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Floral and yield attributes of African marigold as influenced by pinching and gibberellic acid in different seasons

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Abstract
An investigation was conducted to study the floral and yield attributes of African marigold as influenced by pinching and gibberellic acid in different seasons at Experimental Orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during 2015-16. It consisted of two seasons (winter and summer) with four levels each of pinching (no pinching, pinching at 2, 3 and 4 weeks after transplanting) and gibberellic acid (0, 150, 250 and 350 ppm). This field experiment was designed in a factorial randomized block design with thirty two treatments and three replications. Results revealed that the maximum values in terms of duration of flowering (56 days), fresh weight of flower (4.57 g) and flower yield per hectare (10.89 t) were recorded in winter, whereas, early appearance of the first flower (52.30 days) with longer flower stalk length (9.55 cm) and the maximum number of flowers per plant (43.25) were observed in summer. Plants pinched at 2 weeks after transplanting produced the maximum values in terms of flower stalk length (10.38 cm), the number of flowers per plant (44.91) and flower yield per hectare (10.33 t). However, the minimum days to first flower (55.82 days) with a longer duration of flowering (50.18 days), maximum flower diameter (5.62 cm) and maximum fresh weight of flower (4.06 g) were recorded in un-pinched plants. Foliar application of 250 ppm gibberellic acid significantly resulted in the maximum number of flowers per plant (46.29) and maximum flower yield per hectare (11.53 t), whereas, minimum days to first flower (55.77 days) and maximum duration of flowering (50.31 days), maximum flower diameter (5.71 cm) with longest flower stalk length (11.13 cm) and maximum fresh weight of flower (4.13 g) were recorded from plants sprayed with 350 ppm gibberellic acid. It may be concluded that foliar spray of 250 ppm gibberellic acid on plants pinched at two weeks after transplanting showed better results in terms of floral and yield attributes of African marigold.

Keywords: Pinching, gibberellic acid, season, African marigold, floral and yield attributes

1. Introduction

Marigold is a highly remunerative crop, mainly grown for its globular blooms of varied colors having versatile uses. In India, marigold occupies prime importance due to its wide adaptability to varied agro-climatic conditions, easy culture, high productivity and good keeping quality. It belongs to the Asteraceae family and is commonly known as *Gainda*. Its inflorescence is known as head or capitulum having two types of florets, *i.e*., the peripheral ray florets and the central disc florets. The disc florets in the center are perfect having both anthers and pistil. The surrounding ray florets with strap-like petals are pistillate only and are male sterile. Mainly two types of marigold i.e. African marigold and French marigold are commercially grown in India at a large scale. African marigold is a hardy ornamental annual with single to fully double globular flowers of vivid colors like lemon yellow, bright yellow, orange and golden. It grows taller and bears larger bloom than French marigold. Loose flowers of marigold are mainly used as garlands in various religious and social functions. It is also suitable for growing as a pot plant or in flower beds and borders for landscaping purposes. Marigold flowers are also used for the extraction of carotenoids and essential oil. It is widely used as poultry feed, medicine, natural dye and nematode repellent. Marigold requires a sunny location for its better growth and development. It prefers a mild climate for luxuriant growth and profuse flowering. Sowing and transplanting of marigold can be done during rainy, winter and summer seasons and hence flowers of marigold can be obtained almost throughout the year. At high temperatures, plant growth ceases and it remains mostly in the vegetative stage with very few flowering. So flower quality, as well as quantity, is adversely affected.

Pinching is done mostly in annuals and herbaceous perennials by removing a small apical portion of the plant to stimulate branching. More branches would provide more scope to bear flowers and in turn, contribute to higher flower yield. It also encourages bushiness with compact growth and uniform spread of plants. Pinching at fifteen days after transplanting was found best for the increasing number of flowers per plant and flower yield per hectare in marigold (Badge *et al*. 2014) [2]. Among all the plant growth regulators, gibberellic acid is considered the most potent plant growth regulator in flower crops. It has diverse effects and is mainly used to induce early flowering and increase plant height, number of flowers, flower weight and yield in plants by promoting cell elongation and cell division. Foliar application of 250 ppm GA_3 resulted in the production of the maximum number of flowers per plant as well as maximum flower yield per plant (Kumar *et al*. 2020 and Acharya *et al*. 2021) [8, 1], while the maximum fresh weight of flower was recorded with 350 ppm GA_3 treatment in African marigold (Acharya *et al*. 2021) [1]. Plant growth regulators are mainly used for the regulation of plant growth and development by modifying various physiological processes of the plant. The impact of stressful conditions like drought mainly due to high temperature during the early growing season can be minimized by the treatment of plants with growth regulators (Domaratskiy *et al*. 2018) [3].

The influence of pinching and gibberellic acid on various physiological processes responsible for the growth and development of the plant is fairly well understood but limited information exists about the interactive effect of pinching and gibberellic acid on floral and yield attributes of African marigold in different seasons. Some intercultural practices like pinching and gibberellic acid application in marigold for enhancing flower quality and yield under agro-climatic conditions of Haryana have not yet been standardized so far. The genetic makeup of the plant is also responsible for the production, productivity and quality of flowers. Therefore, there is tremendous scope for improving the floral and yield attributes of African marigold.

Considering the above facts, the present experiment entitled "Floral and yield attributes of African marigold as influenced by pinching and gibberellic acid in different seasons" was planned to study the influence of pinching and gibberellic acid on various floral and yield attributes of African marigold in different seasons.

