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# Effect of NPK on Growth and Flower Yield of Hibiscus *(Hibiscus rosa-sinensis)*

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

The research work on "Effect of NPK on growth and flower yield Hibiscus rosa sinensis" was conducted in the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2019-2020. The experiment was conducted in randomized block design with three replications & 12 treatments. Treatments were allocated randomly to each replication each treatment comprised of one plants which made a total of 36 plants. The best results were achieved in treatment T4 NPK (100:105:105) gram per plant with maximum plant height (113.62), maximum number of leaves per plant (71.99), maximum number of branches per plant (10.07), minimum days to bud initiation (43.31 days), minimum days taken flowering (49.87 days), maximum number of flower per plant(15.83), maximum flower diameter(cm) (13.06), flower weight(g) was found maximum (3.82), number of flower was found maximum (39575) along with maximum cost-benefit ratio (1: 1.46).

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## 1. INTRODUCTION

Hibiscus is a genus of more than 200 species of deciduous and evergreen shrubs, trees, annuals, and herbaceous perennials, widely distributed in warm-temperate subtropical and tropical regions [1]. Hibiscus rosa-sinensis shrubs are exotic and make great container plants on patios and decks [2]. H. rosa-sinensis (rose of China) is a rounded, bushy, evergreen, large shrub or small tree with hairless or slightly hairy shoots and ovate to broadly lance-shaped, glossy, dark green leave (15 cm long), with toothed margins [3]. Solitary, 5-petaled, bright crimson flowers, 10 cm across, with yellow anthered red stamens, are produced from the leaf axils from the summer to autumn [4]. Flower colors range from crimson to orange, yellow, or white. Cooperi cultivar of H. rosa-sinensis is a compact (1-2 m), with lance-shaped leaves marbled olive green and white, sometimes tinted pink and bearing red flowers [5,6].

The tropical Chinese hibiscus, or China rose (Hibiscus *rosa-sinensis*), which may reach a height of 4.5 metres (15 feet), rarely exceeds 2 metres in cultivation [7]. It is grown for its large somewhat bell-shaped blossoms [8]. Cultivated varieties have red, white, yellow, or orange flowers. The East African hibiscus (H. *schizopetalus*), a drooping shrub with deeply lobed red petals, is often grown in hanging baskets indoors [9]. Many species of Hibiscus are grown for their showy flowers or used as landscape shrubs. Hibiscus has also medicinal properties and takes part as a primary ingredient in many herbal teas [2]. This plant is popular landscape shrub, creates a bold effect with its bed textured, glossy dark green leaves and with 4- 6 inch wide and up to 8 inch long, showy flowers, produced throughout the year and grows up to 7-12 [10]. Sometimes its demand time to time increases during different Puja festivals. Hibiscus is propagated through vegetative methods by cutting and grafting for produce quality planting material on large scale [11]. Cutting is most convenient method of propagation [12].

The cutting should be taken from new growth or softwood. Softwood is branches on the hibiscus that have not yet matured [13]. The hibiscus cutting should be 4 to 6 inches (10 to 15 cm.) long. Remove everything but the top set of leaves. A slant cut give at the base of the cuttings and each cutting [14]. A transverse cut give at top of each cutting. Dip the bottom of the hibiscus cutting in rooting hormone then place the cutting in well-drained soil and in partial shade. The cuttings should be rooted in about eight weeks [15]**.**

Hibiscus rosa sinensis, a highly potential functional and valuable medicinal plant, has been reported in the ancient medicinal literature with beneficial effects in various disorders of humans [16,17]. This is a tropical shrub, with large, glossy green leaves and spectacular trumpet shaped flowers. Its medicinal values have been mentioned in traditional folk medicines for variety of diseases [18].

Keeping all the above points in view, the present investigation was conducted on Hibiscus with the following objective.

- To find the most suitable treatment for plant growth and flower yield of *Hibiscus rosa sinensis*.
- To work out the economics of different treatments.

