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ORIGINAL RESEARCH ARTICLE

Unleashing the potential of *Phlox* (*Phlox drummondii*): Evaluating the influence of growth regulators and growing media

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ABSTRACT

During the early spring in the woodlands of eastern North America, *Phlox drummondii* emerges as a perennial plant adorned with a profusion of blooms in shades of blue, purple, pink, or white. Its evergreen nature adds to its charm. To manage the growth of plants or specific plant parts, plant growth regulators (PGRs) are synthesized and employed, serving as valuable tools for controlling and directing the development of various plant species. A diverse range of ornamental plants, such as *Phlox drummondii*, have been documented to receive exogenous applications of plant growth regulators (PGRs). Among these regulators, gibberellins (GA) play a vital role by delaying senescence in flowers and promoting the breaking of dormancy in seeds, bulbs, and corms of ornamental plants. The experiment aimed to assess the performance and determine the optimal growth medium for *Phlox*. Five distinct growth media were employed as treatments during the study, which took place in the Horticulture Department of Gomal University. Collected data underwent analysis through ANOVA and Tuckey HSD tests. The study's findings revealed that the highest plant height (16 cm) was observed in the control treatment with PGR 1, closely followed by PGR 2 (11.5 cm). The treatment labeled as T5, composed of a mixture of 1/3 sand, 1/3 poultry manure, and 1/3 soil, demonstrated the most favorable results across multiple parameters such as bud initiation (BI), first flower emergence (FFE), flowers per plant (FPP), branches per plant (BPP), leaves per plant (LPP), number of roots (NR), field life of flowers (FLF), and flower diameter (FD). T4, T3, T2, and T1 treatments also exhibited similar positive outcomes, aligning with the promising performance of T5.

Keywords: *Phlox drummondii*; Gibberellins; Indole Acetic Acid; Poultry Manure; Plant Growth

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1. Introduction

The Polemoniaceae family encompasses approximately 65 plant species, renowned for their captivating clusters of flowers that find appreciation both in cultivated gardens and in their natural habitats. With all but one species originating from Northern Asia, North America serves as the primary home to these floral gems. Within the genus *Rhododendron*, a diverse range of flowering plants can be found, including the notable *Phlox drummondii*, a branched annual *Phlox* that stands at a height of 45 cm (1.5 ft) and bears reddish-purple flowers[1]. Cultivators have also developed various *Phlox drummondii* cultivars, showcasing two-toned petals and a star-like appearance. Another enchanting member of the family is the spring-flowering forest perennial, *P. divaricata*, which presents clusters of blue to white flowers and reaches a height of 45 cm. In the central regions of North America, the hairy perennial *Phlox* (*P. pilosa*) flourishes during the summer, displaying vibrant red-purple flowers at a similar height[2]. *Phlox drummondii*, an evergreen shrub, adorns the woodlands of eastern North America with its abundant blooms in hues of blue, purple, pink, or white during early spring. These creeping and freely spreading moss pinks are commonly cultivated as perennial plants in gardens. They are known for their easy cultivation and prolonged flowering period[3]. Planting *Phlox* seeds in outdoor settings is best done in the spring, particularly in regions with short growing seasons. It is recommended to sow the seeds 8–10 weeks before the onset of frost and 2–3 weeks after the last threat of frost has passed. Before transplantation, the seedlings should be hardened off[4]. The genetic influence on targeted plant shoot biomass was greatly influenced by the varietal mix within a pot, while the pattern of this influence changed with plant density and soil treatment. Notably, the interaction between density and soil treatment had a significant impact, particularly when soft nutrient contents were lower, leading to a more pronounced detrimental effect on branch development by neighboring plants[5]. Recent research revealed substantial interactions between soil nutritional status and seed source, affecting the average size and survival probability of *Phlox drummondii* varieties grown in mixed stands at high densities[6]. *Phlox* plants show a preference for well-drained soil with a pH range of 6.5 to 7.0, and they display resilience to heat during dry seasons when exposed to ample sunlight. They thrive particularly well in cooler months, making them an ideal choice for borders, garden beds, or containers, thanks to their abundant flower clusters and extended blooming period. The vibrant hues of these plants enhance the visual appeal of any setting[7]. Furthermore, *Phloxes* offer advantages in commercial applications, as they contribute to agricultural practices by utilizing organic manure as a valuable source of fertilization. The organic materials present in manure, coupled with the assistance of microorganisms, enrich the soil with nutrients, improve its structure, support soil microbial activity, and facilitate optimal plant nutrition and growth[8]. The growth and development of plants depend on key factors including media fertility, structure, pH, microbial activity, and moisture content, all of which are vital for their health and overall growth. However, there is a lack of local research conducted on *Phlox* regarding its growth in various media[9].

