"Effect of seaweed fertilizers on the growth and yield of Cluster bean (*Cyamopsis tetragonoloba* L. Taub Var. Pusanavbahar) crop"

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Abstract

Seaweeds, otherwise known as marine algae. Algae are primitive non flowering photosynthetic macrophytes occurring in tidal regions of seas and oceans that occupy 71% of all the globe and they are natural renewable resources. The present study, three different seaweeds were selected viz., *Sargassum wightii*, *Kappaphycus alvarezii* and *Turbinaria ornata*. The formulation was evaluated for bio stimulant potential by performing a pot culture on cluster bean. The different concentrations such as 3%, 6% and 9% and mixed concentrations along with control were prepared and given as foliar spray and observed various parameters like, seed germination percentage, 30th day survivability, 7th day and 15th day shoot length and root length, days to first blooming, plant height (cm), number of leaves per plant, length of fruit (cm), breadth of the fruit (cm), Weight of fruit per plant (g). Among the three weeds examined *Kappaphycus alvarezii* are better results when compared to control and other treated concentrations. All the parameters were significantly decreased increasing dose/concentrations. 7th day and 15th day shoot length and root length maximum was observed in mixed algae when compared to control and other treated concentrations. Days to first blooming (earliest flowering) was observed in *Kappaphycus alvarezii* and *Sargassum wightii* (35 days) 3% concentration. The growth enhancing potential of sea weed might be attributed to the presents of carbohydrate, phenyl acetic acid, micro and macro elements. SLF could serve as cost effective ecofriendly product for sustainable agriculture.

Keywords: SLF, cluster bean, seaweed, germination, yield.

Introduction

Seaweed extract is new generation of natural organic source of nutrients help the plant growth and development entire crop cycle from seed germination to plant maturity in a number of ways, including improving the efficiency of the plant's metabolism to induce yield and enhanced crop value (Saravanan *et.al.*, 2003). Seaweed liquid extract newly gained importance as foliar spray for lots of crops with various varieties of grasses, flowers, cereals, vegetables and spices (Pramanick *et.al.*, 2014). The seaweed extracts are good source of macronutrients (Ca, K and P) and micronutrients (Cu, Zn, B, Mn, Co and Mo), organic acids, vitamins, amino acids, antioxidants and composite minerals that can be recovered from its extracts (Craigie 2011., Stirk *et.al*., 2014 and Herrera *et.al*., 2014).

The seaweed extracts directly manipulate a wide array of responses in plants such as, root and shoot growth, superior chlorophyll content, enhanced nutrient uptake, augmented flower and fruit set leading to elevated yields, delayed senescence and longer shelf life of fruits (Khan *et.al*., 2009, Stirk *et.al*., 2014 and Dominguez *et.al*., 2014). Seaweed fertilizer is made from fresh or dried seaweeds by mechanical grinding, aqueous extract, acid hydrolysis or alkaline hydrolysis and the efficiency differs for the mode of treatment, like seed treatment, soil application, root dip, foliar application and irrigation (Cristofano *et.al.*, 2021).

Seaweed's metabolic activity look like terrestrial plants; it contains Auxin, Gibberellin, Cytokinin and other phytohormones responsible for plant growth, maturity and yield (Yalcln *et.al*., 2020).

Seaweed manure besides increasing the soil fertility increases the moisture holding capacity and supplies suitable trace metals thereby improving the soil structure (Sridhar and Rengasamy, 2010 and Paul and Yuvaraj, 2014). The wide range of beneficial effects of seaweed foliar spray applications on plants in terms of health of plants, increase in rate of growth and antioxidant properties, resistance to frost, fungal and insects attack, higher yield of 25 to 30% etc (Kalaivanan *et.al.*, 2012). Liquid extracts obtained from seaweeds have gained popularly as foliar sprays for many crops. These extracts contain cytokines, growth promoting hormones, elements, vitamins and aminoacids (Ajmal *et.al*., 2018).

Guar or cluster bean (*Cyamopsis tetragonoloba* L. Taub) is summer annual plant, belonging to Fabaceae (Leguminaceae) family. Young pods of guar (cluster been) have been a good source of protein, carbohydrates, vitamins A and C, as well as containing necessity minerals such as Ca and Fe (Kumar and Singh, 2002). Guar seeds are the main source of natural polysaccharide (galactomannan) which is commercially known as guar gum. Guar gum has been beneficial uses as an appetizer, laxative, digestive aid, cooling agent and also in dyspepsia and anorexia. Antiulcer, cyto protective, hypolipidemic, hypo-glycemic, anti-secretory and antihyperglycemic effects (Mukhtar *et.al.*, 2006). Hence the present study was conducted to find out the effect of seaweeds on the growth and yield.

Materials and methods

The three seaweeds were selected for this study like, *Sargassum wightii*, *Kappaphycus alvarezii* and *Turbinaria ornate*, locations are *Sargassum wightii*- N $09^0 12.568^0$, E $079^0 18.634^0$Gulf of Mannar, *Kappaphycus alvarezii*- N $09^0 17.409^0$, E $079^0 19.283^0$ Palk Bay and *Turbinaria ornata*N $09^0 12.568^0$, E $079^0 08.634$ Gulf of Mannar.

The samples were collected from Mandapam, Ramnathapuram District, Tamil Nadu. Collected samples were shade air dried and prepare a fine powder. About 20g dried seaweed powder with 200ml distilled water was added. It was heated to 60^0C and maintained at the temperature for 24h using a hot air oven. The 100 ml extract was filtered and stored in air tight bottles at 4° C (100% seaweed concentrate) Rama Rao., 1990. Suitable dilution (3%, 6%, 9% and mixed concentrations along with control) seaweed liquid fertilizers was used for soil application on Cluster bean crop. The viable cluster bean seeds (Variety-Pusanavbahar) were collected from Tenkasi District Tamil Nadu. The formulation was evaluated for bio stimulant potential by performing a pot culture on cluster bean. Weeding and watering were done at regular intervals throughout the experimental period.

Plants from each treatment were randomly selected to study the growth parameters like, Seed germination percentage, 30^{th} day survivability, 7^{th} day and 15^{th} day shoot length, 7^{th} day and 15^{th} day root length, Days to first blooming, Plant height (cm), Number of leaves per plant, Length of fruit (cm), Breadth of fruit (cm), Weight of the fruit and Total number of fruits per plant were recorded.

Results and Discussion

The present investigation three seaweeds were selected for this study like, *Sargassum wightii*, *Kappaphycus alvarezii* and *Turbinaria ornata.* To observe the effect of SLF on the seed cluster bean field. The hundred percentage germination was observed in Control *Kappaphycus alvarezii*, *Sargassum wightii*, *Turbinaria ornata* and mixed algae (Table-1). The effect of SLF 30th day survivability in cluster bean 100% survivable observed in *Kappaphycus alvarezii*, *Sargassum wightii*, *Turbinaria ornata* and control. The decreasing survivability was observed in mixed algae (Table-2).

The application of seaweed extracts enhanced plant growth development, yield and mineral composition of plants. The use of seaweed extracts in agriculture are not only reduces the application of harmful agrochemicals but it helps in protecting the environment (Ashok Kumar and Thapa., 2022).

