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EFFECT OF SODIUM NITROPRUSSIDE ON PLANT GROWTH AND SEED YIELD ATTRIBUTES PARAMETERS IN CALIFORNIA POPPY

Pankaj Kumar Meena*, Anjana Sisodia and Vishnu Kumar Sharma
Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005 (U.P.), India.
*Corresponding author E-mail: pankajmeena626@gmail.com
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ABSTRACT

An experiment was carried out to investigate the effect of sodium nitroprusside on plant growth and seed attributes in California poppy. The field experiment was conducted during 2021-2022 at Horticultural Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. There were eight treatments of sodium nitroprusside (200, 400, 600, 800, 1000, 1200, 1400 and1600µM). Various doses of sodium nitroprusside were sprayed after 21 days of transplanting up to runoff stage. All the plant growth and seed attributing parameters were found significantly superior due to various levels of SNP. The maximum plant height was recorded at 60 DAT (14.43 cm) with SNP 1000µM, and seed weight (1.32 g) also. whereas, maximum plant spread (49.58 cm), maximum number of primary branches (26.94), maximum leaf area (40.53 cm^2), maximum fresh weight of leaves (7.50 g), minimum days to capsule development (92.51 DAT), maximum number of capsules per plant (107.13), earlier capsule maturity (107.25 DAT), number of seed per capsule (114.96) and seed yield/plant (14.36 g) were recorded with treatment SNP 1200µM.
Keywords **:** California poppy, plant growth, seed yield, sodium nitroprusside.

Introduction

The California poppy (*Eschscholzia californica*) is a member of the Papaveraceous family and is native to California (USA). Along with demand in local markets, both developed and developing nations need a significant quantity of California poppy seeds. It is appropriate for flower beds, as well as walks and paths in gardens (Singh, 2005). The leaves are ternate and almost glabrous, with three finely divided lobes. Plants produce upright flowers with four satiny petals that range in colour from bright orange to light yellow and may have distinct, darker orange centres on freely branching stems (Ai *et al*., 2017). The California poppy is a commercially significant decorative and medicinal flowering plant that is widely grown for its vivid orange, yellow, and red blossoms (Love *et al*., 2021). It is useful for stress-physiology research because of its great drought resistance and membership in the Papaveraceae family (Asadi-Sanam *et al*., 2018). In the winter, the open cup-shaped flowers look very attractive (Pearson *et al*., 2021). The California poppy is distinguished from other species in the genus by the presence of a torus rim, a pedestal at the receptacle that resembles a collar. Flowers close phototropically—that is, at night and on overcast days—when light levels are low (Aziz *et al*. 2021). In recent years, it has been discovered that plants contain nitric oxide (NO), a biologically active gas that regulates several physiological and developmental processes at nanomolar concentrations (1.0 nmol L) (Eum *el al*., 2009). Nitric oxide is involved in germination and the initiation of lateral roots (Sarath *et al*., 2006), as well as delaying senescence (Neill *et al*., 2003). Nitro press is a brand name for sodium nitroprusside (SNP) (Chohan *et al*. 2012). Nitroprusside is an inorganic compound with the formula $Na_2[Fe(CN)_5NO]_2H_2O$, which is usually found as a dihydrate (Ramadan *et al*. 2019). Sodium nitroprusside (SNP) -an external nitric oxide (NO) donor- has been found effective to impart salinity tolerance to plants (Zhang *et al*., 1972). Nitric oxide is involved in germination and the initiation of lateral roots (Sarath *et al*., 2006). Growth regulators is

a substance like SNP (sodium nitroprusside) may modulate nitric oxide signalling and alter flowering time and quality (Jhanji *et al*., 2012). NO also modulates antioxidant enzyme activities, reduces reactive oxygen species and improves stress tolerance, which may indirectly enhance plant performance (Omer *et al*., 2018). Enhanced chlorophyll and photosynthetic performance (if observed) could lead to more assimilate supply, supporting flowering (Neill *et al*., 2008) SNP is used in improving morphological, physiological and biochemical attributes of flowering crops under salinity stress (Graziano and Lamattina, 2007).

