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# Effect of NPK levels on seed yield and seed quality of annual chrysanthemum (*Chrysanthemum coronarium* L.)

**SM Raghatate, DM Panchbhai, BM Muradi and MJ Patokar**

## Abstract
The experiments were laid out in a Factorial Randomized Block Design with three replications at Experimental field, Department of Floriculture and Landscape Architecture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.), during the year 2018-2019 and 2019-2020 to study the effect of NPK levels on seed yield and seed quality of annual chrysanthemum. There were twenty seven treatment combinations of three levels each of nitrogen (100, 150 and 200 kg $ha^{-1}$), phosphorus (50, 75 and 100 kg $ha^{-1}$) and potassium (50, 75 and 100 kg $ha^{-1}$). The results of the present investigation revealed that, the seed yield parameters *viz*., flowers $plant^{-1}$, seed weight $flower^{-1}$, seed yield $plant^{-1}$, seed yield $ha^{-1}$ and seed quality parameters *viz*., test weight and germination percent of seed were recorded highest with an application of nitrogen 200 kg $ha^{-1}$, phosphorus 100 kg $ha^{-1}$ and potassium 100 kg $ha^{-1}$.

**Keywords:** NPK levels, seed yield, annual chrysanthemum

## Introduction
Annual chrysanthemum (*Chrysanthemum coronarium* L.) is considered to be the most important cultivated commercial loose flower crop grown all over India. It belongs to the family asteraceae and originated in Southern Europe. The species is also referred to as *Leucanthemum coronarium* or *Glebionis coronarum*. It is winter season annual propagated through seeds. Annual chrysanthemum is commercially grown in the states of India are Maharashtra, Tamilnadu, Karnataka, Andhra Pradesh, Uttar Pradesh, Telangana, Punjab and Haryana. Annual chrysanthemum is also known as 'Crown Daisy' or 'Garland chrysanthemum'. In India the annual chrysanthemum flower is also locally called as 'Bijli' in Maharashtra, 'Babbona' in Haryana, 'Guldhak' in Punjab, 'Gendi' in Uttar Pradesh and 'Market' in Delhi. It has also a medicinal value. It is a vigorous, hardy and tall growing winter annual attaining height of about 100 to 120 cm. The leaves of the plants are deeply cut and lanceolated. It produces white and yellow coloured flowers or white with cream colour at the centre of flower, size varies from 2.5 to 6.0 cm depending upon the species, varieties and other environmental factors. It having single to fully double forms. They are mainly classified as single petelled and double petelled flowers. Annual chrysanthemum flowers have high demand in the market during festivals and is in great demand during various functions, marriages and floral decorations particularly in winter. Nitrogen being a major food for plants is an essential constituent of protein and chlorophyll. Nitrogen plays a most important role in various physiological processes. It imparts dark-green colour in plants, promotes leaves, stem and other vegetative parts, growth and it also stimulates root growth. Phosphorus is also important major nutrient for the plant growth and development. Phosphorus has a great role in energy storage and transfer. Phosphorus is a constituent of nucleic acid, phytin and phospho-lipids, it is important component of seed and it promotes early flowering and good quality of the seed.

Potassium plays an important role in the activation of enzymes which serves as catalysts for chemical reactions. Plants depend upon potassium to regulate the opening and closing of stomata. The pores through which leaves exchange carbon dioxide ($CO_2$), water vapor, and oxygen ($O_2$) with the atmosphere. Proper functioning of stomata are essential for photosynthesis, water and nutrient transport, and plant cooling. When water supply is short, potassium is pumped out of the guard cells. The pores close tightly to prevent loss of water and minimize drought stress to the plant. Potassium helps in formation of proteins and chlorophyll which are important for photosynthesis and it increases the quality of flower. This element is necessary for the formation of good quality seeds.

## Materials and Methods

The experiments were laid at Experimental field, Department of Floriculture and Landscape Architecture, Dr. PDKV, Akola (M. S.) during the winter season of the year 2018-2019 and 2019-2020. The experiments were laid out in a factorial randomized block design in a factorial arrangements having three factors *viz*., nitrogen, phosphorus and potassium and each having three levels, nitrogen ($N_1$-100, $N_2$-150 and $N_3$-200 kg $ha^{-1}$), phosphorus ($P_1$-50, $P_2$-75 and $P_3$-100 kg $ha^{-1}$) and potassium ($K_1$-50, $K_1$-75 and $K_3$-100 kg $ha^{-1}$) with twenty seven different treatment combinations and replicated thrice. The thirty days old seedlings were transplanted at the distance of 45 x 30 cm (Row to row and Plant to plant) on flat beds. Calculated doses of nitrogen, phosphorus and potassium were applied into the experimental fields as per the treatment combinations. Half dose of nitrogen was given at the time of transplanting in the form of urea and remaining half dose of nitrogen was given thirty days after transplanting. Full dose of phosphorus and potassium were applied at the time of transplanting in the form of single super phosphate (SSP) and muriate of potash (MOP), respectively. The observations were recorded in respect of seed yield parameters *viz*., flowers $plant^{-1}$, seed weight $flower^{-1}$, seed yield $plant^{-1}$, seed yield $ha^{-1}$ and seed quality parameters *viz*., test weight and germination percent. The data obtained on various parameters was statistically analyzed as per methods suggested by Panse and Sukhatme (1976) [8].

## Results and Discussions

### Seed yield parameters

### Effect of nitrogen levels

The pooled results from the table 1 (a) revealed that, the increased level of nitrogen $N_3$ (200 kg $ha^{-1}$) significantly increased the flowers $plant^{-1}$ (86.07), seed weight $flower^{-1}$ (146.94 mg), seed yield $plant^{-1}$ (12.30 g) and seed yield $ha^{-1}$ (7.59 q). Whereas, significantly lowest flowers $plant^{-1}$ (74.96), seed weight $flower^{-1}$ (120.71 mg), seed yield $plant^{-1}$ (9.29 g) and seed yield $ha^{-1}$ (7.73 q) were recorded with the treatment level nitrogen $N_1$ (100 kg $ha^{-1}$). This might be due to the application of nitrogen mainly because of increased carbohydrate reserve for the development of floral primordial apart from the structural development of the plant which might be resulting in more number of flowers $plant^{-1}$ and better seed set in flower and ultimately higher seed weight in flower, seed yield $plant^{-1}$ and higher seed yield $ha^{-1}$. Similar results are also reported by Tembhare (2016) *et al.* in China aster, Nikam *et al.* (2018) [6] in annual chrysanthemum and Shinde *et al.* (2019) in African marigold.

