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Effect of Spacing and Fertilizer Dose on Growth and Yield of Statice (*Limonium sinuatum* Mill.)

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ABSTRACT: A field study was conducted during September 2021 to April 2022 at floriculture unit, Department of Horticulture, University of Agricultural Sciences, Bengaluru to know the effect of spacing and fertiliser dose on growth and yield parameters of statice (*Limonium sinuatum* Mill.). Very few studies are conducted till date for the standardization of agro-techniques for Statice. So the main objective of the study was to standardize the fertilizer requirement and Spacing to get better yield and quality under shade net condition for Statice. The treatment T_3 -75% fertiliser dose and 30 cm × 45 cm has resulted in highest plant height, treatment T_{11} –125% fertiliser dose and 30 cm × 45 cm has recorded maximum number of leaves per plant, least number of days taken for panicle initiation from the day of transplanting and highest number of panicles per plant. Whereas the total yield of panicles per hectare was noticed highest in treatment T_9 – 125% fertiliser dose and 30 cm × 15 cm.

Keywords: Statice, fertiliser dose, spacing, growth, yield.

INTRODUCTION

Limonium, commonly called as Statice or Sea Lavender is a popular filler material in floral art. Which is also suitable for dry flowers. It belongs to the family ‘Plumbaginaceae’. The genus Statice is native to Europe, the Mediterranean regions, Asia and the Canary Islands and there are about 40 species under this genus. The important species are *Limonium sinuatum* and *L. suwurowii* are grown as annuals while the species *L. latifolium, L. vulgarae and L. capsia* are grown as perennials. The commercial production of flower crops has undergone a change in recent years due to adoption of high yielding varieties and use of chemical fertilizers. Statice is a potential annual flower crop commercially used as filler material in floral boquets and floral arrangements as fresh flower under wet storage conditions. It is also commercially exploited as Dry flower and Dry flower based floral art. At present statice is grown under protected as well as open field conditions. It also requires balanced fertilizers to meet the demand of nutrients and plant density management for better growth and yield. The planting at optimum spacing and the combined application of both organic and inorganic fertilizers under controlled conditions may be useful in the production of quality flowers (William *et al.,* 1991).

Annual statice cultivars (*L. sinnuatum*) originating from the Mediterranean region, are becoming more popular in the U.S. Statice is commonly used either dried or fresh as a filler flower in floral arrangements. The multiple uses of statice make it an ideal crop for certain climatic areas. Growers can produce statice for the fresh cut market and sell the crop during the early spring. Statice may be produced year round, anywhere cool temperatures are found. Planting statice in different climatic zones influences time of flowering. In temperate climates, it is generally grown as a winter crop, while in tropical regions, statice is grown in highland areas during the winter. Statice is an annual plant which has a rosette plant habit. The plant has deeply lobed leaves which grow parallel to the soil. The 12 to 24" flower stems have colored bracts which surround the white flower. The bract colors include white, yellow, lavender, peach and shade of blue (Brian *et al.,* 1994, Biruk *et al.,* 2013 and Nataraj *et al.,* 2009).

For the cultivation of statice any type of soil is suitable. The soil should be well drained; sandy or sandy-clay soils are recommended. The advised planting distance between each plant is 30 cm × 30 cm. when planting in August / September; flower production can be expected from October onwards. The growth of statice is very much light depending. A day length of 14 hours or more promotes earlier flowering and better quality of flowers. For planting under extreme sharp light conditions a maximum 40% shade net can be applied. As soon as the plants are well established the shade net should be removed. In summer the plants will start generative growth soon after planting. These first flower stems should be pinched until the plant has a rosette with a diameter of at least 25-30 cm, as well as a sufficient vegetative developed plant. The plants are sensitive to high moisture content. A high humidity in the green house must be avoided, especially during the flowering period. Ventilation of the green house is necessary 24 hours a day during flowering (Wilfert *et al.,* 1973; Grieve *et al.,* 2005).