PGRs are created and employed to regulate plant growth, either stimulating or restraining it. Phytohormones, the natural plant hormones, control physiological and growth processes, exerting their influence even in small quantities and at a distance from their origin[10]. The impact of PGRs varies based on factors like application method, concentration, timing, plant species, and environmental conditions. Considering these parameters is essential for achieving the desired results when utilizing PGRs in plant growth[11]. Preplant soaking of plant material in PGRs is effective but uncommon on a commercial scale[12]. This method offers advantages like time and labor savings, accurate dosage, but disposal of residual solutions poses environmental toxicity concerns[13]. Ornamental plants such as gladiolus, dahlia[14], tulip[15], and lily[16] have been subjected to exogenous PGR application. While initially confined to scientific research, its implementation has now extended to commercial farms. Forward-thinking producers utilize PGRs to augment desirable traits in visually appealing plants. The specific goals of PGR treatment differ according to the plant species, aiming to achieve heightened leaf compactness in some ornamentals and enhanced floral attributes in others[17]. PGRs have found application in altering various characteristics of ornamental plants. These include regulating plant height, enhancing compactness, increasing flower quantity, promoting early flowering, boosting lateral shoot growth, delaying flowering, controlling flower sex ratio, extending flower life, and inducing resistance against related diseases[18,19]. For successful *Phlox* cultivation, it is crucial to choose a well-drained and porous medium. Growers often opt for pre-made commercial combinations, which may include fertilizer. Various factors, including structure, texture, pH, nitrogen, and phosphorus, significantly affect the plant's growth[20]. The composition of the growing medium plays a pivotal role in determining the quality of blooming. *Phlox*'s growth has been extensively studied across different media, and the selection of the growth material ultimately determines the quality of flower output. Ornamental plants derived from 500 endosperms were successfully cultivated using Murashige and Skoog media supplemented with specific additives[21]. The inclusion of 2,4-dichlorophenoxyacetic acid, 6-benzylaminopurine, casein hydrolysate, and Napthaleneacetic acid (NAA) promoted the growth of plants with higher water requirements. By combining BAP (10 M) and a relatively low concentration of indole acetic acid (0.5 M), shoot elongation of up to 99% was achieved within 4–5 weeks. The resulting shoots reached a length of approximately 7 cm with 5–6 internodes. Notably, these plants exhibited thicker stems and leaves compared to regular diploid plants[22].

Gibberellins play a role in postponing flower senescence and facilitating the emergence of dormant seeds/bulbs/corms in ornamental plants. Additionally, they promote growth and flowering[23]. However, the response to PGRs is influenced by factors such as cultivar, temperature, plant age, light, vigor, nutrients, and endogenous hormones. Growth regulators are used in ornamental plants for purposes like propagation, post-harvest handling, increasing flower production, inhibiting growth, enhancing foliage color, and improving the visual appeal of ornamental grasses[24]. In Fernandez's study, it was found that leaf mold offers ideal conditions for the development and height of foliage plants. A high-quality growth medium plays a vital role by providing essential nutrients, water, oxygen, and enabling gas exchange for root health. Unfortunately, this aspect is frequently neglected in commercial flower cultivation practices[25].

To address this, the current research aims to examine how different growing media impact the growth and blooming of *Phlox* (*Phlox drummondii*) plants.

2. Materials and methods

In pursuit of examining the ramifications of diverse substrates on the development and efficacy of *Phlox* (*Phlox drummondii*) in a controlled setting, a pot experiment was meticulously carried out at the Department of Horticulture, Faculty of Agriculture, Gomal University situated in Dera Ismail Khan, KP, Pakistan. The experiment comprised the utilization of five distinctive growing mediums as individual treatment modalities. Following a transplantation interval of two weeks, plant growth regulators were administered only once. Nursery plants, attaining a stature of 3–4 cm, were procured from Bahar e Madina Nursery, in D.I. Khan. Subsequently, these plants were introduced into pots containing their respective designated growing mediums during the initial week of December in the year 2021.

2.1 Composition of growing media

The growing media were comprised different treatments. Treatment 1 (T1) control (soil), treatment 2 (T2) 50% soil + 50% sand, treatment 3 (T3) 50% soil + 50% poultry manure, treatment 4 (T4) 50% sand + 50% poultry manure and treatment 5 (T5) 33.3% sand + 33.3% poultry manure + 33.3% soil, respectively.

2.2 Plant growth regulators

The different concentrations of "GA" and NAA 100 ppm and 100 ppm, respectively were applied in the form of foliar spray practice. For optimal blooming, it is imperative to ensure that *Phlox* plants receive consistent watering, as well as regular hoeing and weeding, throughout their entire growth season.

