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ROLE OF CLYBIO APPLICATION ON SUMMER ONION (*Allium cepa*) PRODUCTION IN BANGLADESH

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Abstract

A field experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, from June to October 2021 to evaluate the influence of Clybio concentrations on summer onions (*Allium cepa*) production. The variety used was BARI Piaz-3. The single factorial experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. The experiment consisted of four treatments, namely, T_0 = control (no Clybio application), T_1 = Clybio @ 2 ml/L, T_2 = Clybio @ 4 ml/L and T_3 = Clybio @ 6 ml/L, and in total, this was applied six times, starting from 10 DAT until 60 DAT and was applied in a foliar manner to both leaves and surrounding soil. Among the treatments, the maximum plant height (60.8cm), the number of leaves per plant (16.7), leaf length (54.2cm), leaf weight (31.3g), diameter of pseudo stem (11.9mm), root length (8.4cm), number of roots (33), bulb diameter (43.8mm), bulb length (52.7mm), weight of a single bulb (45.7g), average bulb yield per plot (33.2 t/ha) was recorded at T_3 treatment. The highest length of pseudo stem (49.4 mm) was found in the T_1 treatment. On the contrary, the minimum plant height (38.3cm), number of leaves per plant (7.0), leaf length (24.1cm), leaf weight (17.7g), root length (4.5cm), number of roots (26), bulb diameter (22.7mm), bulb length (42.0mm), weight of a single bulb (22.0g), average bulb yield per plot (16.0 t/ha) was observed at T_0 (control) treatment. The lowest diameter of the pseudo stem was found at the T_1 (7.5mm). No statistically significant variation was found in the length of the pseudo stem (mm) in response to different treatments. When compared to control (T_0), the highest increase in yield percentage was observed at T_3 treatment (107.5%). A highly significant, very strong ($R^2 = 0.99$) and positive correlation was discovered between bulb weight and root length, indicating that bulb weight increased as root length increased. Considering the aforementioned findings, T_3 (Clybio @ 6 ml/L) treatment delivered the best results in terms of growth and yield attributes of offseason onions.

Key words: Summer onion, Clybio, Bacillus, Yeast, Effective microorganisms.

Introduction

The onion (*Allium cepa*) is an indispensable spice and vegetable that is largely grown as a winter crop all over the world. It is a member of the Amaryllidaceae family and is cultivated largely for its bulb. Onion is one of the major spices in Bangladesh and it ranks first in production among the spice crops (BBS, 2014). It is grown extensively during the winter season in Bangladesh, at its maximum level both in area and production (BBS, 2011). The demand for onions in Bangladesh is increasing steadily, driven by population growth and rising per capita income. From August to March, there is a major shortage of onion bulbs in the vegetable markets, which are filled primarily by imports from India. In 2019–20, Bangladesh imported 640.917 million metric tons of onions and produced 1954 thousand metric tons (BBS, 2020). The Ministry of Agriculture in Bangladesh reports a 2.8 million metric ton annual demand for onions, indicating an increasing demand (Mila *et al.*, 2022). This shows that, as a nation, we are trailing behind in the development of the onion farming industry. Initiating summer onion production among farmers can represent a significant turning point in total onion production and the supply chain by bridging this enormous supply and demand mismatch and reducing annual import expenses. In order to reduce its dependency on imports and achieve onion self-sufficiency, the government is emphasizing the production of onions in the summer or off-season. The Bangladesh Agricultural Research Institute (BARI) has created a number of year-round cultivable summer onion varieties, including BARI Piaj-2, BARI Piaj-3, and BARI Piaj-5. However, because of a number of circumstances, growing onions in Bangladesh during the summer can be a difficult task. Onions may prematurely bolt due to the high temperatures and humidity, and pests and diseases including onion maggots, thrips, purple blotch, and basal rot may harm the harvests. Onion development requires consistent watering, but excessive monsoon rains might cause overwatering and root rot. Poor drainage and high clay content in the soil are two other soil factors that can prevent optimal onion bulb development. Post-harvest losses might also be caused by inadequate storage facilities. For Bangladeshi onion farming to be effective, several problems must be resolved. To overcome these constraints, Clybio can be applied while growing summer onions. Clybio is a mixture of yeast fungi, Bacillus natto, and Lactobacillus, which can improve the yield and quality of vegetables. Clybio can prevent different fungal diseases, reducing the requirement for pesticides during the growing season

