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Effect of Gibberellic Acid and Potassium on Phenotypic and Floral Characteristics of Star Anise (Pimpinella anisum L.)

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Abstract

This subject study become carried out at the Botanical Garden of the Department of Life Sciences, College of Basic Education, Al-Mustansiriya University, throughout the winter developing season of 2024-2025. The goal changed into to explore how varying concentrations of the increase regulator gibberellic acid (GA) and potassium fertilizer, as well as their interaction, impact the phenotypic and floral characteristics of celebrity anise (Pimpinella anisum (L.). Anise seeds had been planted on November 1, 2024, with potassium tiers set at 0, 100, and 200 kilograms according to hectare ($kg \cdot ha^{-1}$) introduced to the soil. Additionally, flowers had been handled with gibberellic acid at concentrations of 0, 50, and 100 mg/L^{-1}. The look at became designed the usage of a randomized complete block design, offering three replicates and a factorial format (3x3x3) that blanketed 27 experimental units, every measuring 1 x 1 square meter. Throughout the examine, ordinary monitoring changed into performed to carry out crucial soil and crop management duties along with irrigation, weed control, and fertilization. Spraying gibberellin at a attention of 50 mg/L^{-1} led to fantastic increases: the quantity of branches rose with the aid of 32.99%, dry weight accelerated with the aid of 46.04%, and the quantity of fundamental inflorescences in line with plant grew with the aid of 30.69%, compared to the manage remedy. When 100 kg/ha^{-1} of potassium was applied, the results showed an increase in branches by 22.58%, dry weight by 26.52%, the number of main inflorescences by 12.46%, and flowers per main inflorescence by 11.00%, again in comparison to the control treatment. Furthermore, the combination of gibberellic acid and potassium had a substantial impact on several traits. Specifically, the interaction between a concentration of 50 mg/L^{-1} of gibberellic acid and 200 kg/ha^{-1} of potassium resulted in remarkable improvements: plant height increased by 58.01%, the number of branches surged by 65.74, and dry weight jumped by 84.42%, all in contrast to the control treatment.

Keywords: Anise, potassium, gibberellin, inflorescences, growth regulators, plant hormones.

INTRODUCTION

Anis (Pimpinela Anisam L.) is a medic plant that belongs to the Ambelifare family. These herbaceous plants are breeding by seeds and are known for its fruit, rich in essential oils and proteins. The oil contained in the rectum from the anis has a unique taste and aroma. Its properties promote digestion, eliminate muscle cramps, and help relieve gas. (1). Anis is significant in the production of essential oils and contains various medical active compounds that have entered the therapeutic pharmaceutical industry. Among its benefits, some combinations show antibacterial and anti-tumor effects, in which powerful anal nalgasic anthol is a major component, making about 80% essential oils (2).

Potassium plays a crucial role in mineral nutrition, as it is the third essential macronutrient required for the development of healthy plants. This positive ion dominates other positive ions in importance (3). Potassium is important to help cope with environmental stress, such as drought and salinity. It actively participates in numerous processes, including photosynthesis, nutrient transport and OX Xidation, photosynthesis products from leaves to storage organs and M smootic potential maintenance. Instead of forming complex organic molecules, potassium mainly acts as an enzyme activator (4). Its presence is necessary to improve yield, increase quality and promote plant elasticity into drought (5).

Plant increase regulators notably have an effect on increase styles, tissue specialization, and the redistribution of dry be counted in the plant, all of that are vital for healthy development. One essential growth regulator is gibberellic acid (GA3), known for its potential to enhance increase by using selling cell department and

enlargement. It effectively enlarges the meristematic area and helps cell wall boom (6). GA3 also has some distance-achieving consequences in the course of numerous boom degrees, influencing physiological techniques or phenomena like stimulating seed germination, encouraging stem elongation thru multiplied mobile boom, selling flowering in lengthy-day vegetation, breaking dormancy in buds, generating seedless end result, defining floral sex, enhancing fruit set, and managing the getting older of leaves and fruits (7)

