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Impact of Foliar Application of Sea Weed Extract (Pilatus Plus) on Performance of Onion & Potato

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ABSTRACT

A field experiment was conducted in 2018 at main campus BCKV, Mohanpur (Kolkata) to observe the effect of foliar application of seaweed extract (Pilatus Plus). In this study Potato (Solanum tuberosum L cv. Jyothi) and Onion (Allium cepa L cv. Sukhsagar) were examined for impact evaluation. In plains, cultivation of potato and onion is constrained by their shallow root systems and high sensitivity to drought, often resulting in reduced yields. The study involved applying various dosages (1000, 1250, 1500, and 2500 ml/ha) of the extract at three growth stages in both crops. Control plants were treated with water only. It was focused assessing the efficacy of Pilatus Plus on vegetative growth, yield, and quality of onion and potato with optimal spray dose. There was a noticeable improvement in tuber growth, yield and quality of potato with Pilatus Plus applications. The vegetative parameters are more or less increased with the spray dose of 1500 ml/ha. The optimal dosage for highest yield was 1250 ml/ha, which was statistically equivalent to 1500 ml/ha. Parameters such as individual weight of bulb/tuber, number of tubers/bulbs per plant, and total soluble solids (TSS) showed noticeable enhancement. The results confirmed that, foliar application of seaweed extract showed positive response towards the plant growth, yield and qualitative parameters in both crops. The best results were observed with three applications at a concentration of 1250 ml/ha, indicating this as the optimal dosage. This suggests that, treatment is a promising biostimulant and an eco-friendly alternative to conventional chemical growth promoters.

Keywords: *Bio-stimulant; Sea weed extract; Potato tuber; Onion bulb; Pilatus plus; Yield of potato; Yield of onion; Foliar Spray.*

INTRODUCTION

Due to their high dietary fiber content and abundance in vital vitamins, minerals, trace elements, and antioxidants vegetables are vital to human health. The two main vegetable crops i.e., potato and onion account for more than 40% of vegetable production in India (1). Vegetables are annual herbaceous plants that need a lot of nutrients in a short amount of time to produce at their best. A new generation of natural organic fertilizers called seaweed extract promotes plant growth and development in a variety of ways, from seed germination to plant maturity. These include enhancing crop quality and yield by increasing plant tolerance to abiotic stresses, facilitating nutrient assimilation, translocation, and utilization, and improving plant metabolism efficiency. Improving sugar content, color, and other quality aspects of product making water use more effective.

The seaweed liquid extract has recently acquired popularity as a foliar spray for a wide range of crops, including different varieties of grasses, flowers, cereals, vegetables, and spices (2). Furthermore, scientists were experimented with a number of seaweed extract application methods, including foliar spraying, soaking seeds prior to sowing, and applying the extract to the soil (3).

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However, the results shows that the extract not only improved seed germination but also increased nutrient uptake, provided resistance to fungal diseases and frost, and increased plant vigor.

Overuse of these artificial compounds can lead to chemical contamination of soil, water supplies, and harvested goods, as well as negative effects on non-target species. Farmers are still looking for environmentally friendly ways to increase agricultural yields while minimizing their negative effects on the environment. Several workers have stated that using seaweed extract as bio-fertilizers and bio-stimulants offers a potential answer to this issue. Because seaweed extracts include bioactive chemicals at low concentrations that have the ability to stimulate growth, they are categorized as bio-stimulants. One well-known seaweed species that is frequently utilized in agriculture is Ascophyllum nodosum, which is a member of the brown algae family (4). A report shows that seaweeds are utilized to replenish nutrients and biostimulants for the production of agricultural and horticultural crops, with 15 Million MT occurring every year (5). Furthermore, the presence of macro and micronutrients may contribute to the seaweed extract's capacity to enhance growth. Vigna sinensis L. showed comparable outcomes as well (6).

While there are numerous publications on the application of Ascophyllum extract in plant culture, there is comparatively less information regarding its use in tropical and subtropical environments with underground vegetables. There is also a dearth of research on the effectiveness of Pilatus Plus as a phytostimulant in potatoes and onions, including the best dosages for Pilatus Plus as bio-stimulants in potato and onion

for growth, yield, and quality. With the following goals in mind, the current study was carried out to standardize the effectiveness of Pilatus Plus:

In order to boost production and quality in two specific vegetable crops, the current study details the dosage and application stage of a biostimulant made from Ascophyllum nodosum (AQUASAP is the brand name of Aqua Agri) with following objectives.

- To ascertain how the biostimulant "Pilatus Plus" affects the growth, yield, and quality in Potato and Onion.
- To determine ideal Pilatus Plus dosages and application stages in Potato and Onion.
- Pilatus Plus in Comparison to the competitive Product.