2.3 Parameters

Different parameters were investigated during this course of study such as BI, FFE, FPP, BPP, LPP, NR, FLF, and FD, respectively.

2.4 Analysis

The collected data underwent analysis of variance (ANOVA) to examine significant differences. Subsequently, means that exhibited significant variations were further subjected to DMR test for mean comparison. This analysis was conducted using Statistix 8.1 software.

3. Results and discussion

The delineation of parameters utilized for the depiction of the influence exerted by diverse plant growth regulators upon the progression and maturation of *Phlox drummondii* has been elucidated.

3.1 Plant height (PH)

Figure 1(A) illustrates the influence of different growing mediums and plant growth regulators on the PH of *Phlox* plants. Both the choice of growing medium and application of PGRs significantly impact the growth and development of the plants. The research findings demonstrate that the utilization of different growing mediums and various PGRs had a substantial and statistically significant effect (P 0.05) on PH of *Phlox* plants. The PH height (16 cm) was recorded for PGR 1 in the control treatment, followed by PGR 2 with a height of 11.5 cm. Among all the treatments without any growth regulator, T5 exhibited the most favorable results in terms of PH. Under PGR 2, T2, T3, and T4 displayed the highest PH at 10.5 cm, 8.5 cm, and 9.6 cm, respectively, whereas T4 exhibited the lowest PH among the treatments in the control group with a growth regulator.

The findings from the study revealed that T5, characterized by the highest nutrient content and superior water retention capability, exhibited superior outcomes compared to the other treatments. These findings align with the research conducted by Tiku *et al.*[22], where they observed a significant augmentation in the number of leaves per plant and stem length with the application of GA, while the utilization of CCC as a growth retardant hindered these parameters of vegetative growth in both controlled conditions and various soil compositions[22]. Similarly, Wang *et al.*[26] reported an increase in auxin content as a result of administering GA, which consequently led to apical dominance and likely contributed to the observed improvement in PH[26].

3.2 Days to flower bud initiation (DFBI)

Figure 1(B) portrays the impact of distinct growing mediums and PGRs on the duration required for FBI in *Phlox* plants. Both the choice of growing medium and application of PGRs play

