteristic of Helichrysum, which makes its suitability as a dry flower.

5.1.7 Lupine (*Lupinus hartwegii* Lindl.)

The estimates of variation in parameters were high, moderate, and low. Here, considerable variations were found in these characters *viz*. The number of flowering stems per plant (16.00-34.00), number of flowers per plant (88.00-167.00), diameter of flower (1.20-2.15 cm), petal length (1.30-2.10 cm), petiole length (0.60-1.20 cm), vase life (2.70-4.60 days), flower yield per plant and plot (47.00-85.00 g and 0.90-1.40 kg) and seed yield per plant and per plot (17.30-47.80 g and 0.55-0.96 kg) recorded scope of improvement through modification of production technology due to wide range of variations. Foliar application of Fe or the mixture of Fe + Mn +Zn significantly increased plant dry weight, number of branches, number of pods, seed yield in lupin. (Tawfik, 1997). On the other hand, it is evident from the data that Plant height, Plant spread N-S and E-W, leaf length, leaf breadth, leaf area, days taken for FBI, days taken for 50 per cent flowering, days taken for marketable flower harvest, and a number of petals per flower recorded the least variability with petite values of coefficient of variation. Ranges for these parameters are 48.00-71.00 cm, 23.00-38.20 and 27.00-41.50 cm, 4.50-7.00 cm, 0.90-1.70 cm, 3852.00-4329.50 cm^2, 62.00-72.00 days, 74.00-83.00 days, 73.50-81.00 days and 5.00-5.00. These slender ranges of variations clearly indicate the steadiness of observations with a minimum probability of improvement through production technology and environment manipulation. A moderate range of observations were found in parameters *viz*. number of leaves (75.00-133.00), fresh weight (226.00-337.00 g), total dry matter production (35.30-51.60 g), duration of flowering (52.00-73.00), days taken for flower senescence (3.50-4.80 days), petal breadth (0.70-1.10 cm), stalk length (47.00-68.40 cm) and germination percentage (76.00-97.00) and shelf life (1.50-2.20 days).

5.1.8 Salvia (*Salvia splendens* L.)

The variability estimates in parameters were high, moderate, and low. In this winter annual, significant variations were recorded for various characters *viz*. Total dry matter production (3.35-4.20 mg/g of fresh weight), number of flowering stems per plant (12.00-21.00), petal length (2.30-4.10 cm), petiole length (0.35-0.80 cm), stalk length (14.50-27.00 cm), flower yield per plant (34.00-66.00 g), shelf life (1.00-2.10 days), vase life (2.00-3.50 days), seed yield per plant and per plot (1.30-3.70 g and 0.05-0.08 kg) and germination percentage (6.20-13.00). The parameters mentioned above, which had higher variations with a maximum coefficient of variation, need a scope of improvement through fine-tuning of production technology along with the cultural practices, nutrition, breeding, etc. Mohanty *et al*. 2002 revealed that the days required for flowering was prolonged with the application of nitrogen (30 g/ m^2) in marigold. In contrast, plant height, plant spread N-S and E-W,

leaf length, leaf breadth, number of leaves, leaf area, days taken for 50 per cent flowering, days taken for marketable flower harvest and number of petals per flower were most consistent characters having a narrow range as 22.00-38.50 cm, 25.00-41.50 and 27.50-34.60 cm, 4.70-8.10 cm, 4.25-6.20 cm, 88.00-162.00, 2165.22-2605.80 cm^2, 60.50-69.50 days, 54.50-63.00) and 2.00-2.00 respectively, with least chances of improvement. Sharma (2012) revealed that among the different treatments, GA3@20 mg/l was found to be the best for maximizing seedling emergence percentage, plant height, plant spread, earliest first flowering, number of flowers per plant, number of capsules per plant in pansy. Reticent variability was evident in parameters *viz*. Fresh weight (146.20-194.50 g), total chlorophyll (3.35-4.20 mg/g of fresh weight), days taken for FBI (42.50-53.00 days), duration of flowering (36.00-49.50 days), number of flowers per plant (76.00-122.00), diameter of flower (0.90-1.42 cm), petal breadth (1.10-1.60 cm) which recorded moderate coefficient of variation.

5.1.9 Sweet pea (*Lathyrus odoratus* L.)

The estimates of variation in parameters were high, moderate, and low. In this annual, substantial variations were recorded for these parameters *viz*. Days taken for flower senescence (5.50-9.00 days), number of flowering stems per plant (13.00-32.00), number of flowers per plant (47.00-85.00), petal length (1.40-3.20 cm), petiole length (0.70-2.70 cm), stalk length (10.20-16.50 cm), flower yield per plant and per plot (26.40-57.00 gm and 0.76-1.36 kg) and seed yield per plant (31.60-64.20 g). These parameters recorded a wide range of variations and have a better scope of improvement through the sophistication of cultural practices. Morteza *et al*. (2009) obtained the maximum number of flowering stems per plant in valerian (*Valeriana officinalis* L.) when planted on August 10 as compared to late planting, i.e., September 1 and September 20. Florincescu and Zaharia (1995) studied the variability of ornamental characteristics in four cultivars and three species of Lathyrus and revealed that the number of flowers per inflorescence was higher in *Lathyrus latifolius* and the flower size was more significant in *L. Odoratus*. On the contrary, it is in the plain sight from the data that plant height (71.50-110.00 cm), Plant spread N-S and E-W (25.60-35.50 cm and 28.50-38.00 cm), leaf length (4.20-5.60 cm), leaf breadth (1.90-2.40 cm), number of leaves (169.00-254.00 cm), leaf area (1450.00-1602.00 cm^2), days taken for 50 per cent flowering (55.00-61.00 days), days taken for marketable flower harvest (52.00-58.00 days) and number of petals per flower (5.00-5.00) recorded the lowest probability of improvement with diminutive values of coefficient of variation. These slender ranges of variations clearly indicate the steadiness of observations with a minimum likelihood of improvement through production technology and environment manipulation. A moderate range of observations were found in parameters *viz*. Total dry matter production (14.10-17.60 g), total chlorophyll (1.55-2.60 mg/g of fresh weight), days taken for FBI (38.00-44.00 days), fresh weight (53.50-78.40 g), duration

of flowering (36.00-43.00 days), diameter of flower (2.30-3.10 cm), petal breadth (1.20-1.80 cm), germination percentage (83.00-96.20), seed yield per plot (1.25-1.90 kg), shelf life (1.00-2.20 days) and vase life (2.10-3.50 days).

5.1.10 Sweet William (*Dianthus barbatus* L.)

The estimates of variation in parameters were high, moderate and low. In this winter annual, significant variations were recorded for various characters *viz*. Fresh weight (76.70-119.30 g), petal length (1.10-1.80 cm), petiole length (4.10-7.60 cm), shelf life (1.10-2.30 days), stalk length (14.50-32.00 cm), flower yield per plant (29.30-72.40 g), vase life (2.00-4.10 days), flower yield per plot (0.80-1.30 kg), seed yield per plant and plot (1.86-3.50 g and 0.07-0.13 kg). This data shows the scope of improvement through modification of production technology and environment manipulation due to a wide range of variations. With an increase in temperature (14, 17, 20, and 23° C), days taken for flowering increased (40, 47, 56, and 70 days respectively) in Dianthus and (25, 29, 33, and 40 days respectively) in Snapdragon (Blanchard and Runkel, 2009). The September 17 planting resulted in increased earliest flowering, duration of flowering, number of flowers per stem, number of capsules per plant, and seed yield per plant in *Dianthus barbatus* L. (Sharma *et al*., 2015). On contrary, it is apparent from the data that plant height (24.00-33.40 cm), Plant spread N-S and E-W (19.10-31.50 cm and 21.00-29.50 cm), leaf length (7.60-14.10 cm), leaf breadth (1.20-1.80 cm), number of leaves (65.00-96.00 cm), total chlorophyll (3.30-3.86 mg/g of fresh weight), days taken for 50 per cent flowering (59.00-64.00 days), days taken for marketable flower harvest (60.00-51.00 days), number of petals per flower (5.00) and germination percentage (0.00 recorded less variation with diminutive values of coefficient of variation. This narrow range of variation indicates constancy of observations with the least chances of improvement. A moderate range of observations were found in parameters *viz*. Leaf area (705.05-922.50 cm^2), total dry matter production (15.40-23.80 g), days taken for FBI (33.00-42.00 days), duration of flowering (52.00-66.00 days), days taken for flower senescence (7.00-9.50 days), number of flowering stems per plant (36.00-52.00), number of flowers per plant (142.00-178.00), diameter of flower (2.10-2.90 cm) and petal breadth (1.20-1.60 cm). Azharuddin *et al*. (2017) reported that the benefit-cost ratio and net returns were maximum (1:2.75 and Rs.72, 004 /ha, respectively) in S2N1P1K (30x30 cm and 10:10:10g NPK/m^2) in Sweet William (*Dianthus barbatus*)

