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Effect of different concentrations of commercial seaweed liquid extract of *Ascophyllum nodosum* as a plant bio stimulant on growth, yield and biochemical constituents of onion (*Allium cepa* L.*)*

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Abstract
Seaweed extracts are inexpensive source of naturally occurring plant growth regulators which have greater potential as biostimulants in agriculture. The endogenous plant growth regulators present in the seaweed extracts and concentrates are thought to be involved in the promoting plant growth and yield. Present study examined the effect of seaweed liquid extracts of *Ascophyllum nodosum* as a plant biostimulant on growth and yield of onion. Six treatments are allocated randomly with four replications using RBD viz. T_0- Control(0.00%), T_1- (0.35%), T_2- (0.45%), T_3- (0.55%), T_4- (0.65%) and T_5- (0.75%). On the basis of present investigation, it may be concluded that treatment recieving 0.55% was found to be the best treatment in terms of leaf number (9.08/plant), plant height (55.20cm/plant),Crop growth rate (33.65g/m^2/day), fresh bulb diameter (5.13cm/plant),bulb fresh weight (120.21g/plant), harvest index (77.44%), chlorophyll 'a' (0.81mg/g), chlorophyll 'b' (0.58mg/g), carotenoid content (0.61mg/g), bulb sulphur content (1.80ppm), bulb protein content (1.19mg/g) and leaf protein content (0.46mg/g).While the higher concentration of the extract shows decreasing trend. Our study provide important information on optimization of seaweed liquid extracts on onion crop.

Keywords: Biostimulant, Onion (*Allium cepa* L.), Plant growth regulator, Seaweed

1. Introduction
Modern agriculture is searching for new tools that would allow for a reduction in the use of chemical inputs without negatively affecting crop yield or the farmers' income. The fast growing population is mounting tremendous pressure in food production in the country. To meet out this increasing demand, farmers use chemical fertilizers to enhance the crop production in the country. The toxic chemicals (arsenic and cadmium) from the chemical fertilizers accumulate in plant products causing health problems in human by biomagnifications (Hansra, 1993) [12]. Biofertilizers has emerged as a promising tool for increasing crop growth and yield without affecting soil health and environment.
Availability of organic fertilizers from one or two sources is not adequate so as to meet the increasing demand, the use of seaweeds as a biofertilizer to boost the production of crop is necessary. In recent years, the use of seaweeds as fertilizers has allowed for substitution in place of conventional synthetic fertilizer (Hong *et al.*, 2007; Crouch and Saden, 1993) [13] [5]. Seaweed extracts are marketed as liquid fertilizers and biostimulants since they contain many growth regulators such as cytokinins, auxin, gibberellins, betaines, macronutrients such as Ca, K and P and micronutrients like Fe, Cu, Zn, B, Mn, Co and Mo (Khan *et al*., 2009; Strik *et al*., 2004) [16] [21]. It was also reported that seaweed manure is rich in potassium but poor in nitrogen and phosphorus than the farm manure (Kingman *et al*., 1982) [17]. The inorganic components of *A. nodosum* extract include nitrogen, phosphorous, potassium, calcium, iron, magnesium, zinc, sodium and sulphur (Rayorath *et al.*, 2009) [18, 16]. Further most a relatively small proportion of the total number of seaweed species are of significant importance as animal and human food/supplements and also in agriculture as mulches/manure and modified extracts (Craigie, 2011; Khan *et al*., 2009; Rayorath *et al*., 2009) [6] [16] [16, 18]. One of the major components of commercial extracts of all seaweeds are the polysaccharides. These may account for up to 30–40% of the extract on a dry weight basis (Rayorath *et al*., 2009) [16, 18].
Our study examines the effect of seaweed extract derived from *Ascophyllum nodosum* on production of onion crop although India ranked second on the production of onion throughout the world. The demand is still increasing day by day and couldn't get along with the current production. Further, the increased population and change in land use pattern exerting pressure on production and productivity of onion. Onion is rich in various nutrients, vitamins and rich

mineral composition of onion can be recommended for patients in diseased conditions like ricket, osteomalacia and hypertension (Edet *et al*., 2015) [9]. The key constituent of onion is the allyl propyl disulphide, which is a sulfur based compound responsible for the characteristic alliaceous odor and is also known to possess antibacterial properties. It also plays an important role in preventing heart diseases and other ailments (Augusti, 1990) [3]. Our assumption is use of seaweed extract may trigger the nutrient availability and will increase the production in limited land under ecologically secure way.

