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Influence of climatic parameters on performance of carnation *(Dianthus caryophyllus* L.*)* under protected cultivation

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Abstract
Carnation is an important flower crop having great commercial value as a cut flower due to its excellent keeping quality, wide array of colour and forms and from medicinal point as cardiotonic, diaphoretic and alexiteric. The experiment was conducted at Hi-Tech Horticulture of RAU Pusa, Bihar to study the effect of climatic parameters on performance & evaluation of carnation inside the polyhouse compared to outside. Observations were undertaken to record and evaluate various climatic parameters i.e. ambient air temperature, relative humidity etc. inside and outside the polyhouse, plant growth parameters among three verities Corex Collina and Gionek. Plant parameters like plant height, days to budding and flowering, plant mortality, flowers per square meter different treatments were measured under polyhouse and outside the polyhouse.

The average increases in maximum and minimum temperature inside greenhouse were found 5.72°C and 7.82°C respectively. The average increases in maximum and minimum relative humidity inside greenhouse were found 4.67percent and 10.62 percent respectively. Corex recorded highest plant height (103cm) while variety Gionek (81cm), was shortest types. Collina (5.5%) was found very resistant to mortality and varieties Corex and Gionek fairly resistance to mortality with (8.8) & (12.2%) % respectively. Maximum number of flowers per square meter was recorded in variety collina (33.58) and variety which was recorded minimum number of flowers per square meter (25.67) was Gionek. Variety Corex (30.89) was mediate in no of flowers per square meter. Plant height, plant mortality, earliness in budding & flowering, average yield per plant and productivity was minimum in outside the polyhouse and maximum in inside the polyhouse.

Keywords: Carnation, climate, greenhouse, protected cultivation

Introduction
Carnation is an important flower crop having great commercial value as a cut flower due to its excellent keeping quality, wide array of colour and forms, also become useful in gardening for bedding, edging, borders, pots, and rock gardens. From medicinal point of view, the Carnation flowers are considered to be cardiotonic, diaphoretic and alexiteric (Shiragur *et al*. 2004b). Some carnation varieties are annual, biennial or perennial Carnation (*Dianthus caryophyllus* L.) belongs to the family Caryophyllaceae having diploid chromosome number 2n=30. Carnation plants are half hardy herbaceous perennial. The flowers are solitary, terminally formed. They are cultivated on large scale in the Mediterranean region. Growth and flowering of Carnations are influenced by several factors. It is genetically a quantitative long day plant (Blake, 1955). A good supply of light is required for high quality flower formation. Extremely high light intensity, which exceeds photosynthetic capability of the plants results in photo-inhibition, pale foliage and flowers, whilst it is also possible that plants will become burnt. It forms flowers fasters during long day than in short day. It requires more than 21.5 kilolux light intensity, cyclic lighting or continuous lighting from dusk to dawn hastens flowering. Temperature plays an important role in Carnation growing. Temperature fluctuations result in reduction of flower yield, stem strength, increased calyx splitting and shorter keeping quality. In India, there is a wide fluctuation in temperature, light intensity and humidity which not only affect the yield and quality of flowers but also limit their availability fore particular period of a year. In India, it is common practice to have the plants growing in greenhouses for the cut flower production resulting in increased crop production. On the other hand, when the plants are grown in open condition especially plants in northern India, the planting after April has to pass through a great stress due to prevailing high temperature.

Though such low temperature conditions exist in India during winter months but the shortage of light during winter months is the main barrier for its reduced and delayed flower production owing to its long day requirement. It is necessary to grow Carnation under polyhouse condition for obtaining good quality flowers. Increased production per unit of greenhouse area, along with high flower quality, could be achieved during winter months in the area of high light intensity. Polyhouse fitted with fan and pad system can bring down the temperature by 8-10^{0}C. However, top ridge and side ventilation also gives good fresh air exchange and lowers the temperature. The crop must be protected from rain by covering the plants with polyethylene sheets. Carbon dioxide level affects both growth and quality. Low-level of CO_2 100-150 ppm in greenhouse during the day inhibits the growth. The greenhouse CO_2 level should be maintained at 300-500 ppm on cloudy days and 750- 1500 ppm on sunny days. Carnations require sufficient amount of light and proper ventilation to produce high quality flowers and therefore design and orientation of greenhouse are of greater importance. Carnation is widely cultivated on commercial scale in different parts of the world. The Carnation flowers are sold as cut flowers round the year throughout the world and it is one the top three cut flowers traded in the international market. The demand for Carnation cut flower is gaining momentum with increasing aesthetic sense and higher socio-economic standard of the people It is mainly used as a bedding plant and for cut flower production due to high international market value. Due to their long lasting cut flowers (vase-life of 2-3 weeks), wide range of forms and ability to withstand long distance transportation, carnations are very popularly used in boutonnieres, corsages, bouquets and wide range of floral arrangements. They are very popularly favored on special occasions, especially Mother's Day and weddings. Carnation cut flowers are used to express love, admiration, good luck, fascination and distinction (Anonymous, 1990) [1]. The modern carnation cultivars offer diversity of colors, shapes and sizes not available in other flowering plants. India has been identified as one of the major forces in the world floriculture scenario. With liberalization of Indian economy, floriculture has become a new rising industry in agribusiness.

