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Application of SLF to study the growth parameters of chickpeas

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ABSTRACT

Chickpeas are an important food crop consumed worldwide due to their high nutritional value. Since seaweed Liquid Fertilizers (SLFs) greatly enhance the production and yield of crops and are environment-friendly, the present study aimed to assess the impacts of Seaweed Liquid Fertilizer (SLF) obtained from brown seaweed *Cystoseira indica* (Thivy *et* Doshi), Mariha 1968, on the growth and yield of Desi and Kabuli Chickpeas. The SLF was tested in five concentrations: 1%, 2%, 3%, 4%, and 5%. Growth parameters, including shoot and root lengths, plant height and weight, number of buds, flowers, and pods, and the average weight of pods were recorded. Results show that lower concentrations enhanced all parameters studied in both varieties of chickpeas, while the least positive results were observed in the 5% concentration. The study concludes that *C. indica* can be used as a potential source of SLF for better growth and yield of both varieties of chickpeas.

Keywords: *C. indica*, SLF, *Cicer arietinum*, growth parameters.

1. INTRODUCTION

Cicer arietinum L., chickpeas are an important agricultural crop of the family Fabaceae, as they are rich in proteins, fibres, and minerals (Singh, *et al*., 2021). Even though chickpeas are eaten in more than 50 countries worldwide, South Asia is the largest producer of chickpeas, accounting for about 90% of the world's production (Gaur, *et al*., 2012; Koul, *et al*., 2022). Although several chemicals, as well as organic fertilizers are used throughout the world, chemical fertilizers are harmful to the environment, and although organic fertilizers are environment-friendly, their sources are becoming limited due to the increase in demand (Zodape, 2001). Studies suggest that seaweed fertilizers not only enrich the soil but also increase agricultural production, and therefore, they can be used as a safe alternative to other organic fertilizers (Thirumaran, *et al*., 2009; Mostafa, *et al*., 2022). It has been reported that extracts of brown seaweeds can protect plants from abiotic stress, and therefore play an important role in plant growth and development (Ali, *et al*., 2022). Thus, this study aimed to determine the influence of SLF derived from brown seaweed *C. indica*, which has the potential to promote the growth and development of Desi and Kabuli Chickpeas (*Cicer arietinum*).

2. MATERIALS AND METHODOLOGY

2.1 Collection of Samples

Seaweed *Cystoseira indica* was collected from Buleji, Karachi in 2022. After being transported back to the laboratory, the samples were washed thoroughly with tap water to remove epiphytes, sand particles, and other debris. Washed samples were air dried under shade and then ground using an electrical grinder.

Seeds of Desi and Kabuli Chickpeas were brought from a local market located in the University of Karachi. During visual observation, the seeds that were discolored, wrinkled, or showed signs of pest attack, were removed from the sample, and healthy seeds were selected for testing.

2.2 Preparation of SLF

To create a 100% stock solution, 50g of powdered *C. indica* was boiled for 30 minutes with 1000 ml of sterilized distilled water (1:20 w/v). After filtering, 50% of the total volume was recovered. Five different concentrations, 1%, 2%, 3%, 4%, and 5% were prepared from the stock solution (Bhosle, *et al*., 1975).

2.3 Experimental Design

The pots were filled with 1500g of garden soil, and labelled as control, 1%, 2%, 3%, 4%, and 5%. Five seeds were sown in each pot. Once seeds germinated, they were treated with foliar and root application of respective concentrations of SLF every week, while the control was provided with only tap water. All pots were watered every alternate day. Physical features including shoot length, number of leaves, pods, and flowers were also measured weekly, while the whole plant's height and weight, root length, and weight of pods were measured after harvesting. The data represented here shows mean values taken for four months.

3. RESULTS AND DISCUSSION

3.1 Shoot Length

It was observed that in Desi Chickpeas, lower concentrations increased (1%, 2%, and 3%) shoot length as compared to higher concentrations (4% and 5%). Initially, 2% had the highest shoot length, which was 20.45cm, while the lowest shoot length was observed in 5%, which was 12.97cm. At the same time control, 1%, 3%, and 4% had 19.95cm, 19.64cm, 18.72cm, and 16.84cm shoot lengths respectively. Inthe last month before harvesting, the shoot length of 3% pot had a maximum length of 40.38cm. In 5% pots, the shoot length increased from 12.97cm to 24.46cm, but later during the last month; plants started to dry, and the final shoot length was again 12.97cm. It was observed that in control, 1%, 2%, 4%, and 5% pots, shoot length increased for three months, but then the shoot tips started to dry out, therefore decreasing during the last month. Plants of control, 1%, 2%, and 4% had 36.76cm, 36.03cm, 33.23cm, and 29.04cm shoot lengths respectively before harvesting (Figure 1).