On 7th day maximum shoot length was observed in mixed algae 3% concentration (11.5cm) and lowest was observed in *Kappaphycus* concentration of 9% (6.7cm) when compared to the control and other concentrations. The 15th day highest shoot length was observed in Mixed algae, *Kappaphycus alvarezii* and *Turbinaria ornata* (15, 14, 14 cm respectively) in 3% concentrations. The lowest (9.2 cm) was noted in 9% concentration of *Kappaphycus alvarezii* in cluster bean (Table-3). Same result was reported by (Arun *et al.*, 2014) in *Abelmoschus esculentus.*

The growth, biochemical and yield characteristics of vegetable crop cluster bean might be due to the presence of micro and macro elements, growth hormones, trace elements, vitamins (Sivasangari ramya *et al.*, 2011 in cluster bean). The growth enhancing potential of sea weed might be attributed to the presents of carbohydrate, phenyl acetic acid, micro and macro elements (Booth., 1965; Taylor and Wilkinson, 1977 and Challen and Hemingway., 1965)

In 7th day highest root length was observed in *Kappaphycus alvarezii* 3% concentration (5.0cm) and lowest root length was observed in *Turbinaria ornata* concentration of 3% (3.3cm) and *Kappaphycus alvarezii* concentration of 9% (3.2cm) when compared to the control and other concentrations. The 15th day maximum root length was observed in mixed algae 3% (9.5cm). The lowest (4.1cm) was noted in 9% concentrations of *Kappaphycus alvarezii* in cluster bean (Table-4). The seaweed liquid fertilizer was found to be effective in increasing the shoot length and root length, growth, yield and low doses than the control (Narasimha Rao and Reshmi Chatterjee., 2014).

Days to first blooming was observed in *Kappaphycus alvarezii* (35) Table-5. The decrease the blooming time increasing the crop duration. when compared to the control and other concentrations. Seaweed extracts can be recommended as biofertilizer to be used alone or in combinations with other biofertilizers and applied to soil or foliage for improved growth. When abundant distribution, great generation potential and assay mass cultivation, the seaweed biofertilizer seems a feasible substitute to synthetic fertilizers. Such seaweeds are used for organic farming, dependence on chemical fertilizers can be reduced (Divya and Niranjana Reddi., 2017).

The maximum plant height was observed in *Kappaphycus alvarezii* 3% concentrations (88.9cm). The minimum plant height was observed in mixed algel concentration of 9% (65.9) (Table-6) when compared to the control and other concentrations. Seaweed is valuably use for plant germination and their growth there by recover the yield and resistance ability of many crops (Moller and Smith 1998 and Zodape *et.al.*, 2010). Fertilizer potential of sea weed *Kappaphycus* and *Gracilaria* saps in potato crop plant heights are significantly increased plant height when compared to the control (Singh *et al.*, 2017).

The highest number of leaves in *Cyamopsis tetragonoloba* observed in *Kappaphycus alvarezii* (20 number) 3% concentrations and lowest number of leaves was observed in mixed algae (11) 9% concentrations (Table-7). Foliar application of SLF positively increased number of leaves. The application of SLF highest rate was not efficacious. The lowest concentration is promoting number of leaves when compared to the control and other concentrations. Seaweed contains considerable number of micronutrients and some plant growth hormones which helps plant growth and germination. Same results were reported by (Mazhar Abbas *et al.*, 2020 and Arun *et al.*, 2014).

The maximum length of fruit were observed in *Kappaphycus alvarezii* 3% concentration (14.8) and lowest observed in 9% concentration (11.8) of cluster bean (Table-8). The plant *Abelmoschus esculentus* observed (Magesh vedpathak and Balbhim Chavan., 2018 and Singh *et al.*, 2017 in potato and Sivasangari ramya, 2011 in cluster bean shows the same results.

In breadth of fruit length highest noticed in 3% concentration of *Kappaphycus alvarezii* (1.5cm). The lowest was noticed in mixed algae (1.0cm) 3% and 6% respectively (Table-9). Higher concentrations were found to show inhibitive effect. Same results were observed by Sivasangari ramya., 2011in cluster bean.

Weight of the fruit and number of fruits per plant, the highest weight and number of fruits was observed in *Kappaphycus alvarezii and* followed by *Sargassum wightii* of lowest concentrations of seaweeds. The lowest was noticed in 6% concentration of mixed algae. When compared to the control and other treated concentrations of seaweeds.

SLF to vegetables is recommended to the farmers for attaining better growth and yied over chemical fertilizers. Seaweed extracts can be recommended as bio fertilizer apply for soil or foliar spray for improved growth. With abundant distribution, great generation potential and essay mass cultivation, the seaweed bio fertilizer seems a feasible substitute (Divya and Niranjana Reddi., 2017).

Conclusion

Cluster bean is an important vegetable crop which is a source for higher nutrition such as Fiber, Potassium,VitaminA, VitaminC, Calcium, Iron. Seaweed liquid fertilizers are useful for achieving higher agricultural production, because the seaweed extract contains growth promoting hormones like Auxins, cytokinins, Gibberllins, Abscisic acid, Ethylene, Betaine and Polyamines other than the trace elements, vitamins, amino acids, antibiotics and micronutrients.

In the present investigation, the seaweed extracts of *Sargassum wightii*, *Kappaphycus alvarezii*and *Turbinaria ornate* was studied on the Cluster bean variety- Pusanavbahar. The aqueous extract of SLF (3 ,6 and 9%) concentrations using various parameters were observed. Among the three-weed examined *Kappaphycu salvarezii* are better results when compared to control and other treated concentrations. All the parameters were significantly decreased increasing dose/concentrations. Days to first blooming (earliest flowering) was observed in *Kappaphycus alvarezii* and *Sargassum wightii* (35days) 3% concentration. Seaweed liquid fertilizer to vegetables is recommended to the farmers for attaining better growth and yield over chemical fertilizers. Seaweed extracts can be recommended as bio fertilizer apply for soil or foliar spray for improved growth. With abundant distribution, great generation potential and assay mass cultivation, the seaweed bio fertilizer seems a feasible substitute.

Table-1

Determination of seed germination percentage (%) in *Cyamopsis tetragonoloba* L.

Control	100					
Concentrations	3%	Percentage reduction over control	6%	Percentage reduction over	9%	Percentage reduction over
Kappaphycus alvarezii	100	-	100	-	100	-
Sargassum wightii	100	-	100	-	100	-
Turbinaria ornate	100	-	100	-	100	-
Mixed algae	100	-	100	-	100	-

Table-2

Effect of 30th day survivability in *Cyamopsis tetragonoloba* L.

Control	100					
Concentrations	3%	Percentage reduction over control	6%	Percentage reduction over	9%	Percentage reduction over
Kappaphycus alvarezii	100	-	100	-	100	-
Sargassum wightii	100	-	100	-	100	-
Turbinaria ornate	100	-	100	-	100	-
Mixed algae	95	5	90	10	100	-

Table-3

7th day and 15th day shoot length (cm/seedling) in *Cyamopsis tetragonoloba* L.

Parameters	7th day shoot length (cm)			15th day shoot length (cm)		
Control	8.3 ± 1.21 (0.7)			11.7 ± 0.45 (0.26)		
Concentrations	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**
Kappaphycus alvarezii	9.8 ± 1.45 (0.83)	8.0 ± 1 (0.57)	6.7 ± 0.43 (0.25)	14 ± 1.49 (0.68)	10.5 ± 2.49 (1.28)	9.2 ± 2.04 (1.18)
Sargassum wightii	9.5 ± 0.75 (0.43)	9.0 ± 0.55 (0.32)	7.5 ± 0.43 (0.25)	13 ± 2.48 (0.34)	12.3 ± 0.62 (0.28)	12 ± 1.16 (1.01)
Turbinaria ornate	10.2 ± 1.6 (0.92)	8.9 ± 0.62 (0.36)	8.6 ± 0.65 (0.37)	14 ± 1.68 (0.57)	10.2 ± 2.42 (0.97)	13.2 ± 2.25 (1.02)
Mixed algae	11.5 ± 0.81 (0.47)	9.8 ± 1.05 (0.61)	9.7 ± 1.04 (0.60)	15 ± 1.95 (1.15)	11.5 ± 2.35 (0.47)	11 ± 1.39 (1.15)

Table-4 7th day and 15th day root length (cm/seedling) in *Cyamopsis tetragonoloba* L.