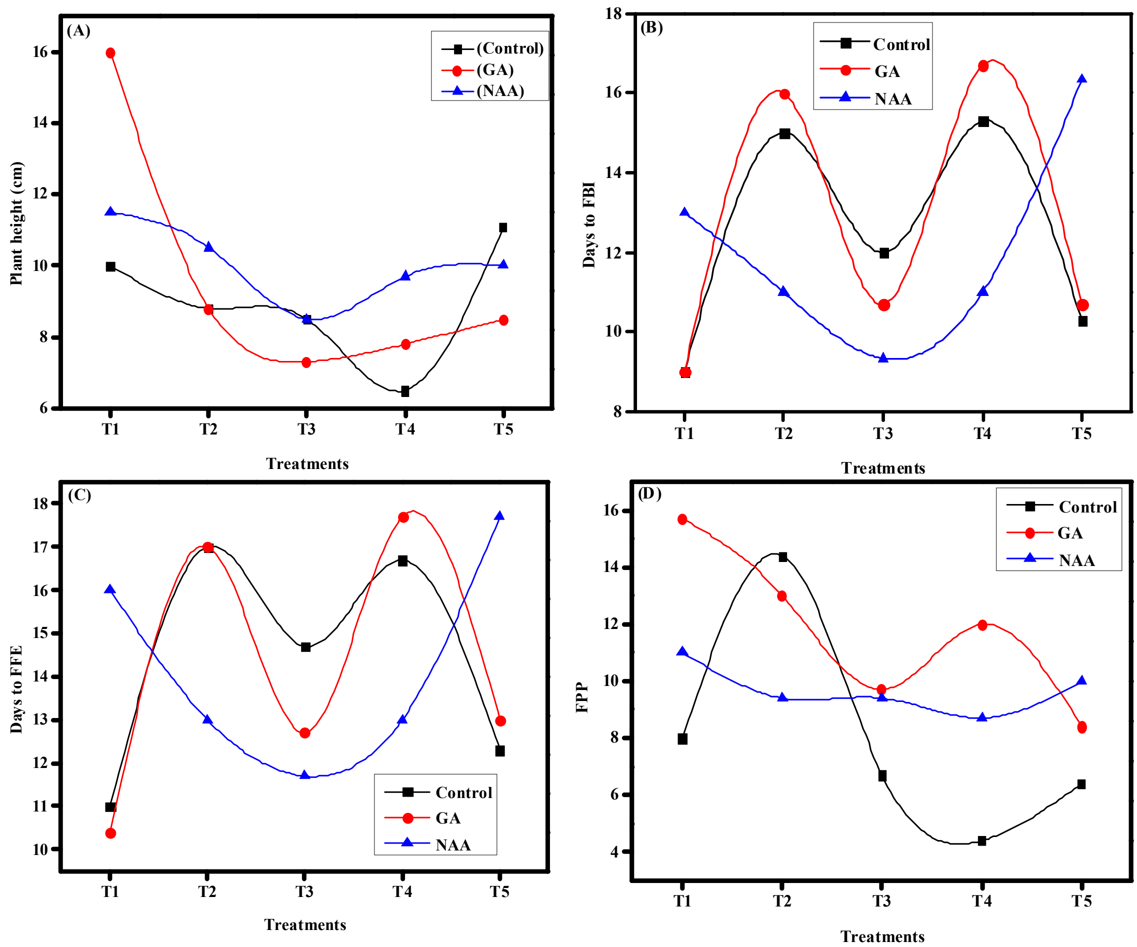

Figure 1. Response of **(A)** PH, **(B)** DFBI, **(C)** FFE and **(D)** FPP towards different PGRs and treatments.

pivotal roles in the overall growth and development of the plant. The research findings underscore that the utilization of different growing mediums and various PGRs exerted a substantial influence on the FBI in *Phlox* plants. The maximum duration required for bud initiation (with a mean of 16.66 days) was observed in PGR 1 under T4, followed by PGR 2 at 11.5 days. Among all the treatments under PGR 2, T5 exhibited the most favorable outcomes. Under the growth regulator condition (P0), T1, T2, T3, and T4 displayed the best results, with bud initiation occurring in 9, 15, 12, and 15 days, respectively. Conversely, T1 under PGR 1 exhibited the minimum DFBI. Furthermore, the results demonstrated that T5, which had the highest nutrient content and water-holding capacity, yielded superior outcomes compared to the other treatments, as depicted in **Figure 1(B)**. The research undertaken by Shavrukov *et al*.[27] lends credence to the notion that the induction of floral buds in decorative plant species is subject to a myriad of factors, encompassing developmental cues, environmental stimuli, and the intricate interplay with PGRs[27]. Furthermore, soil pH was highlighted as an influential element in bud initiation. Another study conducted by Fatima *et al*.[7] revealed that the application of vermicompost potentially enhanced the availability of essential plant nutrients, thereby, facilitating root and shoot growth, which, in turn, contributed to bud initiation[7]. Moreover, the utilization of GA3 was posited to stimulate cell enlargement, cell division, and protein synthesis, leading to increased dry matter and the establishment of apical dominance across diverse environmental conditions.

3.3 First flower emergence (FFE)

The duration required for the FFE in *Phlox* plants is impacted by the choice of growing mediums and the application of PGRs, as depicted in **Figure 1(C)**. The growth and development of the plant are intricately influenced by both the cultivation substrates and PGRs, each playing pivotal roles in this process. The empirical evidence suggests that diverse substrates utilized for cultivation, as well as a range of PGRs, wield a substantial impact on the temporal duration required for the emergence of FFE in *Phlox* plants. The maximum duration of 17.6 days was observed for PGR 1 in treatment T4, followed by the control treatment with a duration of 16.6 days. Among all the treatments under growth regulator P2, T5 exhibited the most favorable outcomes, displaying the best results. Conversely, T2, T3, and T4 required fewer days for the FFE compared to T5 under PGR 2, with durations of 13, 11, and 13 days, respectively. T1, under PGR 1, exhibited the minimum number of days for FFE compared to the control treatment. These findings align with the results indicating that T5, which had the highest nutrient content and water-holding capacity, produced superior outcomes compared to the other treatments. These findings find support in the research conducted by Karnawat *et al*.[9], who postulated that the longer duration of flowering, increased length of flower stalks, and quicker onset of the first flower observed in certain treatments could be attributed to higher nitrogen content in the soil[9]. The enhanced nutrient availability, facilitated by the application of PGRs, may have accelerated protein synthesis, thereby promoting the early development of floral primordia. Additionally, another study by Bhattarai *et al*.[28] demonstrated that factors such as low humidity, high temperatures, and reduced rainfall, along with the foliar application of PGRs, contribute to the earlier FFE. Our findings align with the conclusions presented by Bhattarai *et al*.[28], further reinforcing the relationship between these environmental conditions, PGR application, and the timing of FFE[28].