5.1.11 Golden everlasting [*Xerochrysum viscosum* (Seiber ex DC.)]

The variability estimates in parameters were high, moderate, and low. In this annual, substantial variations were recorded for these parameters *viz*. Flower yield per plant (21.80-39.60 g), petal breadth (0.30-0.70 cm), number of flowering stems per plant (5.65-13.20), shelf life (1.20-3.00 days), stalk length (17.00-31.40 cm), flower yield per plot (0.60-1.10 kg), number of flowers per plant (6.40-32.00), germination

percentage (46.00-69.50), seed yield per plant and plot (0.20-0.40 gm and 0.05-0.10 kg). These parameters recorded a wide range of variations and have a better scope of improvement through the sophistication of cultural practices. On the other hand, the parameters *viz*. plant height, plant spread N-S and E-W, leaf length, leaf breadth, number of leaves, total chlorophyll, days taken for 50 per cent flowering, days taken for marketable flower harvest, duration of flowering, days taken for flower senescence recorded the least variability with petite values of coefficient of variation. Ranges for these parameters were 19.50-33.60 cm, 26.00-41.50 cm and 28.00-38.00 cm, 7.40-12.50 cm, 1.70-3.10 cm, 19.00-58.00, 1.25-1.68 mg/g of fresh weight, 51.00-57.00 days, 47.00-54.00 days, 42.00-49.00 days, 16.00-21.00 days, respectively. This narrow range of variation indicates constancy of observations with the least chances of improvement. It shows that the manipulation of growing factors can improve these parameters also. The statement could be supported by the findings of Sharma (2013) that more number of stems per plant resulted in more spread of the plants. Sainath *et al*. (2012) stated that the application of GA_3 @ 200 ppm resulted in significantly higher plant height, a number of branches , leaf area, dry weight, and maximum flower yield per plant in *Chrysanthemum coronarium* L. Moderate range of observations were found in parameters *viz*. Leaf area (322.05-504.10 cm^2), total dry matter production per plant at peak flowering stage (29.20-46.80 g), days taken for FBI (32.00-44.00 days), diameter of flower (3.10-4.30 cm), number of petals per flower (22.00-35.00) and petal length (0.70-1.00 cm)

5.1.12 Zinnia (*Zinnia elegens* Jacq.)

The estimates of variation in parameters were high, moderate and low. In this winter annual, significant variations were recorded for various characters *viz*. Number of flowers per plant (18.00-43.00), fresh weight (75.60-118.40 g), total dry matter production at peak flowering stage (14.40-22.80 g), petal breadth (0.70-1.20 cm), shelf life (1.20-2.30 days), number of petals per flower (14.00-26.00), vase life (2.00-4.10 days), flower yield per plant (27.50-62.40 g) and seed yield per plot (0.18-0.33 kg). These parameters, which had higher variations, had a scope of improvement through fine-tuning of production technology along with the cultural practices, nutrition, breeding, etc. On the contrary, it is evident from the data that plant height, Plant spread N-S and E-W, leaf length, leaf breadth, number of leaves, total chlorophyll, days taken for 50 per cent flowering, days taken for marketable flower harvest recorded least variations. Ranges for these observations are 24.50-39.80 cm, 19.30-30.50 cm and 21.00-28.50 cm, 3.00-5.80 cm, 2.20-3.90 cm, 47.00-81.00 cm, 3.62-3.80 mg per g of fresh weight, 32.00-39.00 days, 29.00-34.00 days, respectively. These slender ranges of variations clearly indicate the steadiness of observations with a minimum probability of improvement through production technology and environment manipulation. A moderate range of observations were found in parameters

viz. Leaf area (379.00-486.30 cm^2), days taken for flower bud initiation (20.00-26.00 days), duration of flowering (30.00-39.00 days), days taken for flower senescence (8.00-11.00 days), number of flowering stems per plant (12.00-17.00), petal length (1.30-1.70 cm), flower yield per plot (1.20-1.62 kg), petiole length (3.10-4.70 cm), diameter of flower (4.10-5.40 cm), stalk length (17.50-28.00 cm), flower yield per plot (1.20-1.62 kg), germination percentage (64.00-83.00) and seed yield per plant (3.10-4.70 g). The similar results were observed in Zinnia by Al-atrakchii *et al*. (2010) and (Baloch *et al*. 2010).

5.2 Comparison of seasonal annuals for various growth, flowering, and yield parameters

Data recorded on various growth parameters has been depicted through Fig. 2, which reveals a significant difference in plant height, plant spread (N-S), plant spread (E-W), and number of leaves of different winter annuals. It is clear from Fig. 1 that maximum plant height was observed in *Chrysanthemum coronarium* (111.01 cm) followed by *Lathyrus odoratus* (91.68 cm) and minimum plant height was recorded in *Dianthus barbatus* (25.81 cm) followed by *Xerochrysum viscosum* (27.69 cm). Among all the crops under observation, maximum plant spread (N-S) was recorded in *Chrysanthemum coronarium* (44.82 cm), followed by *Calendula officinalis* (42.77 cm), and minimum plant spread (N-S) was recorded in Zinnia elegens (23.76 cm). The parameter, plant spread (E-W), was recorded maximum in *Chrysanthemum coronarium* (45.21 cm) followed by *Gomphrena globosa* (44.10 cm) and the minimum was recorded in *Cosmos bipinnatus* (23.99 cm) followed by *Zinnia elegens* (25.63 cm). Among all the crops, the maximum number of leaves was recorded in *Lathyrus odoratus* (221.54), followed by *Chrysanthemum coronarium* (215.19).

The above results are in conformity with the results of Priya (2013), who reported that plants of *Chrysanthemum coronarium* on 17th September resulted in the tallest plants (120.29 cm) having maximum spread (55.50 cm). Mittal (2013) stated that the plant height of *Dianthus chinensis* ranged from 21.50 cm – 27.90 cm. Dharmendra *et al*. (2019) reported that *Callistephus chinensis* cv Phule Ganesh White recorded the highest number of leaves (192.05). Sainath *et al*. (2012) stated that the application of GA3 @ 200 ppm in annual chrysanthemum (*Chrysanthemum coronarium* L.) resulted in significantly higher plant height (97.28 cm) and a number of branches (27.32).