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for vegetables (Akter *et al.*, 2021). Additionally, various studies on horticultural crops have shown that the use of beneficial microorganisms improves vegetative growth and boosts crop yield (Uddin *et al.*, 2020, Rakibuzzaman *et al.*, 2021). The components of Clybio also have significant functionality of their own which protects plants against biotic and abiotic stresses. Clybio improves soil health and plant growth by harnessing the power of enzymes and the synergy of Lactobacilli, Yeast Fungi, and Bacillus Natto. It has antibacterial qualities, deters pathogens, promotes leaf microbes, increases resiliency, elevates the presence of natural microbes, improves mineral uptake, and aids in nitrogen digestion. Also, it lessens the need for pesticides and fertilizers. The goal of the current study was to determine how Clybio affected the growth and yield characteristics of summer onions as well as how it affected production limitations during the summer.

Methodology

The study was conducted from June 2021 to October 2021 at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The soil was non-calcareous dark grey having a pH of 6.5. The soil was adequately drained and had sufficient irrigation. The single factorial experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. The data recorded for different parameters were statistically analyzed using Statistix-10 data analysis software to figure out the significance of variation among the treatments and the treatment means were compared by Least Significant Difference (LSD) test at 5% level of significance.

Planting material, Nursery bed preparation, Seed sowing, Land preparation and Transplanting

The seeds of onion were collected from Bangladesh Agricultural Research Institute (BARI) and the variety used was BARI Piaz-3. The soil of the nursery bed was well prepared by breaking the large soil blocks, removing weeds making it flat using a ladder, and applying fertilizers before sowing. Lines were made in the soil with appropriate depth and the seeds were sown in line. After sowing the seeds were covered with loose soil and light irrigation was provided. A plastic tunnel was built over the nursery bed to prevent direct rain splashes. The land preparation took place inside a poly shed structure. The soil inside the poly shed was well prepared, and good tilth was ensured for summer onion production. After soil preparation, fertilizers were applied according to doses recommended by BARI. For onion bulb cultivation, a proper drainage system was ensured. After the land was prepared, the experiment's field layout and design were immediately implemented. The spacing was 15cm × 10cm where the row-to-row distance was 15cm and plant-to-plant distance was 10cm. The size of each plot was 1m × 1m and the plot-to-plot distance was 50 cm. The experiment consisted of 12 plots. 40 days old healthy and uniform seedlings were transplanted in the experimental plots inside the poly shed. The bulbs were planted completely inside the soil leaving only the leaves above the ground. After transplanting, immediate irrigation was provided to avoid the drying out of the seedlings. Necessary intercultural practices were done to ensure the proper management of onion plants. Harvesting was done after 100 days of transplants when the bulbs reached the maturity stage.

Treatments

Clybio was supplied as a solution in various concentrations to serve as a treatment. To make clybio solutions of various concentrations, different Clybio doses were added per liter of water. Using a hand sprayer, the treatments were applied in a foliar manner to both leaves and surrounding soil. Clybio was applied in total six times. The first application was made after 10 days of transplanting. Thereafter, they were applied a further five times, at intervals of ten days: at 20, 30, 40, 50, and 60 DAT.The following treatments were applied in this experiment to observe their effects on the growth and productivity of summer onion: T_0 = Control (no Clybio application), T_1 = Clybio @ 2 ml/L, T_2 = Clybio @ 4 ml/L and T_3 = Clybio @ 6 ml/L