2. Materials and Methods

The present investigation was conducted at Experimental Orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during the crop season of 2015-16. Hisar has situated at 29º 10` North Latitude and 75º 46` East Longitude at an altitude of 215.2 meters above mean sea level. The climate of the Hisar region is semi-arid with very hot summers, relatively cool winters and scanty rainfall. The maximum day time temperature during summer varies between 40ºC and 46ºC and during winter, from 1.5ºC to 4ºC. This experiment was laid out as a factorial randomized block design with thirty two treatments and three replications. It comprised of two seasons *viz*., S_1 - Winter and S_2 - Summer with four levels of pinching *viz*., P_1 - No pinching, P_2 - Pinching at 2 WAT (Weeks After Transplanting), P_3 - Pinching at 3 WAT, P_4 - Pinching at 4 WAT and four levels of gibberellic acid *viz*., G_0 - Control, G_1 - 150 ppm, G_2 - 250 ppm, G_3 - 350 ppm. Before the start of this experiment; a Physico-chemical analysis of soil was done. The soil was sandy loam with 0.36% organic carbon, 7.6 pH and 0.34 dS/m EC. It was medium in available nitrogen (146 kg/ha) and phosphorus (10 kg/ha), but high in available potash (470 kg/ha). It was found suitable for the cultivation of African marigold based on this analysis. Healthy and viable seeds of African marigold cv. Local Selection (MGH 133-1-2) were taken from previously maintained germplasm at Experimental Orchard of the Department of Horticulture, CCS HAU, Hisar. Experimental plots of 1.60 × 2.00 m^2 size were prepared. Uniform application of 10 kg FYM/plot was done before 20 days of transplanting. A basal dose of nitrogen (10 g/m^2), phosphorus (20 g/m^2) and potassium (10 g/m^2) was applied in all experimental plots. Another dose of nitrogen (10 g/m^2) was applied after 30 days of transplanting. One month old healthy and vigorous seedlings were transplanted at a spacing of 40 cm × 40 cm on 19th February 2015 in summer and again on 16th October 2015 in winter. Light irrigation was applied immediately after transplanting. Irrigation was applied at 5-7 days intervals in the summer season and 10-12 days intervals in the winter season. Pinching was done by removing the apical portion of the plant as per the time mentioned in the treatments. Gibberellic acid was sprayed after four weeks of transplanting as per the dose given in treatments, while water was sprayed over control plants. Five representative plants were selected randomly from each experimental plot and tagged for recording various floral and yield attributes. The data recorded for various floral and yield attributes were subjected to statistical analysis using factorial randomized block design for analysis of variance as suggested by Panse and Sukhatme (1995) [13].

3. Results and Discussion

3.1 Floral attributes

Season, pinching and gibberellic acid had exerted a significant effect on days to bud initiation, days to first flower and duration of flowering. Earlier bud initiation (40.60 days) and appearance of the first flower (52.30 days) was recorded in the summer as compared to the winter (41.58 days & 64.71 days, respectively) but a longer duration of flowering (56.00 days) was observed in winter than summer (34.53 days) (Table 1). Early bud initiation in the summer may be due to earlier completion of the juvenile period required for inducing flowering. Summer season conditions were favorable for the formation of early flowers so the first flower was formed early in summer, whereas, during winter the climatic conditions were congenial for flowering, so flowers were formed for a longer period. Similar findings were reported by Singh *et al*. (2015) [16] and Mohanty *et al*. (2015) [11] in African marigold. Plants without pinching took the minimum days to bud initiation (39.05 days) and first flower (55.82 days) with the maximum duration of flowering (50.18 days), whereas, the maximum days to bud initiation (43.11 days) and first flower (60.98 days) with the minimum duration of flowering (39.76 days) were observed in plants pinched at four weeks after transplanting (Table 1). This might be due to the reason that the source of auxin is removed as a result of pinching so the plant utilized its energy toward the formation of lateral branches and thus bud initiation was delayed. In pinched plants, the newly emerged shoot took more time to become physiologically mature for bearing flowers as the speed of auxiliary shoot growth is slow after pinching and thus resulted in the delayed appearance of the first flower. Similar results were also reported by Mohanty *et al*. (2015)

[11] and Meena *et al*. (2015) [9] in African marigold. The earliest bud initiation (39.58 days), visibility of the first flower (55.77 days) and maximum duration of flowering (50.31 days) were recorded significantly with 350 ppm GA_3 treatment, while delayed bud initiation (42.76 days) and visibility of the first flower (62.00 days) with the minimum duration of flowering (39.94 days) were found in control plants (Table 1). It may be because gibberellic acid spray stimulated early flowering due to an increase in the endogenous gibberellin levels in the plants, as gibberellins are well known for inducing early flowering in several crop plants. Gibberellins reduce the juvenile period and with the termination of the juvenile phase, the shoot apical meristem instead of producing leaves and branches start producing flower buds (Palei *et al*. 2016) [12]. Gibberellic acid might have elongated the plant height, which has resulted in the flower formation for a longer time and hence a longer duration of flowering. Results obtained were in agreement with the findings of Kumar *et al* (2012) [6], Kumar *et al* (2014) [7] and Acharya *et al*, 2021 [1] in African marigold. All interactions exerted a significant effect on days to the first flower but only S×P interaction was found significant in influencing days to bud initiation, whereas, S×P and S×G interactions showed a significant effect on the duration of flowering (Table 1). Similar findings were also reported by Meena *et al*. (2015) [9] and Mohanty *et al*. (2015) [11] in African marigold. Summer season un-pinched plants (S_2P_1) took fewer days to first flower (50.72 days); however, early bud initiation (38.64 days) along with the maximum duration of flowering (61.68 days) was recorded in winter season un-pinched plants (S_1P_1) (Figure 1, 2 & 3). Similar findings were recorded by Meena *et al*. (2015) [9] and Mohanty *et al*. (2015) [11] in marigold.

Table 1: Effect of pinching and gibberellic acid on flowering of African marigold in different seasons

Treatment	Days to bud initiation	Days to first flower	Duration of flowering (days)
Season (S)			
Winter (S_1)	41.58	64.71	56.00
Summer (S_2)	40.60	52.30	34.53
C. D. (P=0.05)	0.34	0.34	1.08
Pinching (P)			
No pinching (P_1)	39.05	55.82	50.18
Pinching at 2 WAT* (P_2)	40.66	57.87	47.98
Pinching at 3 WAT* (P_3)	41.55	59.34	44.60
Pinching at 4 WAT* (P_4)	43.11	60.98	39.76
C. D. (P=0.05)	0.48	0.48	1.53
Gibberellic acid (G) (ppm)			
Control (G_0)	42.76	62.00	39.94
150 ppm (G_1)	41.56	59.31	44.49
250 ppm (G_2)	40.45	56.93	47.78
350 ppm (G_3)	39.58	55.77	50.31
C. D. (P=0.05)	0.48	0.48	1.53
Season x Pinching (S x P)			
C. D. (P=0.05)	0.68	0.69	2.17
Season x Gibberellic acid (S x G)			
C. D. (P=0.05)	NS**	0.69	2.17
Pinching x Gibberellic acid (P x G)			
C. D. (P=0.05)	NS**	0.97	NS**
Season × Pinching × Gibberellic acid (S x P x G)			
C. D. (P=0.05)	NS**	1.37	NS**
*Weeks After Transplanting **Non-Significant			

