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EFFECT OF SPACING AND PINCHING ON GROWTH, FLOWERING AND YIELD OF CHRYSANTHEMUM (*Chrysanthemum coronarium* L.)

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ABSTRACT

A field investigation entitled "Effect of spacing and pinching on growth, flowering and yield of Chrysanthemum (*Chrysanthemum coronarium* L.)" was carried out at the Horticulture farm of Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur during *Rabi* season. The experiment was conducted with Sixteen combination (Treatment) of Four levels of spacing i.e. **30x30 cm (S_1), 30x45 cm (S_2), 45x45 cm (S_3) 45x60cm (S_4) and Four levels of pinching** i.e. **No pinching (P_0), Single Pinching at 20DAT (P_1), Double pinching at 20 and 30 DAT (P_2) and Triple pinching at 20, 30 and 40 DAT (P_3). On the basis of present investigation it may be concluded that, among spacing treatments the maximum number of flower per plant (134.87) was observed in S4 treatment while, maximum yield of flower per hectare (201.06 q/ha) was observed in S_1 treatment. Similarly, among pinching treatments P3 treatment resulted maximum number of flower per plant (145.03) whereas, maximum yield of flower per hectare (193.32 q/ha) was observed in P_2 treatment.**

Key Words : *Spacing pinching growth, flowering, yield, chrysanthemum.*

Floriculture is fast emerging as a major venture on the world scenario. Many kind of ornamental plans are grown for domestic and international trade in developed and developing countries. Our country has a rich heritage of ornamental horticulture. Flowers are commonly used for beauty, aesthetic, religious and decoration purposes. Searching for new species is increasing in floriculture, which has emerged as a field of great commercial importance both national and international. In India there is a total area under commercial floriculture is 1.14 lakh ha with a production 670000 MT of loose flowers and 13009.3 million numbers of cut flowers respectively. The export of floricultural products was Rs. 578.00 million in 2005-06 (1). Among the commercial ornamental plants Chrysanthemum occupies second position in flower production in the world after rose and in India its rank third after Jasmine and rose (2). Chrysanthemum botanically known as Chrysanthemum coronarium L, belongs to family Asteraceae and native of China. It is an annual under Chrysanthemum group. It is more hardy, vigorous and tall growing. Its flowers are in various shades of yellow, white, have single or double forms. It is also said the "Queen of East". In India, the crop has been naturalized and locally called as Bijli in Nagpur, Baboona in Hariyan , Guldawoodi in Rajasthan and Gandi in U.P.It is supplementing the production of florist Chrysanthemum in many area of our country and it occupies approximately 3600 ha of open field mainly in the state of Maharashtra, Karnataka, Bihar, Punjab, Hariyana, UP, MP and Rajasthan. In India as well as in Rajasthan state, the demand for different flowers for various purposes has been increasing tremendously. Farmers in this region have also realized the economic importance of the flower crops as these crops produce more income as compared to other crops. Therefore, more area in this region is being brought under the cultivation of the floriculture crops in general and chrysanthemum is one of them. However, the growers in this region lack in the scientific information of improved agro-technique of chrysanthemum. As a result the yield of quality flowers per unit area is low. Consequently, the standardization of agro-techniques in chrysanthemum is essential to obtain the higher yield of better quality flowers.

The cultural practices viz., the suitable plant spacing and pinching play an important role in influencing the growth, yield and quality of flowers. Too closer spacing results in greater competition among the plants and thus flower yield may be impaired. It may also result in the production of flowers of small size due to greater competition among plants. Too wider spacing may result in low flower yield due to insufficient number of plants per unit area. Pinching is one of the important horticultural practices, which is

being practiced in chrysanthemum to reduce the plant height and to encourage more number of branches on plant and thereby more flower yield per plant can be obtained. However, due to pinching, the flowering period is delayed and thus it helps in avoiding the glut of flowers in market. The rapid and uniform development of the axillary shoots obtained in pinched plants resulted in a high yield of flowers per unit area in chrysanthemum cv. “Pink Pearl” and “Gem”. Under investigation an attempt was made to increase the production of Chrysanthemum by manipulating plant spacing and pinching. The result on the influence of plant spacing and pinching on growth, flowering and yield of Chrysanthemum is presented in this paper.