3.4 Flower per plant (FPP)

The number of FPP in *Phlox* plants is influenced by various growing mediums and plant growth regulators, as demonstrated in **Figure 1(D)**. The selection of a suitable cultivation substrate and the judicious utilization of PGRs are indispensable factors that significantly contribute to the comprehensive progression and maturation of the plant. The research findings indicate that different growing mediums and various PGRs exert a significant influence on the number of FPP in *Phlox* plants. The maximum FPP (15.6) was observed for PGR 1 in the control treatment, followed by PGR 2 with a count of 11. Among all the treatments without a growth regulator, T2 exhibited the highest number of FPP. Under the PGR 2, T5, T3, and T4 displayed higher numbers of FPP, with counts of 10, 9, and 8 respectively. Conversely, T4 yielded a lower number of FPP under the control (P0). These results align with the findings that the combination of T5, which had the maximum nutrient content and water-holding capacity, produced superior outcomes compared to the other treatments. Our research findings found support in the study conducted by Wu *et al*.[29] where they proposed that the increased number of FPP could be attributed to the utilization of soil compost[29]. The application of compost is known to enhance the biological and physical properties of the soil, which, in turn, can positively influence plant physiology and facilitate the transition from the vegetative to the reproductive stage. Additionally, compost has been shown to improve photosynthetic efficiency, leading to enhanced food production and overall plant development, ultimately resulting in a higher number of FPP. A distinct inquiry undertaken by Hopkins and Rausher[30] unveiled that the augmentation in flower quantity, subsequent to GA3 treatment, can be ascribed to the capacity of GA3 to amplify the provocation of flower bud emergence and the delineation of floral primordia within the apical growth zone[30]. This process facilitated by GA3 leads to an amplified production of FPP.

3.5 Branches per plant (BPP)

The quantity of BPP in *Phlox* plants is influenced by various growing mediums and PGRs, as illustrated in **Figure 2(A)**. The selection of a suitable cultivation substrate and the judicious utilization of PGRs are indispensable factors that significantly contribute to the comprehensive progression and maturation of the plant.

The research findings indicate that different growing mediums and various PGRs exert a significant influence on the number of BPP in *Phlox* plants. The highest number of BPP (8.3) was observed for PGR 1 in treatment T5, followed by PGR 2 with a count of 5 branches. Among all the treatments under PGR 1, T5 exhibited the most favorable outcomes, displaying the best results. Additionally, T2, T3, and T4 showed a greater number of BPP under PGR 1, with counts of 7.6, 7.6, and 6.7, respectively. However, T5 exhibited the minimum number of branches among all the treatments under the control (P0). These results align with the findings indicating that T5, which had the highest nutrient content and water-holding capacity, produced superior outcomes compared to the other treatments. Our research findings find support in the results reported by Bunn *et al*.[31], who concluded that the application of PGPR (plant growth-promoting rhizobacteria) substantially increased the number of BPP[31]. Furthermore, another study conducted by Purohit[32] indicated that the inoculation of P1, a specific strain of PGPR, resulted in a significant increase in the number of BPP. This observed increase in branch count can be attributed to the positive effects of PGPR on ornamental plants, as it promotes their growth and development[32].

3.6 Leaves per plant (LPP)

The quantity of LPP in *Phlox* plants is influenced by various growing mediums and PGRs, as depicted in **Figure 2(B)**. The selection of a suitable cultivation substrate and the judicious utilization of PGRs are indispensable factors that significantly contribute to the comprehensive progression and maturation of the plant. The research findings indicate that different growing mediums and various PGRs exert a significant influence on the number of LPP in *Phlox* plants. The maximum number of LPP (14) was observed for PGR 1 in the control treatment, followed by PGR 2 with a count of 11 leaves. Among all the treatments without a growth regulator, T5 exhibited the highest number of LPP. Under the PGR 1, T2, T3, and T4 also displayed a higher number of LPP, with counts of 12.6, 12.3, and 13.3, respectively. However, T5 exhibited the minimum number of LPP under PGR 2. These results align with the findings indicating that T5, which had the highest nutrient content and water-holding capacity, produced superior outcomes compared to the other treatments. These findings were corroborated by Mikovski *et al*.[33], who documented the augmentation in leaf count and leaf