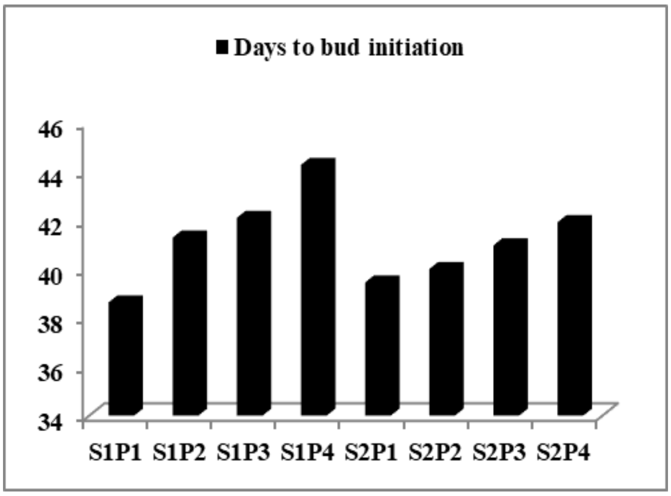

Fig 1: Interaction effect of S×P on days to bud initiation in African marigold

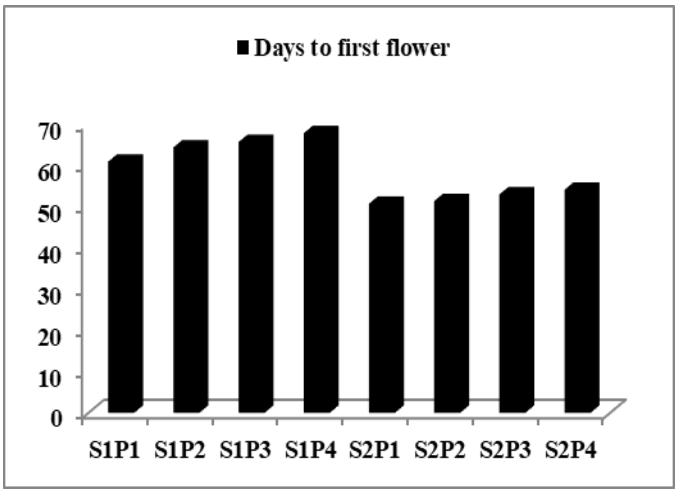

Fig 2: Interaction effect of S×P on days to first flower in African marigold

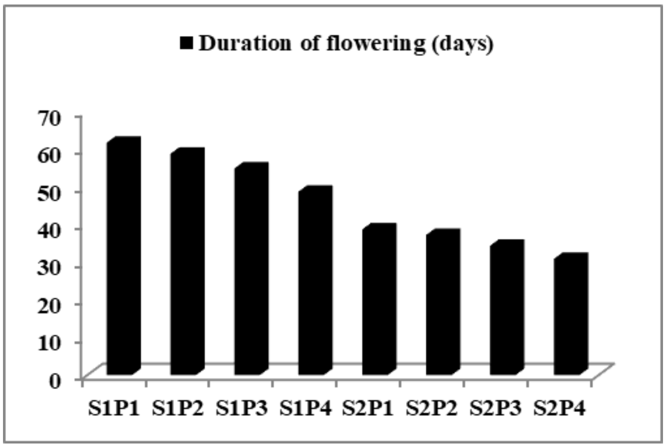

Fig 3: Interaction effect of S×P on duration of flowering (days) in African marigold

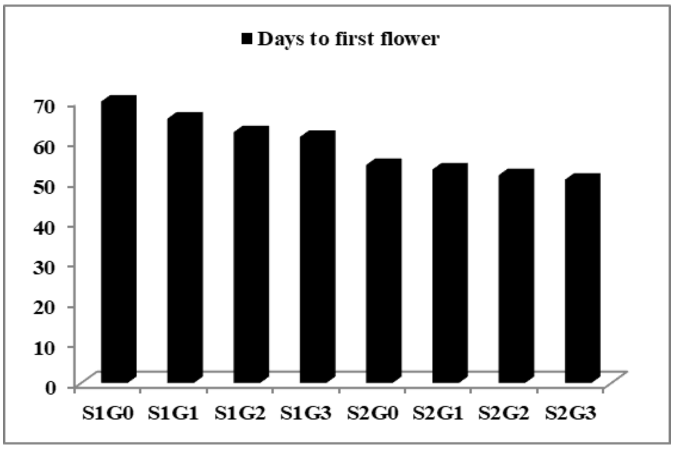

Fig 4: Interaction effect of S×G on days to first flower in African marigold

The minimum days to first flower (50.46 days) and maximum duration of flowering (62.68 days) were recorded with 350 ppm GA_3 in summer (S_2G_3) and winter (S_1G_3), respectively (Figure 4 & 5). Foliar spray of 350 ppm GA_3 on un- pinched (P_1G_3) resulted in the minimum days to the first flower (51.85 days) (Figure 6). Further, it was recorded that earliest appearance of the first flower (48.53 days) was recorded with 350 ppm GA_3 spray in un-pinched plants of the summer season ($S_2P_1G_3$) (Figure 7).

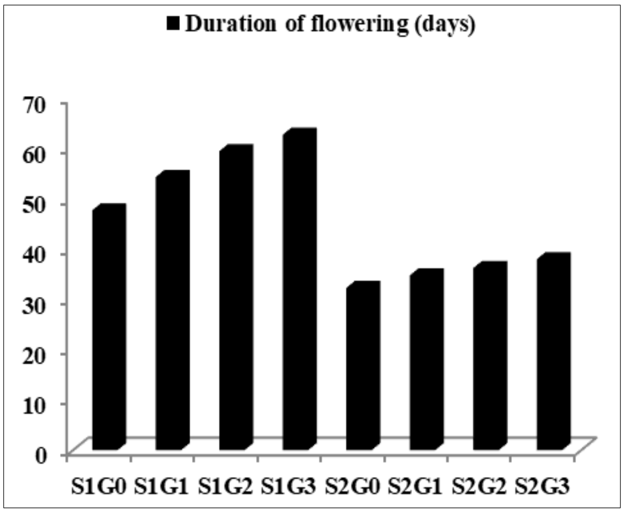

Fig 5: Interaction effect of S×G on duration of flowering (days) in African marigold