Parameters studied in the experiment

Growth parameters

The height of the plants was measured in centimeters (cm) using a meter scale from the point of attachment of the plant to the ground level up to the tip of the longest leaf and the mean value was calculated. Data were collected at 15 days intervals starting at 30 days to 45, 60, 75 and 90 days after transplanting. The number of leaves per plant was collected from randomly selected plants at 15 days intervals starting at 30 days to 45, 60, 75 and 90 days after transplanting. The length of the leaf was collected by detaching the leaves from the pseudo stem and then measuring the length in centimeters (cm) using a meter scale. The length was taken from the base of the leaf to the tip of the longest leaf. The weight of the leaves was counted after detaching the leaves from the bulb and measuring it in grams (g) using a digital balance. After removing the leaves, the pseudo stem was cut right above the bulb's top portion and its length was measured in millimeters (mm) using a Digital slide caliper-515 (DC515). The diameter of pseudo stem was measured in millimeters (mm) by placing a Digital slide caliper-515 at the middle portion of the pseudo stem. The root portion was cut from the base of the bulb. The length of the root was calculated using a meter scale in centimeters (cm) and the number of roots was counted separately.

Yield parameters

The diameter of the bulb was measured in millimeters (mm) by placing a Digital slide caliper-515 at the middle portion of the bulb. The length of the bulb was calculated using a Digital slide caliper-515 (DC515) from the base of the bulb to the tip of the bulb after the removal of the pseudostem. The weight of the bulb was calculated using a digital balance and expressed in grams(g). The average yield per plot of onion bulbs was calculated by

multiplying the number of bulbs per plot and the average weight of a single bulb in kg/m^2 then converted into t/ha. The following formula was used:

Average yield = average weight of single bulb × bulbs per plot

The percentage of yield increased by the Clybio concentration was calculated against the yield obtained in control using the following formula:

$$Percent\ of\ yield\ Increase = \frac{yield\ of\ treatment - yield\ of\ control}{yield\ of\ control} \times 100$$

Result and Discussion

Plant height and Number of leaves

In the case of plant height foliar application of Clybio demonstrated significantly higher values compared to control at 30 days, 45 days, 60 days, 75 days, and 90 days after transplanting. The highest plant height (60.8 cm) was found in the T_3 treatment at 90 days after transplanting (Figure 1). Whereas, the lowest plant height (38.3 cm) was observed at control (T_0) (Figure 1). Notably, the plant height increased significantly as the level of Clybio concentration increased. This was possibly caused by the effect of Lactobacillus. LAB has been demonstrated in studies to have a variety of plant growth-stimulating properties to enhance the availability of nutrients to its host plants allowing them to deal with stress and inhibit plant nematodes (Jaffar *et al.*, 2023). Results revealed that for the number of leaves per plant, in all cases, foliar application of Clybio demonstrated significantly higher values compared to the control at 30 days, 45 days, 60 days, 75 days, and 90 days after transplanting. The highest number of leaves per plant (16.7) was found in the T_3 treatment at 90 days after transplanting while having the lowest number of leaves per plant at T_0 (7.0) (Figure 2). The findings of Akter *et al.* (2021), which showed that Clybio application in spinach performed better in all aspects of growing parameters like germination percentage, plant height, number of leaves per plant, leaf diameter, chlorophyll percentage, root length, and leaf fresh weight, while the control treatment performed least well in all perimeters, support the findings of this study.