Parameters	7th day root length (cm)			15th day root length (cm)		
Control	3.6 ± 0.52 (0.31)			7.0 ± 1.5 (0.86)		
Concentrations	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**
Kappaphycus alvarezii	5.0 ± 0.43(0.25)	4.5 ± 0.62 (0.36)	3.2 ± 0.75 (0.43)	6.5 ± 0.95 (0.55)	6.0 ± 0.3 (0.17)	4.1 ± 0.62 (0.36)
Sargassum wightii	3.5 ± 0.55 (0.32)	4.0 ± 0.7 (0.41)	4.5 ± 0.7 (0.41)	6.7 ± 0.55 (0.32)	6.2 ± 0.43 (0.25)	5.8 ± 0.52 (0.31)
Turbinaria ornata	3.3 ± 0.65 (0.37)	3.8 ± 0.7 (0.41)	3.5 ± 0.62 (0.36)	7.1 ± 0.7 (0.41)	5.0 ± 0.26 (0.15)	6.5 ± 0.9 (0.51)
Mixed algae	4.5 ± 0.78 (0.45)	3.5 ± 0.52 (0.31)	3.9 ± 0.65 (0.37)	9.5 ± 0.75 (0.43)	5.5 ± 0.62 (0.36)	4.8 ± 0.52 (0.31)

Table- 5

Days to first blooming (Days) in *Cyamopsis tetragonoloba* L

Control	37± 1.88 (0.59)		
Concentrations	Mean± SD (SE) **3%**	Mean± SD (SE) **6%**	Mean± SD (SE) **9%**
Kappaphycus alvarezii	35± 1.55 (0.32)	36± 1.63 (0.32)	42± 1.71(0.25)
Sargassum wightii	35± 1.59 (0.38)	38± 1.43 (0.29)	40± 1.78 (0.41)
Turbinaria ornate	39± 1.25 (0.28)	40± 1.73 (0.42)	39± 1.45 (0.22)
Mixed algae	42± 1.69 (0.31)	39± 1.35 (0.27)	39± 1.25 (0.29)

Table-6

Determination of plant height (cm) in *Cyamopsis tetragonoloba* L .

Control	56.0± 2.09 (0.66)		
Concentrations	Mean± SD (SE) **3%**	Mean± SD (SE) **6%**	Mean± SD (SE) **9%**
Kappaphycus alvarezii	88.9± 3.09 (0.91)	78.1± 2.11 (0.43)	75.0± 2.76 (0.12)
Sargassum wightii	85.2± 2.09 (0.96)	76.8± 3.09 (1.20)	72.3± 2.55 (0.16)
Turbinaria ornate	76.0± 2.99 (0.07)	71.6± 2.76 (0.82)	68.8± 2.09 (0.66)
Mixed algae	68.5± 2.69 (1.34)	67.4± 2.45 (1.22)	65.9± 1.77 (0.55)

Table-7

Range of Number of Leaves in *Cyamopsis tetragonoloba* L .

Control	10± 2.02 (0.64)		
Concentrations	Mean± SD (SE) **3%**	Mean± SD (SE) **6%**	Mean± SD (SE) **9%**
Kappaphycus alvarezii	20± 3.02 (1.03)	18± 2.51 (0.79)	15± 2.33 (0.73)
Sargassum wightii	19± 2.69 (0.68)	16± 2.47 (0.23)	14± 1.09 (0.23)
Turbinaria ornate	18± 2.19 (0.60)	16± 2.39 (0.50)	13± 1.29 (0.06)
Mixed algae	13± 1.09 (0.68)	12± 2.00 (0.01)	11± 1.03 (0.17)

Table- 8 Effect of seaweed liquid fertilizer treatment on length of Fruit (cm) in *Cyamopsis tetragonoloba* L

Control	10.4 ± 0.81 (0.47)		
Concentrations	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**
Kappaphycus alvarezii	14.8 ± 0.43 (0.25)	13.4 ± 0.52 (0.31)	12.1 ± 0.65 (0.37)
Sargassum wightii	14.1 ± 0.3 (0.17)	12.9 ± 0.96 (0.55)	13.9 ± 1.15 (0.66)
Turbinaria ornata	12.9 ± 0.45 (0.26)	12.5 ± 1.94 (1.12)	12.2 ± 0.26 (0.15)
Mixed algae	13.7 ± 1.17 (0.68)	12.0 ± 1 (0.57)	11.8 ± 1.47 (0.85)

Table-9 Effect of seaweed liquid fertilizer treatment on breath of fruit (cm) in *Cyamopsis tetragonoloba* L .

Control	0.9± 0.42 (0.13)		
Concentrations	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**
Kappaphycus alvarezii	1.5± 0.09 (0.21)	1.2± 0.47 (0.15)	1.2± 0.47 (0.15)
Sargassum wightii	1.4± 0.66 (0.22)	1.1± 0.33 (0.11)	1.3± 0.56 (0.18)
Turbinaria ornata	1.1± 0.33 (0.11)	1.0± 0.16 (0.55)	1.31.3± 0.56 (0.18)
Mixed algae	1.0± 0.16 (0.55)	1.0± 0.16 (0.55)	1.1± 0.33 (0.11)

Table-10

Effect of SLF treatment on weight of the fruit (gm) in *Cyamopsis tetragonoloba* L.

Control	2.8 ± 1.49 (0.86)		
Concentrations	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**
Kappaphycus alvarezii	5.3 ± 0.43 (0.25)	4 ± 0.79 (0.45)	3.3 ± 0.45 (0.26)
Sargassum wightii	4.6 ± 0.5 (0.28)	3.1 ± 0.7 (0.40)	3.6 ± 0.55 (0.32)
Turbinaria ornate	4 ± 0.7 (0.41)	3.4 ± 0.8 (0.46)	3.7 ± 0.6 (0.34)
Mixed algae	4.5 ± 1.08 (0.62)	3.1 ± 0.51 (0.3)	3.4 ± 0.62 (0.36)

Table-11

Effect of seaweed fertilizer treatment on total number of fruits per plant in *Cyamopsis tetragonoloba* L.

Control	18± 2.06 (0.68)		
Concentrations	Mean ± SD (SE) **3%**	Mean ± SD (SE) **6%**	Mean ± SD (SE) **9%**
Kappaphycus alvarezii	47± 2.02 (0.64)	24± 2.71 (0.85)	22± 1.93 (0.61)
Sargassum wightii	39± 2.60 (0.82)	25± 2.60 (0.82)	27± 2.31 (0.75)
Turbinaria ornata	26± 1.58 (0.5)	24± 2.71 (0.85)	29± 2.21 (0.7)
Mixed algae	17± 1.81 (0.57)	11± 2.65 (0.84)	20± 2.11 (0.66)