## 2. MATERIALS AND METHODS

A field experiment entitled “Effect of NPK on growth and flower yield of Hibiscus *(Hibiscus rosa-sinensis)*” was carried out in the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences during the year 2019-2020. The hibiscus cuttings were planted in the pits with dimension $30cm^2$ at a spacing of 1mx1m containing a mixture of 5 kg FYM & vermicompost. The experiment was conducted in a Randomized block Design with (11+1) treatments and three replications. The experiment includes NPK application, at an interval of 30,60,90,120,150 and 180 days. Plants were selected randomly from each treatment per replication and their observations were recorded at 30 days intervals. Data were statistically analyzed by the method suggested by Fisher and Yates, 1963.

## 3. RESULTS AND DISCUSSION

After analyzing the data, the following data, the following outcomes were noted.

## 3.1 Growth Parameters

### 3.1.1 Height of plant (cm)

The plant height was influenced by different levels of NPK at 30,60,90,120,150 DAP. The maximum plant height was observed in the treatment $T_4$ NPK (100:105:105) gram per plant followed $T_3$ NPK (75:80:80) gram per plant and the minimum was observed in the treatment $T_0$ Control N: P: K (0:0:0) gram per plant. The data is shown in Table 2.

### 3.1.2 Number of leaves per plant

The Number of leaves per plant was influenced by different levels of NPK at 30,60,90,120,150 DAP The maximum number of leaves per plant (71.99) was observed in the treatment $T_4$ NPK (100:105:105) gram per plant and was found to be the minimum (38.94) in the treatment $T_0$ Control N:P:K 0:0:0 g/plant. The data is shown is Table 3.

### 3.1.3 Number of branches per plant

The number of branches per plant was influenced by different levels of NPK at 30,60,90,120,150 DAP. The maximum number of branches per plant (10.07) was observed in the treatment $T_4$ NPK (100:105:105) gram per plant and was found to be minimum (6.86) in the treatment $T_0$ Control N:P: K 0:0:0 g/plant. The data is shown is Table 4.

**Table 1. Treatment details**

| Sr. no | Treatment No. | Treatments combination |
|---|---|---|
| 1 | $T_0$ | Control |
| 2 | $T_1$ | NPK (25:30:30) gram per plant |
| 3 | $T_2$ | NPK (50:55:55) gram per plant |
| 4 | $T_3$ | NPK (75:80:80) gram per plant |
| 5 | $T_4$ | NPK (100:105:105) gram per plant |
| 6 | $T_5$ | NPK (125:130:130) gram per plant |
| 7 | $T_6$ | NPK (150:155:155) gram per plant |
| 8 | $T_7$ | NPK (175:180:180) gram per plant |
| 9 | $T_8$ | NPK (200:205:205) gram per plant |
| 10 | $T_9$ | NPK (225:230:230) gram per plant |
| 11 | $T_{10}$ | NPK (250:255:255) gram per plant |
| 12 | $T_{11}$ | NPK (275:280:280) gram per plant |

**Table 2. Plant height at 30,60,90,120,150 and 180 DAT**

| Sr. No. | Treatment No. | Plant height (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 90 DAT | 120 DAT | 150 DAT | 180 DAT |
| 1 | $T_0$ | 34.80 | 39.32 | 43.84 | 49.65 | 55.10 | 59.25 |
| 2 | $T_1$ | 62.02 | 67.90 | 73.35 | 79.57 | 85.72 | 90.24 |
| 3 | $T_2$ | 67.12 | 73.56 | 79.16 | 85.72 | 92.05 | 96.41 |
| 4 | $T_3$ | 82.23 | 89.05 | 94.49 | 100.90 | 107.15 | 111.29 |
| 5 | $T_4$ | 84.55 | 91.01 | 96.42 | 102.98 | 109.39 | 113.62 |
| 6 | $T_5$ | 81.35 | 88.17 | 93.72 | 100.16 | 106.60 | 111.11 |
| 7 | $T_6$ | 76.28 | 82.74 | 88.19 | 94.63 | 100.96 | 105.62 |
| 8 | $T_7$ | 73.87 | 80.39 | 86.02 | 92.34 | 98.62 | 103.02 |
| 9 | $T_8$ | 73.99 | 80.24 | 85.38 | 91.63 | 98.04 | 102.32 |
| 10 | $T_9$ | 73.61 | 80.06 | 85.18 | 91.30 | 97.55 | 102.36 |
| 11 | $T_{10}$ | 76.68 | 83.01 | 88.23 | 94.56 | 100.89 | 105.44 |
| 12 | $T_{11}$ | 74.41 | 80.86 | 86.07 | 92.88 | 99.02 | 103.18 |
| | F-Test | S | S | S | S | S | S |
| | S.Ed. (±) | 2.00 | 1.942 | 2.02 | 1.93 | 2.08 | 1.98 |
| | **C.D. at 0.5%** | 4.14 | 4.02 | 4.15 | 4.01 | 4.31 | 4.11 |