In the case of Kabuli Chickpeas, after germination the maximum shoot length was initially 14.65cm in 2% pots, while the average minimum length was observed in 3% pots which was 9.89cm. At the same time shoot lengths of control, 1%, 4%, and 5% were 12.48cm, 10.75cm, 10.91cm, and 10.38 cm respectively. When measured before harvesting, the maximum length was observed in 4% which was 34.96cm, while 3% had a minimum length of 10.28cm. Except for 4% pots, all other concentrations showed the best results during 3rd month of the experiment; and started to dry out during the final days. The maximum lengths of control, 1%, 2%, 3%, and 5% were 25.38cm, 30.93cm, 19.5cm, 12.3cm and 16.05cm (Figure 1).

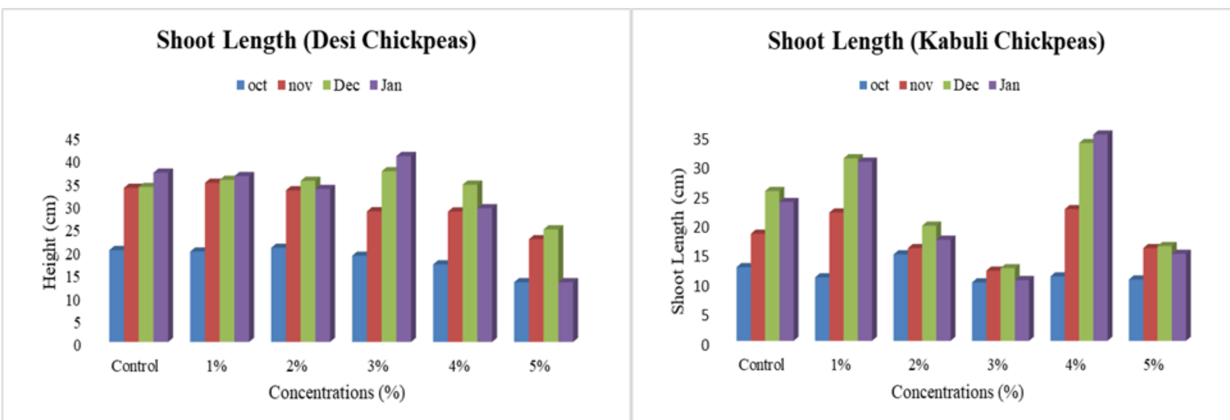

Figure 1: Shoot Length of Desi and Kabuli Chickpeas over Four Months

3.2 Number of Leaves

Both varieties of chickpeas possess imparipinnate leaves with 9-15 leaflets in each leaf (Pundir, *et al.*, 1990). The maximum number of leaves in each variety of chickpeas was present in the third month after starting the experiment, after which many leaves started to dry, thus reducing the total number of leaves at the time of harvesting. Initially, 1% and 2% had the maximum number (8) of leaves, 5% had minimum (6) leaves, while control, 3%, and 4% had 7 leaves each in the case of Desi chickpeas. Later, the maximum number of leaves was observed in 3%, which was 29. At the time of harvesting, the total number of leaves was 22, 20, 14, 21, 19, and 9 in control, 1%, 2%, 3%, 4% and 5% respectively. In the case of Kabuli chickpeas, initially, 1%, 2%, and 5% had a higher number of leaves (6), while control, 3%, and 4% had 5 leaves. Overall, 1% and 4% showed the most number of leaves in the third month (29). During the last days, control, 1%, and 4% had maximum leaves (23), while 3% had the least number of leaves (9) (Figure 2).

3.3 Root Length

The root length, total height, and weight of chickpea plants were recorded after harvesting. In Desi chickpeas, the maximum root length was present in 4% (17.96cm), while the minimum root length was seen in control (11.68cm). In the case of Kabuli chickpeas, the best results were observed in 3% (41.35cm), while 5% concentration showed the least growth in root length (7.96cm) (Figure 3).