Material and methods

The present investigation was carried out to study the performance of Carnation (*Dianthus caryophyllus* L.) varieties under naturally ventilated polyhouse at the College of Agricultural Engineering, RAU Pusa. The experimental plot used was situated at Hi-Tech Horticulture (Plate 3.1) of RAU Pusa, (25^{0}85' N and 85^{0}40' E) in Samastipur district of Bihar which is at 54.4 m above MSL. The studies were undertaken to record and evaluate various climatic parameters i.e. ambient air temperature, relative humidity etc. inside and outside the polyhouse, plant growth parameters i.e. plant height, number of branches, days to budding, flowering etc. of different treatments.

Climate

Climate is sub-humid and sub tropical with fairly good rainfall during monsoon. The average rainfall of the area is 1270 mm, out of which 80 per cent received during monsoon (July to September). The temperature varies from 60^{0}C in January to 43^{0}C in June. The maximum humidity varies from 80 to 95 per cent during rainy seasons while minimum from 40 to 60 per cent during summer season. The soil is sandy loam type.

Experimental Details

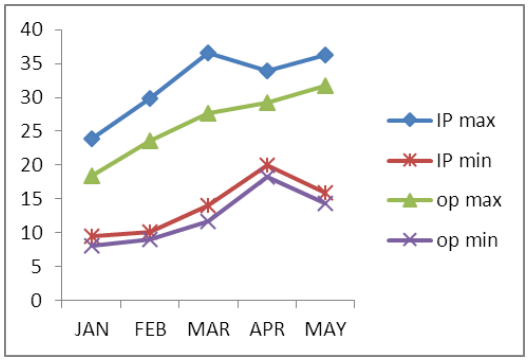
Crop:	Carnation
Spacing:	30 X 30cm2
Area:	16.02 m2
No. of replication :	three
Treatment details :	three varieties

The data of different varieties of Carnation were recorded daily, weekly and monthly and analyzed. Study of Weather Parameters reveals the average weekly variations in the weather parameters such as temperature, relative humidity, solar radiation inside and outside of polyhouse.

Results

Air Temperature

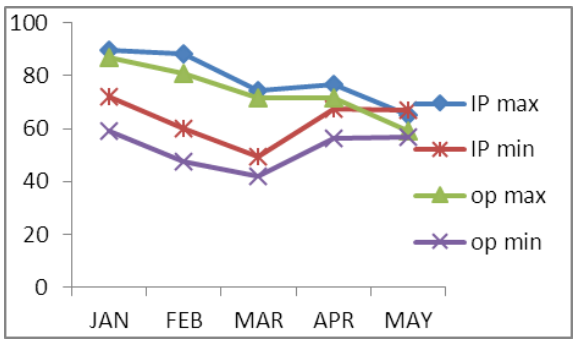
The average increases in maximum and minimum temperature inside greenhouse were found 5.72°C and 7.82°C respectively. The variation in the maximum air temperature was minimum (4.66 °C) in the month of February and maximum (8.29°C) in the month of May. The variation in average minimum air temperature inside greenhouse was minimum (4.28°C) in the month of January and maximum (9.64°C) in the month of April.



Relative Humidity

The average increases in maximum and minimum relative humidity inside greenhouse were found 4.67percent and 10.62 percent respectively. The variation in the maximum relative humidity was minimum (2.26 percent) in the month of january and maximum (5.67 percent) in the month of may. The variation in average minimum relative humidity inside greenhouse was minimum (6.47 percent) in the month of March and maximum (13.12 percent) in the month of January.

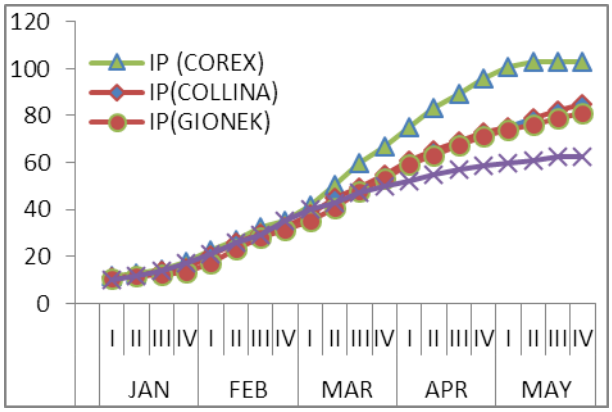
Treatments	Colour of petals
T_1- Corex	red
T_2- Collina	yellow
T_3- Gionek	white



Plant height (cm)

The data pertaining to mean weekly plant height at different stages of growth in different Carnation varieties are illustrated through Fig. 4.5

Plant height at among the different varieties differed significantly under greenhouse condition. Inside polyhouse Variety Corex recorded highest plant height (103cm) while variety Gionek (81cm), was shortest types. However variety Collina (85 cm) was medium in their height.