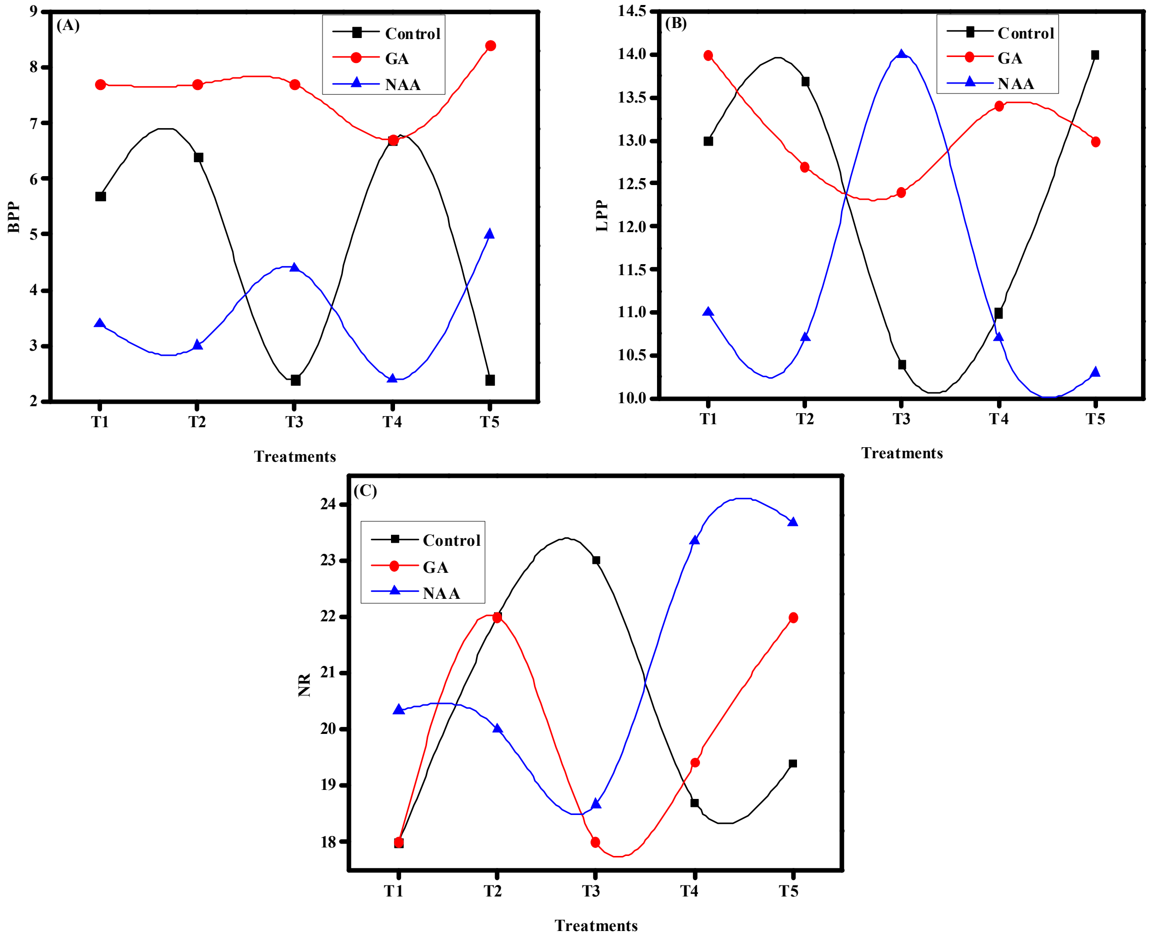

Figure 2. Effect of PGRs and different treatments on **(A)** BPP, **(B)** LPP and **(C)** NR.

mass in plants subjected to various PGRs[33]. Another investigation conducted by Münzbergová[34] affirmed that the amalgamation of soils with a composite impact notably bolstered the number of leaves per branch and the mass of branches in numerous plants, while the application of foliar SA significantly augmented branch quantity and grain mass[34].

3.7 Number of roots (NR)

The NR in the *Phlox* plant is influenced by varying media compositions and the application of PGRs, as depicted in **Figure 2(C)**. The selection of media and the implementation of PGRs are crucial factors in governing the overall growth and maturation of the plant. The study revealed that distinct media compositions and diverse PGRs exerted a significant impact on the NR in the *Phlox* plant. Notably, the highest NR (23.6) was observed in the case of PGR 2 in conjunction with treatment T5, closely followed by PGR 1 (22), in comparison to the control group. In addition, T4 exhibited a higher NR compared to all other treatments under the influence of PGR 2. Specifically, T2, T3, and T1 exhibited 20, 18, and 20.3 roots, respectively, when subjected to PGR 2. Conversely, T3 displayed the minimum NR when influenced by PGR 1. Notably, the outcomes indicated that T5, characterized by the highest nutrient content and water-holding capacity, exhibited taller plants with the maximum NR compared to the other treatments. These findings are corroborated by Hopkins, who posited that plants infected with plant growth-promoting rhizobacteria (PGPR) experienced a significant increase in root area[35]. The noted enhancement in the root region of plants subjected to SA and put treatments can be attributed to the modulation of the activating phytohormones, specifically IAA and cytokinin, by SA and put. An additional inquiry, undertaken by García-Fortea *et al.*[36], lends further substantiation to our observations. They indicated that in terms of root parameters, the sensitive variety exhibited a greater responsiveness to both PGPR and PGR[36]. This is due to the inclination of PGPR to produce IAA, which is well-known for its beneficial effects on root parameters, thereby enhancing root development.