There are many filler materials in the floriculture industry which are mainly used in floral bouquets and floral arrangements. Statice is a spreading floral spike with long lasting minute flowers is used as filler material in such floral decorations and also commercially exploited more in dry flower industry. Hence this study was conducted with an objective to standardize the fertilizer requirement and Spacing (plant density) to get better yield and quality under shade net condition for Statice, which helps to introduce this crop to farmer's fields in commercial scale and to meet the market demand of Statice flowers.

MATERIALS AND METHODS

During the year 2021 – 2022, a field study on 'Effect of spacing and fertilizer dose on growth and yield of Statice (*Limonium sinuatum* Mill.)'. The experiment was conducted in floriculture unit, Department of Horticulture, UAS, GKVK, Bengaluru. The experimental site is located at latitude 13°08′N and 77°56′E Longitude at an elevation of 924m above mean sea level. The experimental site consist of red sandy loam soil with uniform fertility having soil pH of 6.56. the mean maximum and minimum temperature during the period of study were 28.75°C and 17.79°C respectively and the mean rain fall was 106.50 mm. Average maximum and minimum relative humidity during the period of experimentation were 86.50 % and 52.88 % respectively.

The crop was grown under shade net and the statistical design followed to layout the experiment was Factorial Completely Randomized Design (FCRD) with 12 treatments and 3 replications. The treatments were the combination of different doses of fertilizer and varied spacing. The details of treatments are as mentioned below.

Treatment	Fertilizer dose	Spacing
T_1	75%	30 cm × 15 cm
T_2	75%	30 cm × 30 cm
T_3	75%	30 cm × 45 cm
T_4	75%	45 cm × 15 cm
T_5	100%	30 cm × 15 cm
T_6	100%	30 cm × 30 cm
T_7	100%	30 cm × 45 cm
T_8 (CONTROL)	100%	45 cm × 15 cm
T_9	125%	30 cm × 15 cm
T_{10}	125%	30 cm × 30 cm
T_{11}	125%	30 cm × 45 cm
T_{12}	125%	45 cm × 15 cm
NOTE: 40:20:20 Kg NPK/ha. (R.D.F of Golden rod) is taken as the standard dose.		

The treatments were imposed to Statice plants with varied level of fertiliser dose *i.e*., 75%, 100% and 125% of standard dose in combination with varied plant spacing according to the treatment combination *i.e*., 30 cm × 15 cm, 30cm × 30 cm, 30cm × 45 cm and 45 cm × 45 cm. The full dose of fertilizer was applied to plants 21 days after transplanting. The full dose of Potassium (K) and Phosphorous (P) and half dose of Nitrogen (N) were supplied in the form of complex fertilizer 19:19:19 and the remaining half dose of Nitrogen (N) was applied in the form of Urea. Other agronomic practices were carried out as per the requirement of the crop to keep the plot free from weeds, regular observation were made on incidence of pest and diseases and necessary plant protection measures were taken up.

RESULTS AND DISCUSSION

Plant Height (cm). Plant height of Statice plants, influenced by different treatments consisting of varied quantity of NPK fertilizers in combination with different plant spacing was recorded at different stages of plant growth *i.e*., 30 days after transplanting, 60 days after transplanting and 90 days after transplanting. As depicted in Fig. 1 there was no significant difference in plant height of statice plants at 30 days after transplanting, where as there was some significant difference in the plant height in different treatments at 60 days after transplanting further it was clearly observed at 90 days after transplanting.

At 90 days after transplanting the maximum plant height was observed in treatment T_3 -75% fertiliser dose and 30 cm × 45 cm (42.67 cm) followed by treatment T_8 - 100% fertiliser dose and 45 cm × 15 cm (40.70 cm) which is on par with treatments T_{12} – 125% fertiliser dose and 45 cm × 15 cm (40.47 cm) and T_5 – 100% fertiliser dose and 30 cm × 15 cm (40.17 cm). This might be due to the wider spacing which favoured the plants to widen their rhizosphere area and reduced the competition for nutrients and moisture.