Plant height

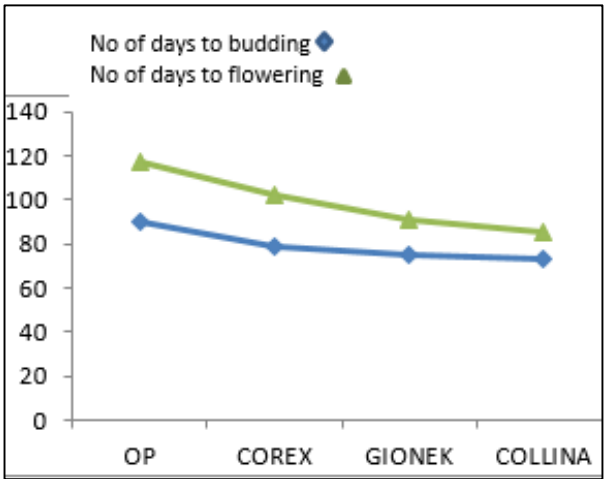
Flowering characters

Days taken for flower bud initiation

Under polyhouse time taken to bud iniation significantly differed over varieties, like variety collina(73days) was 1st to initiate buds and variety Corex(79days)last to initiate while variey Gionek(75days) were midlate in flower bud initiation.

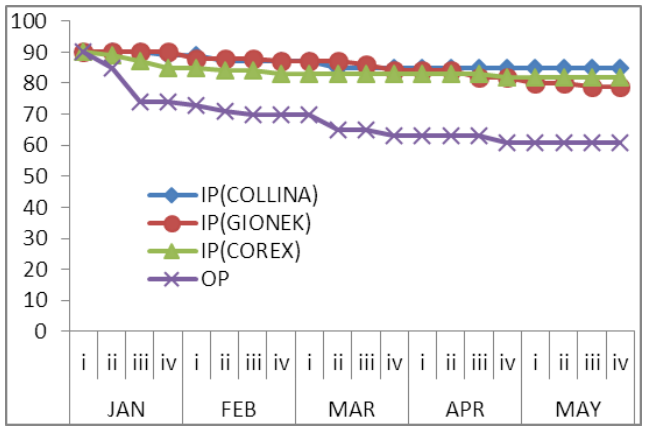
No.of days taken to flowering

Flowering starts in the end of March. The number of days required for flowering among different Carnation varieties grown under greenhouse was recorded. The data revealed that number of days taken for flowering was significant. The variety Collina (85days) was 1st to flowering, variety Corex (102days) last to flowering while variety Gionek (91 days) was mid late in flowering



Plant Mortality

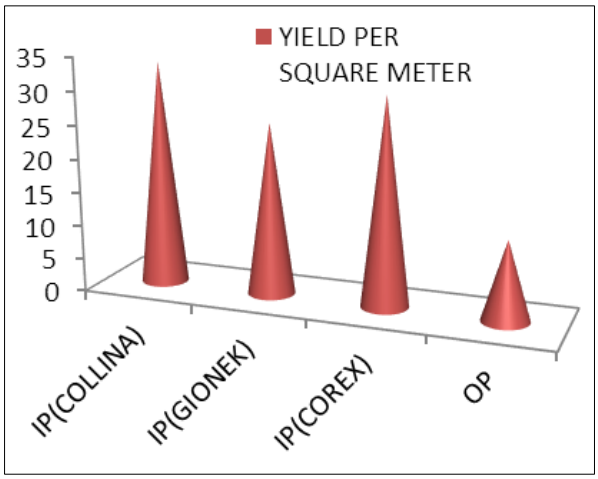
Among different varieties under greenhouse condition variety Collina (5.5%) was found very resistant to mortality and varieties Corex and Gionek fairly resistance to mortality with (8.8) & (12.2%) % respectively.



Plant mortality

Yield (Number of flowers) per square meter

Number of flowers per square meter varied significantly among the different varieties of Carnation grown under greenhouse. Maximum number of flowers per square meter was recorded in variety collina(33.58) and variety which was recorded minimum number of flowers per square meter (25.667) was Gionek. While variety Corex (30.89) was mediate in no of flowers per square meter.



Conclusions

Based on the research work, the following conclusions could be drawn. The average increases in maximum and minimum temperature inside greenhouse were found 5.72°C and 7.82°C respectively. The average increases in maximum and minimum relative humidity inside greenhouse were found 4.67percent and 10.62 percent respectively. Plant height, plant mortality, no of fruits, earliness in budding & flowering, average yield per plant and productivity was minimum in outside the polyhouse and maximum in inside the polyhouse. Variety collina was superior in earliness in budding & flowering. lowest mortality and highest yield per plant and productivity under polyhouse. Hence it can be used for commercial production.

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