Optimizing Vernalization and Photoperiod for Enhanced Growth and Flowering in Pansy (Viola Tricolor L.)

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Abstract

An experiment was conducted during the year November 2022 to March 2023 to investigate the vernalization duration and photoperiod effect on the growth and flowering response of pansies (Viola tricolor L.). The research was done at Horticulture Garden, Sindh Agriculture University Tandojam. The experimental design was two factorial in Completely Randomized Design (CRD) replicated thrice. The bulbs of pansy were kept in different vernalization durations as 02 days at 10oC,04 days at 10oC, 06 days at 10oC and untreated bulbs were treated as control. Vernalization-treated bulbs were planted in earthen pots and kept in tree shade and full sun. Data were observed for days to sprouting, height of the plant in cm, plant spread (cm2), number of leaves-plant-1, days to flower -persistence, number of flowers plant-1, weight of single flower (g), flower diameter (cm) and days to flowering initiation. The growth and flowering characteristics of pansies were significantly affected by vernalization treatments and growing conditions. The result revealed that the vernalization duration 02 days at 10oC significantly affected plant height (6.27 cm), plant spread (9.67 cm2), leaves per plant (18.00), days to flower-persistence (4.75) and flower diameter (5.97 cm). Earlier flower initiation (117.00) was found at vernalization duration 02 days at 10 ºC. While respect to growing conditions Days to sprouting (9.37) was earlier when bulbs were kept in tree shade and tree shade had superior results for plant height (6.48 cm), plant spread (9.6 cm2), leaves per plant (17.33), days to flower-persistence (7.99), number of flowers plant-1 (13.66) and flower diameter (5.17 cm). It is concluded that pansy bulbs had better results for growth and flowering characteristics at vernalization duration 02 days at 10oC. Whereas "tree shade" responded a significantly better growth and the parameters for flowering as compared to "full sun".

Keywords: Pansy, Vernalization, Tree shade, Flowering, Photoperiod.

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Introduction

The pansy (*Viola tricolor* L.), belongs to the *Violaceae* family and is cultivated as a garden flower hybrid plant with a large flower (Yockteng et al., 2003). It is a derivation from the hybridization of numerous species in the section of *Melanium* (Diderot, 2013) with genera *Viola*, in particular *Viola tricolor*, a wild plant in the west European & Asian part known as Heartsease. With little underlying 2 upper leaves, two-sided petals and only beneath leaves and a small beard emanating from the centre of the flower, the diameter of this bloom is 5-8 cm. The colour of their petals could be versatile with white, purple yellow or blueish in colours (Kuta et al., 2012). The favorable soil conditions for this flower are well-drained and the sun is at varying levels which may be grown up to 23 centimetres and 9 inches (Kuta et al., 2012).