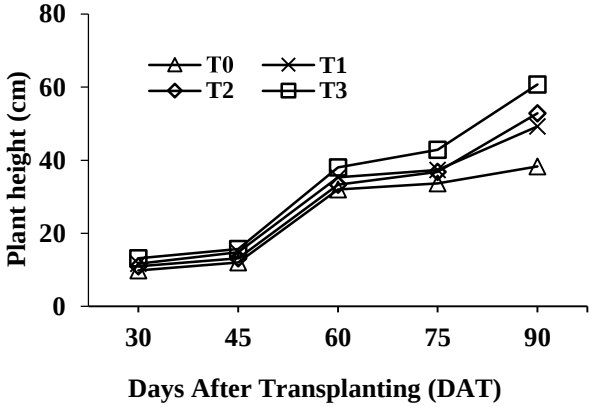

Figure 1. Performance of different concentrations of Clybio on plant height (cm) at different days after transplanting (DAT) (Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration)

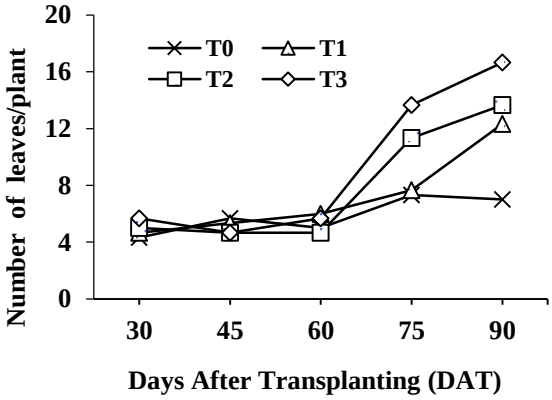

Figure 2. Performance of different concentrations of Clybio on the number of leaves per plant at different days after transplanting (DAT) (Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration)

T_0 T_1 T_2 T_3

Plate 1. Pictorial view showing **a.** summer onion under different treatments; T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration

Leaf length, Leaf weight, Length of pseudo stem, Diameter of pseudo stem, Root length and Number of roots

The highest leaf length (54.2 cm) was recorded in the T_3 treatment which was statistically similar to T_1 (46.2 cm) treatment, whereas, the lowest leaf length was recorded at T_0 (24.1 cm) treatment (Table 1). The highest leaf weight was recorded at T_3 treatment (31.3 g) (Table 1), which was significantly higher than other treatments at

harvest. The highest length of pseudostem (49.4 mm) was found in the T_1 treatment, which was statistically identical to T_2 (46 mm), T_0 (43.5 mm), and T_3 (41.4 mm) at harvest (Table 1). The maximum diameter of pseudostem (11.9 mm) was recorded at T_3 treatment at harvest (Table 1) which was statistically similar to T_2 (9.6 mm) and T_0 (8.0 mm). On the contrary, the minimum diameter of the pseudostem (7.5 mm) was found at the T_1 treatment (Table 1). The highest root length (8.4 cm) was recorded at T_3 treatment. One the other hand, the lowest root length (4.5 cm) was observed at T_0 treatment (Table 1). The maximum number of roots was recorded at T_3 (33) treatment (Table 1). On the contrary, the minimum number of roots was observed at T_0 (26) treatment (Table 1). The improvement of onion plant growth in response to foliar application of yeast extract may be attributed to its contents of proteins, amino acids, different nutrients and a higher percentage of vitamin B which may play an important role in improving growth and controlling the incidence of fungal diseases (Nitalikar *et al.*, 2010). Besides being the most promising biocontrol agents, Bacillus *spp.* promote plant growth via nitrogen fixation, phosphate solubilization, and phytohormone production (Miljaković *et al.*, 2020). A study by Naveen *et al.*, (2022) suggested that colonization of onion roots by beneficial natural resident arbuscular mycorrhizal fungi was higher with the application of plant growth-promoting rhizobacteria (PGPRs).