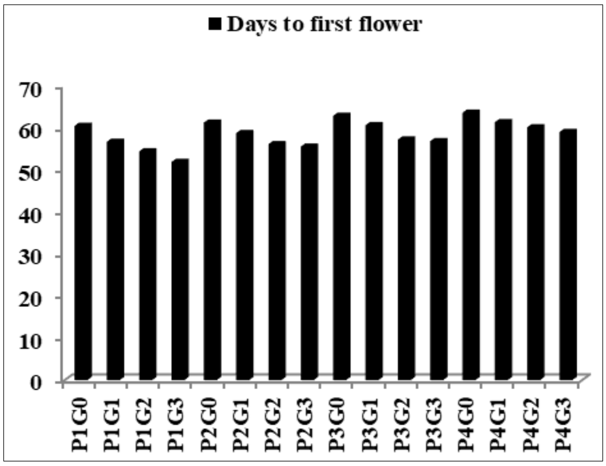

Fig 6: Interaction effect of P×G on days to first flower in African marigold

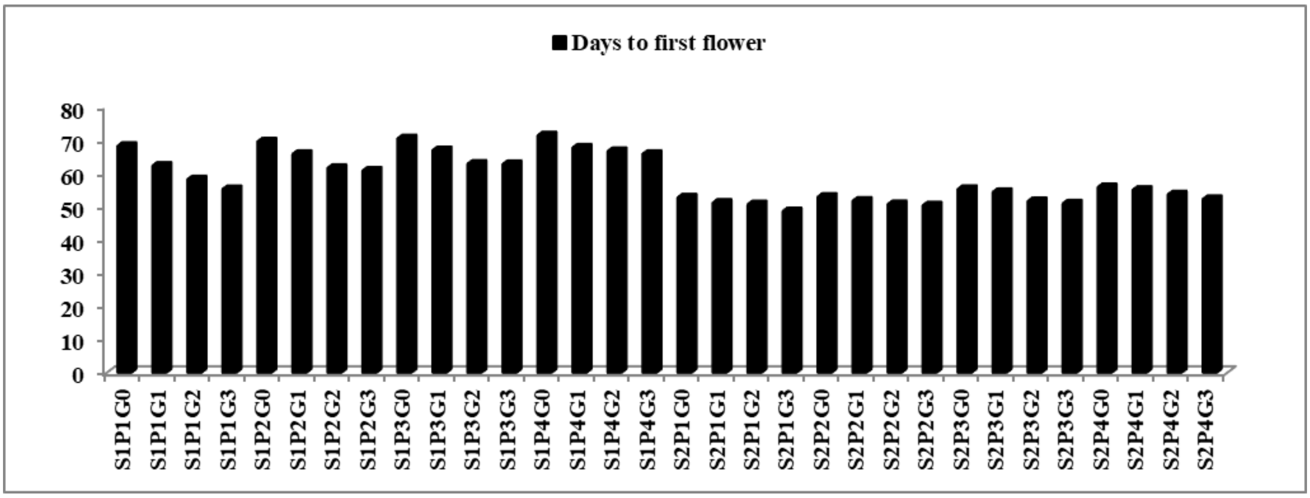

Fig 7: Interaction effect of S × P × G on days to first flower in African marigold

The number of buds per plant, number of flowers per plant and flower diameter differed significantly with different seasons, pinching timings and gibberellic acid doses, while only pinching and gibberellic acid showed a significant influence on flower stalk length and season could not bring any significant change in it (Table 2). Summer crop produced the maximum number of buds per plant (91.76), the number of flowers per plant (43.25) and flower stalk length (9.55 cm) as compared to the minimum (70.12, 37.82 & 9.44 cm, respectively) recorded in winter crop. However, the maximum flower diameter (5.44 cm) was obtained in winter, which was found at par with summer (5.43 cm) (Table 2). This difference in the number of flowers per plant concerning the season may be due to better environmental conditions and more branches per plant. These results are in agreement with the findings of Singh *et al*. (2015) [16] and Mohanty *et al*. (2015) [11] in African marigold. Plants pinched at two weeks after transplanting produced the maximum number of buds per plant (89.83), number of flowers per plant (44.91) and flower stalk length (10.38 cm), whereas, the minimum (71.71, 35.94 & 8.62 cm, respectively) was recorded with no pinching treatment. However, un-pinched plants attained the maximum flower diameter (5.62 cm) and the minimum flower diameter (5.27 cm) was recorded in plants pinched at two weeks after transplanting (Table 2). More branches per plant were produced due to the removal of apical dominance by pinching that in turn contributed to more number of buds and flowers per plant. Similar results were reported by Rajyalakshmi and Rajasekhar (2014) [15], Rajhansa *et al*. (2013) [14] and Mohanty *et al*. (2015) [11] in African marigold.

A gradual increase in the number of buds per plant and number of flowers per plant was observed with increasing concentration of GA_3 up to 250 ppm; thereafter it decreased slightly (Table 2). The maximum number of buds per plant (93.51) was recorded with 250 ppm GA_3, which was found at par with 350 ppm GA_3 treatment (88.65) and the minimum number of buds per plant (63.86) was recorded in control. Similarly, the maximum number of flowers per plant (46.29) was produced as a result of foliar spray of 250 ppm GA_3 and the minimum number of flowers per plant (33.05) was recorded in control. It might be due to the fact that gibberellins might have led to the formation of more buds and also enhanced the internodal length as a result of which the buds were capable of converting into flowers. Similar results were also reported by Kumar *et al*. (2020) [8] and Acharya *et al*. (2021) [1].

Flower stalk length and diameter of flower increased significantly with every rise in the level of gibberellic acid. The maximum flower stalk length (11.13 cm) and maximum flower diameter (5.71 cm) were recorded with 350 ppm GA_3, while minimum flower stalk length (7.90 cm) and minimum flower diameter (5.11cm) were recorded in control (Table 2). This increase in flower diameter might be because of reason that GA_3 might have given sufficient space for the development of the flower. Similar results were recorded by Kumar *et al*. (2014) [7] and Meshram *et al*. (2015) [10] in marigold. All interactions had a significant influence on the number of flowers per plant and flower stalk length but no interaction had any significant effect on the number of buds per plant, whereas, S×P and S×G interactions exerted a significant effect on flower diameter (Table 2)

Table 2: Effect of pinching and gibberellic acid on quantity and quality of African marigold flower in different seasons

