Online ISSN: 2588-3526

Journal of Wildlife and Biodiversity

Volume 7 (Special Issue): 291-299 (2023) (http://www.wildlife-biodiversity.com/)

Research Article

Impact of foliar spraying with Nanophosphorus on some vegetative growth characteristics and production of five genotypes of colored Cauliflower

A.M. AL-Shammari1[1,*], S.K. AL-Khalidi[2]

[1]Department of Horticulture and Landscaping, College of Agriculture, University of Diyala, Diyala, Iraq.
[2] Department of Horticulture and Landscaping, College of Agriculture, University of Diyala, Diyala, Iraq
[*]Email: azizmabd@uodiyala.edu.iq

Received: 18 August 2023 / Revised: 29 October 2023 / Accepted: 05 November 2023/ Published online: 28 November 2023.

How to cite: Al-Shammari, A.M., Al-Khalidi, S.K. (2023). Impact of foliar spraying with Nanophosphorus on some vegetative growth characteristics and production of five genotypes of colored Cauliflower, Journal of Wildlife and Biodiversity, 7 (Special Issue), 291-299. **DOI**: https://doi.org/10.5281/zenodo.10213114

Abstract

Fieldwork was conducted at the College of Agriculture, University of Diyala in the 2022-2023 agricultural season. We aimed to study the impact of foliar spraying with Nano and regular phosphorus fertilizer on the growth and production of colored Cauliflower. The study included two factors, the first factor was hybrids, namely Garno, Di Sicilia Violetto, Verde Di Macerata, Megha, and Fujiyama, and the second factor included 4 levels, namely: Control, spraying regular phosphorus fertilizer P2O5 at a 5 gram per Litter, and spraying with nanophosphorus (17% phosphorus). At a by an amount of 1gram per Litter, spraying with nanophosphorus (17% phosphorus) at a By an amount of 2gram per Litter. The experiment was carried out within a randomized complete block design (RCBD) with a S.P. system with three replications and included 60 experimental units, with an area of 2.5 m^2. The productions can be summarized as follows: All genotype parameters significantly affected the characteristics of vegetative growth and production. For the Verde Di Macerata genotype was superior in giving the best productions for the percentage of nitrogen in the leaves (4.311%) and phosphorus in the leaves (0.5%). The plant production was 9.228 $Kg.m^2$, while Megha was superior in the percentage of potassium in the leaves (4.407%), and Garno recorded the best production for the diameter of the pink disc (23.62 cm $disc^{-1}$). All foliar spraying treatments with Nano- and regular phosphorus had a significant impact on vegetative growth characteristics and production, as foliar spraying at an amount of 2gram per Litter was superior in giving them the best percentage of nitrogen in the leaves (4.542%),

phosphorus in the leaves (0.467%), and potassium in the leaves was 4.320 %, the diameter of the flower disk was 23.03 cm disk $^{-1}$, and the total plant production was 8.103 kg m^{-2}.
Keywords: Colored Cauliflower, The hybrids, Nanophosphorus

Introduction

Cauliflower belongs to *Brassica oleracea* var. botrytis, it is widely grown all over the world and is a good source of antioxidants because it contains phenolic and flavonoids (Zeb et al., 2022), It contains a wide range of biologically active compounds such as vitamins, polyphenols, glucosinolates, and anti-toxins (Koss-Mikołajczyk et al., 2019) When a substance is less than 100 nanometers in size, it appears to have new properties that are different from its known properties and in its natural molecular form (Ruttkay-Nedecky et al., 2017). The use of Nano fertilizers in plant nutrition is one of its main applications in sustainable agriculture and has many beneficial impacts on plant systems and soil. Such as providing plants with nutrients, increasing nutrient economy, and achieving higher crop productivity (Awad-Allah, 2023). Phosphorus plays prominent roles in enhancing storage functions in plants and building the plant structure, especially in the cell wall and ADP and ATP compounds, in addition to being involved in the synthesis of nucleic acids. Soil is a source of phosphorus for plants, and the amount of phosphorus in the soil and its pH are the two main factors that regulate the solubility and availability of phosphorus to plants (Aimen et al., 2022), Given the importance of introducing new genetic combinations to determine their suitability to Iraq's environmental conditions and to demonstrate the success rate of those combinations and the importance of Nano fertilizers and phosphorus for the plant. This study aimed to determine the distinct genetic composition of coloured Cauliflower crops and the best amount of phosphorus to obtain the best quantity and quality of the crop.