Figure-1 **Seed germination percentage % in cluster bean**

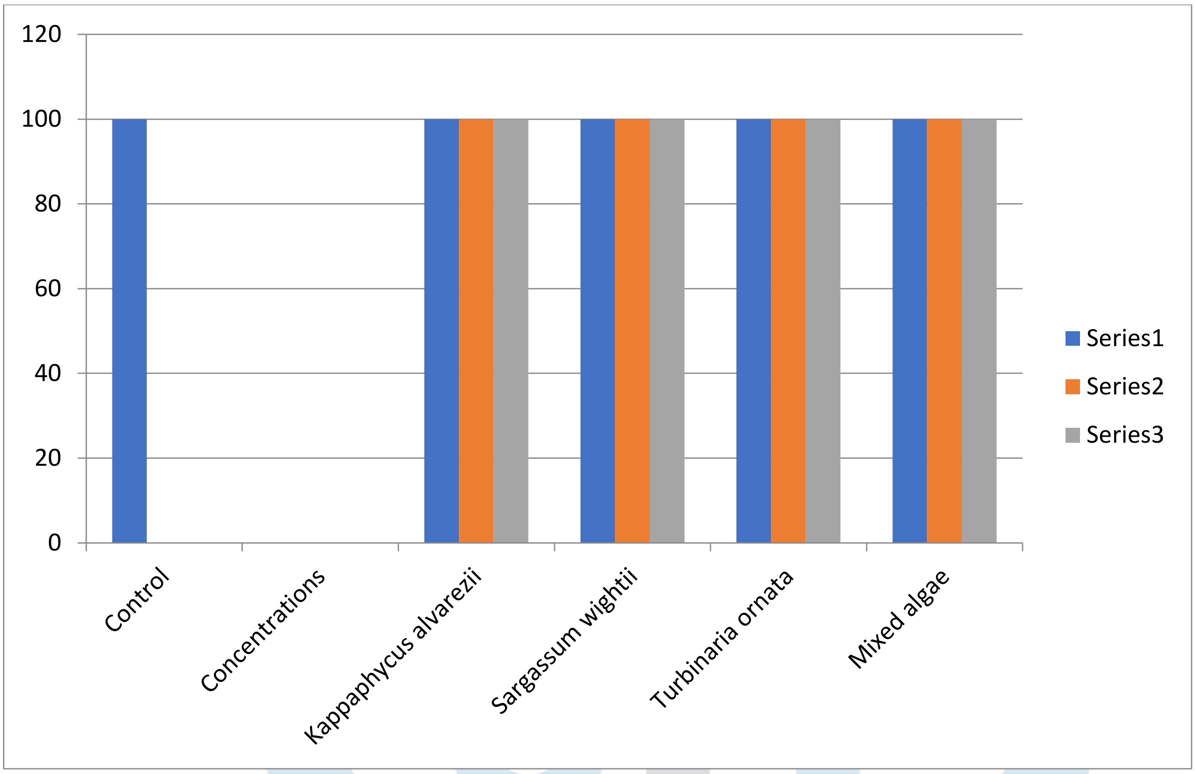


Figure-2 **30th day survivability in cluster bean**

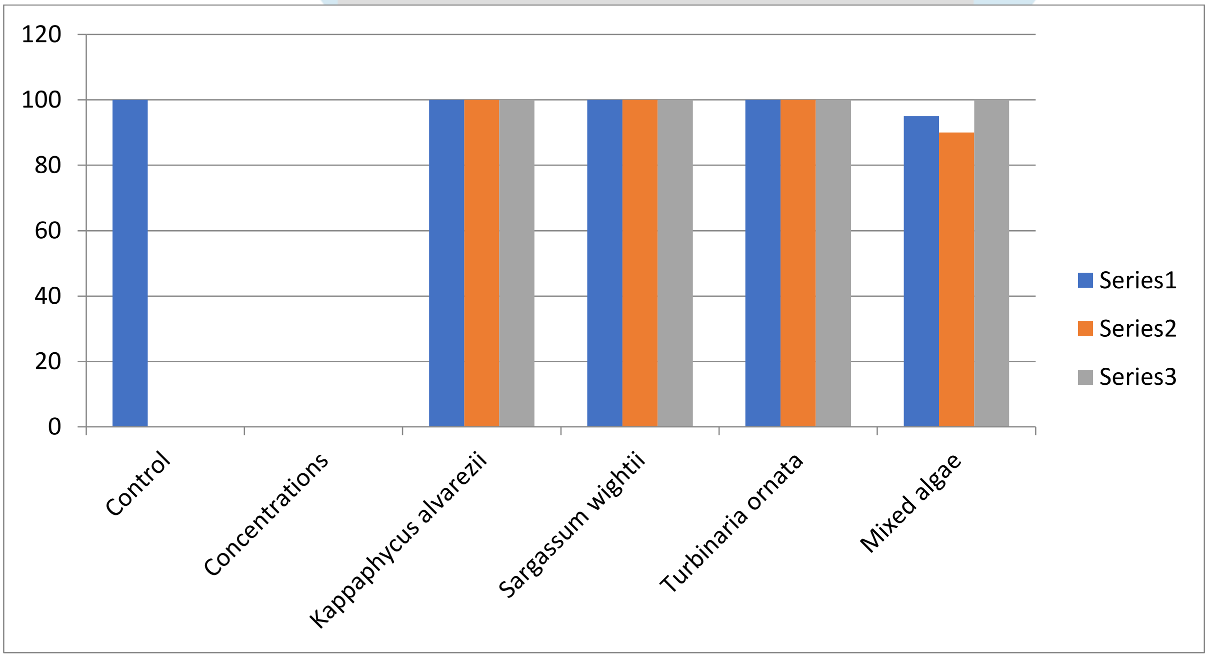


Figure-3 **7th day shoot length(cm/seedling) in *Cyamopsis tetragonoloba***

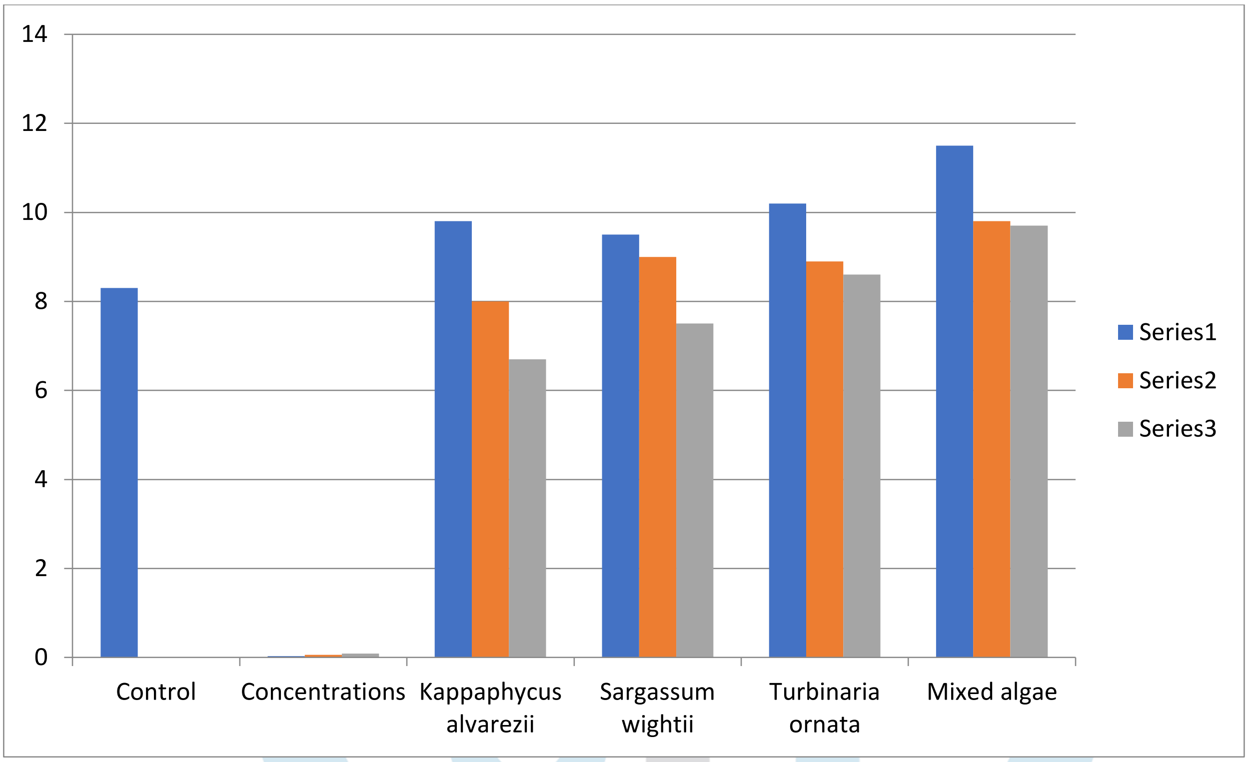