Treatment	Number of buds per plant	Number of flowers per plant	Flower stalk length (cm)	Flower diameter(cm)
Season (S)				
Winter (S_1)	70.12	37.82	9.44	5.44
Summer (S_2)	91.76	43.25	9.55	5.43
C. D. (P=0.05)	4.12	0.35	NS**	0.02
Pinching (P)				
No pinching (P_1)	71.71	35.94	8.62	5.62
Pinching at 2 WAT* (P_2)	89.83	44.91	10.38	5.27
Pinching at 3 WAT* (P_3)	83.67	42.11	9.70	5.37
Pinching at 4 WAT* (P_4)	78.56	39.55	9.27	5.48
C. D. (P=0.05)	5.83	0.50	0.21	0.02
Gibberellic acid (G) (ppm)				
Control (G_0)	63.86	33.05	7.90	5.11
150 ppm (G_1)	77.75	39.29	8.62	5.37
250 ppm (G_2)	93.51	46.29	10.31	5.57
350 ppm (G_3)	88.65	43.52	11.13	5.71
C. D. (P=0.05)	5.83	0.50	0.21	0.02
Season x Pinching (S x P)				
C. D. (P=0.05)	NS**	0.70	0.30	0.03
Season x Gibberellic acid (S x G)				
C. D. (P=0.05)	NS**	0.70	0.30	0.03
Pinching x Gibberellic acid (P x G)				
C. D. (P=0.05)	NS**	1.00	0.42	NS**
Season × Pinching × Gibberellic acid (S x P x G)				
C. D. (P=0.05)	NS**	1.41	0.59	NS**
*Weeks After Transplanting **Non-Significant				

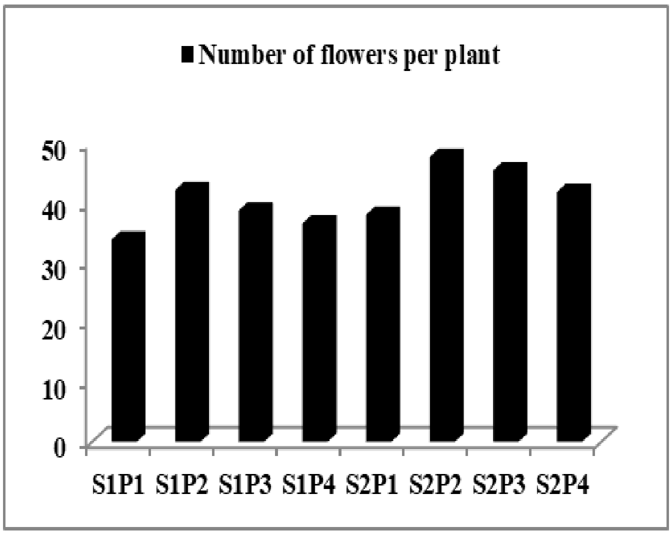

Fig 8: Interaction effect of S×P on number of flowers per plant in African marigold

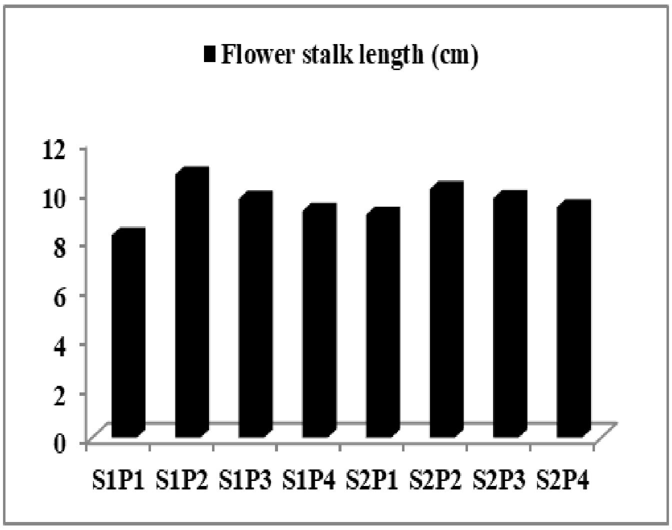

Fig 9: Interaction effect of S×P on flower stalk length (cm) in African marigold

Plants pinched at two weeks after transplanting produced the maximum number of flowers per plant (47.70) in summer (S_2P_2) (Figure 8), while the maximum flower stalk length (10.67 cm) was recorded in winter (S_1P_2) (Figure 9). However, the maximum flower diameter (5.70 cm) was recorded in un-pinched plants of winter (S_1P_1) (Figure 10).

The maximum number of flowers per plant (48.29) was recorded with 250 ppm GA_3 sprayed on summer plants (S_2G_2) (Figure 11), while maximum stalk length of flower (11.53 cm) (Figure 12) and flower diameter (5.76 cm) (Figure 13) were recorded with winter application of 350 ppm GA_3 (S_1G_3). The maximum number of flowers (51.71) and maximum flower stalk length (12.42 cm) were recorded in plants pinched at 2 weeks after transplanting with foliar spray of 250 ppm GA_3 (P_2G_2) (Figure 14) and GA_3 350 ppm (P_2G_3), respectively (Figure 15). The maximum number of flowers per plant (53.18) was observed in summer plants pinched at 2 weeks after transplanting with 250 ppm GA_3 spray ($S_2P_2G_2$) (Figure 16). However, winter plants pinched at 2 weeks after transplanting and sprayed with 350 ppm GA_3 produced the longest flower stalk (13.53 cm) ($S_1P_2G_3$) (Figure 17)

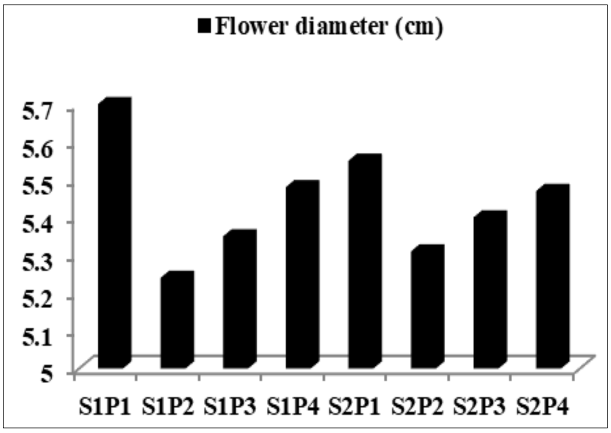

Fig 10: Interaction effect of S×P on flower diameter (cm) in African marigold

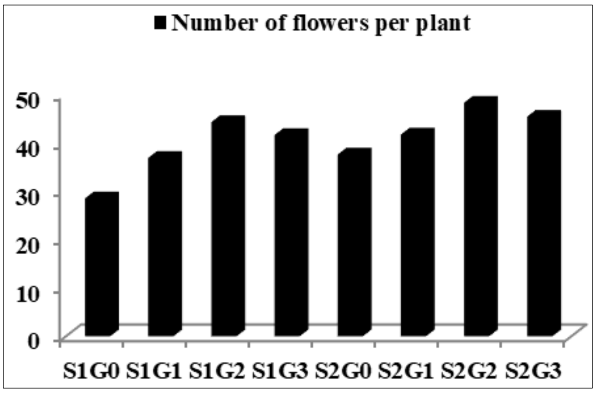

Fig 11: Interaction effect of S×G on number of flowers per plant in African marigold