Materials and Methods

A field experiment on onion crop (*Allium cepa* L.) variety N-53 was conducted during *Rabi* season at 2015-16 at Vegetable research farm, Sam Higginbottom Institute of Agriculture, Technology and Sciences. Allahabad (U.P). Seeds are collected from the market and are sow on prepared nursery bed until the seedlings are ready to be transplanted to the main field. Commercially available Premium liquid Seaweed from 'organic dews' which content 100% natural seaweed (*Ascophyllum nodosum*) was used. We assessed different concentration at 0%, 0.35%, 0.45%, 0.55%, 0.65% and 0.75% designated as T_0, T_1, T_2, T_3, T_4 and T_5 respectively. Each plot of $1m^2$ is prepared with four replications by adopting RBD. Foliar application was done 4 times starting from 30DAT on 15 days interval. Plant were planted with standard spacing of 15 cm × 10 cm and observation were recorded viz. plant height, number of leaves, Crop growth rate, fresh bulb diameter, bulb fresh weight, harvest index, chlorophyll 'a', 'b', carotenoid, protein and bulb sulphur content.

Results

Vegetative growth parameter

The application of seaweeds extracts facilitates the efficient uptake of nutrient thereby increasing vegetative growth character. Significant differences were observed on various parameters. Among the evaluated treatments average maximum number of leaves (9.08/plant), Plant height (55.20cm/plant) at 80 days after transplanting and Crop growth rate (33.65 g/m^2/day) at 80 to 100 days after transplanting were recorded under T_3 (0.55%). The data on vegetative growth parameter are presented in Table 1.

Yield parameter

Significant differences were observed on Bulb fresh weight, Bulb diameter and Harvest index on onion. The average maximum bulb fresh weight (120.21g/plant), bulb diameter (5.13cm/plant) and Harvest index (77.44%) were recorded under T_3 (0.55%).The data on yield parameter are presented in Table 2.

Biochemical constituents

The data of several biochemical studies are presented in Tables 3. There was a significant differences in biochemical status of different concentration levels. The highest chlorophyll 'a' (0.81mg/g FW), chlorophyll 'b' (0.58mg/g FW) and carotenoid (0.61mg/g FW), leaf protein (0.46mg/g FW), bulb protein (1.19mg/g FW) and bulb sulphur content (1.80ppm) were recorded under T_3 (0.55%).

Discussion:

Seaweed products contain growth regulators (auxins, cytokinine and gibberellins), amino acids and mineral nutrients, that accordingly positively affect plant growth and division as reported by (Berlyn and Russo 1990) [4]. Seaweed extracts improve nutrient uptake by roots (Crouch *et al*., 1990) [7]. The extracts of *A. nodosum* affect the root growth, plant height and number of leaves of *Arabidopsis* at very low concentration (Rayorath *et al*., 2008) [20]. Similarly in our present study maximum No. of leaves/plant, plant height and crop growth rate (CGR) were recorded in T_3 (0.55%). Similarly higher plant height, weight and yield is observed in pea also (Rana *et al*., 2007) [19]. Increased root and shoot growth in rapeseed treated with seaweed extract were associated with enhanced uptake and accumulation of nitrogen and sulphur (Jannin et al., 2013) [14]. The data on vegetative growth parameters are presented in Table 1.