**Table 3. Number of leaves per plant at 30,60,90,120,150 and 180 DAT**

| Sr. No. | Treatment No. | Number of leaves per plant | | | | | |
|---|---|---|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 90 DAT | 120 DAT | 150 DAT | 180 DAT |
| 1 | $T_0$ | 14.06 | 17.51 | 23.76 | 31.79 | 32.69 | 38.94 |
| 2 | $T_1$ | 18.39 | 24.71 | 37.23 | 46.95 | 52.99 | 65.51 |
| 3 | $T_2$ | 16.75 | 22.89 | 35.30 | 46.53 | 51.45 | 63.86 |
| 4 | $T_3$ | 22.56 | 29.08 | 41.52 | 54.34 | 58.23 | 70.67 |
| 5 | $T_4$ | 24.53 | 30.65 | 43.06 | 55.37 | 59.58 | 71.99 |
| 6 | $T_5$ | 21.37 | 27.62 | 39.95 | 54.44 | 57.11 | 69.44 |
| 7 | $T_6$ | 18.80 | 25.11 | 37.32 | 46.15 | 52.47 | 64.68 |
| 8 | $T_7$ | 20.62 | 26.87 | 39.39 | 47.79 | 54.71 | 67.23 |
| 9 | $T_8$ | 19.44 | 25.56 | 37.97 | 46.28 | 53.15 | 65.56 |
| 10 | $T_9$ | 20.26 | 26.78 | 39.10 | 47.80 | 54.32 | 66.64 |
| 11 | $T_{10}$ | 21.48 | 27.58 | 39.99 | 48.46 | 55.23 | 67.64 |
| 12 | $T_{11}$ | 20.16 | 26.38 | 38.71 | 47.10 | 53.83 | 66.16 |
| | F-Test | S | S | S | S | S | S |
| | S.Ed. (±) | 0.98 | 1.05 | 0.96 | 1.00 | 1.02 | 0.99 |
| | **C.D. at 0.5%** | 2.03 | 2.18 | 1.99 | 2.09 | 2.11 | 2.07 |

**Table 4. Number of branches per plant at 30,60,90,120,150 and 180 DAT**

| Sr. No. | Treatment No. | Number of branches per plant | | | | | |
|---|---|---|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 90 DAT | 120 DAT | 150 DAT | 180 DAT |
| 1 | $T_0$ | 1.10 | 2.31 | 3.36 | 4.58 | 5.64 | 6.86 |
| 2 | $T_1$ | 2.17 | 3.45 | 4.66 | 5.96 | 8.29 | 9.71 |
| 3 | $T_2$ | 2.26 | 3.59 | 4.82 | 6.14 | 8.55 | 9.90 |
| 4 | $T_3$ | 2.51 | 3.72 | 4.90 | 6.18 | 8.48 | 10.10 |
| 5 | $T_4$ | 2.63 | 3.88 | 5.11 | 6.33 | 8.65 | 10.07 |
| 6 | $T_5$ | 2.48 | 3.71 | 4.92 | 6.23 | 8.67 | 10.13 |
| 7 | $T_6$ | 2.20 | 3.47 | 4.69 | 5.89 | 8.41 | 9.93 |
| 8 | $T_7$ | 2.06 | 3.29 | 4.49 | 5.77 | 8.43 | 9.88 |
| 9 | $T_8$ | 2.15 | 3.37 | 4.60 | 5.82 | 8.34 | 9.75 |
| 10 | $T_9$ | 2.16 | 3.41 | 4.65 | 5.88 | 8.44 | 10.07 |
| 11 | $T_{10}$ | 2.25 | 3.48 | 4.70 | 5.94 | 8.45 | 9.96 |
| 12 | $T_{11}$ | 2.18 | 3.42 | 4.63 | 5.77 | 8.49 | 9.94 |
| | F-Test | S | S | S | S | S | S |
| | S.Ed. (±) | 0.118 | 0.115 | 0.116 | 0.121 | 0.136 | 0.134 |
| | **C.D. at 0.5%** | 0.244 | 0.238 | 0.241 | 0.250 | 0.282 | 0.277 |