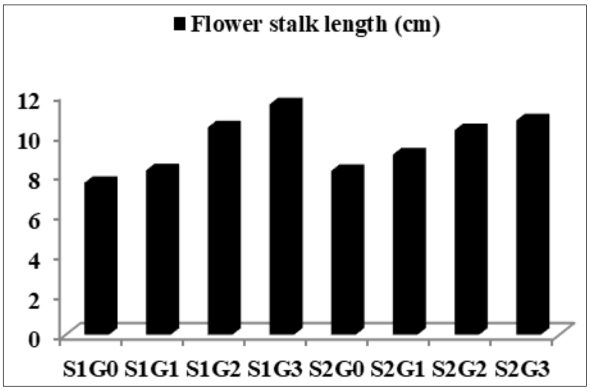

Fig 12: Interaction effect of S×G on flower stalk length (cm) in African marigold

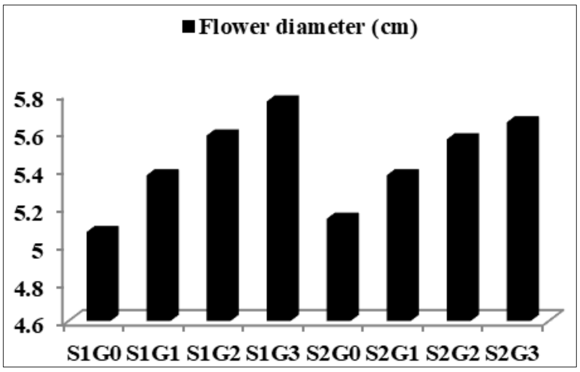

Fig 13: Interaction effect of S×G on flower diameter (cm) in African marigold

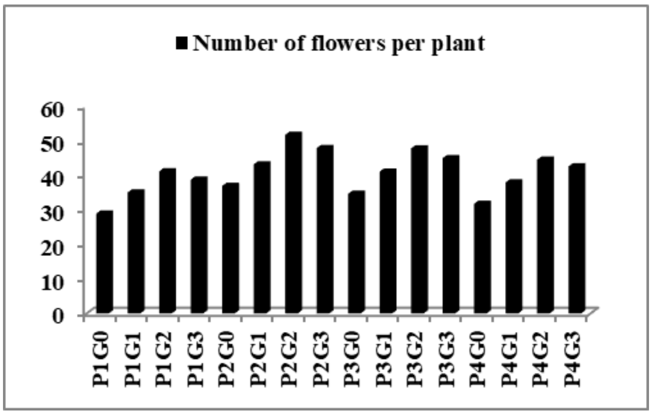

Fig 14: Interaction effect of P×G on number of flowers per plant in African marigold

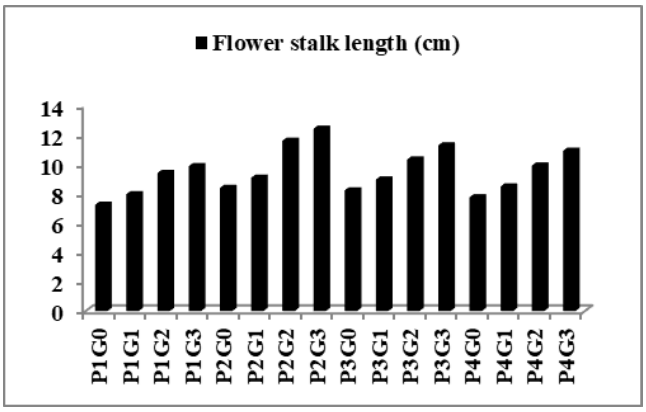

Fig 15: Interaction effect of P×G on flower stalk length (cm) in African marigold

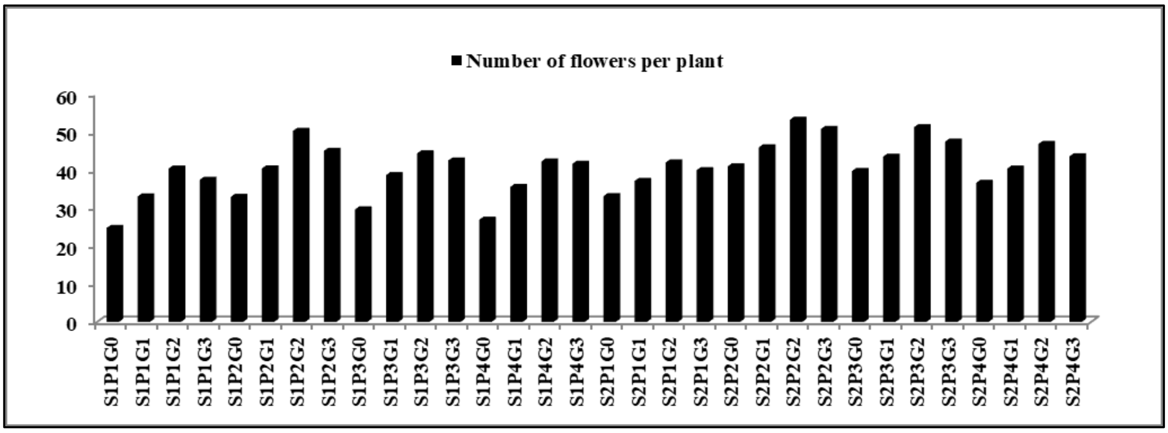

Fig 16: Interaction effect of S×P×G on number of flowers per plant in African marigold