Materials and methods of work

The work was in the College of Agriculture, University of Diyala, during the 2022-2023 agricultural season to study the impact of foliar spraying with Nano and regular phosphorus on the growth and production of coloured Cauliflower. The study included five hybrids namely

- The yellow Garno hybrid from Vaniya Seed, of German origin, is symbolized as V1 in the study.
- Hybrid Di Sicilia Violetto, purple in colour, Italian company Omaxe, symbolized by the study V_2.
- The Verde Di Macerata hybrid is green in colour, Italian made by Omaxe, and is designated by the designation V_3.

- The Megha hybrid is white, manufactured by Seminis, of German origin, and is designated V_4.
- The Fujiyama hybrid is white from the Japanese company Tokita and is designated by the designation V_5.

While foliar spraying with Nano and regular phosphorus included four levels:

- The comparison treatment without fertilization, And his symbol F_0, Fertilization by regular phosphorus P_2O_5 at a By an amount of 5gram per Litter (Muhammad et al., 2013) symbolized in the study as F_1., Spraying with the first level of Nano-phosphorus at a By an amount of 1gram per Litter (less than the recommendation). The Green Company is of Iranian origin and is symbolized by the study F_2.
- Spraying with the second level of Nano phosphorus at a by an amount of 2 grams per Litter (according to the recommendation). The Green Company is of Iranian origin and is designated by the study F_3.
- Data were taken from five plants randomly from each experimental unit and the following traits were studied:

Estimation of nitrogen in leaves (%)

200 mg of dry weight and grinding of the leaves were taken and digestion was carried out using sulfuric and perchloric acid according to the method of (Cresser & Parsons, 1979), and then nitrogen was determined using a microcalcium oxide device according to the method of (S. Haynes et al., 1980).

Estimating the percentage of phosphorus in leaves (%)

The percentage of phosphorus in leaves digested with ammonium molybdate and ascorbic acid was estimated using a spectrophotometer at a wavelength of 662 nm (Olsen & Sommers, 1965).

Estimating the percentage of potassium in the leaves (%)

Potassium in the leaves was estimated by taking 200 mg dry and ground weight, and the digestion process was carried out using perchloric and sulfuric acid, then measured with a flame photometer according to the method (R. J. Haynes, 1980).

Diameter of the curd (cm)

The diameters of five heads were measured for each experimental unit taken at random, by placing the head horizontally between two wooden boards, measuring the distance with a tape measure, and then taking the mean.

Plant production per square meter (Kg m^{-2})

According to the following equation

Plant production per square meter (kg m^{-2}) = mean weight of flower disc x number of plants per square meter.

Statistical analysis

The data were analyzed using the statistical program SPSS according to the design used, and the means were compared with the Duncan multinomial test at the probability level of 0.05 (Al-Sahooki & Wahib, 1990).

Percentage of nitrogen in leaves (%)

The data obtained indicate that Table 1 showed that there was a significant impact of hybrids on the percentage of nitrogen in the leaves, as V3 plants had the highest percentage, amounting to 4.311%. In contrast, the lowest values were for V4 and V5, reaching 2.742 and 2.99%, respectively. The Table also showed a significant impact of the different Nanophosphor, as F3 plants gave the highest percentage of nitrogen in the leaves, amounting to 4.542%, while non-fertilized plants recorded the lowest value, amounting to 2.575%.

Table 1. Impact of genotype and foliar spraying with Nano and regular phosphorus on the percentage of nitrogen in the leaves (%) of five hybrids of coloured cauliflower

Phosphorus levels	Cauliflower hybrids					Means of spraying with phosphorus
	Garno (V_1)	Di Sicilia Violetti (V_2)	Verde Di Macerata (V_3)	Megha (V_4)	Fujiyama (V_5)	
F0	2.860 fg	2.390 gh	3.356 ef	1.920 h	2.350 gh	2.575 D
F1	3.800 de	2.850 fg	3.950 de	2.450 gh	2.730 fg	3.156 C
F2	4.240 bcd	3.900 de	4.690 abc	2.810 fg	2.830 fg	3.694 B
F3	4.730 abc	4.890 ab	5.250 a	3.790 de	4.050 cde	4.542 A
Hybrid Mean	3.907 B	3.507 C	4.311 A	2.742 D	2.990 D	

Percentage of phosphorus in leaves (%)

The data obtained indicate that of Table 2 showed that there was a significant impact of the hybrids on the percentage of phosphorus in the leaves, as V3 plants excelled with the highest value amounting to 0.500%, while this percentage decreased at V5 to 0.311%. The data of the same

Table indicated that there were significant impacts for the levels of Nano and regular phosphorus in the trait, F3 plants showed the highest results, 0.344% compared to F0 plants.

