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Evaluation of glycine application methods (Soil and foliar) on growth performance and yield of cauliflower under Himalayan valley ecosystems

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Abstract

Glycine an essential building block of plant proteins significantly enhances cauliflower growth and yield by improving photosynthetic efficiency, nutrient uptake and stress tolerance. The maximum plant height and number of leaves per plant were recorded in T₅ (Glycine @ 500 ppm foliar application) showing increases of 5.94% and 20.18% respectively the control (T₀). Similarly the highest plant spread was observed in T₆ (Glycine @ 1000 ppm foliar application) which was 15.21% higher than the control. The reproductive growth parameters and curd development parameters of cauliflower were markedly influenced by different treatments. The increases in curd weight (69.05%) curd diameter (16.81%) and curd length (43.60%) under T₅ (Glycine @ 500 ppm foliar application) respectively over the control (T₀). Moreover the earliest curd initiation was observed in T₅ (Glycine @ 500 ppm foliar application) (68.26 days) compared to the control T₀ (72.30 days) indicating a reduction of 5.59% in days taken for curd initiation. The foliar application of Glycine @ 500 ppm resulted in a 39.29% increase in yield over the control. Hence, it may be suggested that concentration of 500 ppm foliar application of glycine could use for enhancing the production of cauliflower cv. pusa himjyoti under Himalayan valley ecosystems.

Keywords: Cauliflower, glycine, soil, foliar application, growth, yield, amino acid

Introduction

Vegetable play an important role in Indian agriculture and nutritional security of the country due to the fact that they are generally short duration in nature with high yielding ability, nutritional wealth, economic viability and ability to generate on-farm and off-farm employment. Cauliflower (*Brassica oleracea* var. *botrytis* L.) is an important commercial cole vegetable crop belongs to family brassicaceae. India is the second largest producer of vegetables next to China (Chakrabarti, 2015) [1]. Cauliflower is one of the most popular vegetable crop among the cole crops and has originated from the Mediterranean region. In 2020, the world produced 25.5 million tons of cauliflower with China and India producing 72% of the global production. In 2023-24 India produces 9794 (MT) thousand metric tons of cauliflower with a total area of 507 thousand hectares. Cauliflower is growing thought the country but the major cauliflower producing states in India are West Bengal, MP, Bihar and Gujarat (Joseph, 2024) [3]. Although amino acids can be a good source of nitrogen for plant uptake and utilization, they can have stimulating effects on plant root and shoot growth. Glycine is a proteinogenic amino acid and the smallest biological amino acid (Souri and Hatamian, 2019) [6]. Application of glycine, plays a significant role in improving stress tolerance in cauliflower by acting as an osmoprotectant. It helps plants withstand abiotic stresses such as heat, frost, drought, and heavy metal toxicity through maintenance of cellular turgidity and scavenging of reactive oxygen species (ROS) and higher photosynthetic efficiency. Furthermore, both soil and foliar application of glycine improve the uptake of essential macro-and micronutrients. The effectiveness of glycine is highly dependent on its concentration. Excessive application, particularly foliar sprays above 1000 ppm may induce phytotoxic effects including leaf necrosis and metabolic imbalance. Since glycine is an important intermediate of the photo respiratory pathway, its excessive accumulation may lead to glycosylate build-up causing feedback inhibition of rubisco activity and negatively

affecting photosynthesis and carbon assimilation. Additionally inefficient amino acid metabolism may increase the plant's energy expenditure thereby reducing energy availability for rapid curd initiation and development (Souri and Hatamian, 2019) [6]. The principal function of glycine is it acts as a precursor to proteins. The work on the aspect of effect of glycine for mitigation of fertilizer requirements on growth and yield parameters of crops has been conducted to a limited extent in Indian conditions. Hence it was felt necessary to conduct an experiment entitled at Horticultural Research Centre, Chauras Campus, Department of Horticulture, Hemwati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand during rabi season 2023-24 with the following objectives-To determine the efficacy of soil application of glycine on growth and yield of cauliflower, to assess the efficacy of foliar application of glycine on growth and yield of cauliflower and to find out the best treatment among the different level and different application methods of glycine in relation to growth and yield of cauliflower.