MATERIALS AND METHODS

The present investigation was carried out at the Horticulture farm of Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur during Rabi season. The main aim of the study was to evaluate the Effect of spacing and pinching on growth, flowering and yield of Chrysanthemum (*Chrysanthemum coronarium* L.). The experiment was conducted with Sixteen combination (Treatment) of Four levels of spacing i.e. 30x30 cm (S_1), 30x45 cm (S_2), 45x45 cm (S_3) and 45x60cm (S_4) and Four levels of pinching i.e. No pinching (P0), Single Pinching at 20DAT (P_1), Double pinching at 20 and 30 DAT (P_2) and Triple pinching at 20, 30 and 40 DAT (P_3). The experiment was laid out in “Factorial Randomized Block Design” with three replications, having net plot size 1.8x1.8 M = 3.24 sq.M. Observation on vegetative, floral and yield characters were recorded during course of investigation. Data recorded on each character were analyzed by the method advocated by (3).

RESULTS AND DISCUSSION

A reference to the data on height of plant revels that, the height of plant was found maximum in S1 treatment i.e.closer spacing at 30x30 cm which decreased gradually as the plant spacing increased. The maximum plant height (107.33 cm) at last picking (120DAT) was observed in S1 treatment whereas, the minimum plant height (75.15 cm) at 120 DAT was recorded in S_4 but at was at par with S_3 treatment (78.30 cm). This might be due to the fact that there would be competition among the plants for sunlight, air and nutritions. Thus plant tends to grow vertically for more light and air and consequently they became taller. A similar response of spacing with respect of plant height have been reported by (4) in chrysanthemum cv.CO-1. Likewise significant more height of plant was observed in no pinching treatment (p_0) as compared to other pinching treatments. The superior plant height (98.95 cm at last picking (120 DAT) was noted in P_0 treatment while, the inferior plant height (75.65 cm) was observed in P_3 treatment. The lower plant height due to pinching treatment may be due to the top most shoots of one third of an inch being removed from the plant at each pinching treatment and therefore, the axillary buds below the pinchined stem of plant forced to grow luxuriantly as the apical dominance of plant was arrested. Similar effect of pinching on plant height was reported by (4) in chrysanthemum cv. CO-1.

The data on number of branches per plant as influenced by spacing and pinching treatment that the significantly maximum number of branches per plant (25.48) was recorded in S_4 treatment i.e. 45x60cm at last picking (120DAT), while the minimum number of branches per plant (15.07) was recorded in S_1 treatment i.e. 30x30 cm at last picking (120 DAT). It might be due to the reason that the total plant population per unit area was less in wider spacing and therefore, there was more space avilable for each of the plant to grow vigorously as they recived sufficient light, air and nutrition’s. The results are in close conformity with the findings of (5) in annual Chrysanthemum and (6) in Chrysanthemum cv. “Local White.” Likewise, pinching also producing a significant effect on number of branches per plant. A maximum number of branches per plant (24.66) at last picking (120 DAT) was found in P_3 treatment followed by P_2 treatment (22.54), where as minimum number of branches per plant (18.10) at last picking (120 DAT) was noted in P_0 treatment. The increase in number of primary branches by pinching treatments might be due to the fect that the axillary buds below the pinched stem of plant forced to grow luxuriantly as the apicl dominance of plant ws arrested. Consequently, more number of branches per plant was noticed. The above findings are in close agreement with the findings of (7) in Chrysanthemum cv.”Flirt”

As evident from the data that, the maximum stem diameter (2.89 cm) was recorded in S_4 treatment i.e. 45x60cm at last picking (120 DAT) but it was found at

par with S_3 treatment while, the minimum 2.44 cm stem diameter was observed in S_1 treatment. The decrease in plant height is always associated with increase in stem diameter, because shorter the height thicker the stem and vice versa. Sem result was also reported by (6) in Chrysanthemumcv. "Local White." Similarly, among pinching treatments, the triple pinching (P_3) treatment was found superior and had recorded more value for stem diameter (2.19 cm) than other treatments viz. P_1 and P_0 (2.67 cm and 2.58 cm, respectively) but found atpar with P_2 treatment (2.18 cm). It is might be due to the fact that decrease in plant height is always associated with increase in stem diameter. The results are in close agreement with the findings of (8) in carnation.

Number of days required for appearance of flower bud was significantly affected by various spacing a pinching treatments. In the present study, significantly less number of days (48.50) was required for the bud appearance in S_1 treatment i.e. closer spacing at 30x30 cm whereas: maximum days (70.00) were required in this regard under S_4 treatment (wider spacing at 45x60 cm). thus, it is noticed that the flower bud appearance delayed successively as the planting distance were increased. This might be due to more competition among plants in closer spacing for space, light, air and nutrition; hence the closer spaced plants tended to grow vertically and led to early physiological maturity as a result of their taller growth. These finding lend support by (15) in annual chrysanthemum. Among different treatments of pinching, P_3 treatment (tiple pinching) significantly delay the flowering and it required the maximum number of days (67.69) for bud appearance than other pinching treatments viz.P_2, P_1 and P_0 (58.44, 49.62 and 35.13 days respectively). In pinching treatment physiological mature portion of plant were removed and thus new shoots, which emerged out from the pinched plants took more time to become physiological inductive to produce flower buds than non pinched plants. These finding lend support by (9) in African marigold cv."African Gaint Double Orange."