The least plant height was noticed in the treatment T4 – 75% fertilizer dose and 45 cm × 15 cm (35.67 cm) followed by T1 – 75% fertilizer dose and 30 cm × 15 cm (36.32 cm) at 90 days after transplanting. This might be due to the higher plant density which might have resulted in competition for nutrients and also may be due to reduced dose of fertilizers. Similar findings were observed by Jain *et al.* (2018) and Nischay *et al.* (2021).

Number of Leaves per Plant. Number of leaves per plant in Statice, influenced by different treatments consisting of varied quantity of NPK fertilizers in combination with different plant spacing was recorded at different stages of plant growth *i.e*., 30 days after transplanting, 60 days after transplanting and 90 days after transplanting. As depicted in Fig. 2 there was no significant difference in number of leaves per plant at

30 days after transplanting and 60 days after transplanting where as some significant difference was clearly noticed at 90 days after transplanting.

The observed data for number of leaves per plant at different stages of growth is presented in Fig. 2, in this figure we can observe that treatment T_{11} – 125% fertilizer dose and 30 cm × 45 cm recorded the highest number of leaves (35.20) followed by treatment T_7 – 100% fertiliser dose and 30 cm × 45 cm (34.67) at 90 days after transplanting. This might be due to the supply of increased quantity of Nitrogen (N) which is responsible for vegetative growth.

The least number of leaves per plant was recorded in treatment T_1 – 75% fertiliser dose and 30 cm × 15 cm (25.13) which is on par with treatments T_5 – 100% fertiliser dose and 30 cm ×15 cm (25.60) and T_4 – 75% fertiliser dose and 45 cm × 15 cm (25.87) at 90 days after transplanting. This may be due to the lesser spacing which has increased plant density which in turn increased the competition for nutrients. The reduction in quantity of nitrogen supplied may also have contributed to reduce the number of leaves per plant. Similar observations were noticed by Kumar *et al*. (1998).

Days Taken for Panicle Initiation. Number of days taken from the day of transplanting for panicle initiation of Statice plants, influenced by different treatments consisting of varied quantity of NPK fertilizers in combination with different plant spacing was recorded regularly. As depicted in Fig. 3 there was significant difference in number of days taken from the day of transplanting for panicle initiation.

In Fig. 3 we can notice that treatment T_{11} – 125% fertiliser dose and 30 cm × 45 cm has taken least number of days from the day of transplanting (94.33) for panicle initiation followed by treatments T_4 – 75% fertiliser dose and 45cm × 15 cm (97.67) and T_{12} – 125% fertiliser dose and 45 cm × 15 cm (99.00). The treatment T_{11} recorded least number of days taken for panicle initiation, this result is due to supply of potassium in higher dose, where as spacing also has contributed for optimum uptake of nutrients essential for panicle initiation.

The more number of days taken from the day of transplanting for panicle initiation was recorded in treatment T_6–100% fertiliser dose and 30 cm × 30 cm (134.67) followed by treatment T_1 – 75% fertiliser dose and 30 cm × 15 cm (132.00). This may be due to the reason that the reduction in quantity of Potassium (K) available per plant which is a result of increased plant density. Similar results were observed by Jain *et al.* (2018) and Marathe (1996).

Yield parameters

Number of Panicles per Plant / per sq. m and per ha^{-1}. The observations recorded on Number of panicles per plant as effected by spacing and fertilizer which is depicted in Fig. 4 shows that treatment T_{11} – 125% fertilizer dose and 30 cm × 45 cm has recorded the maximum number of panicles per plant (12.33) followed by treatment T_{12} – 125% fertiliser dose and 45 cm × 15 cm (10.33). This result is due to the application of higher quantity of Potassium (P) and wider spacing which has increased the per plant availability of nutrients. Where as the lowest number of panicles per plant was noticed in treatment T_1 – 75% fertiliser dose and 30 cm × 15 cm (3.00) followed by treatment T_7 – 100% fertiliser dose and 30 cm × 30 cm (4.67) which is on par with treatments T_2 – 75% fertiliser dose and 30cm × 30 cm (5.00) and T_8 – 100% fertiliser dose and 45cm × 15 cm (5.33). This may be the result of reduction in quantity of Potassium (P) applied and the reduced spacing between the plants which has increased the competition between the plants for nutrients.

