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RESPONSE OF CALENDULA TO PLANT DENSITY FOR CUT FLOWER PRODUCTION

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Abstract

An experiment entitled "Response of calendula to plant density for cut flower production" was carried out at Farm no. 16 of Horticulture Section, College of Agriculture, Nagpur (M.S.), India during the year 2011-12 with seven treatments of spacing *viz.,* 30 × 30 cm, 30 × 20 cm, 30 × 10 cm, 20 × 20 cm, 20 × 10 cm, 15 × 15 cm and 15 × 10 cm in randomized block design. The results revealed that the wider spacing of 30 × 30 cm recorded significantly maximum leaves plant^{-1}, spread of plant, longevity of intact flower, cut flower yield plant^{-1}, diameter and weight of flower and vase life of flower, whereas, closer spacing of 15 × 10 cm recorded significantly longest stalk length of cut flower and earliest 50 per cent flowering. However, the spacing of 30 × 10 cm noted the highest yield of cut flower in calendula and it was found beneficial with the highest C:B ratio for cut flower production. The next best treatment in respect of cut flower yield and economics was 15 × 10 cm.

Key words : Calendula, yield, growth, quality, plant density.

Introduction

Among the various annuals calendula, belonging to family *Compositeae,* is one of the most commonly cultivated seasonal flower crops. It is also known as pot marigold. The plant prefers sunny situations and well drained rich soil. It can be grown as a winter seasonal at the places having mild climate. The flower colour may be yellow, orange, pale sulphur or dull white and the centre of capitulum may be dark. The calendula flower has certain medicinal properties. The alcohol extract from the leaves and flowers of calendula have anti microbial activity and are used for the treatment of patients affected by varicose ulcer and skin lesions. It is effective in wound healing and also posseses anti helminthic properties. As a cut flower, calendula is very useful for flower arrangement in flat bowls. Due to flatness of the flowers, they are not easily mixed with any other flowers. They serve the purpose of useful fillers in the flower bouquets and arrangement. The plants are very popular for growing in beds as well as pot plants, as cut flower and also grown in window boxes. Since, florets close at night they are not suitable for night decorations.

A large number of factors are known to influence the yield and quality of flowers and an important being variety, season, nutrition, irrigation and improved agro-techniques. Proper plant density plays an important role in increasing the growth, yield and quality of flower crops. Many research workers have reported that, maintenance of proper plant population helps to produce high yield of good quality cut flowers. Now a day, calendula is gaining importance as a cut flower and grown on large scale. The flower of calendula has a good scope in cut flower industry, particularly for flower bouquets and arrangements. In cut flower industry, the most important aspects are maximum production of better quality cut flowers in order to fetch more market price. For obtaining better vegetative growth and thereby, increasing the yield of better quality flowers, plant density plays an important role. Very few research works has been carried out in calendula under Vidarbha (M.S.) conditions and hence sufficient information on different agro-techniques followed in this crop as a cut flower is not available. Hence, the present investigation was carried out to find out suitable spacing for better cut flower production of calendula.

Materials and Methods

The field experiment was carried out at Farm No.-16, Horticulture Section, College of Agriculture, Nagpur during *winter* season of the year 2011-2012 to study the effect of spacing and find out suitable spacing for better cut flower production of calendula with the seven treatments and three replications laid out in Randomized Block Design. The treatments comprised of various spacing *viz.,* **T_1**-30 × 30 cm, **T_2**-30 × 20 cm, **T_3**-30 × 10 cm, **T_4** -20 × 20 cm, **T_5** -20 × 10 cm, **T_6** -15 × 15 cm and **T_7** -15 × 10. The experimental plot was brought to fine tilth by ploughing, clod crushing and harrowing. At the time of land preparation, well rotted FYM @ 15 t ha^{-1} was mixed uniformly in the soil before last harrowing. The fertilizer dose of 50 kg ha^{-1} nitrogen, phosphorus 20 kg ha^{-1} and potassium 25 kg ha^{-1} was applied in the form of urea, single super phosphate and muriate of potash, respectively. Half dose of nitrogen and full dose of phosphorus and potash were applied at the time of planting, while, the remaining half dose of nitrogen was applied 30 days after transplanting of seedlings. The field was laid out with flat beds of the dimension 1.2 × 2.1 m. Various observations on growth and flowering parameters v*iz.,* leaves $plant^{-1}$, spread of plant, days for 50 per cent flowering, longevity of intact flower, cut flowers $plant^{-1}$ and ha^{-1}, stalk length of flower, diameter and weight of flower and vase life of calendula cut flower were recorded and the data was statistically analyzed by the method suggested by Panse and Sukhatme (1967).