MATERIALS & METHODS

The current study, "Bio-efficacy study of bio-stimulant (Pilatus plus) on Potato (*Solanum tuberosum L* cv. Jyothi) and Onion (*Allium cepa* L cv. Sukhsagar) for growth, reproductive parameters and quality aspects" was conducted at the Department of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, in an open field in the New Alluvial Zone of West Bengal. The experimental site is located at latitude 23.50N and longitude 800E, with an average elevation of 9.75 meters above mean sea level (MSL). The experimental site was situated on a high area of land with reliable drainage and irrigation systems.

CLIMATE & WEATHER CONDITIONS: The experimental site is located south of the Tropic of Cancer in a warm, humid subtropical climate. In the summer, the average temperature is between 25 and 36.5 0C, and in the winter, it is between 12 and 25 0C. There are roughly 1500 mm of rain on average every year. The experimental site's topography falls inside West Bengal's New Alluvial Zone. The Table (1a) mentioned below also display's the average number of sunshine hours, minimum and maximum temperatures, maximum and minimum relative humidity, and average rainfall that were noted throughout the experiment.

Table 1a: Meteorological data during the cropping season

Month	Max. Temp. (⁰C)	Min. Temp. (⁰C)	Average Rainfall (mm)	Max. R.H. (%)	Min. R.H. (%)	Average Sunshine Hours
September,16	36.9	21.0	22.7	98	49	6.91
October,16	36.2	19.4	20.9	98	48	6.84
November,16	32.5	11	5.9	98	38	6.61
December,16	29.5	7	-	78	46	5.73
January,17	29.3	4.5	-	65	34	7.24
February,17	33.1	8.4	-	64	23	6.60
March,17	36.1	11.4	-	100	70	6.58
April,17	37.6	31	-	98	79	6.06

Source: *Department of Agro-Meteorology and Physics, B.C.K.V., Mohanpur, Nadia, West Bengal.*

Soil Condition: The pH range of the sandy loam soil in the experimental plot was 6.64 to 7.2, indicating a somewhat acidic character. Prior to creating the experiment's architecture, a composite sample of soil ranging in depth from 0 to 30 cm was randomly selected from 10 locations throughout the field. Following their complete mixing and drying, the soil samples were examined mechanically and chemically. The results of the soil analysis showed that the experimental field's soil had a sandy loam texture and was somewhat acidic. The following table-1b lists the physico-chemical characteristics of the soil in the experimental field.

Table 1b: Physico-chemical properties of the soil

S. No.	Particulars	Value obtained	Method adopted	References
01.	Sand (%)	74.2	International Pipette Method	(Piper, 1996)
02.	Silt (%)	14.2	International Pipette Method	(Piper, 1996)
03.	Clay (%)	11.5	International Pipette Method	(Piper, 1996)
04.	Organic Carbon (%)	0.54	Walkley and Black Method	(Walkley and Black, 1934)
05.	Total Nitrogen (%)	0.053	Alkaline Permanganate Method	(Subbaiah and Asija, 1956)
06.	Available Phosphorus(kg/ha)	15.1	Olsen's Method	(Watanabe and Olsen, 1965)
07.	Available Potassium(kg/ha)	153.57	Flame Photometer Method	(Jackson, 1973)
08.	Soil pH	6.75	Glass Electrode pH Meter	(Jackson, 1973)

Experimental Details:

Experimental Design: Design Type: Randomized Block Design (RBD)

- Replications: 4 replications
- Space Assigned per Replication: 45 m^2 (3.0 x 15 meters)

Variety Tested: Potato: Cv. Jyothi; Onion: Cv. Sukhsagar

The Pilatus Plus was applied three times during the cropping season viz., Vegetative phase I, Vegetative phase II and Tuber set/Bulb formation time. Sea weed extract was applied as foliar spray doses of 1000, 1250, 1500, and 2500 ml/ha, along with untreated control plants and competitor product (multiplex) for comparison.