Materials and Methods

A field experiment was conducted at Horticultural Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh to study the effect of sodium nitroprusside on plant growth and seed yield attributes in California poppy. The experiment was laid out in Randomized Block Design with five replications. The experiment site is located near the center of the North-Gangetic alluvial plain, or river Ganga on the left bank, about ten kilometers south-east of Varanasi railway station. Treatment consisted of SNP (200, 400, 600, 800, 1000, 1200, 1400 and 1600µM) along with control (distilled water). One month old, healthy and diseases free seedings were used for transplanting. At a spacing of 60×50 cm seedling was planted followed by light irrigation. SNP was applied third week after transplanting, while control plants were sprayed with distilled water. Observations on various growth and seed yield parameters were recorded and the experimental observations were statistically analyzed with Panse and. Sukhatme, 1985 method.

Result

The application of different SNP treatments statistically influenced all plant growth parameters. The maximum plant height at 60 DAT (14.43 cm) was recorded with SNP 1000µM which was at par with SNP1400µM (14.37 cm). However, maximum plant spread (49.58 cm) at 60 DAT was seen with treatment SNP 1400µM and highest number of primary branches (26.94 cm) as well as fresh weight of leaves (7.50 g) were observed with SNP 1200µM. SNP 1600µM observed maximum leaf area (40.53 cm^2) which was at par with SNP 1000µM (39.53 cm^2). Various SNP levels had significant impacts on seed production in California poppy. The maximum days of capsule development (97.17) was recorded in SNP 1000µM while minimum days to capsule development (92.51) was seen with treatment SNP 1200µM. The maximum no. of capsule per plant (107.13), maximum no. of seed per capsule (114.96) maximum seed yield per plant (14.36 g) and earlier capsule maturity (107.25 DAT) were recorded with treatment SNP 1200µM whereas the maximum no. of 1000 seed weight (1.30 g) was found with SNP 800µM.

Discussion

The data with regard to the effect of SNP on plant height, plant spread and number of primary branches at 60 DAT was significant among all the treatments. Maximum plant height at 60 DAT (14.43 cm) was noticed with SNP 1000 µM, whereas plant spread and number of primary branches at 60 DAT were recorded at SNP 1200 µM. SNP may have contributed to maximum plant height, plant spread and primary branches since it is a potential source of NO, which is necessary for cell elongation, cell division, and tissue differentiation. Similar findings were also reported by Barzin *et al*. (2022) in pot marigold. The reason for this might be due to the function of SNP, which is strongly related to auxin and cytokine activities (Yasir *et al*., 2021) in lentil, Farouk *et al*. 2020).

Significant differences were recorded in seed yield/plant and the number of capsules due to the influence of SNP treatments. This may be because of improvements in photosynthetic activity and assimilate partitioning towards reproductive sinks may explain the improvement in seed output and changes in yield-contributing characteristics seen in the current study in response to SNP treatments (Ramadan *et al*., 2019) in sunflower. These results are in close agreement with the findings of Shallan *et al*. (2012) in cotton. Yasir *et al*. (2021) in lentil, Chohan *et al*. (2012) in chickpea and Gagneja *et al*. (2011) in *Brassica napus*.

Conclusion

Based on the results obtained from the present study, it can be concluded that in California poppy, foliar application of sodium nitroprusside @1000µM expressed the highest plant height (cm) and seed weight (g). Whereas, treatment T7 (SNP 1200µM) was recorded the highest plant spread, no. of primary branches, fresh weight of leaves, no. of capsule/ plant, early capsule maturity (days), no. of seed/capsule and seed yield/ plant (g). The positive response may be attributed to the role of nitric oxide in promoting cell division, photosynthetic efficiency, hormonal regulation, and assimilate translocation. Since the study covers only one growing season, these findings serve as an indicative trend; therefore, multi-season and multi-location trials are necessary to validate the consistency and reliability of the results.

Furthermore, it is stated that the findings of the experiment for one season are only representative of the best on one season of study. Thus, it is proposed that the results be confirmed to verify the correctness of the preceding conclusion.