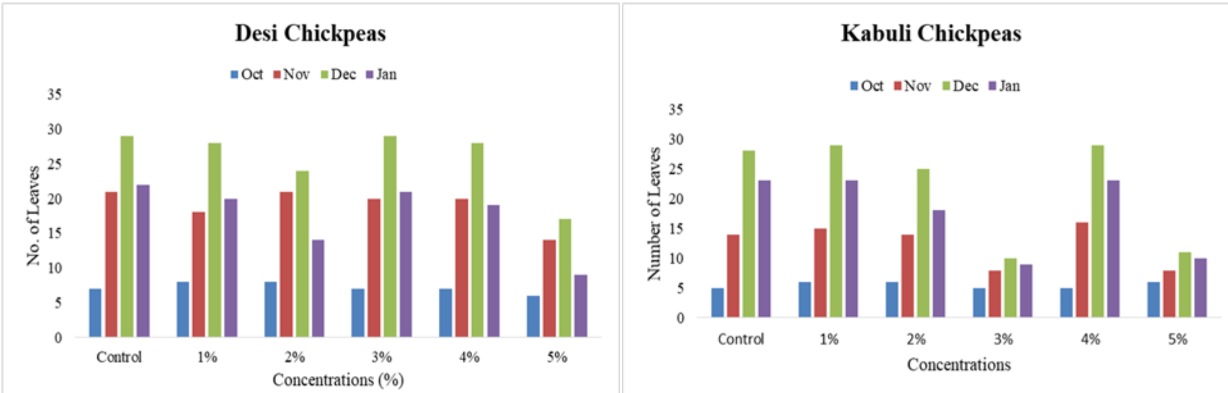

Figure 2: Total Number of Leaves in Desi and Kabuli Chickpeas over Four Months

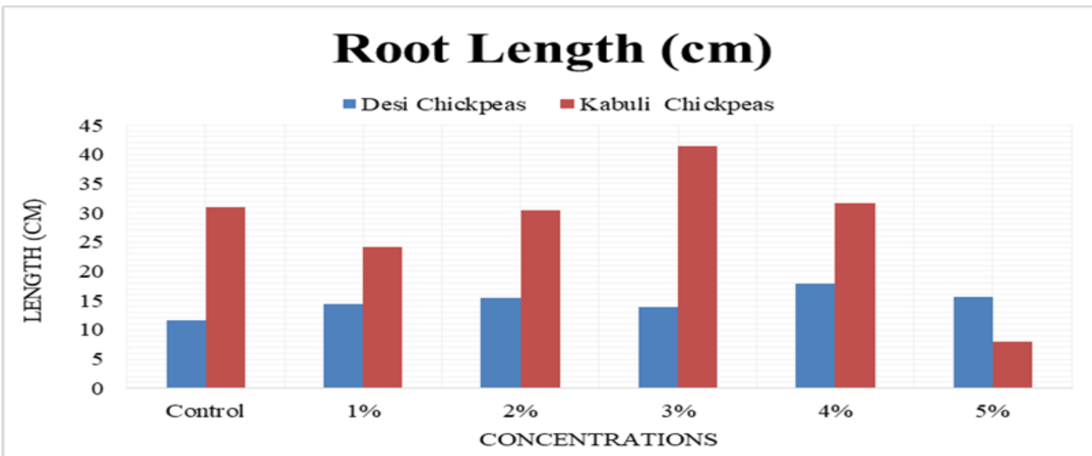

Figure 3: Root Length of Chickpeas Measured After Harvesting

3.4 Plant Height and Weight

The maximum plant height was observed in 4% in Desi chickpeas (53.08cm) and 3% in Kabuli chickpeas (70.77cm), while both varieties showed the least increase in 5% concentration, (42.28cm) and (31.73cm) respectively. Similarly, 5% concentration had the least plant weight in both Desi (0.57g) and Kabuli (1.3g) chickpeas, while 2% had the best result in Desi chickpeas (1.93g) and control had maximum plant weight (4.17g) in Kabuli chickpeas (Figure 4).