Increase in yield was mainly due to increased in No. of leaves, plant height and bulb weight. Nutrients present in the seaweed extracts are readily absorbed by leaves through stomata and cuticle hydrophilic pores. Foliar application of seaweed extract products including those of a commercial *A. nodosum* extract increased the Cu uptake in grapevine, probably by increased permeability of the cell membrane. In another study, it was observed that application of a commercial extract of *E. maxima* on lettuce grown under optimal conditions improved yield and the concentration of Ca, K and Mg in the leaves (Crouch et al., 1990) [7]. Our results relate to earlier studies where application of seaweed extract increase in yield of pepper (Arthur *et al*., 2003).Similar observation were recorded in onion treated with seaweed extract of (*Ascophyllum nodosum*) (Dogra and Mandradia 2014) [8]. The data on vegetative growth parameters are recorded in Table 2.

Seaweed extract treated plants showed increased chlorophyll content in a wide variety of crops including grapevine and strawberry (Fan *et al*., 2013) [11]. Also in Black gram which shows enhanced chlorophyll and Carotenoid content in seaweed derieved from *Caulerpa scalpelliformis* treated at lower concentration (Kalaivanan *et al*., 2012) [15]. Similar observation were recorded in our present study in onion where highest chlorophyll and carotenoid content at T_3(0.55%). The increase in chlorophyll content at lower concentration of SLE might be due to the presence of high amount of Mg. The increased in leaf and bulb protein may be attributed to the increased availability and absorption of necessary elements (Ca, Na, K, Mg, N and Zn) present in the seaweed extracts (Sivasankari Ramya *et al*., 2011; Anantharaj and Venkatesalu 2001, 2002; Erulan *et al*., 2009) [22] [1] [10]. Increase in bulb sulphur content might be due to the enhanced uptake and accumulation of nitrogen and sulphur as studied on rapeseed (Jannin *et al*., 2013) [14].

Table 1: Effect of different concentrations of seaweed liquid extract of A. *nodosum* on vegetative growth parameter of onion.

Treatments	Average plant height (cm/plant)	Average No. of leaves/plant	Crop growth rate(g/m^2/day) 80 to 100 days after transplanting
T0	47.83±0.33	8.08±0.42	29.90
T1	49.20±0.88	8.51±0.12	31.96
T2	51.38±0.99	8.72±0.21	32.37
T3	55.20±0.85	9.08±0.15	33.65
T4	53.63±0.48	8.71±0.16	30.32
T5	52.45±1.05	8.65±0.17	30.67
SEm±	0.58	0.18	
CD(P=0.05)	1.23	0.37	

Table 2: Effect of different concentrations of seaweed liquid extract of *A. nodosum* on yield parameters of onion.

Treatments	Average bulb fresh weight(g/plant) At 100DAT	Average bulb diameter(cm/bulb)	Harvest index (%)
T0	91.20±0.73	3.13±0.22	68.52
T1	100.00±0.82	3.50±0.00	70.38
T2	108.13±0.85	4.00±0.15	73.42
T3	120.21±0.85	5.13±0.11	77.44
T4	111.25±2.06	4.93±0.09	75.61
T5	110.70±1.59	4.00±0.08	76.14
SEm±	0.79	0.11	
CD(P=0.05)	1.68	0.24	

Table 3: Effect of different concentrations of seaweed liquid extract on biochemical parameters of onion.

Treatments	Chl 'a' (mg/g FW)	Chl 'b' (mg/g FW)	Carotenoid (mg/g FW)	Leaf protein content(mg/g FW)	Bulb protein Content (mg/g FW)	Bulb Sulphur content (ppm)
T0	0.53	0.42	0.51	0.29	0.85	1.70
T1	0.60	0.45	0.53	0.31	0.96	1.73
T2	0.66	0.45	0.54	0.33	0.97	1.79
T3	0.81	0.58	0.61	0.46	1.19	1.80
T4	0.77	0.56	0.61	0.43	1.08	1.79
T5	0.70	0.44	0.52	0.40	1.05	1.74
SE.m±	0.01	0.02	0.02	0.01	0.02	0.02
CD(P=0.05)	0.01	0.04	0.04	0.03	0.05	0.05