Data observed on various flowering parameters, as depicted in Fig. 3 reveals that minimum days taken for flower bud initiation and days taken for 50 per cent flowering was observed in *Cosmos bipinnatus* (18.65, 25.72) followed by *Zinnia elegens* (22.48, 36.12), respectively. whereas, maximum days taken for flower bud initiation was observed in *Lupinus hartwegii* (65.83) followed by *Gomphrena globosa* (51.88) and maximum days taken for 50 per cent flowering was observed in *Lupinus hartwegii* (79.35) followed by *Salvia splendens* (65.43). The duration of

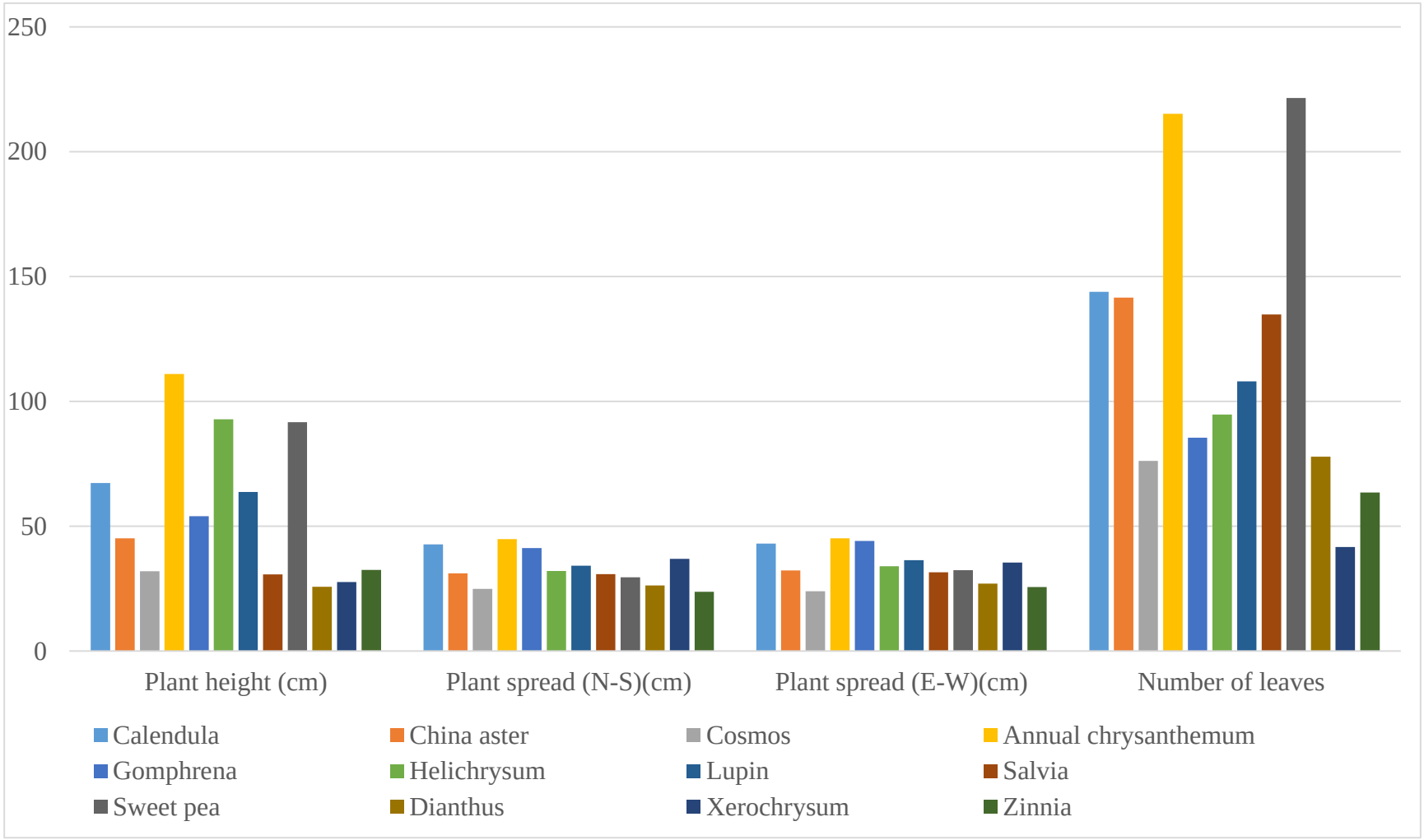


Fig. 2 Comparison of seasonal ornamentals for various vegetative parameters.

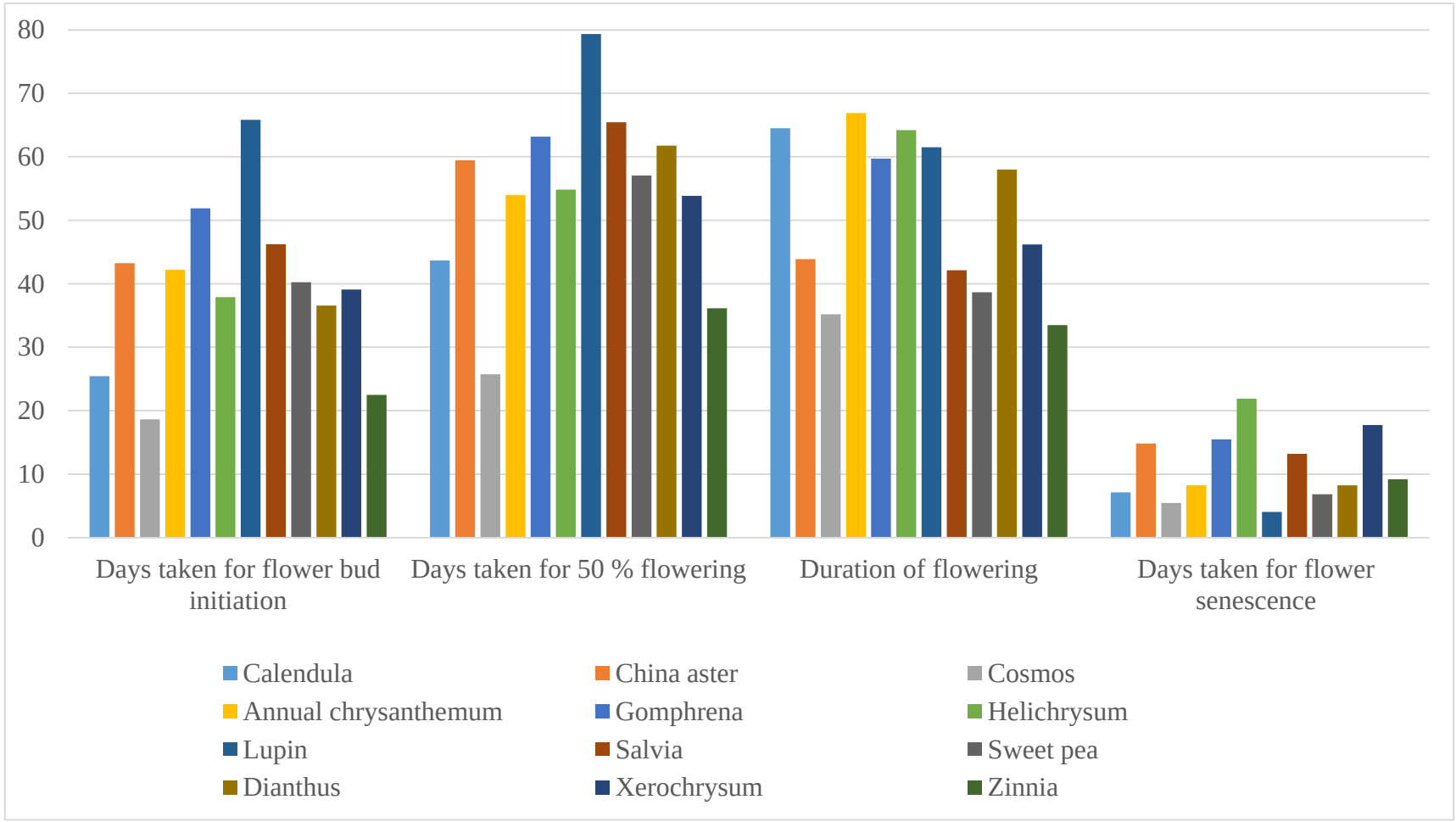


Fig. 3 Comparison of seasonal annuals for various flowering parameters.