Treatment T_9 – 125% fertiliser dose and 30 cm × 15 cm has significantly yielded highest number of panicles per sq. m (205.26) and per hectare (20,52,600) followed by treatment T_5 – 100% fertilizer dose and 30 cm × 15 cm (198 m^{-2} and 19,80,000 ha^{-1}) this is due to the combined effect of increased dose of Potassium and lesser spacing which increased plant density which further contributed to the significant increase in total number of panicles per hectare.

Significantly the lowest yield as effected by spacing and fertiliser dose was recorded in treatment T_7 – 100% fertiliser dose and 30 cm × 45 cm (37.76 m^{-2} and 373600 ha^{-1}) followed by treatment T_3 – 75% fertiliser dose and 30 cm × 45 cm (50.64 m^{-2} and 5,06,400 ha^{-1}). This result is may be the effect of reduced supply of potassium (P) which has reduced number of panicles per plant. There is also significant effect of wider spacing in reducing plant density which in turn lowered the total number of panicles per hectare. Similar findings were observed by Jain *et al.* (2018) Deshpande *et al*. (2001) and Marathe (1996).

Table 1: Effect of spacing and fertiliser dose on yield of statice.

Treatment	Number of panicles per plant	Number of panicles m^{-2}	Number of panicles ha^{-1}
T1	3.00	66	660000
T2	5.00	55	550000
T3	6.33	50.64	506400
T4	7.33	109.95	1099500
T5	9.00	198	1980000
T6	9.33	102.63	1026300
T7	4.67	37.66	373600
T8	5.33	79.95	799500
T9	9.33	205.26	2052600
T10	9.33	102.63	1026300
T11	12.33	98.64	986400
T12	10.33	154.95	1549500
f test	S**		
Sem+	1.12	-	-
C.D @ 5%	2.31	-	-

Table 2: Effect of spacing and fertiliser dose on growth parameters and yield of statice.

Treatment	Plant height (cm)	Number of leaves per plant	Days taken for panicle initiation	Number of panicles per hectare
T1	36.32	25.13	132	6,60,000
T2	38.07	29.8	125	5,50,000
T3	42.67	27.47	127.67	5,06,400
T4	35.67	25.87	97.67	10,99,500
T5	40.17	25.6	127	19,80,000
T6	39.37	29.07	134.67	10,26,300
T7	39.47	34.67	103.67	3,73,600
T8	40.7	28	104.67	7,99,500
T9	38.93	26.53	100.33	20,52,600
T10	38.23	27.53	102.67	10,26,300
T11	38.8	35.2	94.33	9,86,400
T12	40.47	33.67	99	15,49,500
F-test	*	*	*	*
S.Em±	1.72	1.75	3.55	83563.67
C.D. @ 5%	3.56	3.62	7.32	172466.9

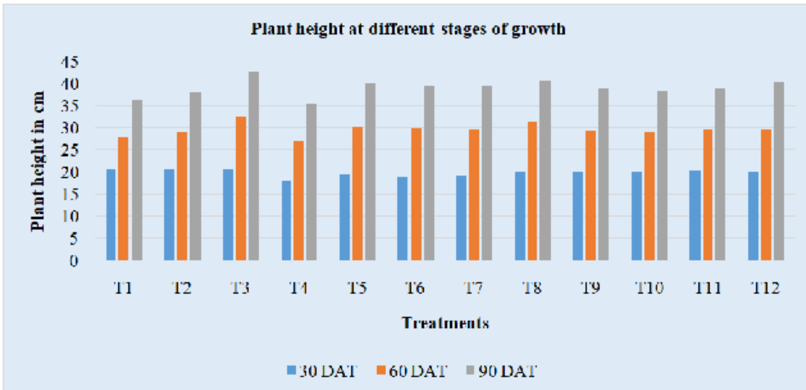

Fig. 1. Effect of spacing and fertiliser dose on plant height of Statice at different stages of plant growth.