MATERIALS AND METHODS

A field experiment was conducted at the Botanical Garden of the Department of Science of Life / Faculty of Basic Education / Al-Mustansiriya University during the 2024-2025 growth station. The experiment included the study of the effect of interaction between gibberelic acid and potassium in some phenotypic and floral characteristics in anise plants. The experiment contained (27) experimental units, each with an area of (1x1) square meters. Anis seeds were planted on November 1, 2024. The experiment used a full randomized block project (R.C.B.D.) with three repetitions (3x3x3) and a factorial experiment agreement. The experiment included the following:-

Three degrees of potassium (0, 100, and 200) kg.Ha^{-1}. The amount of fertilizer for each degree was weighed based at the location of every experimental unit and in keeping with the treatments inside the test. It become brought subsequent to the plant within the form of potassium sulfate fertilizer (K2SO4), in addition to the 0 stage as a control treatment.

- Three concentrations of gibberellic acid (0, 50, and 100) mg/L^{-1} have been organized according to the Stock dilution law. Samples have been taken from the sphere soil before planting to measure some physical and chemical properties of the soil Table (1)

Table (1): Some chemical and physical properties of soil

Trait	Value	Unit
Sand	95	g Kg^{-1} Soil
Loam	748	
Clay	158	
Ec 1:1	1.6	ds m^{-1}
pH	7.5	~~~
O.M	5.2	g Kg^{-1} Soil
Total $CaCO_3$	223.0	g Kg^{-1} Soil
Ca	6.5	Meq L^{-1}
K	0.5	
Mg	6.3	
Na	2.1	
Cl	5.4	
HCO_3	8.1	
CO_3	Nill	
SO_4	2.5	
Available N	40.0	g Kg^{-1} Soil
Available P	12.6	
Available K	114.8	

Random samples were collected from each experimental unit to investigate several key characteristics:

1. Plant Height (cm)

Plant height was measured at the attainment of the vegetative development stage. Measurements were obtained from the junction of the stem and roots to the apex of the stem, use a graduated ruler..

2. Number of Branches (branch.plant^{-1})

The mean number of branches per plant was calculated by choosing five randomly chosen plants from each experimental unit..

3. Dry Weight of the Vegetative System (g)

To measure the dry weight of the vegetative system, plant samples were dried after the roots were removed. The samples were placed in an electric oven at a temperature between 60 and 70°C until they reached a constant weight. The final weights were recorded using a sensitive balance.

4. Number of Main Inflorescences per Plant (Main Inflorescence.plant^{-1})

During the flowering level, the variety of major inflorescences become calculated by using selecting five random flora from each experimental unit. The inflorescences on each plant have been counted, and the average remember in line with plant was then computed.

5. Number of Flowers per Main Inflorescence (flower.plant^{-1})

To determine the variety of plant life according to principal inflorescence, five random vegetation have been again taken from each experimental unit for the duration of complete flowering. The plants on 5 principal inflorescences in step with plant had been counted, and from this, the average wide variety of flora consistent with inflorescence turned into calculated.

The facts had been statistically analyzed, and the least vast distinction (LSD) check become used to examine among concentrations at a 0.05 probability stage. (8)

RESULTS AND DISCUSSION

Plant Height (cm)

The facts supplied in Table 2 imply a terrific growth in plant peak while treated with gibberellin and potassium. Specifically, treating flowers with gibberellin by myself at concentrations of 50 and 100 mg/L^{-1} resulted in height will increase of 6.19% and 12.37%, respectively, in comparison to the control remedy.

The more advantageous growth of anise vegetation sprayed with gibberellin can be attributed to the compound's function in promoting cellular division. Gibberellin efficaciously enlarges the meristematic areas and boosts the quantity of cells present process division. Moreover, gibberellin promotes the elongation of younger stems, impacting young tissues and boom facilities. It additionally works in tandem with auxin, as gibberellin increases the internal tiers of this hormone with the aid of either stimulating its synthesis or hindering its oxidation.

Additionally, the table highlights a massive upward thrust in plant height with growing potassium levels, in particular at prices of 100 to 200 kg/ha^{-1}. The highest awareness of 200 kg/ha^{-1} ended in an outstanding plant peak of 91.28 cm, in comparison to simply 64.78 cm in the control treatment, marking a vast growth of 40.90%.