Among the spacing treatments maximum time required for first flower opening (62.43 days) was recorded in wider spacing i.e. 45x60 cm (S_4) in comparison of minimum time required for first flower opening (52.02 days) was closer spacing i.e.30x30 cm (S_1) treatment. Thus it is noticed that the first flower opening was delayed with the increasing spacing. This finding lends support by (5) in annual chrysanthemum. Pinching also significantly influenced the opening of first flower. As evident from the data that among the pinching treatment the lowest time required for first flower opening (40.46 days) was recorded in P_0 (No pinching) treatment whereas, the highest time was required for first flower opening (72.13 days) in the thrice pinching treatment (P_3) ie pinching at 20,30 and 40 DAT. It is fact that the appearance of first flower bud was early in noon pinched plants than pinched once as a result more time was required for first flower opening in pinched plants. Similar observations were also recorded by (9) in African marigold cv."African Gaint Double Orange."

The maximum flower diameter (5.57 cm) was seen in closing spacing i.e. 30x30cm (S_1) treatment but it was found at par with S_2 medium spacing (30x45 cm) treatment i.e.5.57 cm while, minimum diameter (5.27 cm) was in S_4 (wider spacing) i.e. 45x60 cm. This might be due to the higher number of flower per plant in wider spacing. The developing flowers were supplied with lesser amount of food material as a result flower diameter \was reduced. Similar findings were also finding by (10) in chrysanthemum cv. "Kasturi." Among the pinching treatments the highest flower diameter (6.26 cm) was observed in P_0 (no pinching) treatment while, the lowest (4.92 cm) was recorded in P_3 (triple pinching at 20, 30 and 40 DAT) treatment. The decrease in flower diameter due to pinching might be attributed to fact that in pinched plants, the energy was ashred by the developing side branches whereas, in case non pincned plant, the energy was shared by limited developing flowers on the main branch only. Same results were also reported by (11) in chrysanthemum cv."MDU-1".

The maximum number of lower per plant (124.50) was recorded in closer spacing i.e. 30x30 cm (S_1) treatment but it was at par with S_2 treatment i.e. 30x45 cm (126.83) whereas, the maximum (134.87) was recorded in wider spacing (S_4) i.e. 45x60 cm treatment. The increase in number of flower per plant because of spacing treatment may be correlated with the vegetative growth characters like number of branches and stem diameter where the treatments produced significant feect. Asa result of this the plant had comparatively

Table 1: Effect of spacing and pinching on growth, flowering and yield of chrysanthemum (*Chrysanthemum coronarium* L.)"

Treatments	Plant height (cm)	Number of branches per plant	Diameter of stem (cm)	Appearance of first flower bud (Days)	Time required for first flower opening (Days)	Diameter of flower (cm)	Number of flower per plant	Weight of flower (g)	Flower yield per plant (g)	Flower yield/ plot (Kg)	Flower yield per hectare (q)	Vase life of flowers (Days)
Spacing												
S_1	107.33	15.07	2.44	48.50	52.02	5.57	124.50	2.06	252.96	9.11	281.06	6.66
S_2	79.82	22.12	2.79	51.58	56.38	5.57	126.83	2.03	255.10	6.12	188.96	6.71
S_3	78.30	22.37	2.84	53.84	58.88	5.35	131.23	2.01	265.30	4.24	131.01	6.67
S_4	75.15	25.48	2.89	56.96	62.43	5.27	134.87	1.94	257.16	3.09	95.24	6.74
SEm	1.31	0.29	0.11	0.41	0.44	0.04	0.84	0.01	2.72	0.05	1.56	0.18
CD (P=0.05)	3.77	0.84	0.04	1.19	1.26	0.12	2.43	0.03	7.86	0.15	4.61	NS
Pinching												
P_0	98.95	18.1	2.58	35.13	40.46	6.26	110.95	2.19	242.74	5.20	160.50	6.75
P_1	85.49	19.74	2.67	49.62	54.50	5.39	125.83	2.13	267.77	5.95	183.72	6.23
P_2	80.51	22.54	2.81	58.44	62.63	5.19	135.62	2.10	284.21	6.26	193.32	6.78
P_3	75.65	24.66	2.91	67.69	72.13	4.92	145.03	1.63	235.78	5.14	158.75	7.02
SEm	1.31	0.29	0.11	0.41	.044	0.04	0.84	0.01	2.72	0.05	1.56	0.18
180CD (P=0.05)	3.77	0.84	0.04	1.19	1.26	0.12	2.43	0.03	7.86	0.15	4.61	NS