### Effect of phosphorus levels

It is clear from the pooled results from the table 1 (a) that, application of phosphorus $P_3$ (100 kg $ha^{-1}$) significantly influenced the seed yield parameters of annual chrysanthemum. The treatment $P_3$ recorded significantly highest number of flowers $plant^{-1}$ (82.26), seed weight $flower^{-1}$ (137.60 mg), seed yield $plant^{-1}$ (11.33 g) and seed yield $ha^{-1}$ (6.99 q). However, significantly the minimum flowers $plant^{-1}$ (77.28), seed weight $flower^{-1}$ (125.72 mg), seed yield $plant^{-1}$ (9.88 g) and seed yield $ha^{-1}$ (6.09 q) were recorded with the application of treatment $P_1$ (50 kg $ha^{-1}$). The highest phosphorus application results were found better, it was so because phosphorus is a constituent of protein, enzyme and chlorophyll which might have been helpful in development of better infrastructure of plant and the number of flowers $plant^{-1}$. The maximum seed yield $flower^{-1}$ and $plant^{-1}$ might be due to phosphorus is an integral component of DNA and RNA which contain genetic code to produce proteins and other compounds for the development of seeds and which would resulted in to higher seed yield. The similar results were also reported by Kumar and Moon (2014) in African marigold, Tembhare *et al.* (2015) in China aster and Badole *et al.* (2016) [2] in China aster.

### Effect of potassium levels

The pooled results from the table 1 (a) revealed that, significantly highest number of flowers $plant^{-1}$ (81.70), seed weight $flower^{-1}$ (136.34 mg), seed yield $plant^{-1}$ (11.11 g) and seed yield $ha^{-1}$ (6.85 q) were observed with the application of treatment $K_3$ (100 kg $ha^{-1}$). However, the significantly lowest number of flowers $plant^{-1}$ (78.08), seed weight $flower^{-1}$ (127.59 mg), seed yield $plant^{-1}$ (10.05 g) and seed yield $ha^{-1}$ (6.20 q) had registered with the application of treatment $K_1$ (50 kg $ha^{-1}$). The highest number of flowers $plant^{-1}$ obtained with the increased levels of potassium. This might be due to, potassium is a constituent of many energy rich compounds in the plants and also involved in active root growth and helps in uptake of other nutrients resulted in increased number of flowers $plant^{-1}$ and ultimately resulted in seed weight $flower^{-1}$, seed yield $plant^{-1}$ and seed yield $ha^{-1}$ in annual chrysanthemum. Similar findings were also reported by Kumar and Moon (2014) in marigold, Shinde *et al.* (2014) [10] and Nikam *et al.* (2018) [6] in annual chrysanthemum.

### Interaction effects

### Interaction between nitrogen and phosphorus

The pooled results from the table 1 (b and f) indicated that, the seed yield parameters of annual chrysanthemum influenced significantly due to the interaction of nitrogen and phosphorus levels. Significantly increased number of flowers $plant^{-1}$ (88.88), seed weight $flower^{-1}$ (155.53 mg), seed yield $plant^{-1}$ (13.52 g) and seed yield $ha^{-1}$ (8.35 q) were observed with the treatment combination $N_3P_3$. Whereas, minimum number of flowers $plant^{-1}$ (72.52), seed weight $flower^{-1}$ (116.28 mg), seed yield $plant^{-1}$ (8.82 g) and seed yield $ha^{-1}$ (5.45 q) were noted in the treatment combination $N_1P_1$. The combine application of nitrogen and phosphorus increased yield of flowers $plant^{-1}$ due to nitrogen could be explained on the basis that with the onset of flowering phase, there is subsistence anabolic activities and redistribution of organic and inorganic nutrients components and phosphorus application seems to be due to improvement in yield parameters due to the stimulation in the root growth, which helped in better absorption of water and mineral nutrients in soil ultimately resulted in increased flowers $plant^{-1}$, seed weight $flower^{-1}$, seed yield $plant^{-1}$ and seed yield $ha^{-1}$. Similar results are in congruent with the results of Kumar and Moon (2014) in African marigold and Tembhare *et al.* (2015) in China aster.

### Interaction between nitrogen and potassium

The pooled results from the table 1 (c and g) revealed that, flowers $plant^{-1}$, seed weight $flower^{-1}$, seed yield $plant^{-1}$ and seed yield $ha^{-1}$ were significantly influenced due to the interaction of nitrogen and potassium levels. The treatment combination $N_3K_3$ significantly noted the highest flowers $plant^{-1}$ (87.93), seed weight $flower^{-1}$ (152.52 mg), seed yield plant$^{-1}$ (12.86 g) and seed yield ha$^{-1}$ (7.94 q). Whereas, significantly lowest number of flowers plant$^{-1}$ (72.51), seed weight plant$^{-1}$ (116.00 mg), seed yield plant$^{-1}$ (8.64 g) and seed yield ha$^{-1}$ (5.34 q) had registered in the treatment combination $N_1K_1$. The increase in yield of flowers might be due to application of nitrogen and potassium which help in maximum nutritional uptake. Nitrogen and potassium both affect the protein content in the plant cell. But their interaction enhances the protein content to more extent. It can be explained as abundance of nitrogen availability in the absence of potassium could not synthesize protein. But in presence of protein, enzyme nitrate reductase is activated which catalyzes the formation of protein. This may also increase disease and pest resistance due to which may enhance yield of flowers, seed yield flower$^{-1}$, seed yield plant$^{-1}$ and seed yield ha$^{-1}$. The results obtained during the investigation were similar to the findings of the earlier workers, Kishore *et al.* (2016) in African marigold, Teja *et al.* (2017) in annual chrysanthemum, Nikam *et al.* (2018) [6] in annual chrysanthemum, Dali *et al.* (2019) in African marigold and Shinde *et al.* (2019) in African marigold.