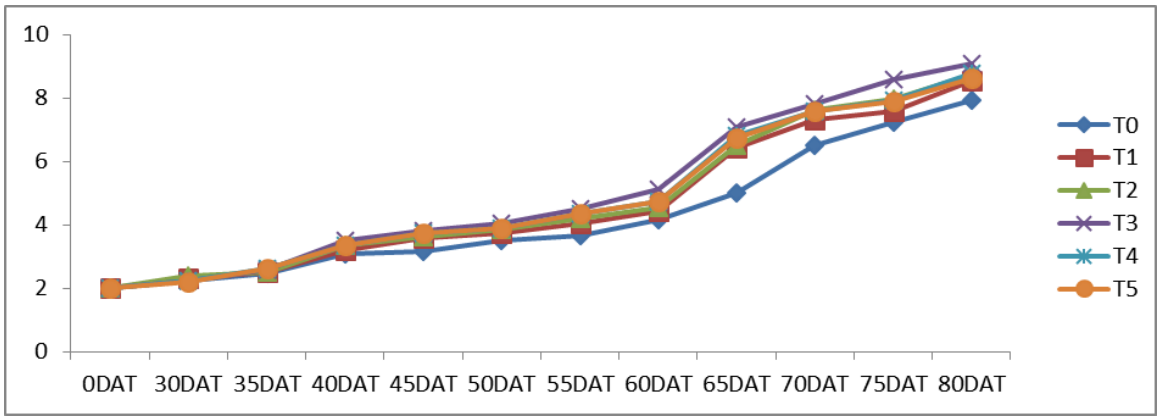

Fig 1: Effect of different concentrations of seaweed liquid extract on number of leaves of onion

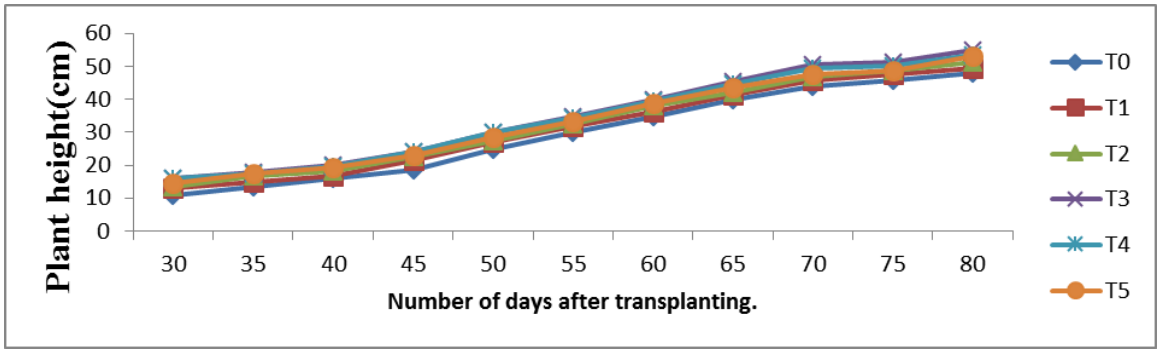

Fig 2: Effect of Seaweed liquid extract on plant height of onion.