Table 1. Influence of Clybio concentration on leaf length (cm), leaf weight (g), length of pseudostem (mm), diameter of pseudostem (mm), root length (cm), and number of roots**

Treatment*	Leaf Length (cm)		Leaf Weight (g)		Length of Pseudostem (mm)		Diameter of Pseudostem (mm)		Root Length (cm)		Number of Roots	
T_0	24.1	c	17.7	b	43.5	a	8.0	b	4.5	d	26	c
T_1	46.2	ab	17.7	b	49.4	a	7.5	b	5.2	c	26.3	c
T_2	40.6	b	18.7	b	46	a	9.6	ab	6.5	b	30.7	b
T_3	54.2	a	31.3	a	41.4	a	11.9	a	8.4	a	33	a
CV (%)	10.6		16.2		12		15.6		2.1		3.7	
$LSD_{0.05}$	8.8		6.9		10.8		2.9		0.3		2.1	

*Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration

** In a column, means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Plate 2. Pictorial Presentation of Summer Onion Under Different Treatments; T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration

Bulb diameter, Bulb length, Weight of single bulb

Clybio demonstrated a significant effect on the bulb characteristics in onion. The highest bulb diameter (43.8 mm) was recorded at T_3 treatment which was significantly higher than other treatments (Figure 3). On the other hand, the lowest bulb diameter (22.7 mm) was observed at T_0 treatment (Figure 3). The bulb length recorded at T_3 (52.7 mm) treatment was significantly higher than other treatments and the lowest bulb length was observed at T_0 (42.0 mm) treatment (Figure 4). The maximum weight of a single bulb was recorded at T_3 (45.7 g) treatment while the minimum weight of a single bulb was observed at T_0 (22.0g) treatment (Figure 5). This increase in bulb diameter, length and weight is attributed to Clybio application. In a study conducted by El-Morsy *et al.* (2011), foliar application of yeast extract gave rise to significant increases in plant height, number of leaves per plant, plant dry weight, bulbing ratio, total yield, bulb weight and diameter, and clove weight in garlic. In summer, onion bulb rot is the major cause of lower bulb quality and yield. In onions, bacterial diseases cause bulb rot. The increase in bulb weight, length, and diameter can be attributed to the ability of biocontrol agents such as Lactobacillus to protect the bulb against such infections. It has been demonstrated that LAB has the ability to produce compounds that are effective in the management of a wide range of bacterial and fungal phytopathogens (Gajbhiye and Kapadnis, 2016; Daranas *et al*., 2019; Duha and Abdullah, 2021).

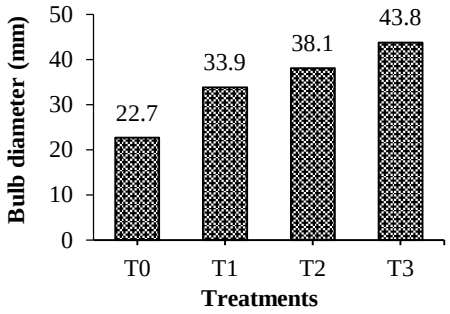

Figure 3. Effect of different treatments on the bulb diameter (mm) of summer onion (Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration)

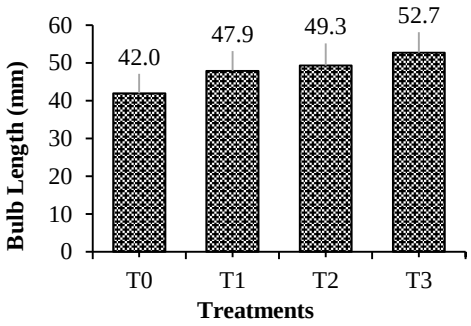

Figure 4. Effect of different treatments on the bulb length (mm) of summer onion (Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration)

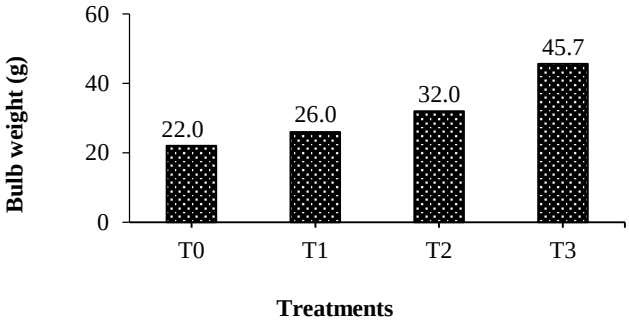

Figure 5. Effect of different treatments on the bulb weight (g) of summer onion (Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration)