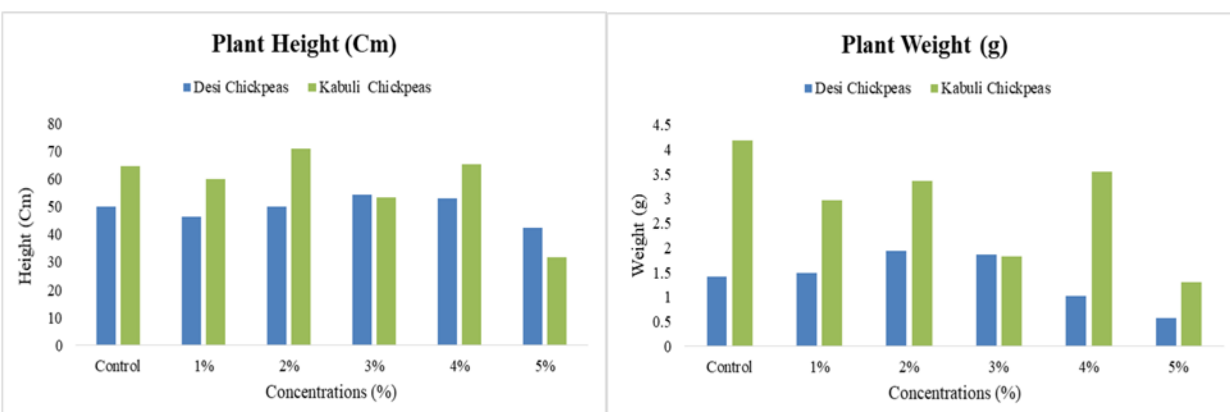

Figure 4: Plant Height (Cm) and Plant Weight (g) of Desi and Kabuli Chickpeas

3.5 Number of Buds, Flowers, and Pods

Although the number of leaves and shoot length started to decrease in the last month, the number of buds and flowers increased in both types. The controls of both varieties had the maximum number of buds on average (21 in Desi and 12 in Kabuli), while the 5% concentration had the least number of buds (4 in Desi chickpeas). Budding failed to occur in Kabuli chickpea at the specified concentration (Fig. 5). In all concentrations tested, a majority of the buds didn't bloom into flowers. In 2% concentration, the maximum flowers bloomed, *i.e.*, 11 and 3 in Desi and Kabuli chickpeas, respectively, while only one flower was bloomed in 4% of Kabuli chickpeas. The 5% SLF-treated Desi variety of chickpeas revealed the presence of seven flowers (Fig. 5). It is an interesting finding that the frequency of budding was inversely proportional to increasing the concentration of SLF in Desi chickpeas, while the pattern of budding was inconsistent in Kabuli type. The total number of pods was greater in the Kabuli variety as compared to its Desi counterpart. In Desi chickpeas, one pod developed each in 2% and 3% concentrations, while in Kabuli chickpeas, maximum pods were produced in 2% concentration (5), and 3 flowers each were present in the control and 3% concentration. The average maximum weight of pods was observed in 3% concentration, which was 0.41g in Desi chickpeas and 0.39g in Kabuli chickpeas (Fig. 6).

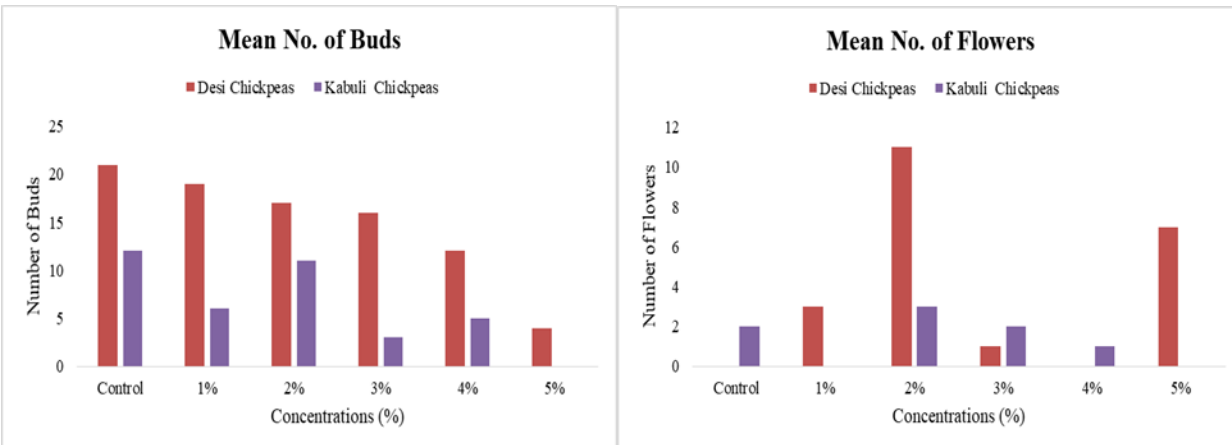

Figure 5: Average Number of Buds and Flowers in Both Varieties.