3.8 Field life of flower (FLF)

The duration of the flower's existence in the field for the *Phlox* plant is influenced by various substances and compounds, as demonstrated in **Figure 3(A)**. These substances and compounds, known as media and PGRs, play significant roles in the overall growth and progress of the plant. The research findings revealed that different types of media and a range of PGRs had a notable impact on the field life of the *Phlox* plant's flowers. The highest recorded FLF (2.4) was observed when using PGR 1 in the control treatment, followed by PGR 2 (2.2). Among all the treatments conducted without any growth regulator, T2 exhibited the most favorable outcomes. Under the influence of growth regulator P2, T3, T4, and T5 displayed the following durations of FLF: 2.05, 2, and 1.95, respectively, in comparison to the control treatment's durations of 1.6, 1.5, and 1.58, respectively. Interestingly, T4 showcased a shorter FLF when subjected to the control growth regulator. The results indicate that T5, which contained the highest levels of nutrients and possessed the maximum water-holding capacity, yielded superior results when compared to the other treatments. The aforementioned observations have been validated by Xue *et al.*[37], who assert that the prolonged existence of flowers in ornamental plants can be attributed to the preservation of chlorophyll, protein, and RNA content, which is facilitated by elevated levels of composite substances present in the plant soil[37]. These heightened levels persist for extended durations, thereby suppressing the process of senescence. Additionally, Farinas *et al*.[38] have provided further support for the variation in shelf life observed among different cultivars[38].

3.9 Stem diameter (SD)

The SD of the *Phlox* plant is subject to modification based on the utilization of different media and PGRs, as visually represented in **Figure 3(B)**. These media and growth regulators hold significant roles in facilitating the overall growth and development of the plant. The research findings highlight that diverse media and a range of PGRs exert a substantial impact on the *Phlox* plant. Notably, the PGR 1, employed in the control treatment, resulted in the maximum SD of 9.8 mm, followed by PGR 2 with a diameter of 8.9 mm. Under the influence of PGR 1, T5 exhibited a smaller SD in comparison to all other treatments. Conversely, when subjected to PGR 2, T2, T3, T4, and T5 displayed SD values of 6.6, 8.9, 7.6, and 5.6, respectively. Notably, T5 showcased the minimum SD when exposed to the control growth regulator. The results indicate that T5, which contained the highest levels of nutrients and possessed the maximum water-holding capacity, yielded superior outcomes when compared to the other treatments. The findings presented here receive further corroboration from the research conducted by Weng *et al*.[39], who assert that the use of distilled water as a growth medium, as well as the application of GA3, led to a significant increase in SD when compared to seedlings[39]. Another study, conducted by Farinas[40], supports our own observations, indicating that while PGRs have a notable impact on stem diameter, the composition of the soil does not have a substantial effect on the SD of ornamental plants[40].

3.10 Diameter of flower (DF)

The DF of the *Phlox* plant undergoes alterations based on the implementation of various media and PGRs, as visually depicted in **Figure 3(C)**. Media and PGRs hold pivotal roles in facilitating the overall growth and development of the plant. The research findings indicate that the different media and diverse PGRs exert a notable influence on the DF of the *Phlox* plant. Notably, the PGR 1, utilized in the control treatment, resulted in the maximum DF of 2.2 mm, followed by PGR 2 with a diameter of 2.06 mm. Among all the treatments administered under PGR 1, T5 exhibited the smallest diameter in comparison to the other treatments. Conversely, when subjected to PGR 2, T2, T3, T4, and T5 displayed DF values of 2.02, 1.99, 1.96, and 1.92, respectively. Notably, T5 showcased the minimum DF when exposed to the PGRs. The results indicate that T5, which possessed the highest levels of nutrients and maximum water-holding capacity, yielded superior outcomes when compared to the other treatments.

The findings presented here receive additional validation from the research conducted by Matiska and Vejsadová[41], who propose that the augmentation in DF can be attributed to the balanced application of fertilizers, leading to enhanced carbohydrate absorption and robust vegetative growth. This increase in floral size is stimulated by an intensified attraction of photosynthesis towards the flower, facilitated by heightened sink activity[41]. Another study, supporting our own observations, suggests that the enlargement of flower diameter could potentially be attributed to an increase in leaf area and leaf count, which in turn promotes greater photosynthesis[42].