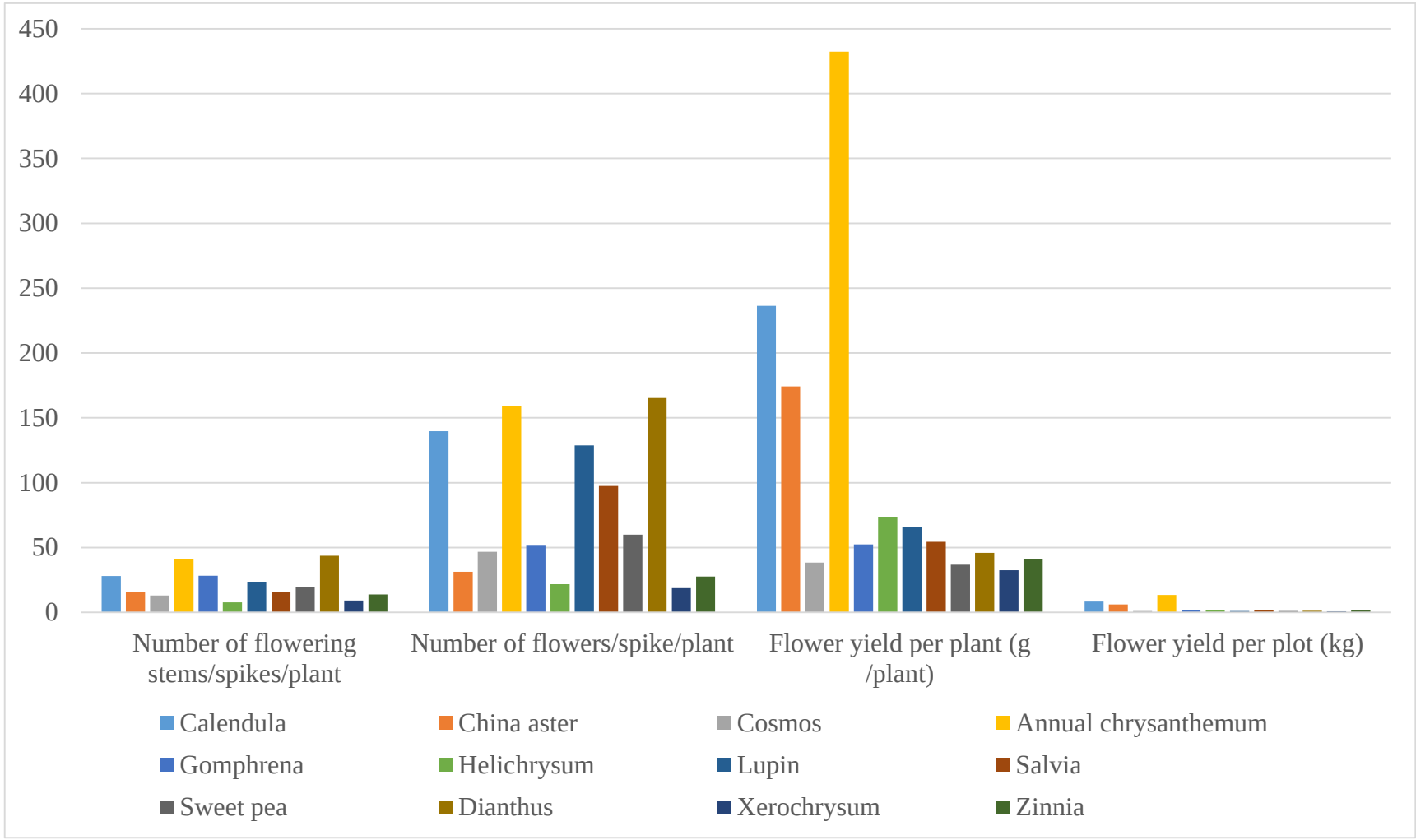


Fig. 4 Comparison of seasonal ornamentals for various flower yield parameters.

flowering was maximum in *Chrysanthemum coronarium* (66.90) followed by *Calendula officinalis* (64.50) and minimum in *Zinnia elegens* (33.50) followed by *Cosmos bipinnatus* (35.18).

Days taken for flower senescence in the plant was maximum in *Helichrysum bracteatum* (21.88) followed by *Xerochrysum bracteatum* (17.75) and minimum in *Lupinus hartwegii* (4.05) followed by *Cosmos bipinnatus* (5.47). Mittal (2013) reported that the duration of flowering of *Calendula officinalis* and *Chrysanthemum coronarium* ranged from 61.00-71.00 and 68.00-89.00 days, respectively. Bhattarai (2014) stated that *Helichrysum bracteatum* took 21.84 days from blooming to wilting.

Data recorded on various growth parameters has been depicted through Fig. 4, which reveals a significant difference in the number of flowering stems /spikes per plant, number of flowers/spike per plant, flower yield per plant, and flower yield per plot of different winter annuals. It is clear from Fig. 3 that the maximum number of flowering stems/spikes/plant was observed in *Dianthus barbatus* (43.75), followed by *Chrysanthemum coronarium* (40.85), and the minimum number of flowering stems per plant were recorded in *Helichrysum bracteatum* (7.62), followed by *Xerochrysum viscosum* (9.20). Among all the crops under observation, the maximum number of flowers/spike/plant was observed in *Dianthus barbatus* (165.26), followed by *Chrysanthemum coronarium* (159.25) and *Calendula officinalis* (139.80). The minimum number of flowers/spike per plant was recorded in *Xerochrysum viscosum* (18.68), followed by *Helichrysum bracteatum* (21.82). Among all the seasonal annuals under observation, the highest flower yield per plant and plot was observed in *Chrysanthemum coronarium* (432.44 g, 13.45 kg), followed by *Calendula officinalis* (236.28 g, 8.23 kg) and *Callistephus chinensis* (174.25 g, 6.19 kg). The minimum flower yield per plant was observed in *Xerochrysum bracteatum* (35.52 gm) followed by *Lathyrus odoratus* (36.80 g), and minimum flower yield per plot was recorded in *Xerochrysum viscosum* (0.85 kg) followed by *Cosmos bipinnatus* (1.08 kg).

The above results are in conformity with results of Kabir *et al*. (2007) revealed that black plastic mulch showed better performance with the maximum number of flowers (178) in *Dianthus chinensis*. Mittal (2013) reported the number of flower heads per plant in *Chrysanthemum coronarium* was 392.87, and in *Calendula officinalis* was 144.33. Sainath *et al*. (2012) stated that the application of GA_3 @ 200 ppm in annual chrysanthemum (*Chrysanthemum coronarium* L.) resulted in significantly higher flower yield per plant (498.6 g). Kumari *et al*. (2017) revealed that hybrid-8 recorded the highest number of flowers per plant (93.66), highest weight of flowers per plant (293.00 gm), and flower yield per hectare (24.68 tonnes).

Data observed on various flowering parameters, as depicted in Fig. 5 reveals that maximum shelf life was recorded in *Callistephus chinensis* (4.68), followed by *Helichrysum bracteatum* (3.71). The maximum vase life was observed in Helichrysum

bracteatum (14.85), followed by *Callistephus chinensis* (8.10). The minimum shelf and vase life was recorded in *Cosmos bipinnatus* (0.98, 1.75 days). Bhargav *et al*. (2019) reported that the genotype IIHRG13 recorded maximum vase life (9.50 days), while maximum shelf life (4.42 days) was recorded in IIHRH3 in *Callistephus chinensis*.