**Interaction between phosphorus and potassium**

The pooled data from the table 1 (d and h) concluded that, an application of the treatment combination $P_3K_3$ observed significantly maximum number of flowers plant$^{-1}$ (84.12), seed weight flower$^{-1}$ (142.35 mg), seed yield plant$^{-1}$ (11.91 g) and seed yield ha$^{-1}$ (7.35 q). However, the treatment combination $P_1K_1$ noted significantly lowest number of flowers plant$^{-1}$ (75.13), seed weight flower$^{-1}$ (121.75 mg), seed yield plant$^{-1}$ (9.45 g) and seed yield ha$^{-1}$ (5.83 q). This might be due to availability of phosphorus and potassium in the soil help the plants to grow vigorously as well as promotes functional characteristics. Potassium requires for wide range of functions in plant cell such as activation of numerous enzymes and uptake of nutrients which give the plant vigorous growth and phosphorus provides energy for the movement of nutrient within plant in the form of adenosine tri-phosphate and adenosine di-phosphate resulted the maximum number of flowers plant$^{-1}$, seed yield plant$^{-1}$ and seed yield ha$^{-1}$. The present research findings were in line with the findings of Kumar and Moon (2014) in African marigold, Moon *et al.* (2018) in gaillardia and Saeed and Amin (2019) [9] in rose.

**Interaction between nitrogen, phosphorus and potassium levels**

The pooled data from the table 1 (e and i) revealed that, significantly maximum flowers plant$^{-1}$ (91.86), seed weight flower$^{-1}$ (163.56 mg), seed yield plant$^{-1}$ (14.58 g) and seed yield ha$^{-1}$ (9.00 q) were noted with the treatment combination of $N_3P_3K_3$. However, the treatment combination $N_1P_1K_1$ noted significantly lowest number of flowers plant$^{-1}$ (68.90), seed weight flower$^{-1}$ (111.23 mg), seed yield plant$^{-1}$ (8.17 g) and seed yield ha$^{-1}$ (5.05 q). This might be due to balanced dose of nitrogen, phosphorus and potassium seemed to have increased vegetative growth, favourable for the synthesis of peptide bond, protein and carbohydrate metabolism that are essential for flower development, seed formation and seed yield. The results are in close conformity with the results of Karetha *et al*. (2011) [4] in gaillardia, Tembhare *et al*. (2016) in China aster, Nikam *et al*. (2018) [6] in annual chrysanthemum, Badge *et al*. (2019) [1] in annual chrysanthemum and Nirgulkar *et al*. (2019) [7] in African marigold.

**Seed quality parameters**

**Effect of nitrogen levels**

The pooled data from the table 2 (a) revealed that, significantly increased test seed weight (1.92 g) and germination percent of seeds (70.88%) were recorded in the treatment $N_3$. However significantly lowest test weight of seed (1.45 g) and germination percent (60.96%) had registered in the treatment $N_1$. The higher level of nitrogen application might favours enlargement of seed which results into maximum test weight of seed. Higher level of nitrogen would be effective in breaking the dormancy of annual chrysanthemum seed. Nitrogen acts as an integral part of many plant processes which might have enhanced the protein synthesis which would have helped for increasing the germination percent. The results of present investigation are in close agreement with the findings Tembhare *et al.* (2016) in China aster and Nikam *et al.* (2018) [6] in annual chrysanthemum.

**Effect of phosphorus levels**

The pooled results from the table 2 (a) revealed that the data in respect of test weight of seed and germination were significantly influenced due to phosphorus levels. Significantly superior test weight of seed (1.77 g) and germination percent (67.66%) had registered in the treatment $P_3$. Whereas, significantly lowest test weight of seed (1.56 g) and germination percent (63.16%) were observed in the treatment $P_1$. This might be due to the fact that, application of phosphorus at higher level might have increased the test weight of seed and germination percent of seed. Phosphorus plays an important role in the seed formation and bold seed which might have increased the test weight of seed. Also, phosphorus is also an integral part of phosphate compounds, energy obtained from photosynthesis and metabolism of carbohydrates is stored in these compounds, which stored in seed which ultimately influenced the germination. Similar results are in close conformity with the findings of Kumar and Moon (2014) in African marigold, Tembhare *et al*. (2015) in China aster and Nikam *et al*. (2018) [6] in annual chrysanthemum.

**Effect of potassium levels**

The pooled data from the table 2 (a) exhibited that, significantly superior test weight of seed (1.75 g) and germination percent of seed (67.16%) were noticed in the treatment $K_3$. However, significantly minimum test weight of seed (1.59 g) and germination percent of seeds (63.81%) were produced in the treatment $K_1$. This might be due to potassium which is essential part of photosynthesis part of photosynthesis, it is required for seed formation and seed development. Due to an application of higher level of potassium might be resulted in to increased test weight of seed and germination percent of seed in annual chrysanthemum. Similar results are also reported by Kumar and Moon (2014) in African marigold and Badge *et al.* (2019) [1] in annual chrysanthemum.

**Interaction effect**

**Interaction effect between nitrogen and phosphorus**

The pooled results from the table 2 (b) revealed that, the seed yield parameters significantly influenced due to the interaction of nitrogen and phosphorus. The treatment combination $N_3P_3$ recorded significantly superior test weight of seed (2.03 g) and germination percent (73.27%). Whereas, significantly lowest number test weight of seed (1.36 g) and germination percent (59.05%) were noted in the treatment combination $N_1P_1$. The findings of the present investigation are in conformity with the results of Tembhare *et al*. (2015) in China aster and Moon *et al*. (2018) in Gaillardia.

**Interaction effect between nitrogen and potassium**

The pooled data from the table 2 (c) revealed that, significantly superior test weight of seed (2.00 g) and germination percent (72.33%) were produced with the treatment combination $N_3K_3$. Whereas, significantly lowest test weight of seed (1.35 g) and germination percent of seed (58.55%) had registered in the treatment combination $N_1K_1$. The results obtained in this investigation are in close conformity with the findings of Badge *et al*. (2019) [1] in annual chrysanthemum.

**Interaction effect between phosphorus and potassium**

The pooled data from the table 2 (d) revealed that the test weight of seed and germination percent significantly influenced due to phosphorus and potassium levels. The treatment combination $P_3K_3$ significantly increased the test weight of annual chrysanthemum seed (1.85 g) and germination percent of seeds (69.44%). However, significantly minimum test weight of seed (1.49 g) and germination percent of seed (61.50%) were noticed in the treatment combination $N_1K_1$. the results of present study confirm the findings of Kumar and Moon (2014) in African marigold.

**Interaction between nitrogen, phosphorus and potassium**

The pooled data from the table 2 (e) revealed that the interaction effect due to nitrogen, phosphorus and potassium levels were found to be significant. Significantly superior test weight of annual chrysanthemum seeds (2.18 g) and germination percent (76%) were recorded with the application of treatment combination $N_3P_3K_3$. However, minimum test weight of seed (1.29 g) and germination percent of seed (56.83%) were noticed with the treatment combination $N_1P_1K_1$. Similar results have been recorded by Kumar and Moon (2014) in African marigold, Tembhare *et al*. (2016) in China aster, Moon *et al*. (2018) in gaillardia and Badge *et al*. (2019) [1] in annual chrysanthemum.