Table 2. Impact of genotype and foliar spraying with Nano and regular phosphorus on the percentage of phosphorus in the leaves (%) of five hybrids of coloured cauliflower

Phosphorus levels	Cauliflower hybrids					Means of spraying with phosphorus
	Garno (V1)	Di Sicilia Violetti (V2)	Verde Di Macerata (V3)	Megha (V4)	Fujiyama (V5)	
F0	0.358 d-g	0.356 d-h	0.420 cde	0.311 gh	0.275 h	0.344 D
F1	0.385 c-g	0.380 c-g	0.454 bc	0.346 e-h	0.305 gh	0.374 C
F2	0.455 bc	0.410 c-f	0.512 b	0.375 c-g	0.329 fgh	0.416 B
F3	0.502 b	0.437 bcd	0.615 a	0.445 bc	0.337 fgh	0.467 A
Hybrid Mean	0.425 B	0.395 BC	0.500 A	0.369 C	0.311 D	

Percentage of potassium in leaves (%)

The productions of Table 3 conveyed that there were significant impacts of Genetic structures of potassium in the leaves, for V4 plants had the highest percentage, amounting to 4.407%, while V5 recorded the lowest percentage, reaching 3.127%. The Table also showed that there was a significant impact for the different levels of phosphorus in the trait, as F3 plants gave the highest results of potassium of leaves, but reached 4.320%, whereas this value decreased in non-fertilized plants to 3.096%.

Table 3. Impact of genetic composition and foliar spraying with Nano and regular phosphorus on the percentage of potassium in the leaves (%) of five coloured cauliflower hybrids

Phosphorus levels	Cauliflower hybrids					Means of spraying with phosphorus
	Garno (V1)	Di Sicilia Violetti (V2)	Verde Di Macerata (V3)	Megha (V4)	Fujiyama (V5)	
F0	2.280 f	3.580 b-e	3.640 b-e	3.380 c-f	2.600 ef	3.096 C
F1	3.850 b-e	3.850 b-e	3.880 bcd	3.990 bcd	2.930 def	3.700 B
F2	4.100 bcd	4.140 bcd	4.250 bc	4.680 ab	3.240 c-f	4.082 AB
F3	4.350	3.183	4.750	5.580	3.740	4.320

	bc	c-f	ab	a	b-e	A
Hybrid Mean	3.645 BC	3.688 BC	4.130 AB	4.407 A	3.127 C	

Diameter of pink disc (cm^{-1} disc)

The productions displayed in Table 4 showed that there were significant impacts of cauliflower hybrids on the diameter of the flower disk. For V1 gave the highest value, reaching 26.67 cm disk^{-1}, whereas it decreased in V5 plants to 17.39 cm disk^{-1}. The Table also indicated the impact of Transactions of Nano and regular phosphorus in the trait, as F3 plants gave the largest disc diameter value of 23.03 cm disc^{-1}, while it decreased to 17.02 cm disc^{-1} in non-fertilized plants.

Table 4. Impact of genotype and foliar spraying with Nano and regular phosphorus on the diameter of the flower disc of five hybrids of coloured cauliflower

Phosphorus levels	Cauliflower hybrids					Means of spraying with phosphorus
	Garno (V1)	Di Sicilia Violetti (V2)	Verde Di Macerata (V3)	Megha (V4)	Fujiyama (V5)	
F0	20.40 c-f	16.26 gh	18.95 d-g	15.46 gh	14.01 h	17.02 D
F1	22.89 bc	18.60 efg	20.70 c-f	17.94 fg	16.26 gh	19.28 C
F2	24.53 ab	20.35 c-f	22.15 b-e	19.95 c-f	18.60 efg	21.11 B
F3	26.67 a	22.56 bcd	23.59 abc	21.65 b-e	20.70 c-f	23.03 A
Hybrid Mean	23.62 A	19.44 C	21.35 B	18.75 CD	17.39 D	

Plant production per square meter (Kg m^{-2})

The productions of Table 5 differences impact of cauliflower hybrids on plant production per square meter, for V3 She gave the results value amounting to 9.228 kg m^{-2}, while V4 had the lowest value (5.311 kg m^{-2}). The Table also indicated a significant impact for the levels of Nano and regular phosphorus on the Adjective. F3 plants recorded the highest value of 8.103 Kg m^{-2}, whereas non-fertilized plants gave the lowest value of 5.694 Kg m^{-2}.