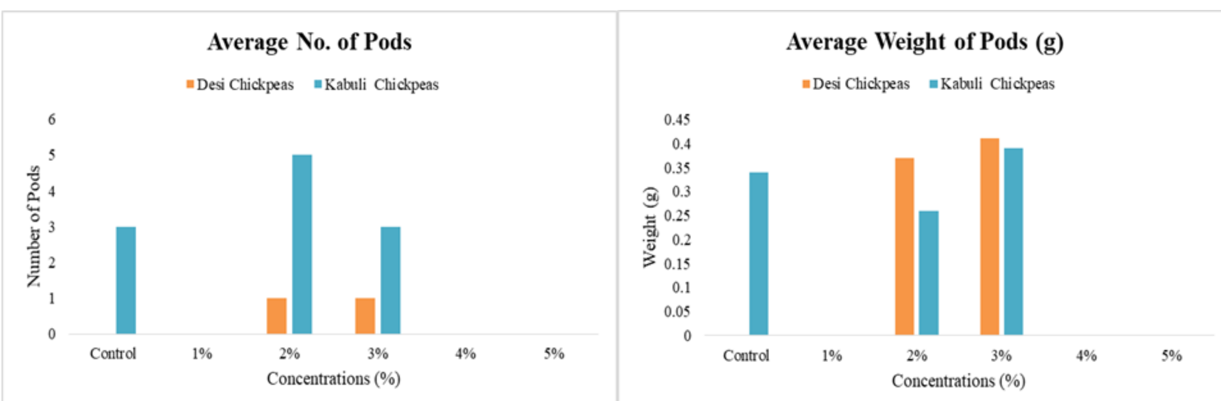

Figure 6: Yield and Weight of Pods in Desi and Kabuli Chickpeas

Seaweeds are rich in minerals, vitamins, and growth-promoting agents, due to which they enhance yield and can play a significant role in plant growth (Bharath, *et al.*, 2018; Saeid, *et al.*, 2021). Therefore, this research was carried out to study the effects of seaweed liquid fertilizer (SLF) obtained from *Cystoseira indica* on the physical parameters of Desi and Kabuli chickpeas. Five different concentrations, 1%, 2%, 3%, 4%, and 5%, were tested. The experiment was carried out for four months. The shoot length, number of leaves, buds, flowers, and pods were measured weekly, while root length, plant height, plant weight, and weight of pods were observed after harvesting (Figures 7 & 8).