This increase in plant peak related to potassium fertilizer is likely due to the detail's organic efficacy in stimulating cellular division and elongation. This tremendous effect on carbon metabolism and the transport of crucial nutrients to active meristematic regions additionally plays a critical role. Furthermore, potassium aids in developing mechanical systems along with vascular bundles and fiber structures, improving stem stability and the plant's typical resilience in opposition to bending or falling, in the long run contributing to expanded peak.

The interaction between potassium degrees and gibberellic acid concentrations turned into specially impactful, with the mixture of 200 kg/ha^{-1} of potassium and 50 mg/L^{-1} of gibberellic acid yielding the

maximum tremendous peak boom. This mixture reached a exceptional height of 93.34 cm, outperforming all different interactions.

Table (2) Effect of potassium, gibberellic acid, and their interaction on plant height (cm)

Gibberellic acid concentrations (mg/L-1)	Potassium levels (kg/h-1)			Mean
	0	100	200	
0	59.07	75.15	87.92	74.05
50	63.12	79.48	93.34	78.64
100	72.15	84.89	92.59	83.21
Mean	64.78	79.84	91.28	
Lsd 0.05	Gibberellic acid concentrations= 1.66			
	Potassium level = 1.66			
	Interaction= 2.87			

Number of branches per plant

The results in Table (3) show that the effect was significant at a probability of 0.05. Plants treated with 50 mg/l^{-1} of GA showed the highest percentage of the trait on average, reaching 29.75 branches/plant^{-1}, which is equivalent to an increase of 32.99% compared to the control.

The dominance of plants sprayed with 50 mg/l^{-1} may be due to the fact that spraying with lower concentrations of GA reduces but does not eliminate apical dominance (15). This is because the stunting of main stem growth means that nutrients that support the formation and growth of lateral branches are no longer available.

The results also showed that there were significant differences in the average number of branches per plant^{-1} under the influence of potassium addition. The value of 100 kg/ha^{-1} significantly exceeded the other potassium values and resulted in the highest average value of the trait, 28.71 branches per plant, an increase of 22.58% over the control-treated plants, which had the lowest average value of 19.09 branches per plant..

Table (3) Effect of potassium, gibberellic acid, and their interaction on the number of branches per plant of anise (branch.plant-1)

Gibberellic acid concentrations (mg/L-1)	Potassium levels (kg/h-1)			Mean
	0	100	200	
0	19.09	25.46	22.55	22.37
50	27.70	29.90	31.64	29.75
100	23.47	30.75	26.86	27.03
Mean	23.42	28.71	27.02	
Lsd 0.05	Gibberellic acid concentrations= 1.58			
	Potassium level = 1.58			
	Interaction= 2.74			

The stronger overall performance of anise vegetation fertilized at the 100 kg/ha^{-1} level may be linked to the direct impact of potassium on activating enzymes that trigger various physiological approaches within the plant. This includes important features which include carbon metabolism, respiration, and the metabolism of carbohydrates and proteins. Additionally, potassium performs a crucial role in regulating the movement and effectiveness of plant hormones, which are essential for cellular department, elongation, and growth. Consequently, these biological activities substantially promote the vegetative boom of the vegetation (16)(17).

The interaction among potassium dosage and gibberellic acid concentration turned into extensively impactful, with the combination of 200 kg/ha^{-1} of potassium and 50 mg/L^{-1} of gibberellic acid resulting within the maximum wide variety of branches, attaining an impressive 31.64 branches in line with plant.

Regarding dry weight (g/plant), the results in Table (4) indicated a extensive impact. Applying growing concentrations of gibberellic acid yielded a marked increase inside the dry weight of the vegetative device. Specifically, the 50 mg/L^{-1} awareness produced the very best common, achieving 7.01 g/plant^{-1}, which represents a amazing boom of 46.04% in comparison to the manipulate remedy.