Fig. 6 shows the Benefit-Cost Ratio of seasonal annuals for flower and seed production, wherein some annuals which are suitable for loose flower production are utilized for flower harvest and marketing. Only the 1st harvest is being used for flower marketing rest of flowers are utilized for seed production. The cost of cultivation and net returns details are presented in Appendix IV. The data shows that the maximum Benefit-Cost Ratio was recorded in *Calendula officinalis* (12.88), followed by *Chrysanthemum coronarium* (11.74), *Lathyrus odoratus* (9.55), and *Lupinus hartwegii* (9.07). The minimum Benefit-Cost Ratio was recorded in Salvia splendens (0.18). Mittal (2013) reported that maximum BCR (15.02) was found in *Chrysanthemum coronarium* L. and the minimum BCR (0.43) was recorded in *Viola* × *wittrockiana* Hort.

5.3 CONCLUSION

In the present study, twelve different winter annuals were evaluated for various growth, flowering, and seed parameters. The results of study revealed that the variability exists within the genotype in respect of growth characters, earliness, duration of flowering, quality of flowers, flower yield, and seed yield. The highest score (5.00) for cut flower suitability among the annuals was obtained in *Callistephus chinensis* (L.) Nees, *Gomphrena globosa* L., *Helichrysum bracteatum* L., followed by *Chrysanthemum coronarium* L. (4.76), and *Calendula officinalis* L. (4.22). The maximum score (5.00) for loose flower suitability was obtained in *Callistephus chinensis* L., *Chrysanthemum coronarium* L., followed by *Calendula officinalis* L. (4.74) and *Gomphrena globosa* L. (4.66). The winter annuals *viz*. *Chrysanthemum coronarium, Calendula officinalis*, Callistephus chinensis, were best suited for flower purposes. In the case of seed production, *Calendula officinalis, Chrysanthemum coronarium, Lathyrus odoratus, Lupinus hartwegii*, and *Callistephus chinensis* were recorded best of all winter annuals under study. *Chrysanthemum coronarium, Calendula officinalis*, *Lathyrus odoratus* and *Lupinus hartwegii* recorded the highest Benefit-Cost ratio with the best suitability for commercialization.

Future line of work

These winter annuals can be involved in a further evaluation program for improving quality, flower, and seed yield parameters. There is no standardized production technology in annual crops. Hence, there is a need to standardize the production technology for commercial cultivation and seed production of seasonals.