Figure-4 **7th day root length(cm/seedling) in *Cyamopsis tetragonoloba***

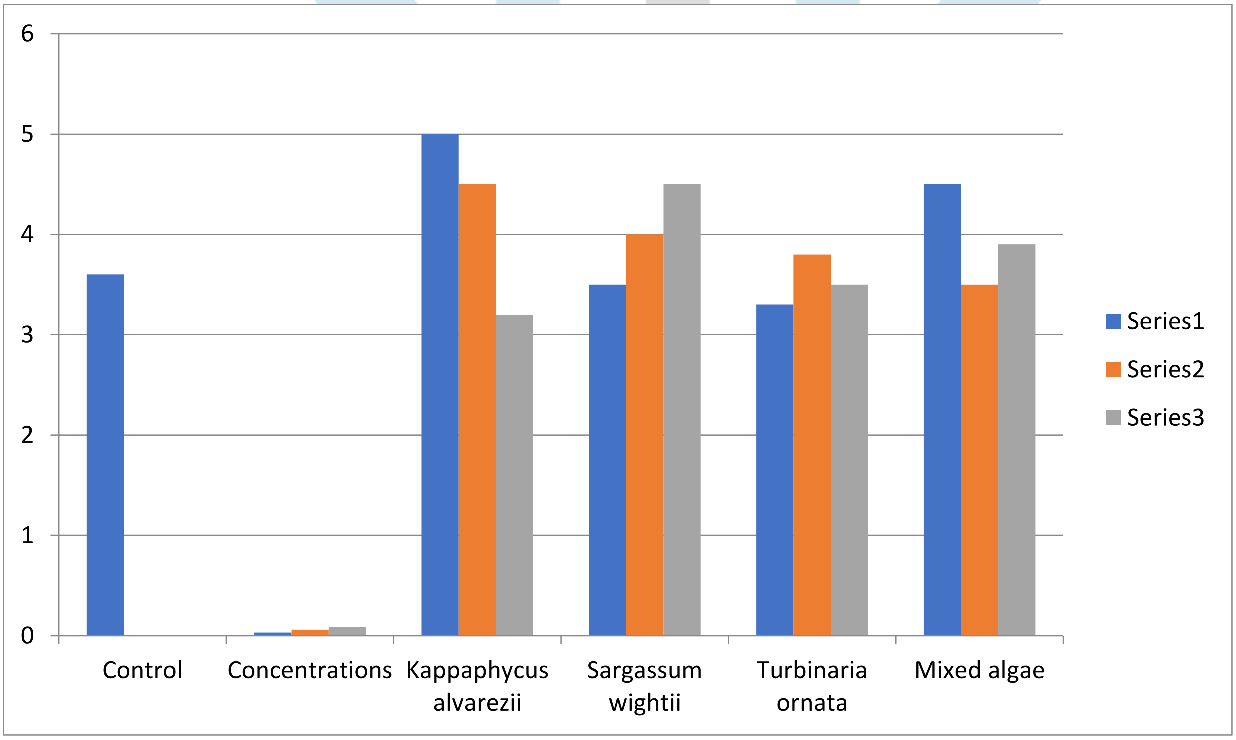


Figure-5 **15th day shoot length(cm/seedling) in *Cyamopsis tetragonoloba***

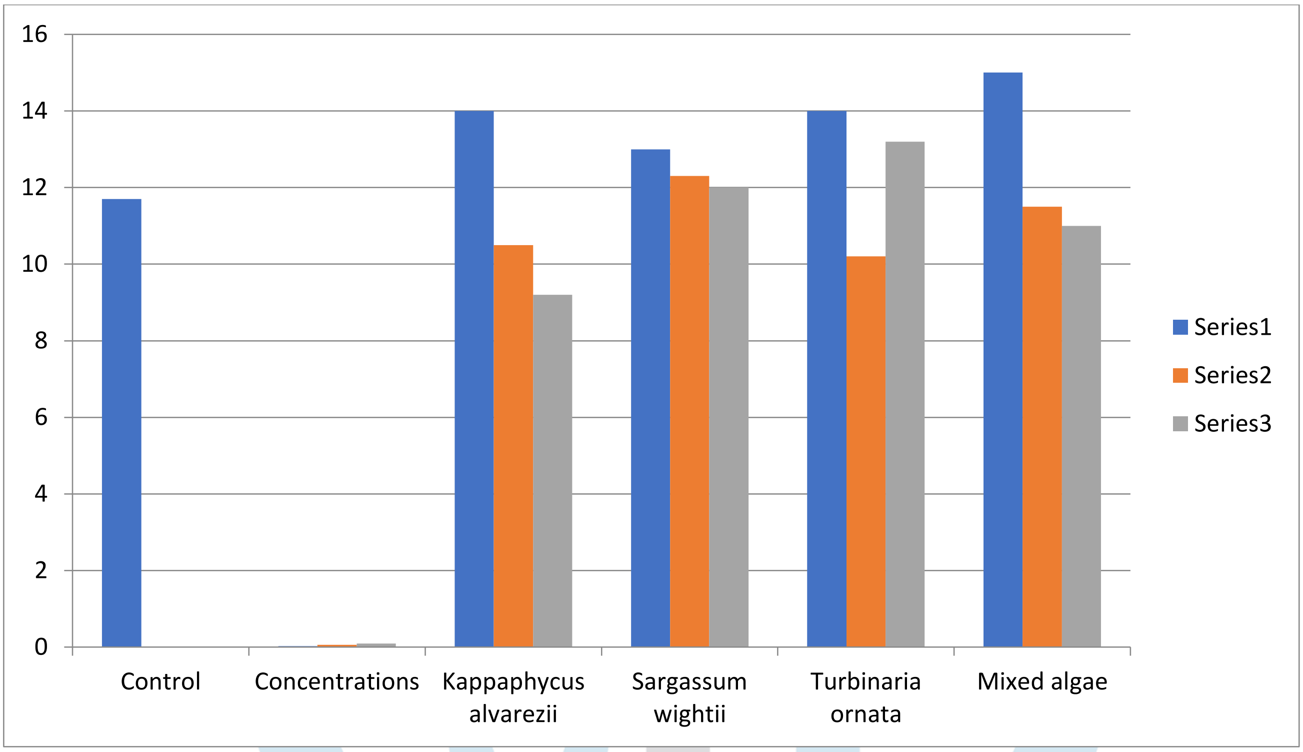


Figure-6 **15th day root length(cm/seedling) in *Cyamopsis tetragonoloba***