Results and Discussion

The data presented in table 1 revealed that, different levels of plant density had significant effect on all growth, flowering, yield and quality parameters of calendula cut flower under study.

Growth

Leaves $plant^{-1}$ of calendula were noted significantly the highest with the wider spacing of 30 × 30 cm (59.07) which was found statistically at par with the spacing of 30 × 20 cm (58.03), whereas, least number of leaves (55.00) was counted with the spacing of 15 × 10 cm. Similarly, the wider spacing of 30 × 30 cm had recorded significantly the maximum spread of plant (36.94 cm) as compared to other spacing treatments and the minimum spread of plant was observed with the closer spacing of 15 × 10 cm (24.23 cm).

'An increase in vegetative growth in terms of leaves $plant^{-1}$ and spread of calendula plant was observed with the wider spacing *i.e.* 30 × 30 cm, which might be due to availability of more space for spreading of plants and abundant sunlight for growth and development of plant, that might have increased nutrient uptake by the plants resulting into more vigorous growth of the plant. Similar results are also obtained by Kumar and Singh (2011), who reported that, the maximum plant spread and leaves $plant^{-1}$ were obtained with the wider spacing of 30 × 30 cm as compared to closer spacing in calendula.

Flowering

The closest spacing of 15 × 10 cm recorded significantly the earliest 50 per cent flowering in calendula (56.20 days), which was found statistically at par with the spacing of 15 × 15 cm (56.87 days) and 20 × 10 cm (57.00 days), whereas, the wider spacing of 30 × 30 cm had recorded late 50 per cent flowering (60.10 days). Delay in flowering under 30 × 30 cm spacing might be due to increased vigour and enhanced vegetative growth of widely spaced calendula plants. However, an early 50 per cent flowering in calendula with closer spacing might be due to early physiological maturity of shoots as a result of minimum vegetative growth of plant in respect of leaves $plant^{-1}$ and spread of plant as compared to wider spacing. The results are in close conformity with findings of Ahmed *et al.* (2010) and Kumar and Singh (2011) in gladiolus and calendula, respectively.

Significantly the maximum longevity of intact flower in calendula (9.10 days) was recorded under the wider spacing of 30 × 30 cm which was statistically at par with the spacing of 30 × 20 cm (8.80 days), however, the closer spacing of 15 × 10 cm recorded the minimum longevity of intact flower (5.27 days) The results are congruent with those of Deshmane *et al*. (2012) in French marigold.

Flower yield

The number of cut flowers $plant^{-1}$ was noticed significantly the highest with the wider spacing of 30 × 30 cm (6.33), which was found to be at par with the spacing of 30 × 20 cm (5.67), whereas, the closest spacing of 15 × 10 cm had recorded least (2.33) number of cut flowers $plant^{-1}$ in calendula. However, significantly the highest cut flower yield ha^{-1} (12.52 lakh) was recorded with the spacing of 30 × 10 cm and it was statistically at par with the spacing of 15 × 10 cm (12.43 lakh) and 20 × 10 cm (11.74 lakh), whereas, the wider spacing of 30 × 30 cm had noted significantly lowest cut flower yield ha^{-1} (5.67 lakh). The cut flowers $plant^{-1}$ in calendula were counted minimum under the closest plant spacing, whereas, the cut flower yield ha^{-1} was found to be the highest under 30 × 10 cm spacing due to the higher plant density and comparatively higher cut flowers produced $plant^{-1}$ under this spacing treatment. The wider spacing resulted in to the production of more number of cut flowers $plant^{-1}$ of calendula. This might be attributed to more vegetative growth of the plants due to availability of maximum nutrients, sunlight, and soil moisture in widely spaced plants. Malam *et al*. (2010) and Rohidas *et al*. (2010) also reported the highest cut flower yield under closer spacing in tuberose and gladiolus, respectively.