**Table 1 (a):** Effect of nitrogen, phosphorus and potassium levels on seed yield of annual chrysanthemum

| Treatments | Flowers $plant^{-1}$ | | | Seed weight $flower^{-1}$ (mg) | | | Seed yield $plant^{-1}$ (g) | | | Seed yield $ha^{-1}$ (q) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | 2019-2020 | Pooled | 2018-2019 | 2019-2020 | Pooled | 2018-2019 | 2019-2020 | Pooled | 2018-2019 | 2019-2020 | Pooled |
| **Nitrogen (N)** | | | | | | | | | | | | |
| $N_1$-100 kg $ha^{-1}$ | 74.86 | 75.07 | 74.96 | 122.74 | 118.68 | 120.71 | 9.00 | 9.59 | 9.29 | 5.55 | 5.92 | 5.73 |
| $N_2$-150 kg $ha^{-1}$ | 78.78 | 79.41 | 79.09 | 129.66 | 128.41 | 129.03 | 9.96 | 10.69 | 10.33 | 6.15 | 6.60 | 6.37 |
| $N_3$-200 kg $ha^{-1}$ | 85.71 | 86.43 | 86.07 | 145.82 | 148.07 | 146.94 | 11.92 | 12.67 | 12.30 | 7.36 | 7.82 | 7.59 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig | Sig | Sig |
| SE(m) ± | 0.17 | 0.18 | 0.14 | 0.49 | 0.51 | 0.35 | 0.08 | 0.05 | 0.05 | 0.05 | 0.03 | 0.03 |
| CD at 5% | 0.47 | 0.50 | 0.38 | 1.39 | 1.45 | 0.99 | 0.21 | 0.14 | 0.14 | 0.13 | 0.09 | 0.09 |
| **Phosphorus (P)** | | | | | | | | | | | | |
| $P_1$-50 kg $ha^{-1}$ | 77.03 | 77.54 | 77.28 | 126.48 | 124.96 | 125.72 | 9.54 | 10.21 | 9.88 | 5.89 | 6.30 | 6.09 |
| $P_2$-75 kg $ha^{-1}$ | 80.34 | 80.82 | 80.58 | 133.59 | 133.13 | 133.36 | 10.35 | 11.06 | 10.71 | 6.39 | 6.82 | 6.60 |
| $P_3$-100 kg $ha^{-1}$ | 81.98 | 82.55 | 82.26 | 138.15 | 137.06 | 137.60 | 10.98 | 11.68 | 11.33 | 6.78 | 7.21 | 6.99 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig | Sig | Sig |
| SE(m) ± | 0.17 | 0.18 | 0.14 | 0.49 | 0.51 | 0.35 | 0.08 | 0.05 | 0.05 | 0.05 | 0.03 | 0.03 |
| CD at 5% | 0.47 | 0.50 | 0.38 | 1.39 | 1.45 | 0.99 | 0.21 | 0.14 | 0.14 | 0.13 | 0.09 | 0.09 |
| **Potassium (K)** | | | | | | | | | | | | |
| $K_1$-50 kg $ha^{-1}$ | 77.87 | 78.30 | 78.08 | 127.99 | 127.20 | 127.59 | 9.72 | 10.38 | 10.05 | 6.00 | 6.40 | 6.20 |
| $K_2$-75 kg $ha^{-1}$ | 80.04 | 80.64 | 80.34 | 133.10 | 132.41 | 132.76 | 10.40 | 11.11 | 10.76 | 6.42 | 6.85 | 6.63 |
| $K_3$-100 kg $ha^{-1}$ | 81.44 | 81.79 | 81.70 | 137.14 | 135.54 | 136.34 | 10.75 | 11.47 | 11.11 | 6.64 | 7.08 | 6.85 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.17 | 0.18 | 0.14 | 0.49 | 0.51 | 0.35 | 0.08 | 0.05 | 0.05 | 0.05 | 0.03 | 0.03 |
| CD at 5% | 0.47 | 0.50 | 0.38 | 1.39 | 1.45 | 0.99 | 0.21 | 0.14 | 0.14 | 0.13 | 0.09 | 0.09 |
| **Interaction (N X P)** | | | | | | | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.29 | 0.31 | 0.23 | 0.85 | 0.88 | 0.61 | 0.13 | 0.09 | 0.09 | 0.08 | 0.05 | 0.05 |
| CD at 5% | 0.81 | 0.87 | 0.66 | 2.40 | 2.51 | 1.72 | 0.37 | 0.25 | 0.25 | 0.23 | 0.15 | 0.15 |
| **Interaction (N X K)** | | | | | | | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.29 | 0.31 | 0.23 | 0.85 | 0.88 | 0.61 | 0.13 | 0.09 | 0.09 | 0.08 | 0.05 | 0.05 |
| CD at 5% | 0.81 | 0.87 | 0.66 | 2.40 | 2.51 | 1.72 | 0.37 | 0.25 | 0.25 | 0.23 | 0.15 | 0.15 |
| **Interaction (P X K)** | | | | | | | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.29 | 0.31 | 0.23 | 0.85 | 0.88 | 0.61 | 0.13 | 0.09 | 0.09 | 0.08 | 0.05 | 0.05 |
| CD at 5% | 0.81 | 0.87 | 0.66 | 2.40 | 2.51 | 1.72 | 0.37 | 0.25 | 0.25 | 0.23 | 0.15 | 0.15 |
| **Interaction (N X P X K)** | | | | | | | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.50 | 0.53 | 0.41 | 1.47 | 1.53 | 1.05 | 0.23 | 0.15 | 0.15 | 0.14 | 0.09 | 0.09 |
| CD at 5% | 1.41 | 1.51 | 1.15 | 4.16 | 4.34 | 2.98 | 0.64 | 0.43 | 0.43 | 0.40 | 0.27 | 0.27 |