Table 1: Effect of sodium nitroprusside on plant growth parameter in California poppy.

Treatment Notation	Treatment	Plant height at 60 DAT (cm)	Plant spread at 60 DAT (cm)	No. of primary branches	Leaf area (cm)	Fresh weight of leaves (g)
T1	Control	13.42	46.21	13.36	32.46	3.76
T2	Sodium nitroprusside 200µM	11.43	43.67	17.97	25.80	4.42
T3	Sodium nitroprusside 400µM	11.67	40.27	19.39	26.83	5.68
T4	Sodium nitroprusside 600µM	10.45	41.34	18.39	25.10	5.87
T5	Sodium nitroprusside 800µM	12.66	40.53	21.41	37.67	7.11
T6	Sodium nitroprusside 1000µM	14.43	44.29	24.25	39.53	6.79
T7	Sodium nitroprusside 1200µM	13.67	49.58	26.94	40.53	7.50
T8	Sodium nitroprusside 1400µM	14.37	39.88	13.33	38.10	7.26
T9	Sodium nitroprusside 1600µM	11.19	35.28	10.58	32.77	5.82
	C.D. at 5%	1.13	2.01	9.16	5.13	1.32

Table 2: Effect of sodium nitroprusside on seed yield attributes parameter in California poppy.

Treatment	Days of capsule development	No. of capsule / plant	Capsule maturity (days)	No of seed / capsule	Seed yield / plant (g)	1000 seed weight (g)
Control	94.22	65.25	107.71	108.66	13.65	1.24
Sodium nitroprusside 200µM	94.74	70.00	108.30	109.53	10.59	1.28
Sodium nitroprusside 400µM	95.40	69.52	114.86	114.00	11.62	1.10
Sodium nitroprusside 600µM	95.48	75.26	110.36	118.69	11.10	1.22
Sodium nitroprusside 800µM	95.29	76.67	109.30	112.11	14.37	1.30
Sodium nitroprusside 1000µM	97.17	88.90	112.23	111.08	12.29	1.32
Sodium nitroprusside 1200µM	92.51	107.13	107.25	114.96	14.36	1.23
Sodium nitroprusside 1400µM	94.47	86.27	109.45	111.58	10.95	1.13
Sodium nitroprusside 1600µM	93.43	92.71	108.46	112.17	13.42	1.24
C.D. at 5%	2.07	2.46	2.60	3.54	1.52	0.05