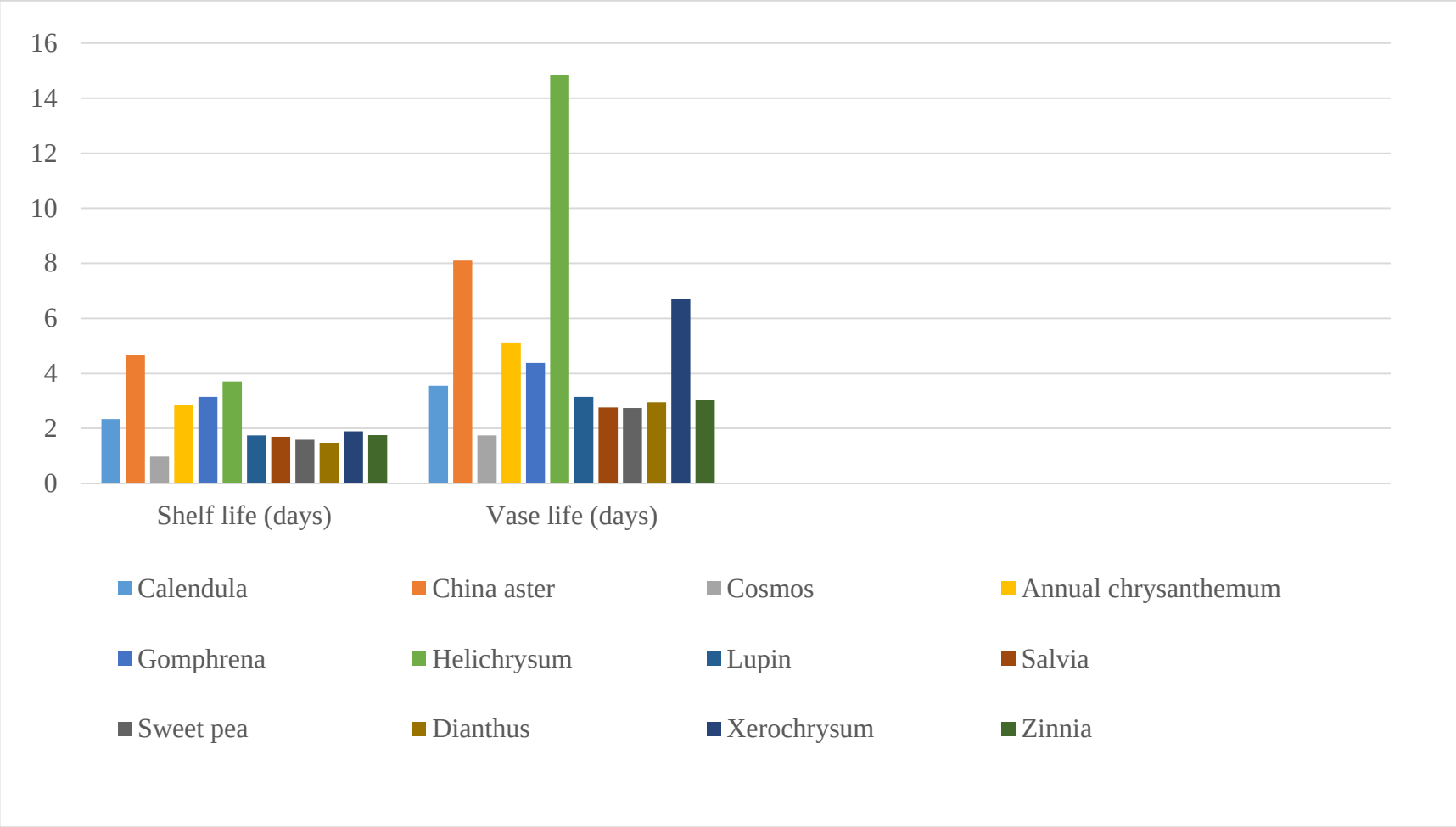


Fig. 5 Shelf life and vase life of winter annuals

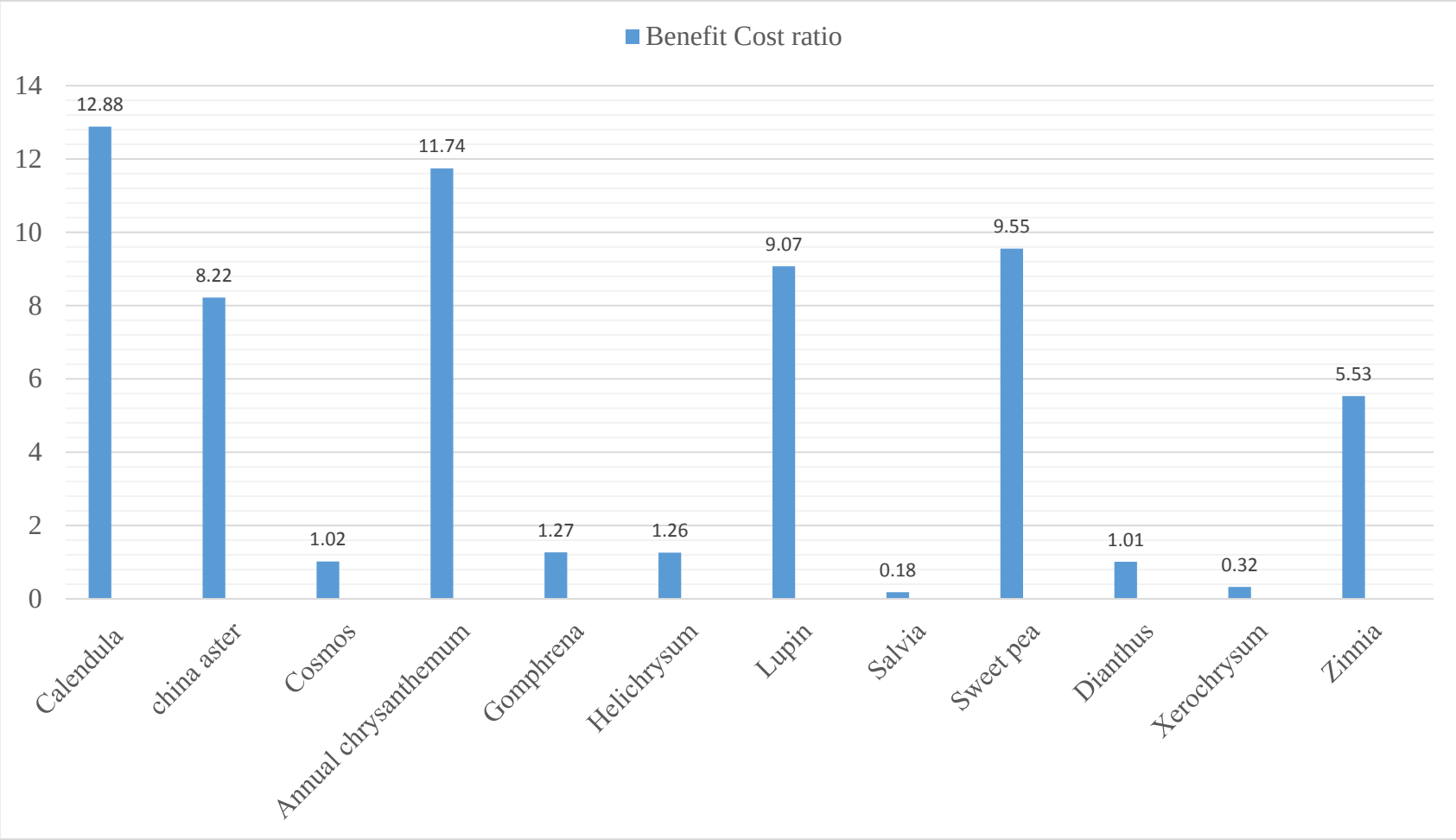


Fig. 6 Benefit-Cost ratio of winter annuals

Plate 4: Vase life, Shelf life of different winter annuals and Sensory evaluation of winter annuals for various attributes.

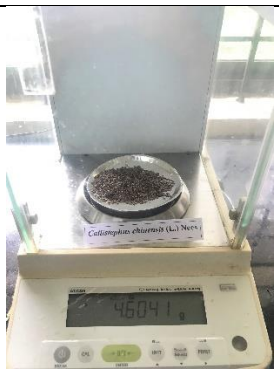
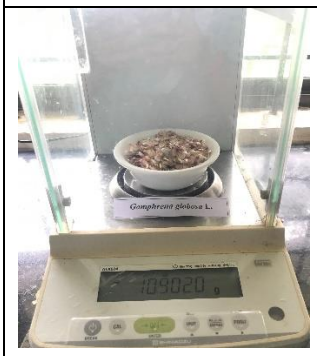
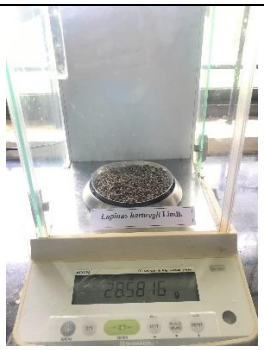
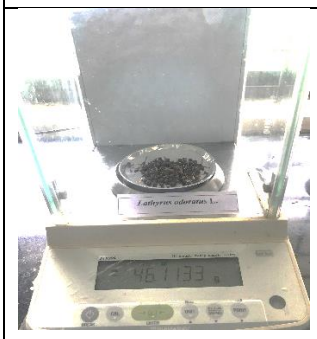
			
Calendula officinalis L.	*Callistephus chinensis* (L.) Nees	*Cosmos bipinnatus* L.	*Chrysanthemum coronarium* L.
			
Gomphrena globosa L.	*Helichrysum bracteatum* Andr.	*Lupinus hartwegii* Lindl.	*Salvia splendens* L.
			
Lathyrus odoratus L.	*Dianthus barbatus* L.	*Xerochrysum viscosum* Rx. Bayer	*Zinnia elegans* L.

Plate 5. Evaluation of different winter annuals on seed yield per plant

Plate 6. Morphological variations of annual seeds under study

SUMMARY

VI SUMMARY

The present investigation entitled "Studies on winter annuals for their growth, flowering, flower quality and yield under hill zone of Karnataka." was carried out in the experimental farm of Department of Floriculture and Landscape Architecture, College Of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga during 2019-2020. The studies were conducted on twelve winter annuals *viz*. *Calendula officinalis* L. (pot marigold), *Callistephus chinensis* (L.) Nees (China aster), *Cosmos bipinnatus* L. (Mexican aster), *Chrysanthemum coronarium* L. (annual chrysanthemum), *Gomphrena globosa* L. (globe amaranth), *Helichrysum bracteatum* Andr. (helichrysum or paper flower), *Lupinus hartwegii* Lindl. (lupin), *Salvia splendens* L. (salvia), *Lathyrus odoratus* L. (sweet pea), *Dianthus barbatus* L. (Sweet William), *Xerochrysum viscosum* R.X. Bayer (golden everlasting), *Zinnia elegens* Jacq. (zinnia). To evaluate their mean performance regarding growth, flowering, and seed production parameters. For experimenting, seedlings were raised during October, and transplanting was carried out during December. The observations recorded on various growth, flowering and seed parameters were analysed using descriptive statistical analysis using mean, range, standard error, and coefficient of variation.

The substantial variations were found for the number of flowering stems per plant, seed yield per plant, seed yield per plot, number of flowers per plant, number of flower spikes per plant, flower yield per plant, petiole length and number of petals per flower in different annuals indicating the wide range of variations and offer scope for improvement. Annuals which are having a high range of variation in the number of flowering stems per plant were *Callistephus chinensis*, *Cosmos bipinnatus*, *Chrysanthemum coronarium*, *Gomphrena globosa*, *Helichrysum bracteatum*, *Lathyrus odoratus,* and *Xerochrysum viscosum* and their coefficient of variation were recorded to be 22.84 %, 35.52 %, 20.89 %, 26.74 %, 50.14 %, 55.04 % and 41.25 %, respectively. Annuals that were having a high range of variation in seed yield per plant were *Calendula officinalis*, *Cosmos bipinnatus*, *Gomphrena globosa*, *Lupinus hartwegii* and *Salvia splendens,* and their coefficient of variation were recorded to be 41.38 %, 42.62 %, 51.66 %, 58.90 % and 63.19 %, respectively. Annuals which had higher variation in seed yield per plot were *Callistephus chinensis* and *Helichrysum bracteatum* and their respective CV were 54.80 % and 96.33 %. The parameter, number of flowers per plant had a wide range of variation in annuals *viz*., *Xerochrysum viscosum* and *Zinnia elegens* with a coefficient of variation 68.69 % and 49.02 %, respectively. The parameter, number of flower spikes per plant, had a wide range of variation in annuals *viz*., *Lupinus hartwegii* and *Salvia splendens* with CV 39.86 % and 29.59 %, respectively. *Dianthus barbatus* recorded maximum variability in flower yield per plant with a 50.68 % CV. *Lathyrus odoratus* recorded maximum

variability in petiole length with 75.15 CV. However, *Chrysanthemum coronarium* indicated opportunities for enhancement in the number of petals per flower with 32.78 % CV.