**Table 1 (b):** Interaction effect between nitrogen and phosphorus levels on flowers plant$^{-1}$ and seed weight flower$^{-1}$ (mg) of annual chrysanthemum

| N X P | Flowers plant$^{-1}$ | | | | | | | | | Seed weight flower$^{-1}$ (mg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $P_1$ | 72.28 | 76.35 | 82.44 | 72.75 | 76.44 | 83.43 | 72.52 | 76.40 | 82.93 | 118.11 | 125.17 | 136.15 | 114.46 | 121.68 | 138.73 | 116.28 | 123.43 | 137.44 |
| $P_2$ | 75.73 | 79.13 | 86.15 | 75.80 | 80.04 | 86.62 | 75.76 | 79.58 | 86.38 | 124.04 | 130.64 | 146.08 | 119.88 | 129.88 | 149.62 | 121.96 | 130.26 | 147.85 |
| $P_3$ | 76.55 | 80.84 | 88.53 | 76.66 | 81.73 | 89.24 | 76.61 | 81.28 | 88.88 | 126.06 | 133.15 | 155.22 | 121.68 | 133.64 | 155.84 | 123.87 | 133.40 | 155.53 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.29 | | | 0.31 | | | 0.23 | | | 0.49 | | | 0.51 | | | 0.35 | | |
| CD at 5% | 0.81 | | | 0.87 | | | 0.66 | | | 1.39 | | | 1.45 | | | 0.99 | | |

**Table 1 (c):** Interaction effect between nitrogen and potassium levels on flowers plant$^{-1}$ and seed weight flower$^{-1}$ (mg) of annual chrysanthemum

| N X K | Flowers plant$^{-1}$ | | | | | | | | | Seed weight flower$^{-1}$ (mg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $K_1$ | 72.51 | 77.57 | 83.51 | 72.51 | 77.95 | 84.43 | 72.51 | 77.76 | 83.97 | 117.84 | 127.48 | 138.62 | 114.15 | 125.55 | 141.88 | 116.00 | 126.52 | 140.25 |
| $K_2$ | 75.26 | 78.91 | 85.95 | 75.64 | 79.62 | 86.66 | 75.45 | 79.26 | 86.31 | 123.40 | 129.66 | 146.22 | 119.28 | 128.06 | 149.88 | 121.34 | 128.86 | 148.05 |
| $K_3$ | 76.80 | 79.84 | 87.66 | 77.06 | 80.64 | 88.20 | 76.93 | 80.24 | 87.93 | 126.97 | 131.82 | 152.62 | 122.60 | 131.60 | 152.42 | 124.78 | 131.71 | 152.52 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.29 | | | 0.31 | | | 0.23 | | | 0.49 | | | 0.51 | | | 0.35 | | |
| CD at 5% | 0.81 | | | 0.87 | | | 0.66 | | | 1.39 | | | 1.45 | | | 0.99 | | |

**Table 1 (d):** Interaction effect between phosphorus and potassium levels on flowers plant$^{-1}$ and seed weight flower$^{-1}$ (mg) of annual chrysanthemum

| P X K | Flowers plant$^{-1}$ | | | | | | | | | Seed weight flower$^{-1}$ (mg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ |
| $K_1$ | 74.91 | 79.02 | 79.66 | 75.36 | 79.37 | 80.15 | 75.13 | 79.20 | 79.91 | 122.80 | 129.40 | 131.75 | 120.71 | 129.91 | 130.97 | 121.75 | 129.65 | 131.36 |
| $K_2$ | 76.84 | 80.75 | 82.53 | 77.53 | 81.42 | 82.97 | 77.18 | 81.08 | 82.75 | 125.75 | 134.37 | 139.15 | 124.48 | 133.73 | 139.02 | 125.12 | 134.05 | 139.08 |
| $K_3$ | 79.33 | 81.24 | 83.73 | 79.73 | 81.66 | 84.51 | 79.53 | 81.45 | 84.12 | 130.88 | 137.00 | 143.53 | 129.68 | 135.75 | 141.17 | 130.28 | 136.37 | 142.35 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.29 | | | 0.31 | | | 0.23 | | | 0.49 | | | 0.51 | | | 0.35 | | |
| CD at 5% | 0.81 | | | 0.87 | | | 0.66 | | | 1.39 | | | 1.45 | | | 0.99 | | |

**Table 1 (e):** Interaction effect between nitrogen, phosphorus and potassium levels on flowers plant$^{-1}$ and seed weight flower$^{-1}$ (mg) of annual chrysanthemum

| N X P X K | Flowers plant$^{-1}$ | | | | | | | | | Seed weight flower$^{-1}$ (mg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $P_1K_1$ | 68.66 | 75.40 | 80.66 | 69.13 | 75.13 | 81.83 | 68.9 | 75.26 | 81.25 | 112.8 | 123 | 132.6 | 109.66 | 119.26 | 133.20 | 111.23 | 121.13 | 132.90 |
| $P_1K_2$ | 72.20 | 75.66 | 82.66 | 73.06 | 75.60 | 83.93 | 72.63 | 75.63 | 83.30 | 116.73 | 123.86 | 136.66 | 113.06 | 118.20 | 142.20 | 114.90 | 121.03 | 139.43 |
| $P_1K_3$ | 76.00 | 78.00 | 84.00 | 76.06 | 78.60 | 84.53 | 76.03 | 78.30 | 84.26 | 124.80 | 128.66 | 139.2 | 120.66 | 127.60 | 140.80 | 122.73 | 128.13 | 140.00 |
| $P_2K_1$ | 74.00 | 78.46 | 84.60 | 73.80 | 79.13 | 85.20 | 73.90 | 78.80 | 84.90 | 119.26 | 129.20 | 139.73 | 115.66 | 128.40 | 145.66 | 117.46 | 128.80 | 142.70 |
| $P_2K_2$ | 76.33 | 79.66 | 86.26 | 76.53 | 80.80 | 86.93 | 76.43 | 80.23 | 86.60 | 125.93 | 131.93 | 145.26 | 121.33 | 131.40 | 148.46 | 123.63 | 131.66 | 146.86 |
| $P_2K_3$ | 76.86 | 79.26 | 87.60 | 77.06 | 80.20 | 87.73 | 76.96 | 79.73 | 87.66 | 126.93 | 130.80 | 153.26 | 122.66 | 129.86 | 154.73 | 124.80 | 130.33 | 154.00 |
| $P_3K_1$ | 74.86 | 78.86 | 85.26 | 74.60 | 79.60 | 86.26 | 74.73 | 79.23 | 85.76 | 121.46 | 130.26 | 143.53 | 117.13 | 129.00 | 146.80 | 119.30 | 129.63 | 145.16 |
| $P_3K_2$ | 77.26 | 81.4 | 88.93 | 77.33 | 82.46 | 89.13 | 77.30 | 81.93 | 89.03 | 127.53 | 133.20 | 156.73 | 123.46 | 134.60 | 159.00 | 125.50 | 133.90 | 157.86 |
| $P_3K_3$ | 77.53 | 82.26 | 91.40 | 78.06 | 83.13 | 92.33 | 77.80 | 82.70 | 91.86 | 129.20 | 136.00 | 165.40 | 124.46 | 137.33 | 161.73 | 126.83 | 136.66 | 163.56 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.50 | | | 0.53 | | | 0.41 | | | 1.47 | | | 1.53 | | | 1.05 | | |
| CD at 5% | 1.41 | | | 1.51 | | | 1.15 | | | 4.16 | | | 4.34 | | | 2.98 | | |