This boom may be attributed to gibberellin's position in promoting cellular division and elongation, in addition to stimulating cellular increase and expansion by means of enhancing cellular wall flexibility. Research suggests that gibberellin interacts with auxin, boosting its levels with the aid of slowing down its decomposition charge. Furthermore, gibberellin has been shown to reduce the hobby of the enzyme's peroxidase and IAA oxidase, while encouraging the production of RNA, specially m-RNA. The common upward thrust within the dry weight of the vegetative gadget is a mirrored image of gibberellin's contribution to improving the vegetative increase, specially increasing leaf place, which in flip boosts photosynthesis (18).

Moreover, the addition of potassium at diverse tiers additionally led to a considerable increase inside the dry weight of the vegetation as compared to the manage. The 100 kg/ha^{-1} potassium degree finished the highest common dry weight at 6.63 g, representing a 26.52% boom over the manage remedy, which recorded the lowest common of 5.24 g.

The increase in the dry weight of the plant can be attributed to potassium's essential role in activating enzymes which can be vital for the synthesis of carbohydrates and proteins. Additionally, potassium contributes to improving the fresh weight of the roots by using selling their period, size, and power, which ultimately leads to an boom in the standard dry weight. This essential nutrient is concerned in severa physiological sports inside the plant, consisting of metabolic techniques, the composition of protoplasm, and the neutralization of essential organic acids. It also encourages the boom of meristematic tissues, resulting in sturdy vegetative and root improvement. This growth, in turn, boosts the plant's performance in soaking up water and vitamins from the soil (19). Furthermore, potassium enhances plant boom and the production of photosynthetic pigments, which considerably will increase the price of photosynthesis. It also promotes mobile division and the boom of meristematic tissues, both of which amplify the plant's increase length and delay the growing older of its organs. Consequently, this ends in a giant upward thrust in the plant's dry weight(20).

Table (4) Effect of potassium, gibberellic acid, and their interaction on the dry weight of anise (g. plant^{-1})

Gibberellic acid concentrations (mg/L-1)	Potassium levels (kg/h-1)			Mean
	0	100	200	
0	4.11	5.38	4.92	4.80
50	6.29	7.15	7.58	7.01
100	5.32	7.37	5.94	6.21
Mean	5.24	6.63	6.14	
Lsd 0.05	Gibberellic acid concentrations= 0.40			
	Potassium level = 0.40			
	Interaction= 0.70			

The interaction between potassium levels and gibberellic acid concentrations had a excellent effect on dry weight. Specifically, making use of 200 kg/ha^{-1} of potassium combined with a 50 mg/L^{-1} attention of gibberellic acid proved to be notably extra effective than other combos. This precise pairing performed the very best dry weight cost, achieving an excellent 7.58 g.

4. Number of Main Inflorescences per Plant (main inflorescence/plant^{-1})

The results provided in Table (5) show that gibberellin concentrations have a enormous effect on the number of inflorescences. The highest average was recorded at 12.39 main inflorescences in line with plant^{-1} at a attention of 50 mg/L^{-1}, reflecting a 30.69% growth in comparison to the manipulate remedy, which yielded the bottom average of 9.48 major inflorescences in line with plant^{-1}.

Additionally, the statistics indicate that potassium tiers additionally performed a essential position in influencing the wide variety of inflorescences. Specifically, a potassium software of 100 kg/ha^{-1} turned into observed to be the most effective, producing a mean of 11.64 fundamental inflorescences in step with plant^{-1}, which interprets to a 12.46% boom.

The discovered rise within the range of inflorescences with gibberellic acid treatment can be attributed to the physiological houses of this acid. It facilitates stimulate the flowering hormone (florigen) and spoil dormancy in flower buds (21). Furthermore, it allows the distribution of nutrients from the vegetative elements to the reproductive ones. When applied at appropriate concentrations, gibberellic acid no longer only boosts the wide variety of inflorescences but also contributes to larger petal size in a system called "gibbing the buds" (22).

On the other hand, the increase in main inflorescence numbers in anise plants that received 100 kg/ha^{-1} of potassium can be linked to the essential role of potassium in stimulating vegetative growth. This nutrient also plays a part in promoting early flowering, enhancing fruit set percentages, and preventing the dropping of inflorescences, all of which positively influence the overall count of inflorescences (14).