Materials and Methods

The experiment entitled "Evaluation of Glycine Application Methods (Soil and Foliar) on Growth Performance and Yield of Cauliflower under Himalayan Valley Ecosystems" was conducted at Horticultural Research Centre, Department of Horticulture, H.N.B.G. University Srinagar, Uttarakhand, during winter season 2023-24. The Horticultural Research Centre is located in a valley with a humid and subtropical climate that features a dry summer and a harsh winter with occasional dense fog from mid-November to mid-February. In the current experiment, Randomized Block Design was followed to evaluate 7 different treatments with three replications and comprised 7 treatments consisting of soil and foliar application of L-glycine viz, (T₀) control, (T₁) glycine @ 250 mg soil application, (T₂) glycine @ 500 mg soil application, (T₃) glycine @ 1000 mg soil application, (T₄) glycine @ 250 ppm foliar application, (T₅) glycine @ 500 ppm foliar application, (T₆) glycine @ 1000 ppm foliar application. The seedlings were sown in the month of October and raised in poly house. The four weeks old healthy and uniform growth seedlings were selected for transplanting. A light irrigation was given before uprooting of seedlings in the nursery bed so that minimum damage may occurs to roots of the seedlings. The seedlings were planted at 60 cm x 45 cm spacing. Treatment application of the foliar application of different glycine concentrations 250 ppm, 500 ppm and 1000 ppm was done four times during the growth period. The first spray was done 2 weeks after transplanting and subsequent were done at 15 days intervals. The soil application of glycine was done in three split applications as soil drenching of a final volume of 250, 500 and 1000 mg/plant after dissolving the amounts in distilled water. For this purpose the first application (83 mg, 167 mg and 333 mg per plant) was done 2 weeks after transplantation and the other sprays were done in 2-week intervals.

During the experiment different observations pertaining to growth and yield parameter were recorded. Five plants from each treatment per replication were tagged randomly for recording the data. The growth parameters: Plant height (cm), Plant spread (cm²), Number of leaf, Yield parameters: Days taken to curd initiation, Days taken to curd maturity, Total weight of plant (kg), Fresh weight of curd (kg),

Diameter of curd (cm), Length of curd (cm), Diameter of stem (mm), Length of stem (cm), Yield per hectare (q). Growth parameters data recorded of five randomly selected and tagged plants were measured at the time of harvesting. The mean data recorded from five randomly selected plants of each replication, were analysed statically involving analysis of variance (ANOVA) test at 5% level of probability. For testing the significant among the treatments the critical differences (CD) were calculated.

Results and Discussion

Growth parameters

The highest plant height at harvest time of cauliflower was recorded in (T₅) Glycine 500 ppm FA. It may be due to the increased leaf area of plants so the exogenous application of Glycine 500ppm foliar application can enhance nutrient uptake and act as precursors for certain plant hormones. Similar findings were observed aminochelates in plant nutrition (Souri and Hatamian, 2019) [6]. The maximum number of leaves of cauliflower was observed in (T₅) Glycine 500 ppm FA. The increased number of leaves could be attributed to foliar Glycine spraying, found a decrease in the leaf length, width and surface area respectively. The only parameter increased in response to L-glycine was the number of leaves. The results of investigation have shown that increasing levels of Glycine significantly increased the plant spread (cm²). Plant spread may have increased as a result of Glycine 500 ppm foliar application because it induced nutrient transport from the root to the aerial parts of the plant also helps in cell division, cell elongation and cell enlargement. It also influences protein and chlorophyll synthesis which leads to an increase in photosynthetic activities in leaf tissues, cell expansion and cell wall formation all of which promote plant spread. The similarly result of amino chelate fertilizers found various studies mentioned in this review revealed that they have a superior effect on plant growth and productivity.