**Table 1 (f):** Interaction effect between nitrogen and phosphorus levels on seed yield plant$^{-1}$ (g) and seed yield ha$^{-1}$ (q) of annual chrysanthemum

| N X P | Seed yield plant$^{-1}$ (g) | | | | | | | | | Seed yield ha$^{-1}$ (q) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $P_1$ | 8.57 | 9.35 | 10.71 | 9.07 | 10.00 | 11.55 | 8.82 | 9.67 | 11.13 | 5.29 | 5.77 | 6.61 | 5.60 | 6.18 | 7.13 | 5.45 | 5.97 | 6.87 |
| $P_2$ | 9.10 | 10.10 | 11.86 | 9.73 | 10.85 | 12.60 | 9.41 | 10.47 | 12.23 | 5.62 | 6.23 | 7.32 | 6.01 | 6.70 | 7.78 | 5.81 | 6.47 | 7.55 |
| $P_3$ | 9.32 | 10.43 | 13.19 | 9.96 | 11.22 | 13.85 | 9.64 | 10.82 | 13.52 | 5.75 | 6.44 | 8.14 | 6.15 | 6.93 | 8.55 | 5.95 | 6.68 | 8.35 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.13 | | | 0.09 | | | 0.09 | | | 0.08 | | | 0.05 | | | 0.05 | | |
| CD at 5% | 0.37 | | | 0.25 | | | 0.25 | | | 0.23 | | | 0.15 | | | 0.15 | | |

**Table 1 (g):** Interaction effect between nitrogen and potassium levels on seed yield plant$^{-1}$ (g) and seed yield ha$^{-1}$ (q) of annual chrysanthemum

| N X K | Seed yield plant$^{-1}$ (g) | | | | | | | | | Seed yield ha$^{-1}$ (q) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $K_1$ | 8.44 | 9.63 | 11.06 | 8.83 | 10.30 | 11.99 | 8.64 | 9.97 | 11.53 | 5.21 | 5.95 | 6.83 | 5.46 | 6.36 | 7.40 | 5.34 | 6.15 | 7.12 |
| $K_2$ | 9.07 | 10.03 | 12.10 | 9.68 | 10.77 | 12.86 | 9.38 | 10.40 | 12.48 | 5.60 | 6.19 | 7.47 | 5.98 | 6.65 | 7.94 | 5.79 | 6.42 | 7.71 |
| $K_3$ | 9.46 | 10.21 | 12.57 | 10.24 | 11.01 | 13.15 | 9.85 | 10.61 | 12.86 | 5.84 | 6.30 | 7.76 | 6.33 | 6.80 | 8.12 | 6.08 | 6.55 | 7.94 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.10 | | | 0.11 | | | 0.08 | | | 0.08 | | | 0.05 | | | 0.05 | | |
| CD at 5% | 0.29 | | | 0.31 | | | 0.24 | | | 0.23 | | | 0.15 | | | 0.15 | | |

**Table 1 (h):** Interaction effect between phosphorus and potassium levels on seed yield plant$^{-1}$ (g) and seed yield ha$^{-1}$ (q) of annual chrysanthemum

| P X K | Seed yield plant$^{-1}$ (g) | | | | | | | | | Seed yield ha$^{-1}$ (q) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ |
| $K_1$ | 9.22 | 9.79 | 10.13 | 9.68 | 10.65 | 10.80 | 9.45 | 10.22 | 10.46 | 5.69 | 6.05 | 6.26 | 5.98 | 6.58 | 6.67 | 5.83 | 6.31 | 6.46 |
| $K_2$ | 9.44 | 10.55 | 11.21 | 10.09 | 11.21 | 12.01 | 9.77 | 10.88 | 11.61 | 5.83 | 6.51 | 6.92 | 6.23 | 6.92 | 7.42 | 6.03 | 6.72 | 7.17 |
| $K_3$ | 9.95 | 10.70 | 11.59 | 10.86 | 11.32 | 12.23 | 10.41 | 11.01 | 11.91 | 6.15 | 6.61 | 7.16 | 6.71 | 6.99 | 7.55 | 6.43 | 6.80 | 7.35 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.13 | | | 0.09 | | | 0.09 | | | 0.08 | | | 0.05 | | | 0.05 | | |
| CD at 5% | 0.37 | | | 0.25 | | | 0.25 | | | 0.23 | | | 0.15 | | | 0.15 | | |

**Table 1 (i):** Interaction effect between nitrogen, phosphorus and potassium levels on seed yield plant$^{-1}$ (g) and seed yield ha$^{-1}$ (q) of annual chrysanthemum