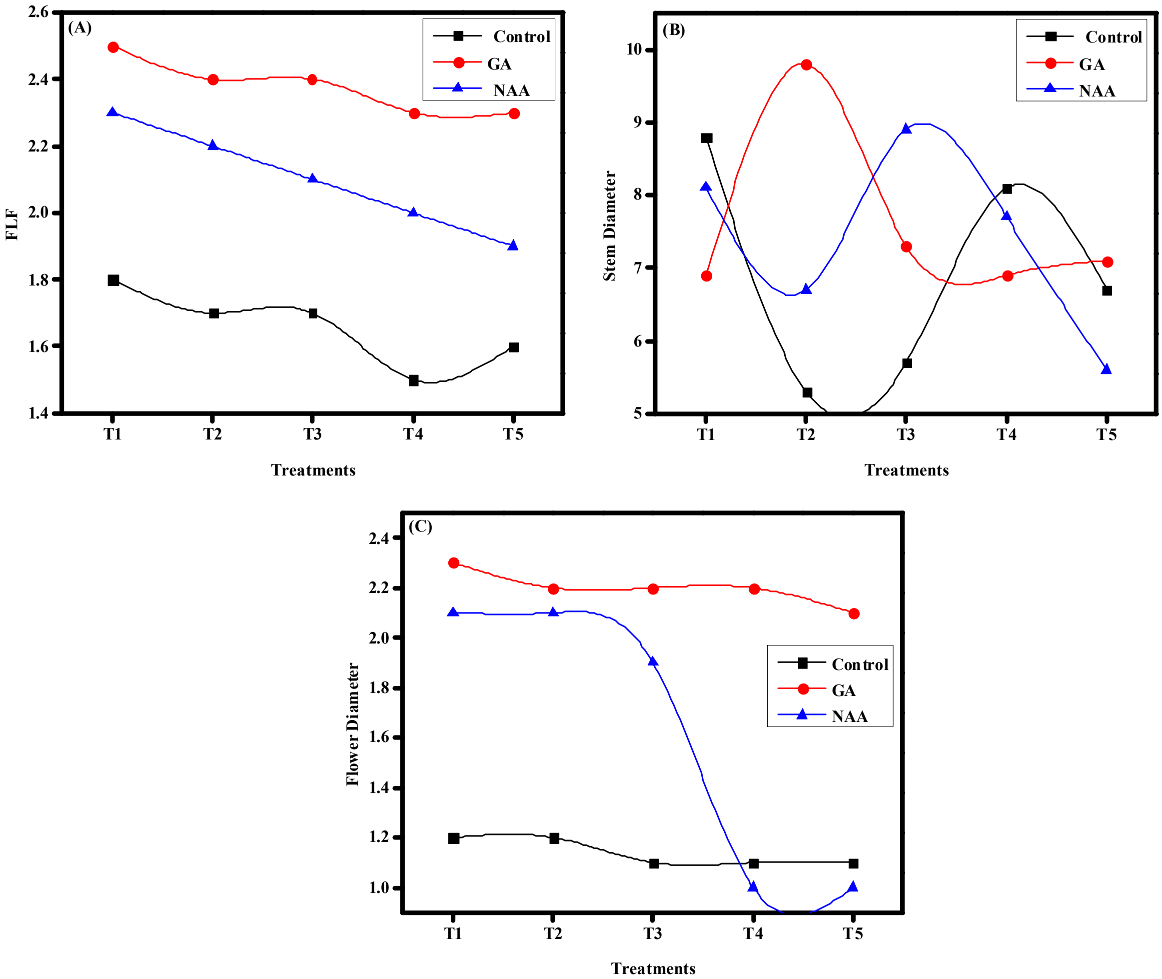

Figure 3. Reaction of **(A)** FLF, **(B)** SD and **(C)** FD towards GA, NAA and different treatments.

4. Conclusion

In conclusion, the experiment aimed to evaluate the performance and identify the most suitable growth media for *Phlox* plants. Five different growth media were utilized as treatments, and the following results were obtained. The maximum PH, reaching 16 cm, was observed when employing PGR 1 in the control treatment. Similarly, the highest value for DBI of 16.6 cm was achieved under PGR 1 in T4. Remarkable outcomes were attained for the duration of FFE, with a maximum value of 17.6 cm observed under PGR 1 in T4. The highest number of FPP, standing at 15.6 cm, was obtained when utilizing PGR 1 in T2. Notably, PGR 1 in T5 demonstrated exceptional results in terms of the number of BPP, with the maximum value of 8.3 cm. As for the number of LPP, PGR 1 in T1 achieved an impressive height of 14 cm. The maximum NR, reaching 23, was attained under PGR 2 in T5. Furthermore, PGR 2 in T1 showcased greater efficacy in extending the FLF. The SD experienced the highest value of 9.8 mm when utilizing PGR 1 in T2. Lastly, the DF reached its peak at 2.2 mm under PGR 1 in T1.

These findings provide valuable insights into the performance and suitability of different growth media and growth regulators for *Phlox* plants, enabling better cultivation practices and achieving desired outcomes in terms of plant height, bud initiation, flower emergence, floral characteristics, and root development.

Conflict of interest

The authors declare no conflict of interest.

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