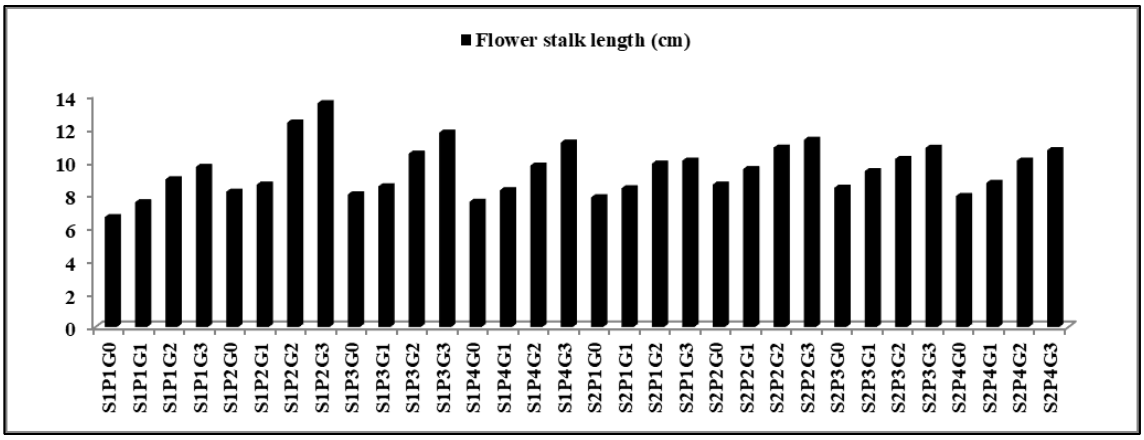

Fig 17: Interaction effect of S×P×G on flower stalk length (cm) of African marigold

3.2 Yield attributes

Season, pinching and gibberellic acid had exerted a significant influence on fresh weight of flower, dry weight of flower and flower yield per hectare. Higher values in terms of fresh weight of flower (4.57 g), dry weight of flower (0.52 g) and flower yield per hectare (10.89 t) were recorded in the winter season in contrary to lower recorded in the summer season (3.15 g, 0.35 g & 8.55 t, respectively) (Table 3). Similar findings were also reported by Singh *et al*. (2015) [16], Mohanty *et al*. (2015) [11] and Joshna and Pal (2015) [4] in African marigold. Un-pinched plants attained the maximum fresh weight of flower (4.06 g) and dry weight of flower (0.47 g), whereas, the maximum flower yield per hectare (10.33 t) was recorded in plants pinched at two weeks after transplanting. The minimum fresh weight of flower (3.69 g) and minimum dry weight of flower (0.41 g) were recorded in plants pinched at two weeks after transplanting, while the minimum flower yield per hectare (9.10 t) was recorded in un-pinched plants followed by plants pinched at four weeks after transplanting (9.52 t) (Table 3). It may be due to increase in the number of flowers per plant as a result of pinching treatment hence; the developing flowers might have been supplied with comparatively lesser quantities of plant bioregulators and food reserve and resulting ultimately in reduction of fresh and dry weight of flower. The increase in yield of flowers under pinching treatments may be since pinching checked the apical dominance and diverted extra metabolites into the production of more flowers. These results are in the agreement with the findings of Rajhansa *et al*. (2013) [14], Badge *et al*. (2014) [2], Rajyalakshmi and Rajasekhar (2014) [15], Mohanty *et al*. (2015) [11] in African marigold. The maximum fresh weight of flower (4.13 g) and maximum dry weight of flower (0.47 g) were recorded with 350 ppm GA_3 treatment, whereas, the minimum fresh weight of flower (3.45 g) and dry weight of flower (0.38 g) was recorded in control. Application of 250 ppm GA_3 on plants resulted in the highest flower yield per hectare (11.53 t) which was found at par with 350 ppm level of GA_3 (11.13 t) and the lowest flower yield per hectare (6.91 t) was recorded in control (Table 3). This increase in fresh weight of flower can be attributed to better translocation of plant assimilates from source to sink due to enhanced reproductive efficiency and photosynthesis, whereas, increase in flower yield might be due to better crop growth; more number of branches thus increased the number of flowers per plant and ultimately increased the flower yield. Present results are in confirmation with the findings of Kumar *et al*. (2012) [6], Kanwar and Khandelwal (2013) [5], Kumar *et al*. (2014) [7], Meshram *et al*. (2015) [10], Kumar *et al*. (2020) [8] and Acharya *et al*. (2021) [1] in marigold. All interactions had exerted a significant influence on the fresh weight of flower but only S×P interaction showed a significant effect on flower yield per hectare, while no interaction was found significant in influencing dry weight of flower (Table 3). These results are in harmony with the findings of Badge *et al* (2014) [2] in marigold. The maximum fresh weight of flower (4.83 g) was recorded in un-pinched plants of winter (S_1P_1) (Figure 18), while the maximum flower yield per hectare (11.61 t) was obtained from winter plants pinched at two weeks after transplanting (S_1P_2) (Figure 19). The maximum fresh weight of flower (4.91 g) was recorded when sprayed with GA_3 350 ppm (S_1G_3) in the winter season (Figure 20). Un-pinched plants attained the maximum fresh weight of flower (4.32 g) with GA_3 350 ppm (P_1G_3) (Figure 21). In relation to S×P×G interaction, the maximum fresh weight of the flower (5.14 g) was recorded with 350 ppm GA_3 in un-pinched plants of the winter season ($S_1P_1G_3$) (Figure 22)

Table 3: Effect of pinching and gibberellic acid on yield attributes of African marigold in different seasons

Treatment	Fresh weight of flower (g)	Dry weight of flower (g)	Flower yield per hectare (t)
Season (S)			
Winter (S_1)	4.57	0.52	10.89
Summer (S_2)	3.15	0.35	8.55
C. D. (P=0.05)	0.03	0.01	0.52
Pinching (P)			
No pinching (P_1)	4.06	0.47	9.10
Pinching at 2 WAT* (P_2)	3.69	0.41	10.33
Pinching at 3 WAT* (P_3)	3.80	0.42	9.94
Pinching at 4 WAT* (P_4)	3.90	0.44	9.52
C. D. (P=0.05)	0.05	0.01	0.73
Gibberellic acid (G) (ppm)			
Control (G_0)	3.45	0.38	6.91
150 ppm (G_1)	3.85	0.43	9.32
250 ppm (G_2)	4.03	0.45	11.53
350 ppm (G_3)	4.13	0.47	11.13
C. D. (P=0.05)	0.05	0.01	0.73
Season x Pinching (S x P)			
C. D. (P=0.05)	0.07	NS**	1.04
Season x Gibberellic acid (S x G)			
C. D. (P=0.05)	0.07	NS**	NS**
Pinching x Gibberellic acid (P x G)			
C. D. (P=0.05)	0.10	NS**	NS**
Season × Pinching × Gibberellic acid (S x P x G)			
C. D. (P=0.05)	0.14	NS**	NS**
*Weeks After Transplanting **Non-Significant			