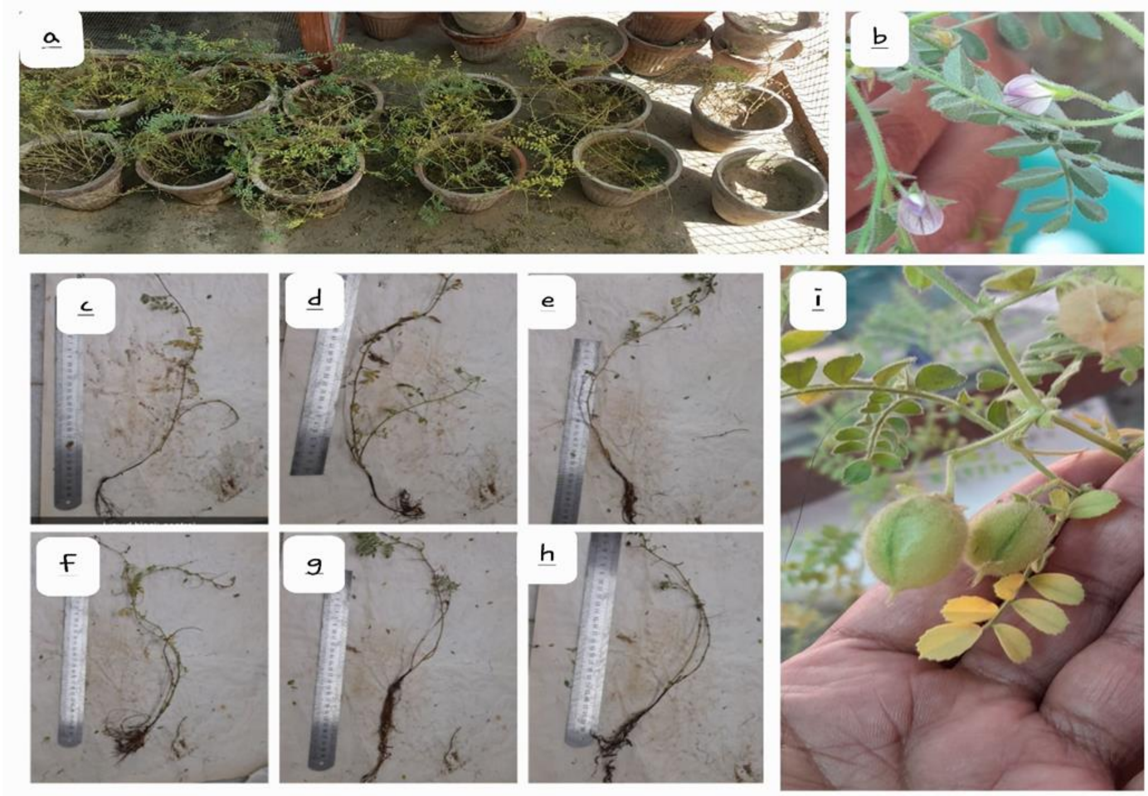

Figure 7: Desi Chickpeas Growing in Pots (a), Flowering in 2% Concentration (b), Plant Height & Root Measurement in Control, 1%, 2%, 3%, 4% & 5% (c-h), and Pods in 2% Concentration (i).

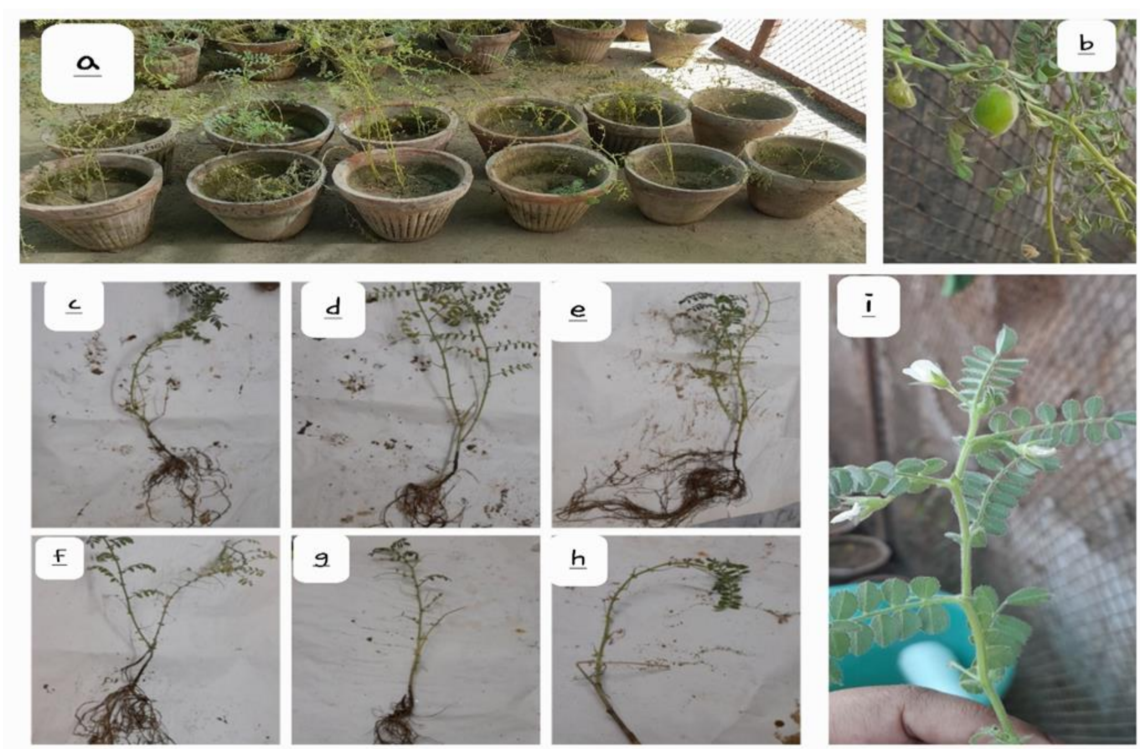

Figure 8: Kabuli Chickpeas Growing in Pots (a), Pods growing in 2% Concentration (b), Plant Height & Root Measurement in Control, 1%, 2%, 3%, 4% & 5% (c-h), and Flowering in 2% Concentration (i).