It is worth noting that the interaction between potassium levels and gibberellic acid concentrations did not show a significant effect on this trait.

Table (5) Effect of potassium, gibberellic acid, and their interaction on Inflorescences per Plant (main inflorescence/plant^{-1})

Gibberellic acid concentrations (mg/L-1)	Potassium levels (kg/h-1)			Mean
	0	100	200	
0	8.48	10.44	9.52	9.48
50	10.41	11.84	11.19	11.15
100	12.18	12.63	12.36	12.39
Mean	10.35	11.64	11.02	
Lsd 0.05	Gibberellic acid concentrations= 0.73			
	Potassium level = 0.73			
	Interaction= N.S			

5. Number of main inflorescence flowers^{-1}

Table 6 indicates a notable increase in the number of main inflorescence flowers with the rise in gibberellic acid concentration. At a concentration of 100 mg/L^{-1}, the trait peaked at 17.58 main inflorescence flowers^{-1}, reflecting a significant 26.29% increase over the control treatment, which recorded the lowest rate of 13.92 main inflorescence flowers^{-1}.

The formation of flower buds and the subsequent development of complete flowers in the plant hinge on a balanced relationship between gibberellins and anthocyanins. Gibberellins are crucial for forming and elongating the flower stalk, marking the initial stage of flower development, whereas anthocyanins play a vital role in the formation of both essential and non-essential floral organs (23).

The same table illustrated a significant improvement, as applying the 100 kg/ha^{-1} level yielded the highest average for this trait, reaching 17.05 main inflorescence flowers^{-1}. This represented an 11.00% increase compared to the control treatment, which had a lower average of 15.36 main inflorescence flowers^{-1}.

The increase in flower numbers in the anise plant attributed to potassium is due to its role in boosting branch development. Potassium is vital for stimulating vegetative growth, promoting earlier flowering and enhancing fruit set while also preventing flower drop and increasing their overall count (24).

Furthermore, the interaction between potassium levels and gibberellic acid concentrations significantly impacted the number of main inflorescence flowers^{-1}. The combination of 100 kg/ha^{-1} potassium and 100 mg/L^{-1} gibberellic acid showed remarkable superiority over other interactions, achieving the highest measurement for this trait at 18.30 g.

Table (6) Effect of potassium, gibberellic acid, and their interaction on Number of main inflorescence flowers^{-1}

Gibberellic acid concentrations (mg/L-1)	Potassium levels (kg/h-1)			Mean
	0	100	200	
0	12.32	16.26	13.18	13.92
50	16.52	16.59	16.59	16.57
100	17.26	18.30	17.19	17.58
Mean	15.36	17.05	15.65	
Lsd 0.05	Gibberellic acid concentrations= 0.43			
	Potassium level = 0.43			
	Interaction= 0.75			

CONCLUSION

The results showed that spraying gibberellic acid at a concentration of 50 mg L-1 and adding potassium levels at a concentration of 100 kg L-1 improvement the morphological and floral characteristics of anise plants Also,the increasing of sprayed gibberellic acid concentrations along with the added potassium concentrations had a positive effect on most of the studied traits.

REFERENCES

(1) Talas, Mustafa (2008). The Most Important Medicinal Plant. Talas House for Studies, Translation and Publishing, Third Edition, Damascus, Syria.

(2) Al-Dajwi, Ali (1996). Encyclopedia of Medicinal and Aromatic Plants. Book One. Madbouly Press, Egypt.

(3) Havlin, J. L., J. D. Beaton, S. L. Tisdale and W. L. Nelson.(2005). Fertility and fertilizers "An Introduction to Nutrient Management". 7th Edn. Prentice Hall. New Jersey, USA. pp. 515.

(4) Amara, Mashreq Naeem.(2004). The effect of the level and method of adding potassium fertilizer on the growth and productivity of tomato crop grown in heated plastic greenhouses. Master's thesis. College of Agriculture. University of Baghdad.