Vernalization refers to the process of artificially exposing plants or seeds to cold temperatures to encourage flowering or improve seed production. This technique ensures early blooming and results in a higher yield. Vernalization triggers flowering in plants, and the appropriate vernalization temperature for seeds promotes early blooming and increases yield. This process involves inducing the flowering phase by exposing plants to extended cold periods, either naturally in winter or artificially (Chia & Kubota 2012). Following vernalization, plants are capable of flowering, but they may still need extra seasonal triggers or additional growth time before they bloom (Diderot, 2013). Vernalization can also describe the requirement of a cold dormancy period for herbaceous (non-woody) plants to generate new shoots and leaves but this practice is not encouraged (Sung et al., 2006; Ha et al., 2013). Numerous plants grown in temperate regions depend on vernalization, where exposure to low winter temperatures initiates or speeds up the flowering process. This ensures that reproductive growth and seed production occur predominantly in spring and winter, rather than autumn (Michael et al., 2003). The required cold is commonly measured in chill hours, with typical vernalization temperatures falling between 5 and 10^{o}C (Amasino, 2004). The main issue for plant growth is when they don't get enough cold to start flowering. The natural vernalization in the field and consequently plant production is mainly dependent on the availability of sunlight and vernalization varies with the light intensity (Dai et al., 2008). One of the bedding plants is “Pansy” possessing the capacity to persist in blossoms from the end of October till May in the Northern Hemisphere under the temperate climatic conditions. Magnitude and quality of light as in the case of many other plants, become dangerous for fruitful production of “pansy” (Runkle, 2004). Climate, plant nutrition and water are the essential factors that have a solid impact on the production and quality of plants One of the crucial elements in a challenging-to-control climate, and plant’s nutrition and water are managed through irrigation practices and fertilization processes (Dai et al., 2008). Any sort of variation in excellence, quantity and duration of light can lead to effects on the physiology, morphology and production of plants (Cai, 2011). Development and growth for photosynthesis in plants need an incessant and suitable supply of light strength (Dai et al., 2008). Shade alters the amount of light plants receive and impacts their microclimate, affecting factors like temperature, humidity, carbon dioxide levels, and evapotranspiration, all of which are vital for plant growth (Song et al., 2012). Plant weight, plant height, internode length, branch number and leaf size are influenced by light quality and quantity (Fan et al., 2013). Red-orange light, with wavelengths ranging from 600 to 700 nanometers, can encourage the elongation of hypocotyls and stems (Yang et al., 2012). Blue light can enhance leaf area index, activate phytochrome, and promote the elongation of hypocotyls, stems, and internodes, thereby stimulating overall plant growth (Johkan et al., 2011). Therefore, the present study was conducted on the use of vernalization duration and photoperiod subsequent effect on the growth structure and flowering response of pansies.

Material & Methods

The performed experiment was laid down from November 2022 to March 2023 in Horticulture Garden, Sindh Agriculture University Tandojam to assess the influence of vernalization duration and photoperiod growing conditions on the growth and flowering response of pansy (*Viola tricolor L.*). The experiment was laid out factorial in a completely randomized design (CRD) with three replications. The bulbs of the pansy variety ''Pansy F1 Majestic giants'' were used for the experiment. Then these bulbs were kept in petri dishes which were kept in the refrigerator at 10^{o}C temperature as per vernalization treatments as 02 days at 10^{o}C,04 days at 10^{o}C, 06 days at 10^{o}C and untreated bulbs were treated as control. Later on, one set of each vernalization treatment was sown in 24 cm diameter pots containing silt and farmyard manure at a ratio of 1:1, which were placed to see the photoperiod quality effect under tree shade, whereas the other set of vernalization treatments was placed under direct sunlight as growing conditions. The observations were recorded for days-to-sprouting, the height of the plant in(cm), plant spread (cm^{2}), no of leaves and flowers-plant^{-1}, days, flower-persistence, single flower-weight in(g), flower diameter (cm) and days to flowering initiation. During the experimental procedures, all the necessary and most likely practices were regularly performed for the timely protection of the plant.

Observations methodology

Days to sprouting

Days of sprouting were counted when 50% of bulb sprouting and then recorded.

Plant height (cm)

A random selection of plants from pots was performed and with the help of a foot, from the surface ground to the top of the plants, height was scaled and when flowers started to bloom, the average diameter was obtained in centimeters.

Plant spread (cm^{2})

Using an f measuring tape, the spread of six randomly chosen plants from each treatment was recorded horizontally from one another end and the average plant time of flowering was worked-out in centimeters.

Number of leaves plants^{-1}

For calculating average count of petals on each plant, a selection of four randomly chosen plants from each variety at varying sowing times was performed.

Days-to flower-persistence

For carrying out this observation, from the day to blossom of the flower appearance until it wilted or fell off of the plant the number of days was calculated, and an average was determined.

Number of flowers plant^{-1}

Flowers in each plant of the randomly selected were counted visually at maturity and the average was worked out.

Weight of single flower(g)

The weight of every variety of flowers was gathered, randomly tagged, and weighed in grams.

Flower diameter (cm)

All of the flowers from the randomly chosen plants had their diameters measured in centimetres using a vernier calliper, and the diameter was calculated using the formula below.