Table 1 : Growth, flower yield and quality of calendula as influenced by plant density.

Treatments (Plant density)	Leaves plant^{-1}	Spread of plant (cm)	Days for 50 per cent flowering (days)	Longevity of intact flower (days)	Cut flowers plant^{-1}	Cut flower yield ha^{-1} (lakh)	Stalk length of cut flower (cm)	Diameter of flower (cm)	Weight of flower (g)	Vase life of flower (days)	Economics (C:B ratio)
T_1- 30 × 30 cm	59.07	36.94	60.10	9.10	6.33	5.67	42.40	5.13	2.98	5.13	0.73
T_2- 30 × 20 cm	58.03	35.69	59.40	8.80	5.67	7.50	42.57	5.01	2.85	4.90	0.84
T_3- 30 × 10 cm	57.80	34.76	59.53	7.80	4.70	12.52	43.74	4.85	2.76	4.53	1.30
T_4- 20 × 20 cm	56.97	32.23	58.53	6.80	3.80	7.68	45.49	4.70	2.67	4.07	0.84
T_5- 20 × 10 cm	56.03	27.17	57.00	6.40	2.93	11.74	47.48	4.53	2.47	3.67	1.05
T_6- 15 × 15 cm	55.13	24.77	56.87	5.67	2.67	9.64	50.08	3.99	2.31	3.67	0.91
T_7- 15 × 10 cm	55.00	24.23	56.20	5.27	2.33	12.43	51.13	3.93	2.21	3.43	1.19
'F' test	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	-
SE (m) ±	0.32	0.32	0.33	0.30	0.27	0.80	0.40	0.13	0.04	0.14	-
CD at 5%	0.96	0.96	0.98	0.91	0.82	2.60	1.21	0.40	0.13	0.42	-

Sig. –Significant.

Flower quality

Significantly the longest stalk of calendula cut flower was recorded with the closer spacing of 15 × 10 cm (51.13 cm) which was statistically at par with the spacing of 15 × 15 cm (50.08 cm), whereas, minimum stalk length of cut flower was recorded with the spacing of. 30 × 30 cm (42.40 cm).

The stalk length of calendula cut flower was found to be increasing with the decrease in spacing. This might be due to lesser availability of space and solar radiation in closely spaced calendula plants. Similar increase in stalk length with reduced spacing was also observed by Malam *et al*. (2010) in tuberose.

From table 1, it is observed that the widest spacing of 30 × 30 cm recorded significantly the highest diameter of flower, weight of flower and vase life of cut flower (5.13 cm, 2.98 g and 5.13 days, respectively) and it was found statistically at par with the spacing of 30 × 20 cm (5.01 cm, 2.85 g and 4.90 days, respectively), whereas, these parameters were recorded minimum under closest spacing *i.e.* 15 × 10 cm (3.93 cm, 2.21 g and 3.43 days, respectively). The maximum diameter and weight of calendula flower was recorded under the wider spacing which might be due to better vegetative growth of individual plants resulting in more availability of carbohydrates and metabolites for development of flowers. Due to which an uptake of water by the flowers would have been increased and their turgidity was maintained and thus, the vase life of calendula cut flower might have been increased. These results are in close conformity with the findings of Singh and Bijimol (2003) in gladiolus and Kumar and Singh (2011) in calendula.

Economics

It is evident from table 1 that the treatment $\mathbf{T_3}$ *i.e.* 30 × 10 cm spacing proved to be the most profitable for cut flower production of calendula with C:B ratio 1.30 and it was followed by the treatment $\mathbf{T_7}$ *i.e.* 15 × 10 cm spacing with C:B ratio 1.19. The C:B ratio of 30 × 10 cm spacing might have been increased due to increase in cut flower yield ha^{-1}.

Thus, it can be inferred from the present investigation that, the spacing of 30 × 10 cm was found to be more beneficial as compared to other spacing treatments in respect of cut flower production in calendula. However, the next best treatment in respect of cut flower yield and economics was 15 × 10 cm.

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