**Table 5. Days to bud initiation, days taken to flowering, number of flowers per plant, flower diameter (cm), flower weight (g), number of flowers per ha**

| Treatment No. | Treatments details | Days to bud initiation | Days taken to flowering | Number of flowers per plant | Flower diameter (cm) | Flower weight (g) | Number of flowers per ha |
|---|---|---|---|---|---|---|---|
| $T_0$ | Control | 68.07 | 84.59 | 7.04 | 10.13 | 2.07 | 17591.67 |
| $T_1$ | NPK (25:30:30) gram per plant | 52.16 | 60.61 | 12.52 | 11.47 | 2.62 | 31308.33 |
| $T_2$ | NPK (50:55:55) gram per plant | 50.17 | 59.10 | 11.48 | 11.16 | 2.57 | 28700 |
| $T_3$ | NPK (75:80:80) gram per plant | 46.03 | 53.55 | 14.54 | 12.74 | 3.70 | 36358.33 |
| $T_4$ | NPK (100:105:105) gram per plant | 43.31 | 49.87 | 15.83 | 13.06 | 3.82 | 39575 |
| $T_5$ | NPK (125:130:130) | 48.42 | 57.05 | 14.07 | 12.91 | 3.61 | 35166.67 |

| Treatment No. | Treatments details | Days to bud initiation | Days taken to flowering | Number of flowers per plant | Flower diameter (cm) | Flower weight (g) | Number of flowers per ha |
|---|---|---|---|---|---|---|---|
| | gram per plant | | | | | | |
| $T_6$ | NPK (150:155:155) gram per plant | 48.18 | 57.33 | 13.57 | 12.61 | 3.31 | 33925 |
| $T_7$ | NPK (175:180:180) gram per plant | 54.81 | 65.33 | 12.78 | 12.37 | 3.31 | 31950 |
| $T_8$ | NPK (200:205:205) gram per plant | 54.72 | 63.87 | 12.44 | 11.52 | 3.54 | 31108.33 |
| $T_9$ | NPK (225:230:230) gram per plant | 52.77 | 62.29 | 13.06 | 11.98 | 2.80 | 32641.67 |
| $T_{10}$ | NPK (250:255:255) gram per plant | 58.47 | 67.69 | 13.24 | 12.08 | 2.63 | 33108.33 |
| $T_{11}$ | NPK (275:280:280) gram per plant | 62.28 | 71.64 | 14.44 | 12.07 | 2.44 | 36108.33 |
| | F-Test | S | S | S | S | S | S |
| | S.Ed. (±) | 1.918 | 1.925 | 0.515 | 0.186 | 0.122 | 1286.81 |
| | **C.D. at 0.5%** | 3.978 | 3.99 | 1.067 | 0.386 | 0.253 | 2668.698 |