(5) Amtmann , A. , S. Troufflard , P. Armengand . (2008). the effect of potassium nutrition on pest and disease resistance in plants . physiol plant , 133 : 682 – 691 .

(6) Al-Dessouki, Hashmat Suleiman Ahmed (2008). Fundamentals of Plant Physiology. Gezira Al-Ward Library, Mansoura, Egypt.

(7) Saleh, Maha Ibrahim (2009). Effect of planting date and spraying with gibberellic acid and phosphorus on growth and oil yield of Cheiranthus cheiri. Master's thesis, College of Agriculture, University of Baghdad, Iraq.

(8) Steel, R. G. and Torrie, Y. H. (1960). Principles and Procedures of Statistics. McGrow - Hill Book Co., Inc. New York. pp. 480.

(9) Attia, Hatem Jabbar and Khadir Abbas Jadoua. (1999). Plant Growth Regulators Theory and Application. Directorate of Dar Al-Kutub for Printing and Publishing. Ministry of Higher Education and Scientific Research. Iraq.

(10) Yassin, Bassam Taha (2001). Fundamentals of Plant Physiology. College of Science, Qatar University, Dar Al Sharq Press.

(11) Kewalan-singh, J. N. and Pandey, C. S. (1998). Effect of plant growth regulators on growth herbage and oil yield of Japanese mint (Mentha arenses) and its economic there from. J. Med. Aromatic plant. Sci., 20 (3): 725.

(12) Internal, potash institute (IPI). (1999). Quality Aspects of K Nutrition in Horticulture crops. Basel. Switzerland.

(13) Adai, Sadiq Kazim Taban (2002). The effect of adding foliar and soil potassium fertilization on the growth and yield of wheat Triticum aestivum L. Master's Thesis, College of Agriculture, University of Baghdad, Iraq.

(14) Sheikh, Fouad Abdel Aziz Ahmed (2008). Fertilizers and Plant, Animal and Human Health. University Publishing House. Cairo, Egypt.

(15) Abdul, Karim Saleh (1991). Advanced Plant Physiology. Part One. Ministry of Higher Education and Scientific Research, University of Salah Al-Din. Iraq.

(16) Munns, R. and R.A. Richards. (2007). Recent advances in breeding wheat for drought and salt stresses, In M.A.Jenks ; P.M.Hasegawa and S.M.Jain.2007. Advances in Molecular Breeding Toward Drought and Salt Tolerant Crops , Springer, Dordrecht, the Netherlands , P.565586.

(17) Al-Saeedi, Iman Saheb (2007). Evaluation of the status and behavior of potassium added from two fertilizer sources under different irrigation systems on the growth and yield of tomato and yellow corn. PhD thesis. Department of Soil. College of Agriculture - University of Baghdad, Iraq.

(18) Mukherji, S and Ghosh , A.K. (1996). Plant Physiology.New Central Book Agency LTD. India.

(19) Imran, Mohamed El-Sayed (2005). Soil Fertility and Plant Nutrition. Arab House for Publishing and Distribution. Faculty of Agriculture/Menoufia University, Egypt.

(20) Borowski,E. ;S.Michalek. (2009). The Effect of foliar Potassium salts and Urea in spinach on gas Exchange,Leaf yield and quality. Department of Plant Physiology, University of Life Sciences in Lublin.62(1):155-162.

(21) Abu Zaid, Shahat Nasr (2000a). Plant Hormones and Agricultural Applications. National Research Center, Arab House for Publishing and Distribution, Cairo, Egypt.

(22) Moore , R. ; W.D. Clark and Vodapich , D.S. (1998). Botany the McGram – Hill compaics. USA, 2nd edition.

(23) Abu Zaid, Al-Shahat Nasr (2000b). Medicinal Plants and Herbs. Second Edition. Arab House for Publishing and Distribution. National Research Center. Cairo, Egypt.

(24) Abbas, Jamal Ahmed (2009). The effect of phosphate and potassium fertilizers on vegetative and floral growth and seed yield of Calendula officinalis L. Iraqi Journal of Agriculture 14 (2): 122-129.