Table 5. Impact of genotype and foliar spraying with Nano and regular phosphorus on Production (Kg m^{-2}) for five coloured cauliflower hybrids.

	Cauliflower hybrids	

Phosphorus levels	Garno (V_1)	Di Sicilia Violetti (V_2)	Verde Di Macerata (V_3)	Megha (V_4)	Fujiyama (V_5)	Means of spraying with phosphorus
F0	6.315 d-i	5.782 f-i	7.583 b-f	4.166 i	4.832 hi	5.694 C
F1	7.095 c-h	6.249 e-i	8.890 abc	5.007 ghi	5.566 f-i	6.561 BC
F2	7.982 b-e	7.220 c-g	9.582 ab	5.774 e-i	6.386 d-i	7.390 AB
F3	8.656 bcd	7.636 b-f	10.85 a	6.300 d-i	7.149 c-g	8.103 A
Hybrid Mean	7.490 B	6.670 BC	9.228 A	5.311 D	5.982 CD	

Discussion

The productions in the Tables above show that there is a significant impact of genotypes on the characteristics of vegetative growth, the biochemical characteristics of the leaves, and the production. The Verde Di Macerata variety excelled in giving the best percentage of nitrogen and phosphorus in the leaves and plant production per square meter, while the Megha variety excelled in giving the best percentage of potassium, Fujiyama in the number of leaves, and Grano in the diameter of the curd. This superiority can be attributed to the difference in the genetic compositions of the hybrids because the genetic compositions overlap and are affected by the environment and the genetic factors greatly affect the growth of the hybrid. In addition, there are static genes (silent genes) which are affected by environmental conditions and hence called environmental genes. These genes enable the plant to adapt to unsuitable environmental conditions, such as temperatures falling below the permissible limit or soil conditions that are not suitable for the growth of this genetic structure and fungal and insect diseases. Their adaptation to these conditions gives a healthy plant with a strong root system capable of absorbing elements. The crisis for growth, and thus the percentage of dry matter and elements in the leaves increases, and these productions are consistent with the findings of (AL-Shammary & ALtamimi, 2016; Al-Zuhairy & AL-Hamdany, 2017). The productions obtained during the experiment show that there is a significant impact of foliar spraying with phosphorus on the characteristics of vegetative growth and the biochemical characteristics of the leaves because spraying with nanophosphorus at By an amount of 2gram per Litter was superior in giving the best productions for the percentage of nitrogen, phosphorus and potassium in the leaves, The number of leaves, the diameter of the flower disk, and the plant's production per square meter.

The reason why nanophosphorus improves these characteristics may be attributed to the role of phosphorus in increasing the number and length of roots, and thus allowing a high absorption of the nutrients that the plant needs and then increasing their percentage. This increase may also be due to the unique properties of nano fertilizers, such as high reactivity, higher penetration power into plant tissues, and heat tolerance. It was found that they are more suitable for stimulating plant growth as linked to environmental conditions and contribute to increasing the plant's tolerance to unfavorable environmental conditions (Verma et al., 2022). Nanofertilizers are also characterized by high absorption and diffusion owing to the small diameter of their particles and high surface area, (Monreal et al., 2016; Tanou et al., 2017). These productions are consistent with the findings of (El-Ghany et al., 2021) when foliar spraying with Nano-ammonium phosphate on bean plants.

Conclusions

The genetic composition led to a significant impact on vegetative growth traits, production traits, and biochemical traits, as the Verde Di Macerata (V3) variety excelled in giving the best productions for most vegetative growth traits, production traits, and biochemical traits**,** Foliar spraying with phosphorus led to improvement of vegetative growth traits, production traits, and biochemical traits. Spraying with nanoscale phosphorus at an amount of 2 g L^{-1} was superior in recording the highest values for most adjectives.

References

Aimen, A., Basit, A., Bashir, S., Aslam, Z., Shahid, M. F., Amjad, S., Mehmood, K., Aljuaid, B. S., El-Shehawi, A. M., & Zuan, A. T. K. (2022). Sustainable phosphorous management in two different soil series of Pakistan by evaluating dynamics of phosphatic fertilizer source. *Saudi Journal of Biological Sciences*, *29*(1), 255–260.