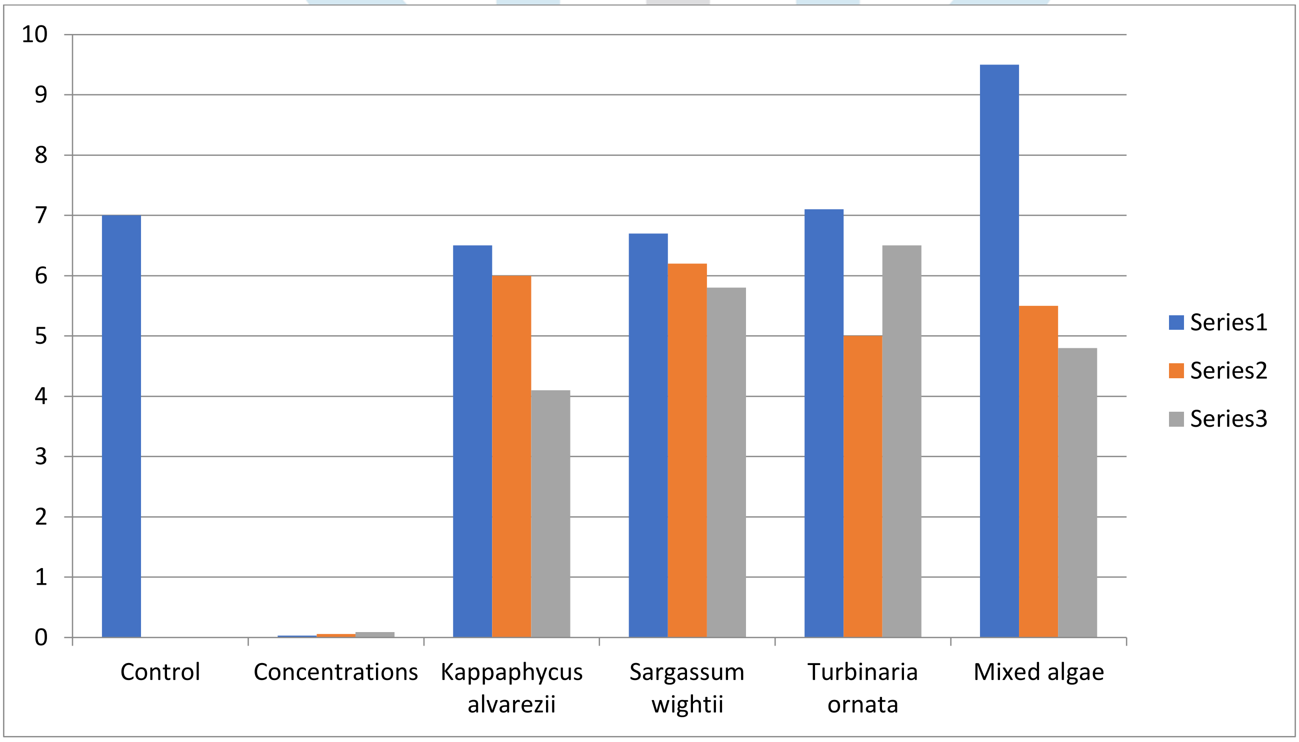


Figure-7 **Days to first blooming in *Cyamopsis tetragonoloba***

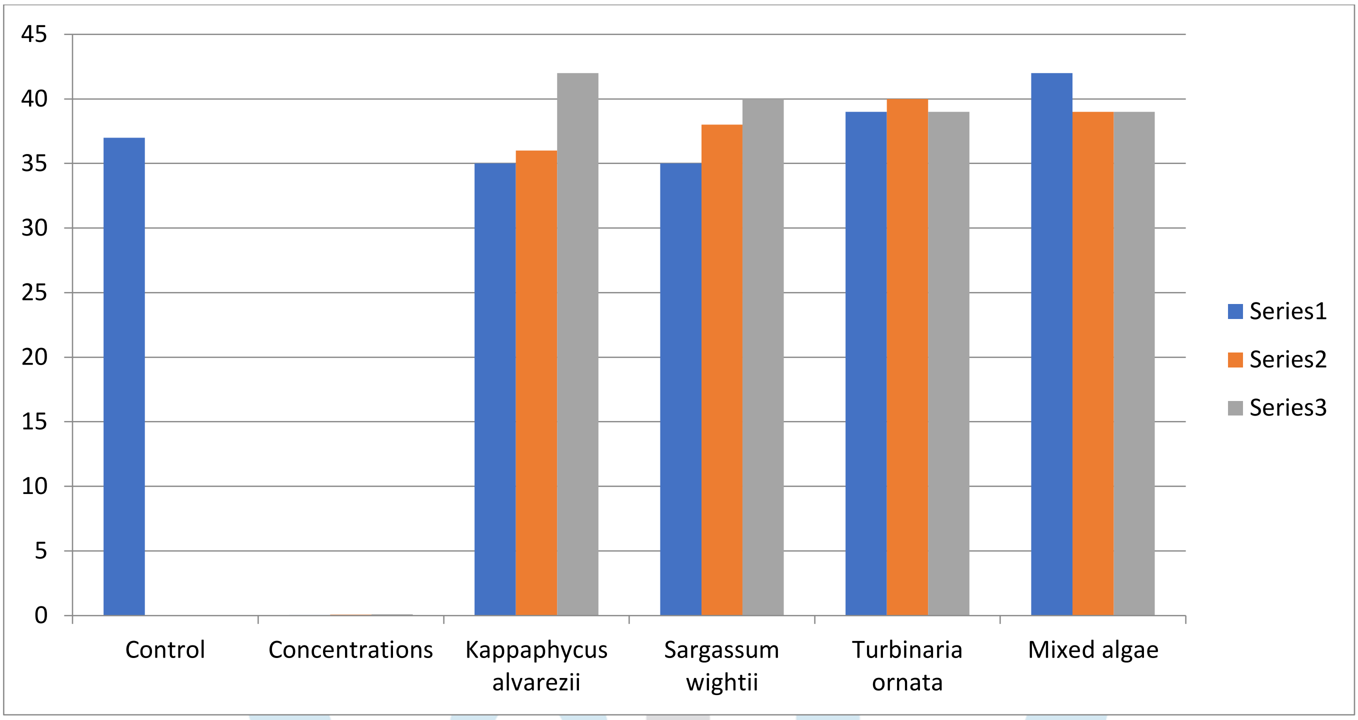


Figure-8 **Plant height (cm) in *Cyamopsis tetragonoloba***

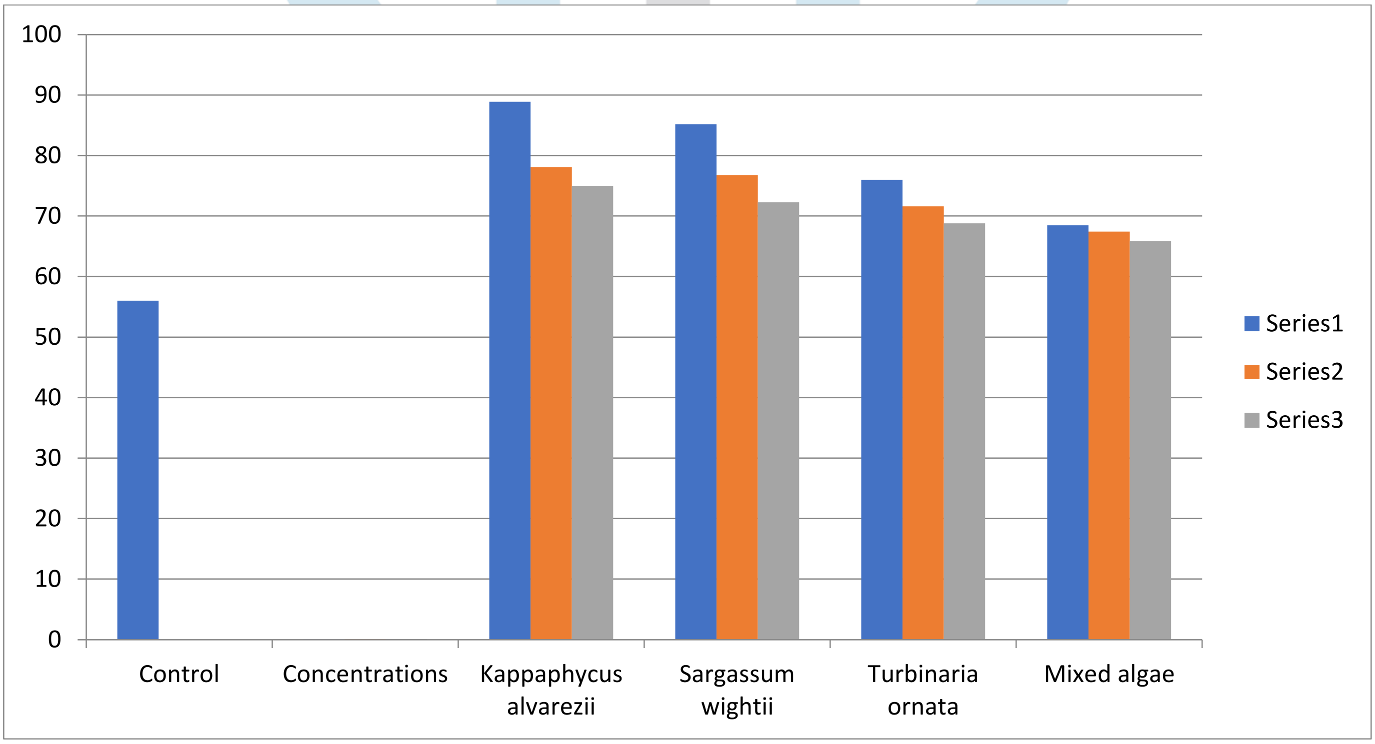


Figure-9 **Number of leaves per plant in cluster bean**