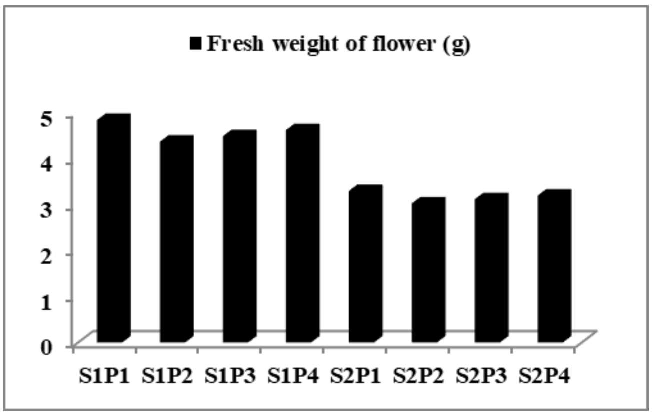

Fig 18: Interaction effect of S×P on fresh weight of flower (g) in African marigold

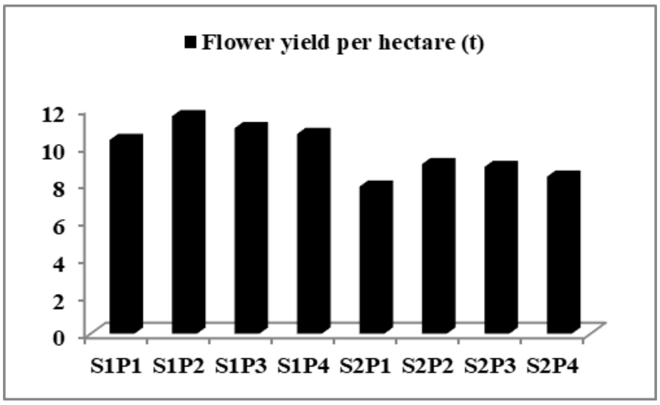

Fig 19: Interaction effect of S×P on flower yield per hectare (t) in African marigold

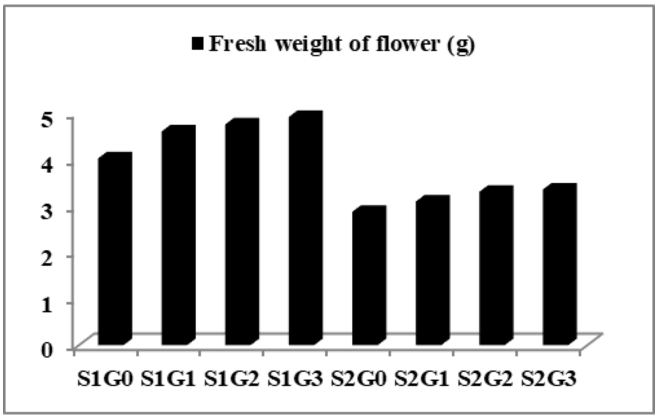

Fig 20: Interaction effect of S×G fresh weight of flower (g) in African marigold

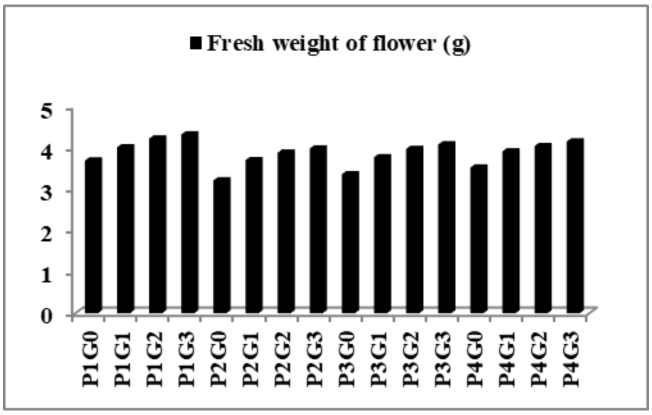

Fig 21: Interaction effect of P×G on fresh weight of flower (g) in African marigold

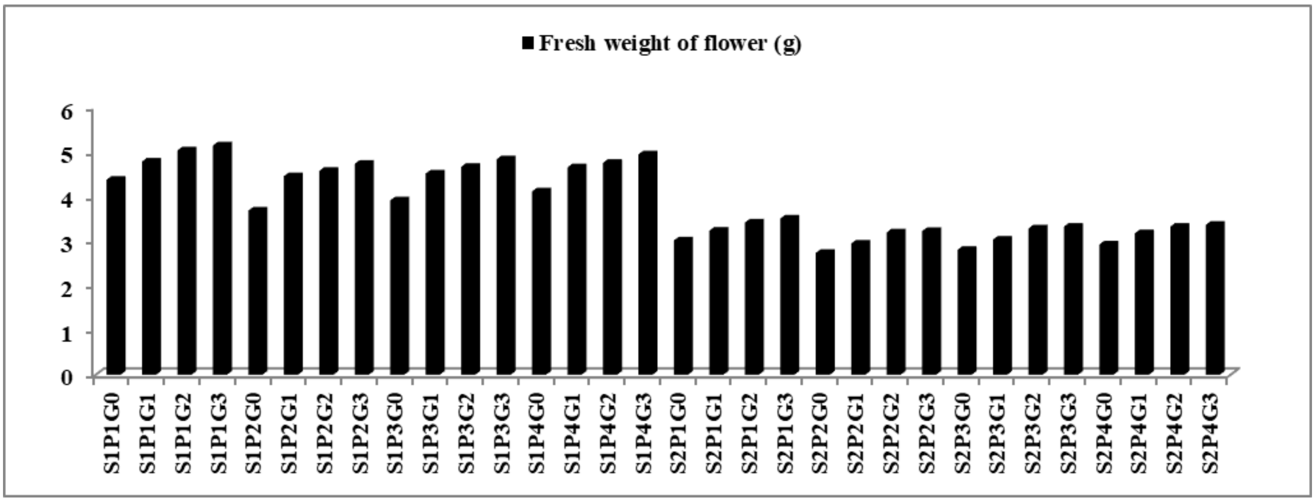

Fig 22: Interaction effect of S×P×G on fresh weight of flower (g) in African marigold

4. Conclusion

From the present investigation, it may be concluded that application of 250 ppm GA_3 as a foliar spray on plants pinched at two weeks after transplanting was found promising in terms of floral and yield attributes of African marigold. The highest number of flowers per plant was observed with GA_3 250 ppm sprayed on summer plants pinched at 2 WAT ($S_2P_2G_2$), however, the maximum flower yield per hectare was recorded when plants pinched at two weeks after transplanting were sprayed with 250 ppm GA_3 during the winter season ($S_1P_2G_2$). The earliest appearance of the first flower with the maximum fresh weight of flower was recorded with 350 ppm GA_3 spray in un-pinched plants of the winter season ($S_1P_1G_3$).

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