Yield parameters

Minimum (68.26) days taken to curd initiation were recorded under Glycine 500 ppm foliar application. The application of glycine amino acids can influence the growth and development of cauliflower plants, including the initiation of curd formation. However, the exact number of days taken for curd initiation can vary based on several factors such as the specific cauliflower cultivar, environmental conditions, and the concentration of glycine and application methods. Glycine can influence the expression of certain genes involved in curd initiation. For instance, the BoFLC2 gene, which is associated with flowering and curd initiation, can be down-regulated by glycine, promoting earlier curd formation (Zhu. Y *et al.*, 2024) [10]. The minimum (82.49) days taken to curd maturity were recorded under Glycine 500 ppm foliar application treatment. Glycine has been shown to promote plant growth by acting as a growth regulator and stress mitigator. Its role in amino acid metabolism and stress responses can influence plant developmental stages, including curd maturity in cauliflower (Norzoolo, 2019) [5].

The maximum average weight of curd was recorded in Glycine 500 ppm FA. The foliar application of glycine involves spraying it directly onto the plant leaves. Effect on curd weight, foliar application can quickly enhance leaf function and photosynthesis, leading to better nutrient

availability and potentially larger curds. This method is effective for rapid growth responses. Similar finding a study (Norzoolo, 2019) ^[5] that foliar application of glycine can enhance growth and yield in sweet basil, indicating potential benefits for curd weight in cauliflower.

The maximum (18.83 cm) curd diameter was recorded in (T₅) Gly @ 500 ppm FA while the minimum (16.12 cm) was recorded in (T₀) control. Foliar application can rapidly enhance leaf function and nutrient assimilation, which can directly affect curd development. Improved photosynthesis and nutrient availability can contribute to larger curds with greater diameter. Foliar applications can provide rapid growth boosts and enhance photosynthesis, leading to increased curd size. Such as a study found in which lettuce crops (Yildirim *et al.*, 2015) ^[8] foliar application of glycine improved nutrient uptake and plant growth, suggesting potential benefits for curd size. The maximum (14.84 cm) curd length was recorded in (T₅) Gly @ 500 ppm FA while the minimum (10.32 cm) was recorded in (T₀) control. Due to foliar application of glycine are crucial for plant growth as they are involved in protein synthesis, hormone production, and other metabolic processes. Research suggests that glycine can enhance overall plant health and potentially influence curd development in cauliflower.

Similar result found (Mohammadipour and Souri, 2019) in coriander crops.

The maximum length of stem and diameter of stem was recorded in (T₃) Glycine 1000 mg SA. Soil applications provide a sustained nutrient supply and support overall plant health, including root and stem development. Glycine can improve the uptake of essential nutrients which can contribute to overall plant growth, including stem length. Enhanced nutrient availability supports robust stem development (Z. Shooshtari *et al.*, 2020) ^[9]. Glycine helps plants manage oxidative stress and other environmental stresses. By reducing stress, plants can allocate more resources to growth, including stem thickening. Effect on curd weight, foliar application can quickly enhance leaf function and photosynthesis leading to better nutrient availability and potentially larger curds. This method is effective for rapid growth responses.

The highest yield per hectare was recorded in (T₅) Glycine 500 ppm FA. Foliar application of amino acids can lead to increased crop yield by enhancing plant growth, stress tolerance and nutrient utilization. Glycine can influence the production of growth hormones like auxin, which potentially leading to improved plant growth and higher yield (Souri and Hatamian, 2019) ^[6].

Table 1: Effect of application methods and among level of glycine on plant height, number of leaf and plant spread at harvest in cauliflower.