The minimum variations were recorded for plant height, plant spread (N-S), plant spread (E-W), leaf length and leaf breadth in different annuals. Annuals that were having less range of variations in plant height were *Callistephus chinensis*, *Lupinus hartwegii* and *Gomphrena globosa*, and their coefficient of variation were recorded to be 1.94 %, 0.98 % and 0.64 %, respectively. Annuals which had less variations in plant spread (E-W) were *Helichrysum bracteatum*, *Lathyrus odoratus*, and *Zinnia elegens* and their CV are 1.25 %, 0.76 % and 1.09 % respectively. The parameter, plant spread (N-S), had minimum variation in annuals *viz*. *Cosmos bipinnatus* and *Chrysanthemum coronarium* with a coefficient of variation of 1.96 % and 1.04 %, respectively. The parameter, leaf length, had minimum variation in annuals *viz*: *Calendula officinalis* and *Salvia splendens* with CV 1.54 % and 0.38 %, respectively. The annuals which had minimum variation in leaf breadth were *Dianthus barbatus* and *Xerochrysum viscosum* with CV 0.38 % and 0.46 %, respectively. These narrow ranges of variations indicate the steadiness of observations with a minimum probability of improvement through production technology and environment manipulation. This data suggests that minimum variations were recorded in the vegetative parameters, and the substantial variations were noted in flower and seed yield parameters.

The various attributes of seasonal annuals like flower color, cut flower suitability, and loose flower suitability have been scored using a 1-5 hedonic scale. The highest score for cut flower suitability among the annuals was obtained in *Callistephus chinensis* (5.00), *Gomphrena globosa* (5.00), *Helichrysum bracteatum* (5.00), followed by *Chrysanthemum coronarium* (4.76), and *Calendula officinalis* (4.22). The maximum score for loose flower suitability was obtained in *Callistephus chinensis* (5.00), *Chrysanthemum coronarium* (5.00), followed by *Calendula officinalis* (4.74), and *Gomphrena globosa* (4.66). The maximum score for overall acceptance was obtained in *Callistephus chinensis* (5.00), *Chrysanthemum coronarium* (5.00), followed by *Gomphrena globosa* (4.92), and *Calendula officinalis* (4.88). The maximum score for flower color was obtained in *Dianthus barbatus* (5.00), followed by *Salvia splendens* (4.90), *Helichrysum bracteatum* (4.82).

While comparing different seasonal annuals for various parameters, it was found that minimum days taken for flower bud initiation and days taken for 50 per cent flowering was observed in *Cosmos bipinnatus* (18.65, 25.72 days) followed by *Zinnia elegens* (22.48, 36.12 days). The duration of flowering was maximum in *Chrysanthemum coronarium* (66.90 days), followed by *Calendula officinalis* (64.50 days) and minimum in *Zinnia elegens* (33.50) and

Cosmos bipinnatus (35.18). The days taken for flower senescence in the plant were maximum in *Helichrysum bracteatum* (21.88). The maximum number of flowers/plant was observed in *Dianthus barbatus* (165.26), followed by *Chrysanthemum coronarium* (159.25), *Calendula officinalis* (139.80). The highest flower yield per plant and per plot was observed in *Chrysanthemum coronarium* (432.44 gm, 13.45 kg), followed by *Calendula officinalis* (236.28 gm, 8.23 kg) and *Callistephus chinensis* (174.25 gm, 6.19 kg). The maximum shelf life was recorded in *Callistephus chinensis* (4.68), followed by *Helichrysum bracteatum* (3.71). The maximum vase life was observed in Helichrysum bracteatum (14.85), followed by *Callistephus chinensis* (8.10). The maximum seed yield per plant and plot was recorded in *Chrysanthemum coronarium* (79.13 g, 2.83 kg), followed by *Calendula officinalis* (56.22 g, 1.68 kg). The maximum Benefit-Cost Ratio was recorded in *Calendula officinalis* (14.67), followed by *Lathyrus odoratus* (12.19), *Chrysanthemum coronarium* (11.74) and *Lupinus hartwegii* (9.07).

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APPENDICES

VIII APPENDICES

APPENDIX-1

Monthly mean meteorological data recorded during the experimental year 2019–20 recorded at the ZAHRS, Mudigere

Month	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)	
		Maximum	Minimum	Maximum	Minimum
January-2019	0.00	28.90	18.12	80.45	24.96
February -2019	9.30	30.75	18.71	82.28	61.35
March-2019	0.00	34.16	19.51	80.45	60.80
April-2019	52.30	32.00	18.50	80.73	60.66
May-2019	83.30	30.06	18.54	82.19	60.5
June-2019	273.70	27.03	18.26	80.53	61.13
July-2019	740.20	25.16	19.70	75.38	63.67
August-2019	1402.70	24.62	19.74	73.61	63.70
September-2019	525.30	25.26	19.83	79.83	60.53
October-2019	329.30	26.25	19.58	80.19	60.96
November-2019	26.30	29.00	18.933	80.26	60.133
December-2019	1.40	28.64	19.00	80.12	60.25
January-2020	0.00	29.00	18.06	80.00	60.12
February-2020	0.00	30.27	17.34	80.41	60.82
March-2020	2.30	32.70	18.61	80.25	60.64
Total	3446.10	-	-	-	-
Mean	229.74	28.92	18.83	79.78	58.68

Appendix- II

Soil physical and chemical properties of the experimental site

Particulars	**Values**	**Method adopted**
Physical properties		
Soil texture	Red Sandy Clay Loam	International pipette method (Piper, 1966)
Sand (%)	40.4	
Fine sand (%)	30.1	
Silt (%)	17.6	
Clay (%)	10.4	
Chemical properties		
Available nitrogen (kg/ha)	312.40	Alkaline permanganate method (Subbaiah and Asija, 1956)
Available phosphorus (kg/ ha)	9.80	Bray's Extractant No-1 method (Jackson,1973)
Available potassium (kg /ha)	112.50	Neutral Normal Ammonium Acetate method (Jackson, 1973).
Organic carbon (g /kg)	0.98	Walkey and Black's method, 1965
Soil pH	6.60	pH meter (Jackson, 1973)
EC dS/m at 25oC	0.35	Conductivity bridge (Jackson, 1973)

APPENDIX III

Scorecard for different parameters of annuals (1-5 hedonic scale)

Flower color		**Cut flower suitability**		**Loose flower suitability**		**Overall Acceptance**	
5	Extremely attractive	5	Highly Suitable	5	Highly Suitable	5	Excellent
4	Attractive	4	Suitable	4	Suitable	4	Very good
3	Moderately attractive	3	Moderately Suitable	3	Moderately Suitable	3	Good
2	Less attractive	2	Less Suitable	2	Less Suitable	2	Fair
1	Not attractive	1	Not Suitable	1	Not Suitable	1	Dislike