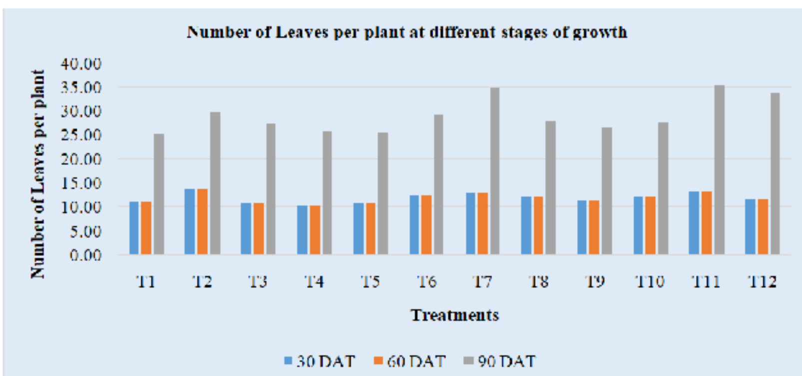

Fig. 2. Influence of spacing and fertiliser dose on number of leaves per plant of statice at different stages of growth.

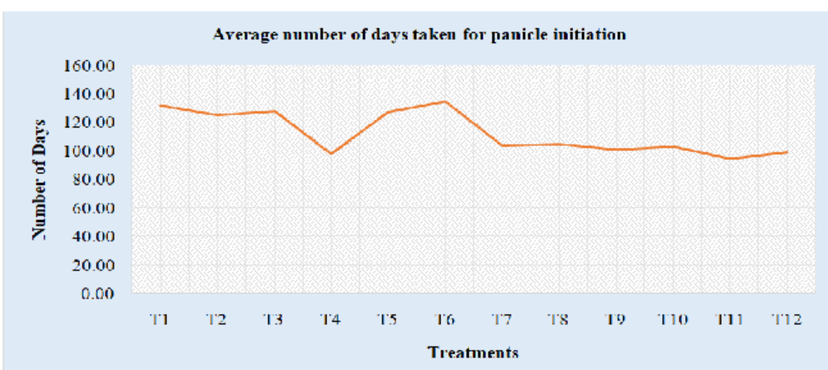

Fig. 3. Effect of spacing and fertiliser dose on number of days taken for panicle initiation from the day of transplanting of statice plants.

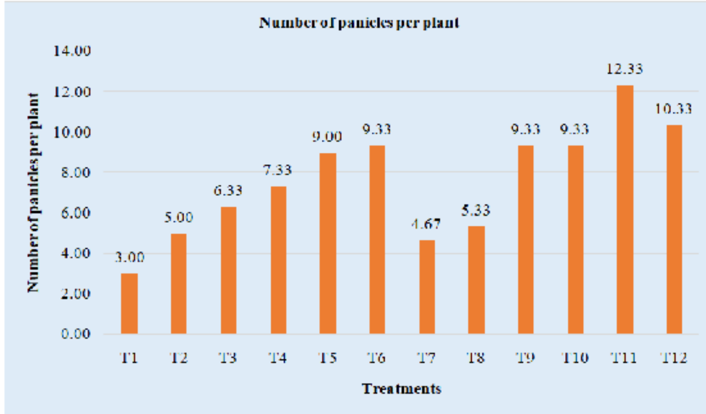

Fig. 4. Effect of spacing and fertiliser on number of panicles per plant of statice.

CONCLUSION

By considering the experimental findings of the study it can be concluded that the wider spacing with (30cm × 30cm) with higher level of fertiliser dose (125%) resulted in better growth and development of the plant, showed earliness in flowering while the lesser spacing (30cm × 15cm) with higher level of fertiliser dose (125%) resulted in higher quantitative yield per unit area.

FUTURE SCOPE

The best performed treatment combinations can be suggested for commercial cultivation of statice. The effect of secondary nutrients on growth and development of statice can be studied by using this study as a base for dosage of major nutrients (NPK).

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Conflict of Interest. None.

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