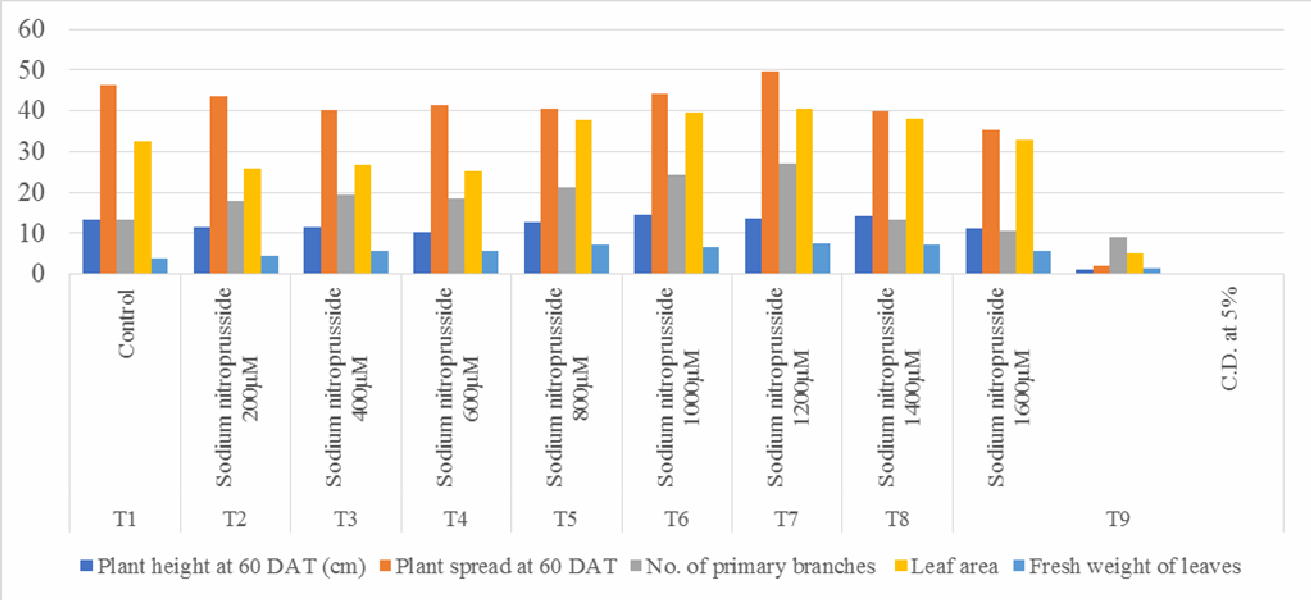

Fig. 1: Effect of sodium nitroprusside on plant growth parameter

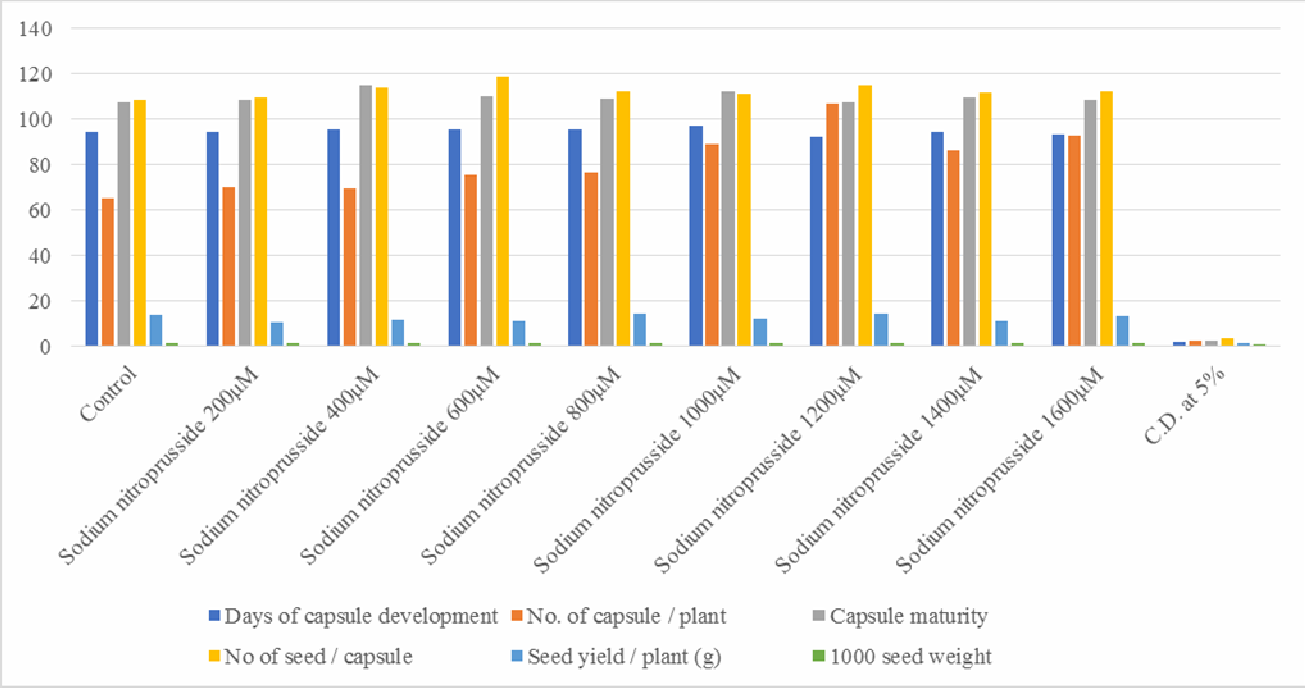

Fig. 2: Effect of sodium nitroprusside on plant seed parameters

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