higher levels of organic reserves, conductive for better floral development and there by increased the number of flowers. More lateral branches might have produced more axis from where flowers originate thereby producing more number of flowers per plant. Similar trend in number of flower per plant was also reported by (10) in chrysanthemum cv."Kasturi". Similarly the lowest number of flower per plant (110.95) was recorded in P_0 (No pinching) treatment as compared to highest (145.03) in P_3 (triple pinching at 20, 30 and 40 DAT) treatment. Due to the pinching treatment more side branches were formed below the pinched portion of the main stem of plant. These more vegetative growth obtained in pinched plant resulted in production of more number of flowers per plant. The results are in close agreement with the findings of (8) in carnation.

The highest weight of flower (2.06g) was seen in S_1 Closer spacing i.e. 30x30 cm treatment while, lowest (1.94g) was seen in S_4 wider spacing i.e. 45x60 cm treatment. It may be pointed out that the spacing (wider spacing) treatments have increased the number of flower per plant; hence the developing flower might have been supplied with comparatively lesser quantities of photosynthates resulting in reduction in weight of flower. The result have support the findings of (12) in Chrysanthemum cv."Flirt". Similarly highest flower weight (2.19 g) was seen in P0 (no pinching) treatment whereas lowest (1.63 g) was observed in P3 (triple pinching at 20, 30 and 40 DAT) treatment. Similar as spacing treatments, pinching treatments have increased the number of flower per plant; hence the developing flower might have been supplied with comparatively lesser quantities of food materials resulting in reduction in weight of flower. Similar result was also reported by (8) in carnation.

The superior flower yield per plant (263.50 g) was observed in S_3 treatment i.e. 45x45 cm as compared to the inferior flower yield per plant (252.96 g) in S_1 treatment i.e. 30x30 cm (closer spacing) but it was at par with S_4 (257.16 g) and S2 (255.10 g) treatments. In wider spacing plant produced more number of flowers with low weight of flower whereas; in closer spacing plant produced lesser number of flowers with higher weight. So the yield of flower per plant increased with increased in the spacing from closer (S_1) to Medium (S_3) but decrease in wider spacing (S_4) treatment.

Similar findings were observed by (6) in Chrysanthemum cv. "Local White." Among pinching treatments the highest flower yield per plant (284.21 g) was recorded in P_2 (double pinching at 20 and 30 DAT) treatment as compared to lowest flower yield per plant (235.78 g) was recorded in P_3 treatment but it was at par with P_0 (no pinching) treatment (242.74 g). The increase in flower yield due to Pinching treatment might be due to the reason that the pinched plants obtained superior vegetative growth and it was responsible for the production of more number of flower per plant and consequently, yield of flower per plant was increased in pinched plants as compared to un pinched plant. Same findings were reported by (8) in carnation.

Among the spacing treatments the maximum flower yield per plot and per hectare (9.11 kg/Plot and 281.06 q/ha, respectively) recorded in closer spacing (s10 i.e 30x30 cm whereas, minimum flower yield per plot and per hectare i.e. 3.07 kg/Plot and 95.24 q/ha, respectively, noted in wider spacing (S_4) i.e. 45x60 cm. The decrease in flower yield (per plot and per hectare) with increasing the spacing was due to the decrease in plant population per unit area. The above findings are closely agreement the findings of (6) in Chrysanthemumcv. "Local White." Similarly highest flower yield per plot and per hectare (6.26 kg/plot and 193.32 q/ha, respectively) were reported in P_2 (double pincing at 20 and 30 DAT) treatment as compared to lowest flower yield per plot and per hectare in P_3 (triple pinching at 20, 30 and 40 DAT) treatment (5.20 kg/plot and 160.50 q/ha, respectively). The decrease in flower yield (per plot and per hectare) in P_3 treatment in comparison of other pinching treatments was due to the lower weight of individual flower than other treatments. The results are supported by the findings of (4) in Chrysanthemum cv. "CO-1."

Vase life of flower was non-significantly affected by the spacing and pinching treatments. Among the spacing maximum vas life of flowers (6.74 days) was recorded in S_4 treatment whereas; minimum (6.66 day) was observed in S_1 treatment. Similarly P_3 treatment recorded highest vase life (7.02 days) in comparison to lowest (6.23 days) was recorded in P_1 treatment.

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