Al-Sahooki, M. M., & Wahib, K. (1990). *Applications in the design and analysis of experiments* (Vol. 810). Dar Al-Hekma for Printing and Publishing, Mosul.

AL-Shammary, A. M., & ALtamimi, D. A. (2016). The effect of organic and chemical fertilizer in vegetative growth for characteristics and yield of three genotypes of Cauliflower. *Diyala Agricultural Sciences Journal*, *8*(2), 229–241.

Al-Zuhairy, H. T. H., & AL-Hamdany, S. A. (2017). EFFECT OF ORGANIC, CHEMICAL FERTILIZERS AND PLANT DENSITY ON: 2-SOME GROWTH AND YIELD CHARCTERISTICS OF CAULIFLOWER Brassica oleracea var. botrytis. *Diyala Agricultural Sciences Journal*, *9*(2), 104–114.

Awad-Allah, E. F. A. (2023). Effectiveness of silica nanoparticle application as plant nano-nutrition: a review. *Journal of Plant Nutrition*, *46*(11), 2763–2776.

Cresser, M. S., & Parsons, J. W. (1979). Sulphuric—Perchloric acid digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. *Analytica Chimica Acta*, *109*(2), 431–436.

El-Ghany, M. F. A., El-Kherbawy, M. I., Abdel-Aal, Y. A., El-Dek, S. I., & Abd El-Baky, T. (2021).

Comparative study between traditional and nano calcium phosphate fertilizers on growth and production of snap bean (Phaseolus vulgaris L.) plants. *Nanomaterials*, *11*(11), 2913.

Haynes, R. J. (1980). A comparison of two modified Kjeldahl digestion techniques for multi-element plant analysis with conventional wet and dry ashing methods. *Communications in Soil Science and Plant Analysis*, *11*(5), 459–467.

Haynes, S., Feinleib, M., & Kannel, W. B. (1980). The relationship of psychosocial factors to coronary heart disease in the Framingham Study. III. Eight-year incidence of coronary heart disease. *American Journal of Epidemiology*, *111*(1), 37–58.

Koss-Mikołajczyk, I., Kusznierewicz, B., Wiczkowski, W., Płatosz, N., & Bartoszek, A. (2019). Phytochemical composition and biological activities of differently pigmented cabbage (Brassica oleracea var. capitata) and cauliflower (Brassica oleracea var. botrytis) varieties. *Journal of the Science of Food and Agriculture*, *99*(12), 5499–5507.

Monreal, C. M., DeRosa, M., Mallubhotla, S. C., Bindraban, P. S., & Dimkpa, C. (2016). Nanotechnologies for increasing the crop use efficiency of fertilizer-micronutrients. *Biology and Fertility of Soils*, *52*, 423–437.

Muhammad, A. S., Karim, N. K., Abdel Aziz, K., & Abdel Eidan, K. (2013). The impact of spraying magnesium and phosphorus on the growth and flowering of Zinnia elegans. *Al-Furat Journal of Agricultural Sciences*, *5*(4), 280–290.

Olsen, S. R., & Sommers, L. E. (1965). Phosphorus Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. *ASA, Inc. SSSA, Inc*, 403–430.

Ruttkay-Nedecky, B., Krystofova, O., Nejdl, L., & Adam, V. (2017). Nanoparticles based on essential metals and their phytotoxicity. *Journal of Nanobiotechnology*, *15*(1), 1–19.

Tanou, G., Ziogas, V., & Molassiotis, A. (2017). Foliar nutrition, biostimulants and prime-like dynamics in fruit tree physiology: new insights on an old topic. *Frontiers in Plant Science*, *8*, 75.

Verma, K. K., Song, X.-P., Joshi, A., Tian, D.-D., Rajput, V. D., Singh, M., Arora, J., Minkina, T., & Li, Y.-R. (2022). Recent trends in nano-fertilizers for sustainable agriculture under climate change for global food security. *Nanomaterials*, *12*(1), 173.

Zeb, A., Khan, S., & Ercişli, S. (2022). Characterization of carotenoids, chlorophylls, total phenolic compounds, and antioxidant activity of Brassica oleracea L var. botrytis leaves from Pakistan. *Biologia*, *77*(2), 315–324.