Area = 3.14 x r^2

Days to flower initiation

Each variety of the randomly chosen plants' days to blooming was recorded as soon as the first flowers appeared following germination and an average was obtained.

Statistical analysis

Data on each parameter obtained was statically analyzed by the use of Statistix8.1 computer software. For comparisons between the applied treated pots, LSD was used for this purpose where it has been felt mandatory (Statistics, 2006).

Results & Discussion

Effect of different vernalization durations on growth and flowering response of pansy

The outcomes for various pansy vernalization durations are presented in Table 1. The data clearly shows that, except for days to sprouting, varied vernalization durations had a substantial impact on nearly all of the observed parameters, num of flowers plant-1 and weight of a single flower. The result of plant height (6.27 cm), plant spread (9.67 cm^2), leaves per plant (18.00) and days per flower-persistence (4.75) showed higher values at vernalization duration 02 days at 10 °C. At the same vernalization duration flower diameter (5.97 cm) exhibits superior results. Minimum days to flower initiation (117.00) were found at vernalization duration 02 days at 10 °C.

Vernalization initiates and stimulates early flowering producing desired yield. The vernalization enables plants to flower. Chemical and physiological metabolisms are altered by temperature (Kim et al., 2009) and the production of cut flowers, particularly when temperature exceeds 38oC (Ha, 2014). The mentioned results agree with Johkan et al. (2012) results which showed that the increase in leaf number and flowering quality-related parameters were also significantly influenced by the vernalization treatments. Lopez et al. (2005) examined the pansy variety 'Trinity' under vernalization treatment at different temperatures and plants were given 9 or 16 hours of photoperiods at 20°C for 0, 4, 8, 12, or 16 weeks and observed flowering was only 40% where photoperiod was short. Lopez and Runkle (2008) worked on the pansy to see the vernalization and photoperiod treatment on their flowering potential. Results showed that time to flowering was 122, 97, 78 or 62 days at temperatures of 14, 17, 20, or 23°C and the diameter of the flowers increased from 7.4 to 8.6 cm with decreasing temperature from 23 to 14°C; but there was no effect of temperature on flower number and height of the inflorescence. Lopez and Runkle (2008) determined that the flowering pansy 'Augres' cultivar was exposed to short days and vernalized at different temperatures for eight weeks. There was a significant increase in the flower diameter 7.4 to 8.6 cm exposing 23-14oC temperature, while inflorescence height and flower number were not affected by the temperature.

Effect of photoperiod on growth and flowering response of pansy

Two growing conditions tree shade and full sun were determined for this study (Table 2). These growing conditions exhibited a significant effect on all the growth and flowering parameters except the weight of a single flower and days to flower initiation. Days to sprouting (9.37) took fewer days when pansies were kept in tree shade as compared to full sun. The highest values for plant height (6.48 cm), plant spread (9.6 cm2), leaves per plant

(17.33) and flower persistence days (7.99) revealed the maximum where pansy was kept in tree shade. At the same growing condition number of flowers, plant-1 (13.66) and flower diameter (5.17 cm) demonstrated the greatest results. Tree shade was found superior in all the growth and flowering responses of pansies as compared to full sun. Temperature and light are the key inputs for florae nourishment and the development of the flowering is provided either by solar light / manmade lighting (Kim et al., 2004). Light leads to different developmental processes (Jung et al., 2013) and under low light conditions in winter, artificial lights are used for the development of plant growth (Chia & Kubota, 2010).