APPENDIX IV

Cost of cultivation and Benefit-Cost Ratio of seasonal annuals

a) Cost of flower and seed production of *Calendula officinalis* L. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	8960	50/100 seedlings	6720
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i) Urea	24.35 kg	5.52/kg	134.41
ii) SSP	70 kg	8/kg	560
iii) MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	12 man days	300/day	2,400
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of flowers and Seeds	5 man-days	300/day	1,500
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 19,681.41
C. Total yield of flowers			1075.20 kg
D. Total yield of seeds			503.73 kg
Total returns when the sale price is Rs. 20/kg of flowers.			Rs. 21,504
Total returns when the sale price is Rs. 500/kg of seeds			Rs. 2,51,865
E. Net returns (D-B)			Rs. 2,53,687.59
F. Benefit: Cost ratio			**12.88**

b) Cost of flower and seed production of *Callistephus chinensis* (L.) Nees. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	8960	150/100 seedlings	13,440
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	31.30 kg	5.52/kg	172.77
ii. SSP	30 kg	8/kg	240
iii. MOP	8 kg	20/kg	160
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	10 man-days	300/day	3,000
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of flowers and Seeds	5 man-days	300/day	1,500
5. Threshing and cleaning of seeds	4 man-days	300/day	1,200
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 27,099.77
C. Total yield of flowers			389.76 kg
D. Total yield of seeds			39.72 kg
Total returns when the sale price is Rs. 30/kg of flowers			Rs. 11,692.80
Total returns when the sale price is Rs. 6000/kg			Rs. 2,38,320
E. Net returns (D-B)			Rs. 2,22,913.03
F. Benefit: Cost ratio			**8.22**

c) Cost of flower and seed production of *Cosmos bipinnatus* Baill. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	12800	50/100 seedlings	6,400
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	6 man-days	300/day	1800
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of seeds	2 man-days	300/day	600
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 17,861.41
C. Total yield of seeds			76.54 kg
Total returns when the sale price is Rs. 500/kg			Rs. 38,270.00
E. Net returns (D-B)			Rs. 20,408.59
F. Benefit: Cost ratio			**1.14**

d) Cost of flower and seed production of *Chrysanthemum coronarium* L. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	5140	75/100 seedlings	3,855
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	10 man-days	300/day	3,000
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of flowers and Seeds	10 man-days	300/day	3,000
5. Threshing and cleaning of seeds	4 man-days	300/day	1,200
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 19,516.41
C. Total yield of flowers			555.12 kg
D. Total yield of seeds			406.72 kg
Total returns when the sale price is Rs. 45/kg of flowers			Rs. 24,980.40
Total returns when the sale price is Rs. 550/kg of seeds			Rs. 2,23,696
E. Net returns (D-B)			Rs. 2,29,159.99
F. Benefit: Cost ratio			**11.74**

e) Cost of flower and seed production of *Gomphrena globosa* L. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	8960	75/100 seedlings	6,720
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	10 man-days	300/day	3000
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of flowers and Seeds	4 man-days	300/day	1,200
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 19,981.41
C. Total yield of flowers			159.52 kg
D. Total yield of seeds			67.80 kg
Total returns when the sale price is Rs. 30/kg of flowers			Rs. 4,785.60
Total returns when the sale price is Rs. 600/kg of seeds			Rs. 40,680
D. Net returns (D-B)			Rs. 25,484.19
E. Benefit: Cost ratio			**1.27**

f) Cost of flower and seed production of *Helichrysum bracteatum* Andr. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	8960	75/100 seedlings	6,720
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	3 man-days	300/day	900
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	8 man-days	300/day	2,400
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of flowers and Seeds	4 man-days	300/day	1,200
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 19,081.41
C. Total yield of flowers			163.52 kg
D. Total yield of seeds			63.79 kg
Total returns when the sale price is Rs. 30/kg of flowers			Rs. 4,905.60
Total returns when the sale price is Rs. 600/kg of seeds			Rs. 38,274
E. Net returns (D-B)			Rs. 24,098.19
F. Benefit: Cost ratio			**1.26**

g) Cost of seed production of *Lupinus hartwegii* Lindl. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	14000	75/100 seedlings	10,500
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	10 man-days	300/day	3,000
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of Seeds	4 man-days	300/day	1,200
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 23,761.41
C. Total yield of seeds			399 kg
Total returns when the sale price is Rs. 600/kg of seeds			Rs. 2,39,400
D. Net returns (D-B)			Rs. 2,15,638.59
E. Benefit: Cost ratio			**9.07**

h) Cost of seed production of *Salvia splendens* L. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	8960	75/100 seedlings	6,720
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	8 man-days	300/day	2,400
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of Seeds	4 man-days	300/day	1,200
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 19,381
C. Total yield of seeds			19.17 kg
Total returns when the sale price is Rs. 1200/kg of seeds			Rs. 23,004
D. Net returns (D-B)			3,623
E. Benefit: Cost ratio			**0.18**

i) Cost of seed production of *Lathyrus odoratus* L. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	2 man-days	300/day	600
c. Planting material (Seedlings)	8960	75/100 seedlings	6,720
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	2 man-days	300/day	600
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	8 man-days	300/day	2,400
c. Weeding and Hoeing	2 man-days	300/day	600
4. Harvesting of seeds	3 man-days	300/day	900
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 17,881.41
C. Total yield of seeds			471.74 kg
Total returns when the sale price is Rs. 400/kg of seeds			Rs. 1,88,696
D. Net returns (D-B)			Rs. 1,70,814.59
E. Benefit: Cost ratio			**9.55**

j) Cost of flower and seed production of *Dianthus barbatus* L. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	14000	75/100 seedlings	10,500
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	8 man-days	300/day	2,400
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of Seeds	4 man-days	300/day	1,200
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 23,161.41
C. Total yield of seeds			71.68 kg
Total returns when the sale price is Rs. 650/kg of seeds			Rs. 46,592
D. Net returns (D-B)			Rs. 23,431
E. Benefit: Cost ratio			**1.01**

k) Cost of flower and seed production of *Xerochrysum viscosum* for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	8960	75/100 seedlings	6,720
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	10 man-days	300/day	3,000
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of flowers and Seeds	4 man-days	300/day	1,200
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 19,981.41
C. Total yield of flowers			162.60 kg
D. Total yield of seeds			13.02 kg
Total returns when the sale price is Rs. 30/kg			Rs. 4,878
Total returns when the sale price is Rs. 2.5/gm			Rs. 32,550
E. Net returns (D-B)			Rs. 17,446.59
F. Benefit: Cost ratio			**0.87**

l) Cost of flower and seed production of *Zinnia elegens* Jacq. for 800 m^2 area

Particulars	Qty.	Rate (Rs.)	Total cost (Rs.)
A. Input cost			
1. Preparatory cultivation			
a. Land preparation	2 hrs	500/hr	1,000
b. Preparation of beds	3 man-days	300/day	900
c. Planting material (Seedlings)	20000	50/100 seedlings	10,000
d. Basal application of FYM, fertilizers	1 man day	300/day	300
e. Planting and Irrigation	4 man-days	300/day	1,200
2. Manures and Fertilizers			
a. FYM (@ 5kg/m^2)	2800 kg	80/Q	2,240
b. Cost of fertilizers			
i. Urea	24.35 kg	5.52/kg	134.41
ii. SSP	70 kg	8/kg	560
iii. MOP	19 kg	20/kg	380
3. Intercultural operations			
a. Spraying insecticides	1 man day	300/day	300
b. Irrigation	8 man-days	300/day	2,400
c. Weeding and Hoeing	3 man-days	300/day	900
4. Harvesting of Seeds	4 man-days	300/day	1,200
5. Threshing and cleaning of seeds	2 man-days	300/day	600
6. Plant protection			
a. Mancozeb	1 kg	347/kg	347
b. Carbendazim	500 gm	80/200 gm	200
B. Total cost			Rs. 22,661.41
C. Total yield of seeds			74.00 kg
Total returns when the sale price is Rs. 2.0/g			Rs. 1,48,000
D. Net returns (D-B)			Rs. 1,25,338.59
E. Benefit: Cost ratio			**5.53**

APPENDIX IV

List of symbols and abbreviations

Symbols	Abbreviations
%	Per cent
@	At
^{o}C	Degree Celsius
CV	Coefficient of variation
SE	Standard Error
cm	Centimeter
cm^2	Centimeter Square
cv.	Cultivar
et al.	and other
gm	Gram
ha	Hectare
hrs.	Hours
i.e.	That is
kg	Kilogram
viz.	As follows
m^2	Meter square
mg	Milligram
Rs.	Rupees
Fig.	Figure
&	and
BCR	Benefit-Cost Ratio
Max	Maximum
Min	Minimum