**Table 6. Economics of different treatments and benefit-cost ratio for cultivation of *Hibiscus rosa sinensis***

| Treatment No. | Treatment Details | Cost of cultivation Rs. /ha | Flower yield q /ha | Sale Rate Rs/q | Gross Return Rs. /ha | Net Return Rs./ ha | Benefit Cost Ratio |
|---|---|---|---|---|---|---|---|
| $T_0$ | Control | 116685 | 17591.67 | 8 | 140733.36 | 24048.36 | 0.21 |
| $T_1$ | NPK (25:30:30) | 119978.48 | 31308.33 | 8 | 250466.64 | 130488.16 | 1.09 |
| $T_2$ | NPK (50:55:55) | 122813.62 | 28700 | 8 | 229600.00 | 106786.38 | 0.87 |
| $T_3$ | NPK (75:80:80) | 125648.77 | 36358.33 | 8 | 290866.64 | 165217.87 | 1.31 |
| $T_4$ | NPK (100:105:105) | 128483.91 | 39575 | 8 | 316600.00 | 188116.09 | 1.46 |
| $T_5$ | NPK (125:130:130) | 131319.06 | 35166.67 | 8 | 281333.36 | 150014.30 | 1.14 |
| $T_6$ | NPK (150:155:155) | 134154.20 | 33925 | 8 | 271400.00 | 137245.80 | 1.02 |
| $T_7$ | NPK (175:180:180) | 136989.35 | 31950 | 8 | 255600.00 | 118610.65 | 0.87 |
| $T_8$ | NPK (200:205:205) | 139824.49 | 31108.33 | 8 | 248866.64 | 109042.15 | 0.78 |
| $T_9$ | NPK (225:230:230) | 142659.64 | 32641.67 | 8 | 261133.36 | 118473.72 | 0.83 |
| $T_{10}$ | NPK (250:255:255) | 145494.78 | 33108.33 | 8 | 264866.64 | 119371.86 | 0.82 |
| $T_{11}$ | NPK (275:280:280) | 148329.93 | 36108.33 | 8 | 288866.64 | 140536.71 | 0.95 |

### 3.1.4 Days to bud initiation

The days to bud initiation was influenced by different levels of NPK at 30,60,90,120,150 DAP. The Days to bud initiation was found to be a minimum (43.31 days) in the treatment $T_0$ NPK 0:0:0 gram per plant and a maximum (68.07 days) in the treatment $T_4$ Control N:P: K (100:105:105)g/plant. The data is shown is Table 5.

### 3.1.5 Days taken to flowering

The days taken to flowering was influenced by different levels of NPK at 30,60,90,120,150 DAP. The days taken to flowering was found to be a minimum (49.87 days) in the treatment $T_0$ NPK 0:0:0gram per plant and a maximum (84.59 days) in the treatment $T_4$ Control N:P: K (100:105: 105)g/plant. The data is shown is Table 5.

## 3.2 Number of Flowers Per Plant

The number of flowers per plant was influenced by different levels of NPK at 30,60,90,120,150 DAP. The Number of flowers per plant was found to be maximum (15.83) in the treatment $T_4$ NPK (100:105:105) gram per plant and minimum (7.04)

in the treatment $T_0$ Control N:P: K 0:0:0 g/plant. The data is shown is Table 5.

### 3.2.1 Flower diameter (cm)

The flower diameter was influenced by different levels of NPK at 30,60,90,120,150 DAP. The flower diameter (cm) was found to be maximum (13.06) in the treatment $T_4$ NPK (100:105:105) gram per plant and minimum (10.13) in the treatment $T_0$ Control N:P: K 0:0:0 g/plant. The data is shown in Table 5.

### 3.2.2 Flower weight (g)

The flower weight was influenced by different levels of NPK at 30,60,90,120,150 DAP. The flower weight (g) was found to be maximum (3.82) in the treatment $T_4$ NPK (100:105:105) gram per plant and minimum (2.07) in the treatment $T_0$ Control N:P: K 0:0:0 g/plant. The data is shown is Table 5.

## 3.3 Number of Flowers Per Ha

The number of flowers per ha. was influenced by different levels of NPK at 30,60,90,120,150 DAP. The number of flowers per ha was found to be maximum (39575) in the treatment $T_4$ NPK (100:105:105) gram per plant minimum (17591.67) in the treatment $T_0$ Control N:P: K 0:0:0 g/plant. The data is shown in Table 5.

## 3.4 Benefit-Cost Ratio for Cultivation

The Benefit-cost ratio was found to be maximum (1: 1.46) in the treatment $T_4$ NPK (100:105:105) gram per plant and minimum (1:0.21) in the treatment $T_0$ Control N:P: K 0:0:0 g/plant. The data is shown in Table 6.

## 4. CONCLUSION

Based on a present investigation, it is concluded that treatment $T_4$ which is application of NPK (100:105:105) was found to be the best in the terms of growth parameter and yield Parameter of Hibiscus and Cost benefit ratio is 1: 1.46.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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