| N X P X K | Seed yield plant$^{-1}$ (g) | | | | | | | | | Seed yield ha$^{-1}$ (q) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $P_1K_1$ | 8.12 | 9.12 | 10.43 | 8.24 | 9.59 | 11.22 | 8.17 | 9.35 | 10.82 | 5.01 | 5.63 | 6.44 | 5.08 | 5.92 | 6.93 | 5.05 | 5.77 | 6.68 |
| $P_1K_2$ | 8.31 | 9.20 | 10.83 | 8.73 | 9.85 | 11.70 | 8.52 | 9.52 | 11.26 | 5.13 | 5.68 | 6.69 | 5.39 | 6.08 | 7.22 | 5.26 | 5.88 | 6.95 |
| $P_1K_3$ | 9.27 | 9.74 | 10.86 | 10.26 | 10.58 | 11.74 | 9.76 | 10.16 | 11.30 | 5.72 | 6.01 | 6.71 | 6.34 | 6.53 | 7.25 | 6.03 | 6.27 | 6.98 |
| $P_2K_1$ | 8.47 | 9.84 | 11.06 | 8.96 | 10.65 | 12.35 | 8.71 | 10.24 | 11.70 | 5.23 | 6.08 | 6.83 | 5.53 | 6.57 | 7.62 | 5.38 | 6.33 | 7.23 |
| $P_2K_2$ | 9.35 | 10.27 | 12.04 | 10.07 | 11.06 | 12.51 | 9.70 | 10.66 | 12.27 | 5.77 | 6.34 | 7.43 | 6.21 | 6.83 | 7.72 | 5.99 | 6.58 | 7.58 |
| $P_2K_3$ | 9.47 | 10.17 | 12.47 | 10.16 | 10.85 | 12.96 | 9.81 | 10.51 | 12.71 | 5.85 | 6.28 | 7.70 | 6.27 | 6.70 | 8.00 | 6.06 | 6.49 | 7.85 |
| $P_3K_1$ | 8.75 | 9.95 | 11.70 | 9.32 | 10.68 | 12.42 | 9.03 | 10.31 | 12.06 | 5.40 | 6.14 | 7.22 | 5.75 | 6.59 | 7.67 | 5.58 | 6.37 | 7.44 |
| $P_3K_2$ | 9.57 | 10.62 | 13.45 | 10.27 | 11.40 | 14.38 | 9.91 | 11.01 | 13.91 | 5.91 | 6.56 | 8.30 | 6.34 | 7.04 | 8.88 | 6.12 | 6.80 | 8.59 |
| $P_3K_3$ | 9.65 | 10.72 | 14.40 | 10.32 | 11.60 | 14.77 | 9.98 | 11.16 | 14.58 | 5.95 | 6.62 | 8.89 | 6.37 | 7.16 | 9.12 | 6.16 | 6.89 | 9.00 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.23 | | | 0.15 | | | 0.15 | | | 0.14 | | | 0.09 | | | 0.09 | | |
| CD at 5% | 0.64 | | | 0.43 | | | 0.43 | | | 0.40 | | | 0.27 | | | 0.27 | | |

**Table 2 (a):** Effect of nitrogen, phosphorus and potassium levels on test weight (g) and germination percent (%) of annual chrysanthemum seeds

| Treatments | Test weight (g) | | | Germination % | | |
|---|---|---|---|---|---|---|
| | 2018-2019 | 2019-2020 | Pooled | 2018-2019 | 2019-2020 | Pooled |
| **Nitrogen (N)** | | | | | | |
| $N_1$-100 kg ha$^{-1}$ | 1.39 | 1.51 | 1.45 | 60.85 | 61.07 | 60.96 |
| $N_2$-150 kg ha$^{-1}$ | 1.58 | 1.71 | 1.64 | 65.41 | 64.70 | 65.05 |
| $N_3$-200 kg ha$^{-1}$ | 1.84 | 2.01 | 1.92 | 72.07 | 69.70 | 70.88 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.01 | 0.01 | 0.01 | 0.17 | 0.15 | 0.12 |
| CD at 5% | 0.02 | 0.03 | 0.02 | 0.48 | 0.44 | 0.34 |
| **Phosphorus (P)** | | | | | | |
| $P_1$-50 kg ha$^{-1}$ | 1.48 | 1.63 | 1.56 | 63.30 | 63.04 | 63.16 |
| $P_2$-75 kg ha$^{-1}$ | 1.63 | 1.77 | 1.70 | 63.30 | 65.52 | 66.07 |
| $P_3$-100 kg ha$^{-1}$ | 1.69 | 1.84 | 1.77 | 68.41 | 66.93 | 67.66 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.01 | 0.01 | 0.01 | 0.17 | 0.15 | 0.12 |
| CD at 5% | 0.02 | 0.03 | 0.02 | 0.48 | 0.44 | 0.34 |
| **Potassium (K)** | | | | | | |
| $K_1$-50 kg ha$^{-1}$ | 1.52 | 1.66 | 1.59 | 64.00 | 63.63 | 63.81 |
| $K_2$-75 kg ha$^{-1}$ | 1.61 | 1.76 | 1.68 | 66.44 | 65.41 | 65.92 |
| $K_3$-100 kg ha$^{-1}$ | 1.67 | 1.83 | 1.75 | 67.89 | 66.44 | 67.16 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.01 | 0.01 | 0.01 | 0.17 | 0.15 | 0.12 |
| CD at 5% | 0.02 | 0.03 | 0.02 | 0.48 | 0.44 | 0.34 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Interaction (N X P)** | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.01 | 0.01 | 0.01 | 0.29 | 0.27 | 0.20 |
| CD at 5% | 0.02 | 0.03 | 0.02 | 0.83 | 0.76 | 0.58 |
| **Interaction (N X K)** | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.01 | 0.01 | 0.01 | 0.29 | 0.27 | 0.20 |
| CD at 5% | 0.02 | 0.03 | 0.02 | 0.83 | 0.76 | 0.58 |
| **Interaction (P X K)** | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.01 | 0.01 | 0.01 | 0.29 | 0.27 | 0.12 |
| CD at 5% | 0.02 | 0.03 | 0.02 | 0.83 | 0.76 | 0.34 |
| **Interaction (N X P X K)** | | | | | | |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| SE(m) ± | 0.02 | 0.03 | 0.02 | 0.50 | 0.46 | 0.35 |
| CD at 5% | 0.05 | 0.08 | 0.05 | 1.43 | 1.31 | 1.01 |

**Table 2 (b):** Interaction effect between nitrogen and phosphorus levels on test weight (g) and germination percent (%) of annual chrysanthemum seeds

| N X P | Test weight (g) | | | | | | | | | Germination percent (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $P_1$ | 1.29 | 1.420 | 1.73 | 1.44 | 1.57 | 1.87 | 1.36 | 1.49 | 1.80 | 58.77 | 61.88 | 69.22 | 59.33 | 61.88 | 67.88 | 59.05 | 61.88 | 68.55 |
| $P_2$ | 1.40 | 1.62 | 1.84 | 1.52 | 1.76 | 2.01 | 1.46 | 1.69 | 1.93 | 61.33 | 66.33 | 72.22 | 61.55 | 65.55 | 69.44 | 61.44 | 65.94 | 70.83 |
| $P_3$ | 1.45 | 1.67 | 1.93 | 1.57 | 1.80 | 2.14 | 1.51 | 1.74 | 2.03 | 62.44 | 68.00 | 74.77 | 62.33 | 66.66 | 71.77 | 62.38 | 67.33 | 73.27 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.01 | | | 0.01 | | | 0.01 | | | 0.17 | | | 0.15 | | | 0.12 | | |
| CD at 5% | 0.02 | | | 0.03 | | | 0.02 | | | 0.48 | | | 0.44 | | | 0.34 | | |