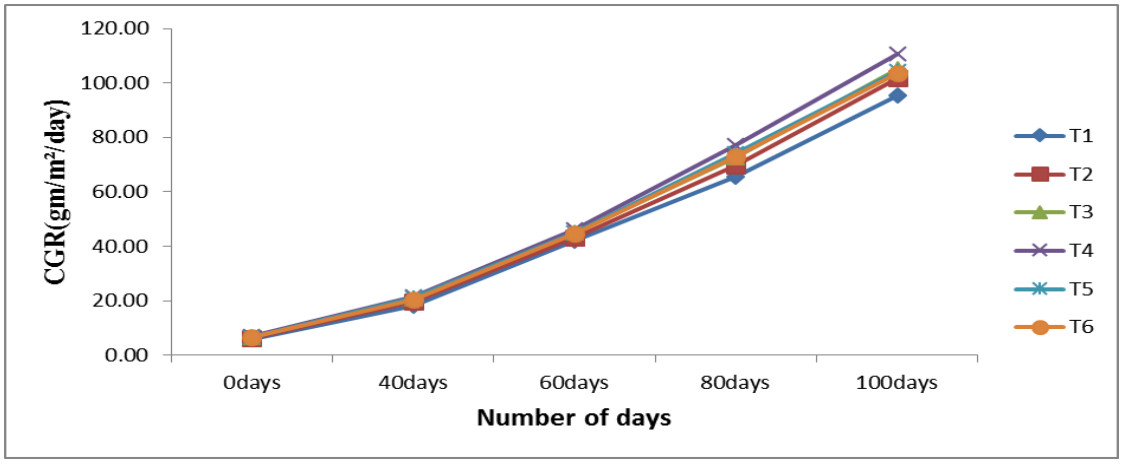

Fig 3: Effect of Seaweed liquid extract on CGR of onion at different intervals.

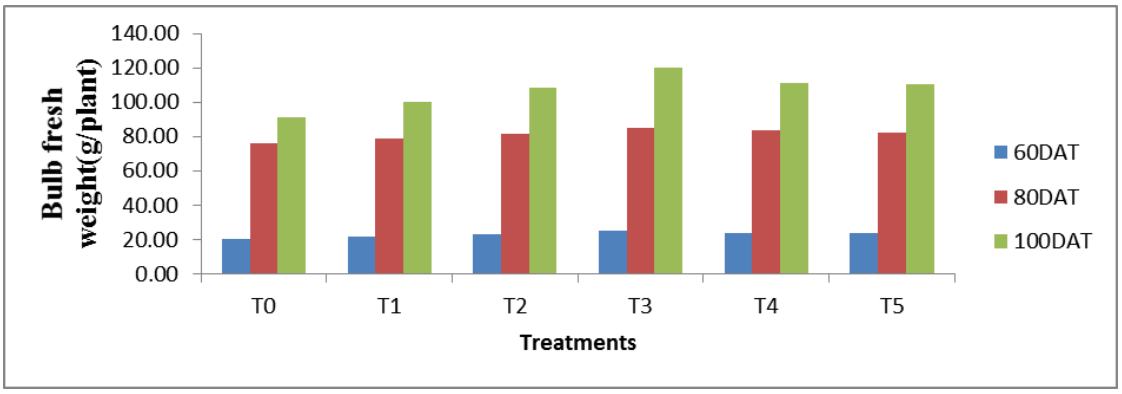

Fig 4: Effect of Seaweed liquid extract on bulb fresh weight of onion at different intervals.

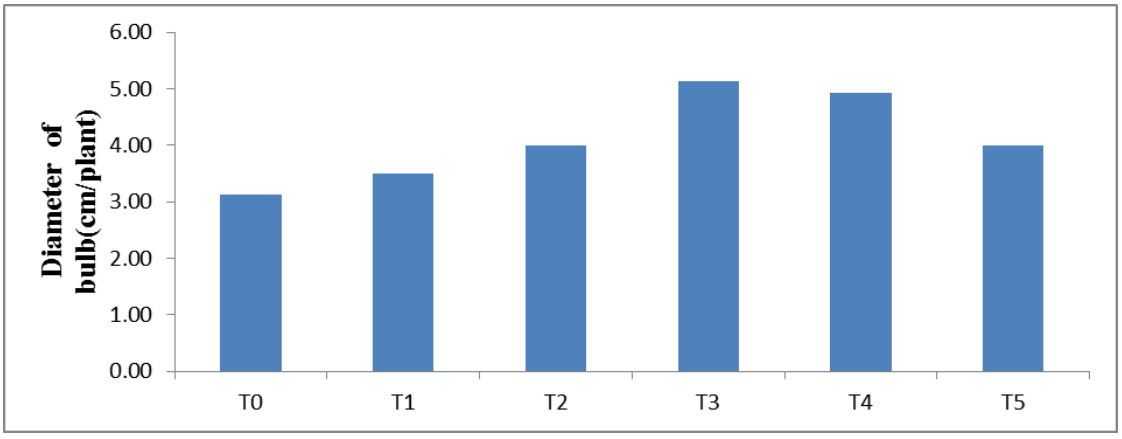

Fig 5: Effect of different concentrations of seaweed liquid extract on bulb diameter of onion.