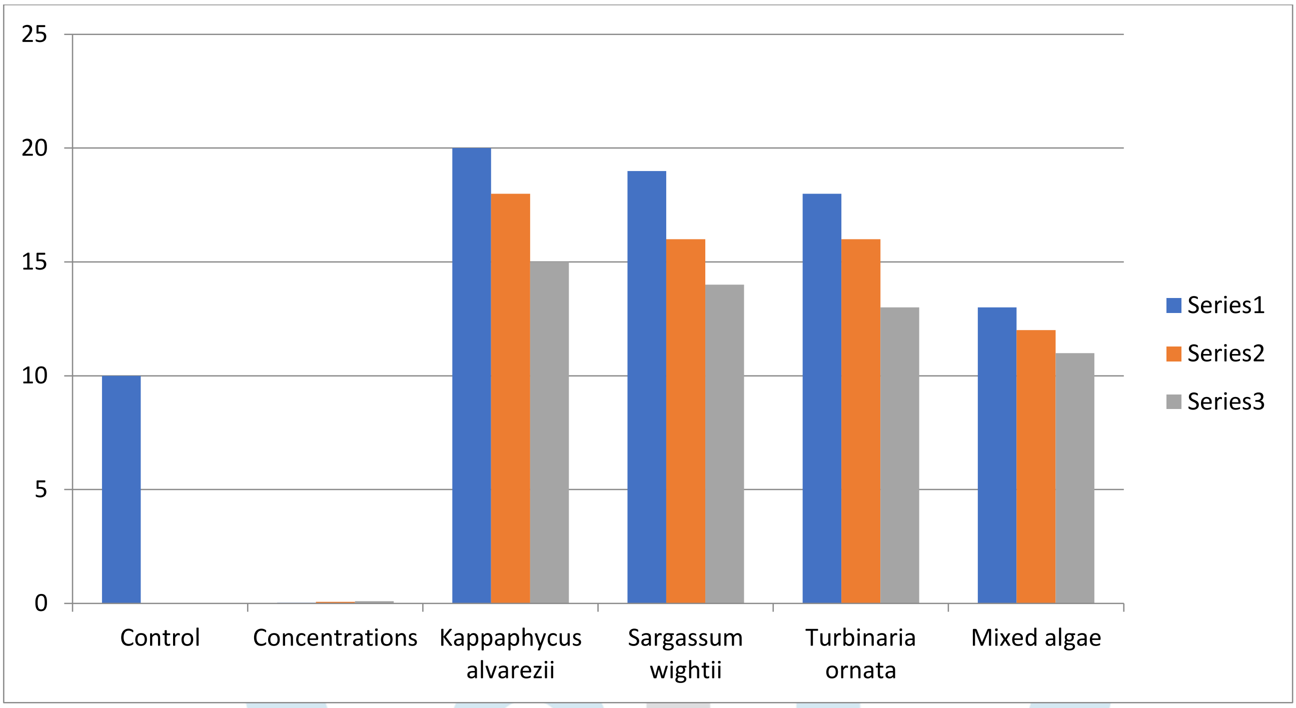


Figure-10 **Length of the fruit (cm) in cluster bean**

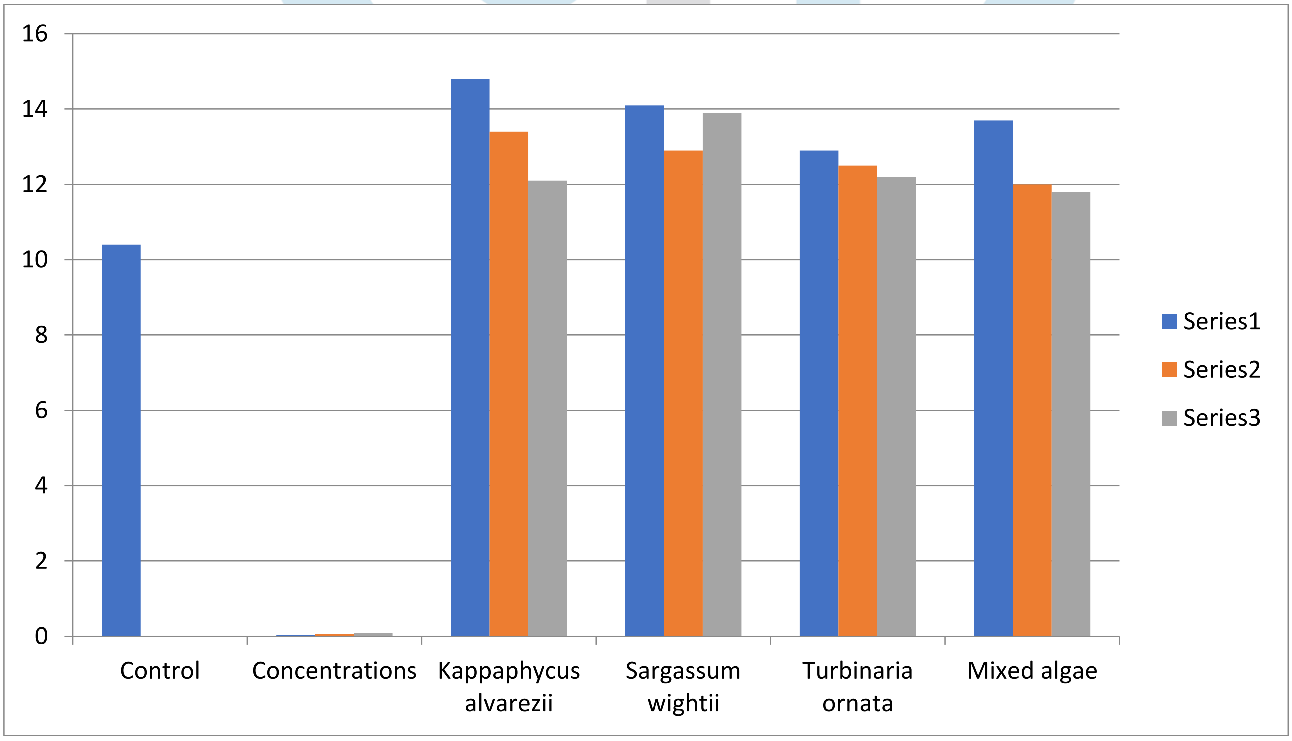


Figure-11 **Breadth of the fruit (cm) in *Cyamopsis tetragonoloba***

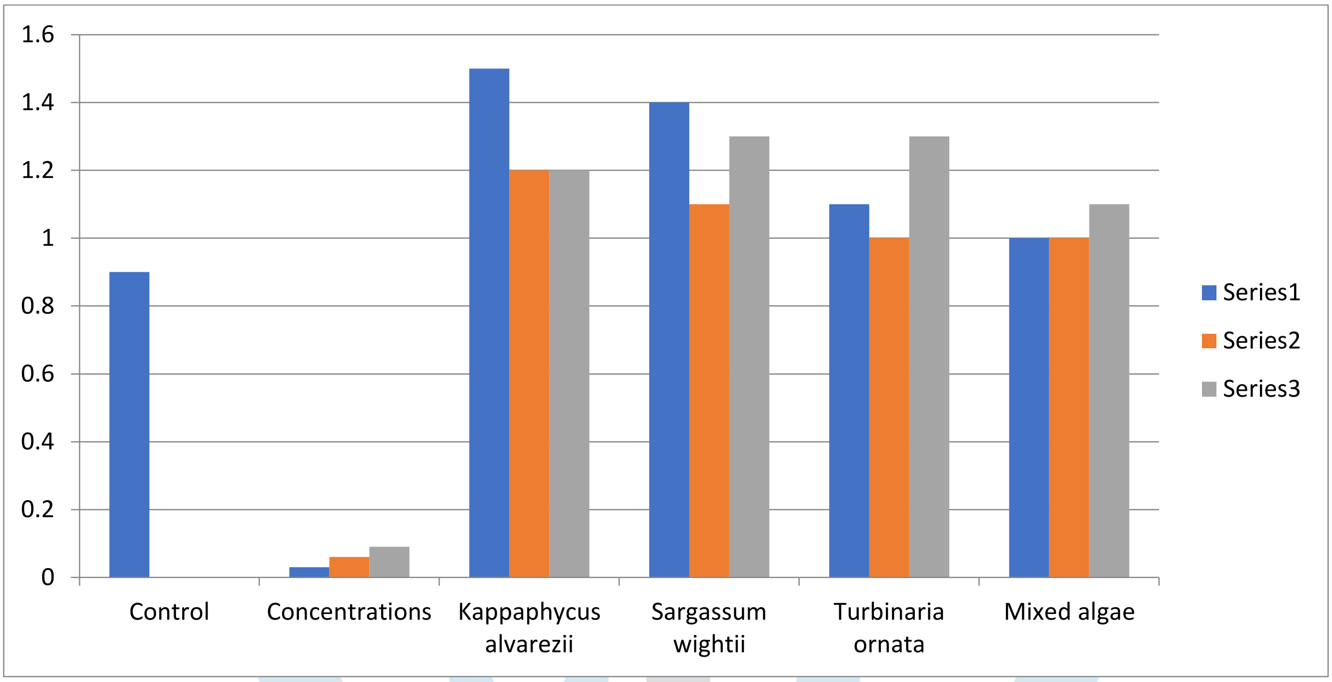


Figure-12 **Weight of the fruit (gm) in *Cyamopsis tetragonoloba***