The above findings can be supported by several other studies including Yang et al. (2014) who reported a significant effect of artificially provided temperature and light intensities on the growth and flower response of ornamental plants including Viola tricolor. Fan et al. (2013) stated that mass, tallness of the florae, distance between the internodes, number of branches and floral proportions are qualitative and quantitative influences of the light. Song et al. (2016) have reported a significant effect of the growing environment of flowering plants on germination, plant growth and flower quality. The plant growth, branching and leaf number were significantly affected by the growing environment and lighting intensities in the flowering plants (fan et al., 2013). Similarly, Yang et al. (2013) stated that under sunlight, generally, the bedding plants respond better than the artificial environment; however, it depends on the soil and climatic conditions and the availability of irrigation water. Under such conditions, the planting of nurseries and seedlings in the shade provides better results. Chia & Kubota, (2010) worked on the effect of duration and quality of light on the production of different garden plants including pansy. It was concluded that daylight hours directly influence flowering and flower quality. On exceeding day length, a critical time, flowering in plants is stopped and vegetative growth is continued. In pansy under longer daylight, they flower in late spring to early summer.

Conclusion

From the conducted experiment, it has been summarized that the effect of vernalization duration remained non-significant in days to sprouting, number of flowers plant-1 and weight of single flower, however, the parameters mostly related to blooming and growing significantly enhanced with the vernalization durations. The superior height of the recorded plant, plant spread, number of leaves plant-1, days to flower persistence, flower diameter and days to flower initiation were recorded in vernalization duration 02 days at 10 ºC. In the case of growing conditions," Tree Shade" performed significantly better as compared to "Full Sun".

Recommendations

Based on the findings, pansy cultivation should prioritize vernalization at 10°C for 2 days to enhance plant height, spread, leaf count, and flower diameter, and accelerate flowering (117 days to initiation). For optimal growth and flowering, tree-shade environments are recommended over full sun, as they improve plant height (6.48 cm), spread (9.6 cm^2), leaf count (17.33), flower persistence (7.99 days), and flower number (13.66 $plant^{-1}$). Growers should avoid prolonged high temperatures (>38°C) to prevent adverse metabolic effects, as highlighted in prior studies. Future research could explore extended vernalization durations (>6 days) and hybrid light regimes (partial shade +

controlled photoperiods) to refine flower yield and resilience.

Table 1. Effect of different vernalization duration on growth and flowering response of pansy

Vernalization duration	**Days to sprouting**	**Plant height (cm)**	**Plant spread (cm²)**	**Number of leaves plant⁻¹**	**Days-to-flower persistence**	**Number of flowers plant⁻¹**	**Weight of single flower (g)**	**Flower diameter (cm)**	**Days to flower initiation**
Control	12.00	4.48 B	6.29 C	10.58 B	3.08 B	7.50	0.10	3.21 C	149.67 A
02 days at 10 ℃	10.75	6.27 A	9.67 A	18.00 A	4.75 A	11.58	2.65	5.97 A	117.00 D
04 days at 10 ℃	9.50	5.72 A	9.40 AB	15.25 AB	3.33 B	10.83	0.26	4.05 C	139.08 B
06 days at 10 ℃	9.16	5.71 A	8.38 B	14.66 AB	3.75 B	9.08	1.58	4.70 B	127.42 C
SE ±	1.2617	0.4551	0.5741	2.0077	0.4645	1.9208	0.3542	0.24446	1.6894
LSD$_{0.05}$	Ns	0.9238	1.1655	4.0759	0.9430	Ns	Ns	0.49666	3.4296

Table 2. Effect of photoperiod on growth and flowering response of pansy

Photoperiod	**Days to sprouting**	**Plant height (cm)**	**Plant spread (cm²)**	**Number-of leaves plant⁻¹**	**Days to flower persistence**	**Number-of flowers plant⁻¹**	**Weight of single flower (g)**	**Flower diameter (cm)**	**Days to flower initiation**
Tree shade	9.37 B	6.48 A	9.6 A	17.33 A	7.99 A	13.66 A	1.74	5.17 A	127.96
Full sun	11.33 A	5.12 B	7.26 B	11.91 B	2.45 B	5.83 B	0.56	3.80 B	138.62
SE ±	0.8922	0.3118	0.4060	1.4197	0.3285	1.3582	0.2505	0.1730	1.1946
LSD$_{.05}$	1.8112	0.6533	0.8241	2.8821	0.6668	2.7275	Ns	0.3512	Ns

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