Table 2a: Treatment details of Biostimulant (Pilatus) in Potato- As per the practice

Product	Rate/ha	Interval
Control (T1)	water	1st application- 10 days after sowing (Vegetative I) 2nd application- 30 days after 1st application (Vegetative II) 3rd application- 30 days after 2nd application (Tuber set / initiation)
Pilatus (T2)	1000 ml/ha	1st application- 10 days after sowing (Vegetative I) 2nd application- 30 days after 1st application (Vegetative II) 3rd application- 30 days after 2nd application (Tuber set / initiation)
Pilatus (T3)	1250 ml/ha	1st application- 10 days after sowing (Vegetative I) 2nd application- 30 days after 1st application (Vegetative II) 3rd application- 30 days after 2nd application (Tuber set / initiation)

Pilatus (T4)	1500 ml/ha	1st application- 10 days after sowing (Vegetative I) 2nd application- 30 days after 1st application (Vegetative II) 3rd application- 30 days after 2nd application (Tuber set / initiation)
Pilatus (T5)	2500 ml/ha	1st application- 10 days after sowing (Vegetative I) 2nd application- 30 days after 1st application (Vegetative II) 3rd application- 30 days after 2nd application (Tuber set / initiation)
Competitor's Product (multiplex)	As per label	As per label claim
Untreated control	Water	-

The experimental site was thoroughly prepared by repeated ploughing, followed by mixing the soil to a loose and friable texture. All weeds and stubble were carefully removed. The field was then properly leveled and divided into plots by dividing by making irrigation channels, as per the experimental design. Farmyard manure (FYM) was applied at a rate of approximately 25 t/ha. Recommended doses of nitrogen (N), phosphorus (P), and potassium (K) were applied in the form of urea, single super phosphate, and muriate of potash, respectively with reference to table (1b). All cultural practices were carried out in accordance with standard recommendations for cultivation of Potato and Onion.

Table 2b: Treatment details of Biostimulant (Pilatus) in Onion- As per the practice

Product	Rate/ha	Interval
Control (T1)	water	1st application- 10 days after planting (flag leaf emergence) 2nd application- 15 days after first application (1-2 true leaves) 3rd application- 15 days after 2nd application (3-4 true leaves)
Pilatus (T2)	1000 ml/ha	1st application- 10 days after planting (flag leaf emergence) 2nd application- 15 days after application (1-2 true leaves) 3rd application- 15 days after 2nd application (3-4 true leaves)
Pilatus (T3)	1250 ml/ha	1st application- 10 days after planting (flag leaf emergence) 2nd application- 15 days after application (1-2 true leaves) 3rd application- 15 days after 2nd application (3-4 true leaves)
Pilatus (T4)	1500 ml/ha	1st application- 10 days after planting (flag leaf emergence) 2nd application- 15 days after application (1-2 true leaves) 3rd application- 15 days after 2nd application (3-4 true leaves)
Pilatus (T5)	2500 ml/ha	1st application- 10 days after planting (flag leaf emergence) 2nd application- 15 days after application (1-2 true leaves) 3rd application- 15 days after 2nd application (3-4 true leaves)
Competitor's Product (Multiplex)	As per label claim	As per label claim
Untreated control	water	

Fig 1- The field was divided into plots for both onion and potato crops to enable efficient management and operation

All the parameters were measured for before and after crop harvest. Ten equally competitive plants were randomly selected from each treatment in each replication, and biometric observations were recorded for every parameter, as shown in table (2a & 2b) and Fig (1). The mean values for these plants were calculated and used to derive the average for each trait. Observations were recorded according to the planned dates and times.

RESULTS & DISCUSSION

***Effect of Pilatus plus on quantitative and qualitative characters of potato*:** A significant improvement in plant growth parameters was observed with the application of Pilatus Plus across various treatments. Notably, a foliar spray dose of 1500 ml/ha resulted in substantial increase in plant height, stem thickness, and tuber weight. However, there were no marked changes in the number of branches per plant or the percentage of dry matter with increasing dosage. The highest plant height (70.717 cm) was recorded in the treatment where 1500 ml/ha was applied topically, followed by 1250 ml/ha. These findings are in agreement with the previous report of Opteine Plus in Tomato, who reported similar outcomes improved vegetative growth with use of sea weed extract (6). The superior performance of Pilatus Plus may be attributed to the inclusion of macro- and micronutrients in the seaweed extract. Similar observations have been reported in *Vigna sinensis* L. (7).

Seaweed extract serves as an effective biostimulant, supplying crops with micro- and macronutrients as well as notable concentrations of cytokinins, auxins, vitamins, and complex polysaccharides (8). These bioactive compounds enhance chlorophyll synthesis by elevating photosynthetic activity, which in turn promotes vigorous vegetative growth.

Similarly, the foliar application of yeast extract has consistently improved vegetative growth across various vegetable species. The similar are obtained in potato (9) and Tomato (10). However, the reports of yeast as sea weed extract also demonstrated a significant enhancement in potato vegetative parameters (11).