Our findings indicate that lower concentrations of SLF (1%, 2%, and 3%) have a higher impact on the shoot length of Desi chickpeas as compared to higher concentrations, while Kabuli chickpeas show maximum shoot length in 4% concentration. Previously, Hafsah, *et al*., (2023), also reported similar results, that Desi Chickpeas show higher germination in lower concentrations, while Kabuli chickpeas show a greater germination rate in higher concentrations when treated with SLF obtained from *C. indica*. Pudoli, *et al.*, (2022) have also proven that 0.5% and 1% liquid extracts obtained from the red seaweed *Gracilaria* sp. significantly increase the growth of Cayenne pepper. It was also observed in this study that the maximum number of leaves was observed in 3% of Desi chickpeas, and 1% and 4% in Kabuli chickpeas. Leila, *et al*., (2018) observed that when Barley (*Hordeum vulgare* L.) was treated with 10%, 30%, 50%, and 100% SLF of brown seaweed *Cystoseira mediterranea*, 50% extract showed significant results on all parameters, including shoot length. Bharath, *et al.,* (2018) have also previously reported that the 3% concentration of *Sargassum polycystum* extract shows the highest shoot and root length, leaf area, root nodules, and fresh and dry weights of *Vigna radiata* and *V. mungo*, while 5% decreases these growth parameters.

The maximum root length and plant height in this experiment were observed in 3% concentration in Desi chickpeas and 4% concentration in Kabuli chickpeas. The highest concentration tested, *i.e.* 5%, had minimum root length, plant height, and plant weight in both varieties. It has been reported that higher concentrations of seaweed liquid fertilizer (SLF) have a toxic effect on plants (Arun, *et al*., 2014). In terms of plant weight, in this study, the control had maximum weight in Kabuli chickpeas, while 2% showed the best results in Desi chickpeas. The increase in root and shoot length of chickpeas can be due to the high amount of phosphorus in seaweed liquid fertilizer (SLF), as SLFs rapidly increase root length, due to which plants can easily penetrate deeper soil and uptake higher amounts of nutrients (Shri Devi, *et al*., 2014). In a previous study, Nerlekar, *et al*., (2021) proved that a lower concentration of 10% obtained from the aquatic plant *Hydrilla* caused the maximum increase in the shoot and root length of chickpeas. Rao, & Chatterjee, (2014) have also previously proved that red seaweed *Gracilaria textorii* and *Hypnea musciformis* when used in lower ratios increased more weight and number of leaves in tomatoes, brinjal, and chillies as compared to higher ratios and control.

The maximum number of flowers in this study was observed in 2% concentration of SLF. Sharma et al 2014 observed that foliar application of macro-algal biostimulants in low concentrations increased the yield of crops. Kalaivany, *et al*., (2019) suggested that the presence of growth-promoting hormones and phosphorus in seaweeds initiates flowering in plants and proved that 20% concentrated extract of *Sargassum crassifolium* L. enhances flowering in Black-eyed peas [*Vigna unguiculata* (L.)]. It was also observed in this experiment that lower concentrations (2% and 3%) had the most number of pods, while 3% had the maximum weight of pods in both varieties. A previous study conducted by Jadhao, *et al.,* (2015) had similar results, in which lower concentration (10%) increased the number of pods as well as pod weight in black gram [*Vigna mungo* (L.) Hepper] and decreased in higher concentration (15%). Kurakula, & Rai, (2021) also proved in their study that a 2% extract of *Ascophyllum nodosum* caused a maximum increase in the yield and weight of pods of both varieties of chickpeas.

Seaweed has been reported to act as bio-fertilizers because of nutrients and growth-promoting components (Khan, *et al*., 2009; Ramya *et al*., 2015). Since chickpeas are a high source of carbohydrates and proteins (Jukanti, *et al*., 2012) and have a high consumption rate, particularly in the subcontinent (Singh & Kochhar 2005; Sharma, *et al*., 2021), this study was carried out to investigate the effects of seaweed liquid fertilizer (SLF) obtained from brown seaweed *Cystoseira indica* on physical parameters and yield of Desi and Kabuli chickpeas.

4. CONCLUSION

Results indicate that when used in small quantities, *C. indica* enhances growth parameters and yield in both varieties of chickpeas. Therefore, this study concludes that SLF obtained from *C. indica* can be used as a safe environment-friendly alternative for better growth and yield of chickpeas. It is further recommended that this SLF should be further tested for other crops as well.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTION

All authors put their equal share as per the expertise.

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