Treatment	Plant height (cm)	No. of leaf	Plant spread (cm ²)
T ₀ (control)	57.26	15.41	4455.34
T ₁ (Gly @ 250mg SA)	58.48	16.39	4836.67
T ₂ (Gly @ 500mg SA)	58.88	18.00 ^c	4989.67
T ₃ (Gly @ 1000mg SA)	60.24 ^b	18.20 ^b	5125.33 ^b
T ₄ (Gly @ 250ppm FA)	57.60	16.30	4839.67
T ₅ (Gly @ 500 ppm FA)	60.66 ^a	18.52 ^a	5111.67 ^c
T ₆ (Gly @ 1000 ppm FA)	60.12 ^c	17.45	5135.00 ^a
CD (5%)	1.14	1.64	380.35
S.E (m)	0.37	0.53	122.08
C.V.	1.07	5.32	4.30

(Gly-Glycine amino acid, SA-Soil application, FA-Foliar application, Mg-Milligrams, PPM-Part per million)

Table 2: Effect of application methods and among level of glycine on curd weight (kg), curd length (cm), curd diameter (mm), days to curd initiation days and curd maturity (day) in cauliflower.

Treatment	Curd weight	Curd length	Curd diameter	Curd initiation	curd maturity
T ₀ (control)	0.84	10.32	16.12	72.30	85.74
T ₁ (Gly @ 250mg SA)	0.88	11.08	17.85	70.41	83.60
T ₂ (Gly @ 500mg SA)	1.02 ^c	12.05	18.00	69.90 ^c	83.71
T ₃ (Gly @ 1000mg SA)	1.05 ^b	13.66 ^c	18.62 ^b	68.37 ^b	82.96 ^b
T ₄ (Gly @ 250ppm FA)	0.92	11.84	17.15	70.06	83.59
T ₅ (Gly @ 500 ppm FA)	1.42 ^a	14.82 ^a	18.83 ^a	68.26 ^a	82.49 ^a
T ₆ (Gly @ 1000ppm FA)	1.00	14.58 ^b	18.03 ^c	69.93	83.30 ^c
CD (5%)	0.26	0.94	1.10	1.72	1.60
S.E (m)	0.08	0.30	0.35	0.55	0.51
C.V.	14.36	4.13	3.45	1.37	1.07

Table 3: Effect of application methods and among level of glycine on length of stem (cm), diameter of stem (mm) and yield per hectare (q) in cauliflower.

Treatments	Length of stem (cm)	Diameter of stem (mm)	Yield per hectare (q)
T ₀ (control)	6.75	27.80	240.67
T ₁ (Gly. @ 250mg SA)	7.23	29.35	275.16
T ₂ (Gly @ 500mg SA)	7.67	31.30	317.51
T ₃ (Gly. @ 1000mg SA)	8.15 ^a	31.75 ^a	323.51 ^b
T ₄ (Gly. @ 250ppm FA)	7.59	29.77	296.36
T ₅ (Gly. @ 500ppm FA)	8.08 ^b	31.65 ^b	335.25 ^a
T ₆ (Gly. @ 1000ppmFA)	7.76 ^c	31.33 ^c	321.91 ^c
CD (5%)	0.68	0.88	19.37
S.E(m)	0.22	0.28	6.22
C.V.	4.95	1.60	3.57

Conclusion

In the study the foliar applications of glycine significantly increased cauliflower economic life (shelf life). It regulates cellular water balance to prevent wilting and activates antioxidant enzymes that delay senescence and curd browning after harvest, vegetative growth and plant yield compared to control plants. Moreover, foliar application of 500 ppm glycine was superior to soil application of 1000 mg/plant, as the foliar application of 500 ppm glycine was able to record the better. This could have significant implications for crop production. Glycine application the overall enhancement in cauliflower growth and curd development due to glycine application was approximately 28.47% and the overall enhancement in cauliflower yield 39.29% over the control. On the other hand, safe production of cauliflower is quite important with regard to consumer's health and application of bio stimulants such as glycine amino acid as a full or partial replacement of chemical fertilization as shown in this study can benefit the soil, plant and human health issues.

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