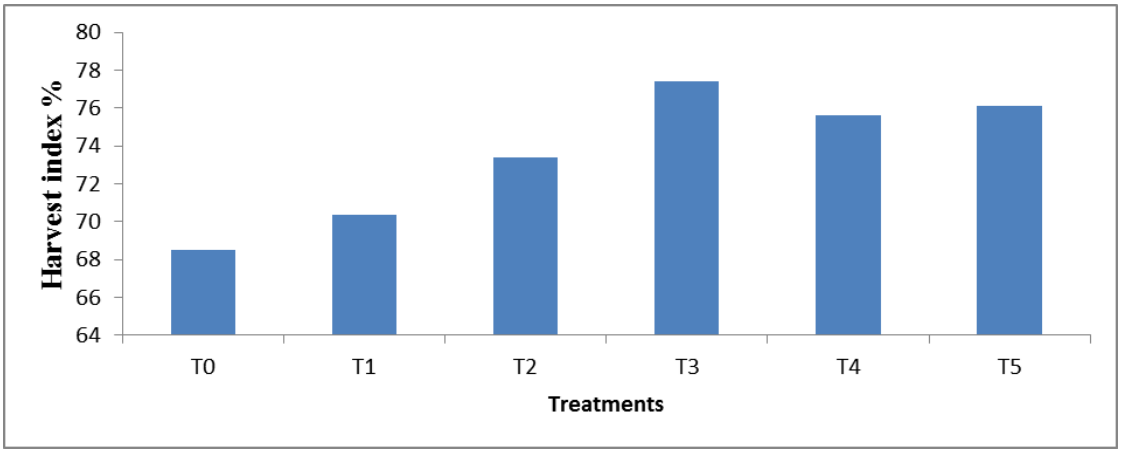

Fig 6: Effect of different concentration of seaweed liquid extract on harvest index of onion.

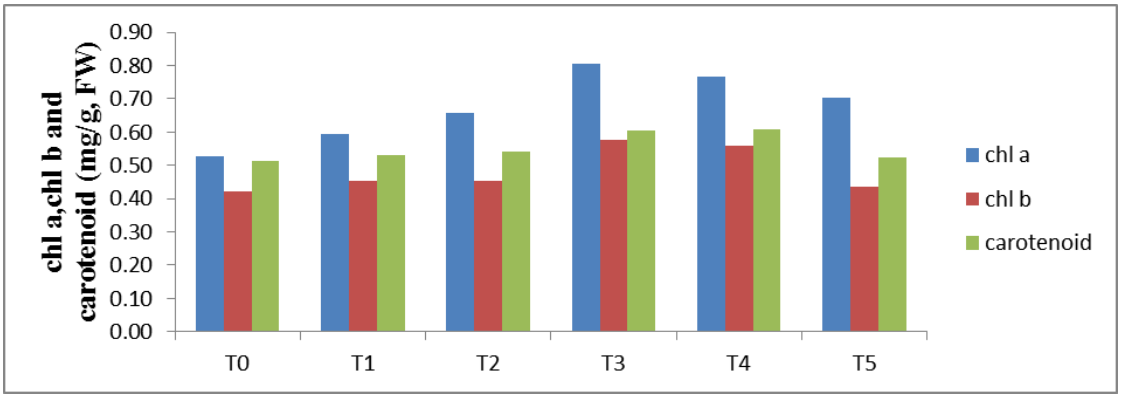

Fig.7: Effect of different concentrations of seaweed liquid extract on Chlorophyll and Carotenoid content of onion.