**Table 2 (c):** Interaction effect between nitrogen and potassium levels on test weight (g) and germination percent (%) of annual chrysanthemum seeds

| N X K | Test weight (g) | | | | | | | | | Germination percent (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $K_1$ | 1.29 | 1.51 | 1.75 | 1.41 | 1.65 | 1.89 | 1.35 | 1.58 | 1.82 | 58.11 | 63.77 | 70.11 | 59.00 | 63.44 | 68.44 | 58.55 | 63.61 | 69.27 |
| $K_2$ | 1.40 | 1.58 | 1.84 | 1.53 | 1.71 | 2.03 | 1.46 | 1.64 | 1.93 | 61.33 | 65.66 | 72.33 | 61.44 | 65.00 | 69.77 | 61.38 | 65.33 | 71.05 |
| $K_3$ | 1.46 | 1.63 | 1.91 | 1.60 | 1.77 | 2.10 | 1.53 | 1.70 | 2.00 | 63.11 | 66.77 | 73.77 | 62.77 | 65.66 | 70.88 | 62.94 | 66.22 | 72.33 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.01 | | | 0.01 | | | 0.01 | | | 0.17 | | | 0.15 | | | 0.12 | | |
| CD at 5% | 0.02 | | | 0.03 | | | 0.02 | | | 0.48 | | | 0.44 | | | 0.34 | | |

**Table 2 (d):** Interaction effect between phosphorus and potassium levels on test weight (g) and germination percent (%) of annual chrysanthemum seeds

| P X K | Test weight (g) | | | | | | | | | Germination percent (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ | $P_1$ | $P_2$ | $P_3$ |
| $K_1$ | 1.42 | 1.56 | 1.57 | 1.55 | 1.69 | 1.71 | 1.49 | 1.62 | 1.64 | 61.33 | 64.88 | 65.77 | 61.66 | 64.44 | 64.77 | 61.50 | 64.66 | 65.27 |
| $K_2$ | 1.46 | 1.65 | 1.715 | 1.59 | 1.78 | 1.88 | 1.53 | 1.72 | 1.80 | 62.88 | 67.33 | 69.11 | 62.66 | 66.11 | 67.44 | 62.77 | 66.72 | 68.27 |
| $K_3$ | 1.56 | 1.66 | 1.783 | 1.72 | 1.82 | 1.92 | 1.64 | 1.74 | 1.85 | 65.66 | 67.66 | 70.33 | 64.77 | 66.00 | 68.55 | 65.22 | 66.83 | 69.44 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.01 | | | 0.01 | | | 0.01 | | | 0.17 | | | 0.15 | | | 0.12 | | |
| CD at 5% | 0.02 | | | 0.03 | | | 0.02 | | | 0.48 | | | 0.44 | | | 0.34 | | |

**Table 2 (e):** Interaction effect between nitrogen, phosphorus and potassium levels on test weight (g) and germination percent (%) of annual chrysanthemum seeds

| N X P X K | Test weight (g) | | | | | | | | | Germination percent (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-2019 | | | 2019-2020 | | | Pooled | | | 2018-2019 | | | 2019-2020 | | | Pooled | | |
| | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ | $N_1$ | $N_2$ | $N_3$ |
| $P_1K_1$ | 1.24 | 1.35 | 1.69 | 1.36 | 1.49 | 1.81 | 1.29 | 1.42 | 1.75 | 56.33 | 60.00 | 67.66 | 57.33 | 60.66 | 67.00 | 56.83 | 60.33 | 67.33 |
| $P_1K_2$ | 1.30 | 1.36 | 1.74 | 1.40 | 1.51 | 1.88 | 1.34 | 1.43 | 1.81 | 58.00 | 61.00 | 69.66 | 59.00 | 61.00 | 68.00 | 58.50 | 61.00 | 68.83 |
| $P_1K_3$ | 1.36 | 1.55 | 1.77 | 1.56 | 1.71 | 1.92 | 1.46 | 1.62 | 1.84 | 62.00 | 64.66 | 70.33 | 61.66 | 64.00 | 68.66 | 61.83 | 64.33 | 69.50 |
| $P_2K_1$ | 1.32 | 1.59 | 1.77 | 1.43 | 1.73 | 1.93 | 1.37 | 1.66 | 1.85 | 58.66 | 65.00 | 71.00 | 59.66 | 64.66 | 69.00 | 59.16 | 64.83 | 70.00 |
| $P_2K_2$ | 1.42 | 1.68 | 1.86 | 1.56 | 1.79 | 2.02 | 1.49 | 1.73 | 1.94 | 62.33 | 67.33 | 72.33 | 62.00 | 66.66 | 69.66 | 62.16 | 67.00 | 71.00 |
| $P_2K_3$ | 1.47 | 1.61 | 1.90 | 1.59 | 1.77 | 2.10 | 1.53 | 1.69 | 1.99 | 63.00 | 66.66 | 73.33 | 63.00 | 65.33 | 69.66 | 63.00 | 66.00 | 71.50 |
| $P_3K_1$ | 1.32 | 1.60 | 1.79 | 1.46 | 1.75 | 1.94 | 1.39 | 1.67 | 1.86 | 59.33 | 66.33 | 71.66 | 60.00 | 65.00 | 69.33 | 59.66 | 65.66 | 70.50 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_3K_2$ | 1.51 | 1.70 | 1.94 | 1.63 | 1.83 | 2.19 | 1.56 | 1.76 | 2.06 | 63.66 | 68.66 | 75.00 | 63.33 | 67.33 | 71.66 | 63.50 | 68.00 | 73.33 |
| $P_3K_3$ | 1.54 | 1.73 | 2.07 | 1.65 | 1.84 | 2.30 | 1.59 | 1.78 | 2.18 | 64.33 | 69.00 | 77.66 | 63.66 | 67.66 | 74.33 | 64.00 | 68.33 | 76.00 |
| 'F' test | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | | Sig | | |
| SE(m) ± | 0.02 | | | 0.03 | | | 0.02 | | | 0.50 | | | 0.46 | | | 0.35 | | |
| CD at 5% | 0.05 | | | 0.08 | | | 0.05 | | | 1.43 | | | 1.31 | | | 1.01 | | |

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