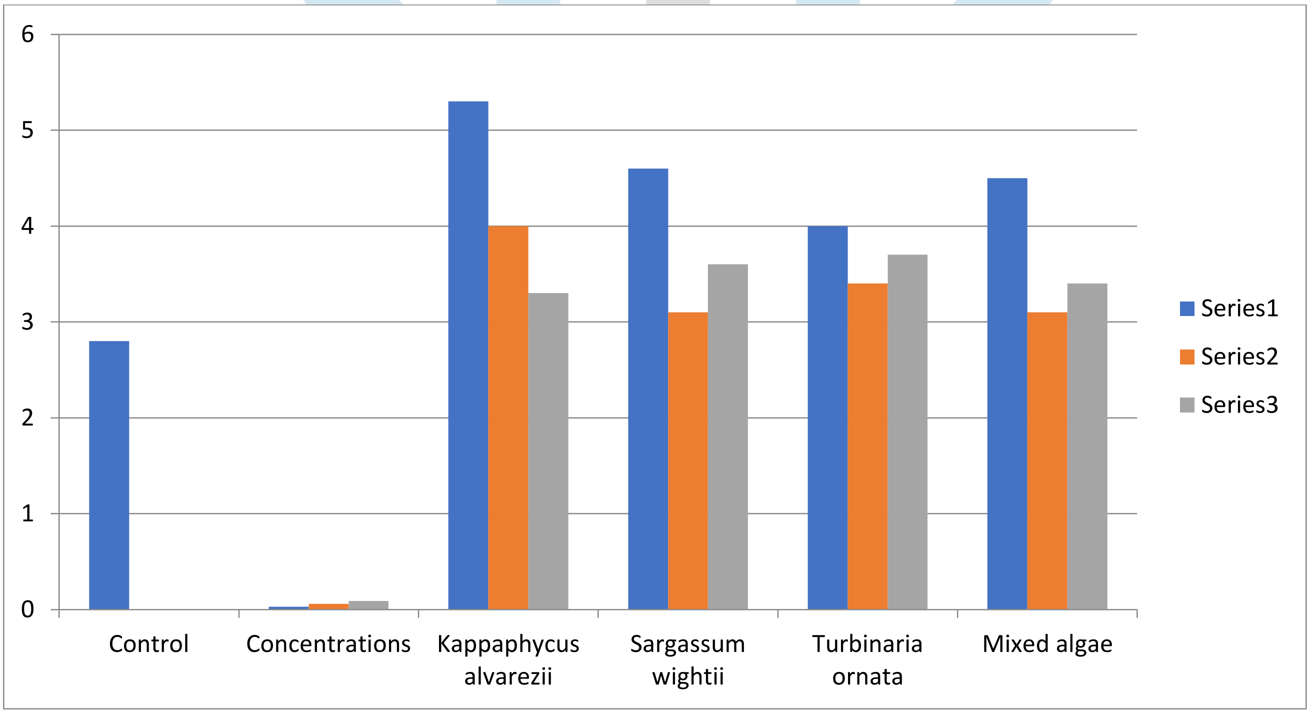
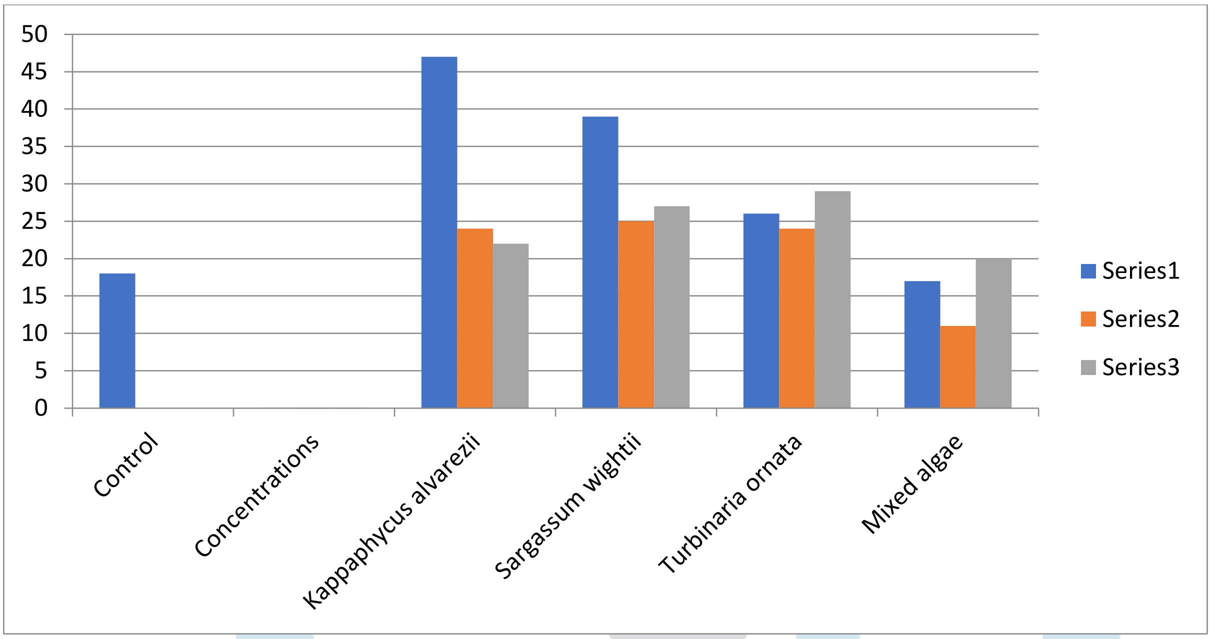


Figure-13 Total number of the fruits per plant in cluster bean



PLATE

Length of cluster bean in control

Kappaphycus alvarezii

Sargassum wightii

Turbinaria ornata

Mixed algae

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