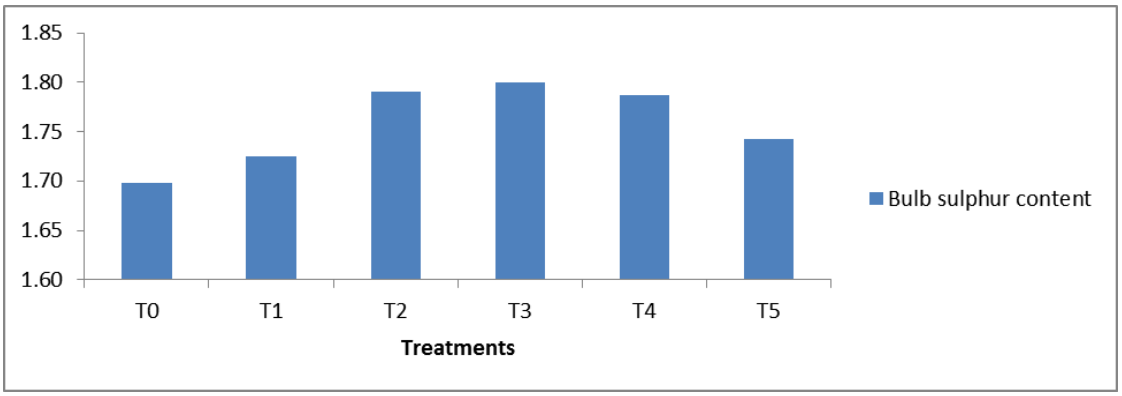

Fig 8: Effect of different concentrations of seaweed liquid extract on bulb sulphur content of onion.

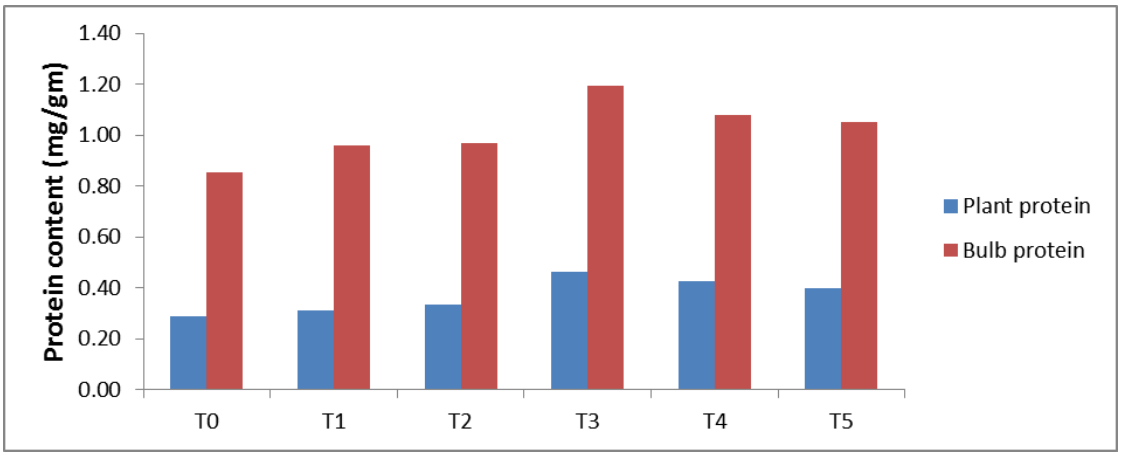

Fig 9: Effect of different concentrations of seaweed liquid extract on protein content of onion.

Conclusion

In this present investigation, it is concluded that seaweed liquid extracts play an important role for increasing plant height, leaf number, bulb diameter, protein content, sulphur content and chlorophyll and carotenoid contents of onion. Plant which received 0.55% concentration is found superior to all treatments while the increased in concentration shows decreasing trends. This implies that at low concentration seaweed extract stimulate plant morphological and biochemical characters of onion while at higher concentration it inhibits.

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