Average yield per plot and percentage of yield increase

The highest average bulb yield per plot was obtained in the case of T_3 treatment (33.2 t/ha) (Figure 6). On the contrary, the lowest average bulb yield per plot was obtained in the case of T_0 (16.0 t/ha) treatment (Figure 6). When compared to the control, the T_1 treatment increased yield by 18.1%, the T_2 treatment increased yield by 45.6%, and the T_3 treatment increased yield by 107.5%. (Figure 7). Hence, the T_3 treatment had the maximum increase in yield in summer onion.

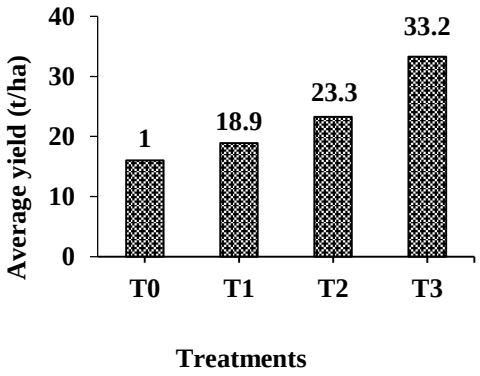

Figure 6. Effect of different treatments on the average yield (t/ha) of summer onion (Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration)

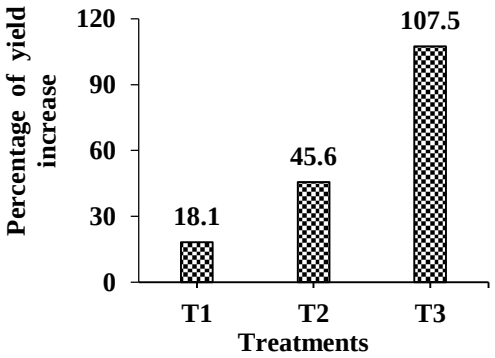

Figure 7. Percentage of yield increase with Clybio treatment compared to control (T_0) (Here, T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration)

T_0 **T_1** **T_2** **T_3**

Plate 4. Pictorial Presentation of Summer Onion Under Different Treatments; T_0 = Control, T_1 = 2 ml/L, T_2 = 4 ml/ L and T_3 = 6 ml/L of Clybio concentration

Relationship between bulb weight and root length

Significant relationship was found between the bulb weight and root length when a correlation was made between these two parameters. A highly significant ($p < 0.01$), very strong ($R^2 = 0.99$) and positive correlation was discovered between bulb weight and root length, indicating that bulb weight increased as root length increased (Figure 8).

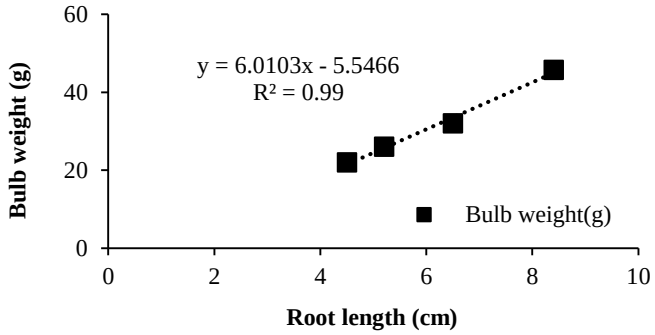

Figure 8. Relationship Between Bulb Weight and Root Length

Conclusion

In conclusion, the study's findings suggest that the application of Clybio concentrations results in a better outcome in terms of the growth and productivity of summer onions when taking into account the aforementioned phenomena. Considering the overall results, especially in the case of bulb yield, and the easy applicability and availability of Clybio, it is recommended that the application of Clybio at 6 ml/L concentration be suggested for application to increase the production of summer onions. This can encourage farmers to grow onions during the summer, guarantee a yearlong supply, and lessen dependency on imported onions.

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