Foliar application of Pilatus Plus also significantly influenced other growth attributes such as the number of tubers per plant, tuber diameter, and tuber weight. According to Table 3, the application of 1250 ml/ha resulted in the highest number of tubers per plant (5.853). Although all dosages showed positive effects, the 1250 ml/ha and 1500 ml/ha treatments were statistically comparable. Likewise, The 1250 ml/ha treatment recorded the highest tuber weight (196.500 g) and the maximum tuber yield (1.285 kg/plant or 28.008 t/ha), as shown in Table - 3. These results are consistent with findings in brinjal for yield attributing characters improvement through application of opteine as physio-activator (12). Overall, a positive trend was observed in all growth and yield parameters with increasing doses of Pilatus Plus. Although the highest total soluble solids (TSS) content was observed at the 1250 ml/ha dose, differences among treatments were not statistically significant.

In contrast, the control and competitor treatments recorded lowest plant height, no improvement in lowest tuber weights, yields and quality parameters as compared to the plants treated with sea weed extract (Pilatus plus).

These results suggest that the inclusion of seaweed extract as an organic biostimulant enhances physiological processes, ultimately improving the yield and quality of potato tubers (13). Pilatus Plus effectively boosts plant growth and yield by supplying essential micro- and macronutrients along with bioactive compounds such as cytokinins, auxins, and vitamins.

***Effect of Pilatus plus on quantitative and qualitative characters of onion*:** The data presented in Table No - 4 indicate that both quantitative and qualitative plant characters were significantly influenced by the treatments, with a notably positive effect observed from the application of *Pilatus Plus* spray. Significant variations were observed in plant characteristics across different doses of *Pilatus Plus*. The maximum plant height (62.617 cm) and highest number of leaves per plant (7.667) were recorded in plants treated with *Pilatus plus* at 1500 ml/ha. However, a further increase in dosage from 1500 ml to 2500 ml/ha resulted in a decline in plant height. The lowest plant height (57.517 cm) was noted in plants treated with the Competitor's Product. The maximum neck thickness (1.158 cm) was also achieved with the 1500 ml/ha *Pilatus Plus* treatment, followed closely by the 1250 ml/ha dosage. The improvement in vegetative parameters is correlated to the maximum photosynthetic activity of the plant.

The improvement in vegetative parameters is closely correlated with the plant's maximum photosynthetic activity. Similar reports of maximum vegetative growth also been observed in Chinese garlic with foliar application of seaweed extract (14).

The foliar application of *Pilatus Plus* at 1250 ml/ha produced the highest fresh root weight (9.250 g) and dry root weight (8.042 g), which were significantly higher than those recorded under other treatments. The lowest fresh and dry root weights were observed in control plants and those treated with the Competitor's Product. Bulb diameter was significantly influenced by the foliar application of *Pilatus Plus*. The 1250 ml/ha and 1500 ml/ha dosages were particularly effective, showing significant improvements in bulb weight and overall bulb yield per hectare. The highest bulb weight (127.250 g) and maximum yield (33.008 t/ha) were recorded with the 1250 ml/ha treatment.

The increased yield of the heaviest bulbs and the improved values of certain physical properties can likely be attributed to enhanced plant vigor resulting from the foliar application of seaweed extracts, as shown in Table - 4. Seaweed extracts are known to promote better plant growth, partly due to their ability to enhance nutrient uptake through the roots (15). Similarly, a significant increase in yield has been reported in peppers following the application of seaweed extracts (1).

Additionally, the Total Soluble Solids (TSS) content of bulbs increased positively with *Pilatus Plus* application, up to an optimal dose. The best response was found at 1250 ml/ha, with a TSS content of 11.133%. A similar type of enhanced yield and quality parameters also indicated using sea weed extract (Opteine Plus) in tomato crop (7).

In conclusion, Pilatus Plus demonstrated a strong boosting effect on plant growth, bulb weight, yield, and quality parameters at appropriate doses. The 1250 ml/ha dose was consistently the most effective across multiple traits. In contrast, the Competitor's Product did not show a favorable impact on growth or yield, with the lowest performance observed in both control and competitor-treated plants.

CONCLUSIONS

Based on the results obtained from the present investigation, it was found that Pilatus plus as bio-stimulant increased plant growth, yield and quality attributes of both onion and potato. However, both the crops in present study responded well to different doses of Pilatus plus. The boosting effect on weight and yield of economic part of both crops, found effective with different doses of Pilatus plus. The application of Pilatus plus @ 1250 ml/ha was found superior for higher bulb yield in onion and tuber yield in potato. The plants treated with the Competitor's product shown minimum values for most of the characters in both crops. It may be concluded from the present investigation that the highest yield and yield attributing characters in Potato and Onion was obtained with the foliar application of Pilatus plus @ 1250 ml/ha. It can be suggested that for producing better bulb and tuber yield foliar application of bio-stimulants helps to boost in both the crops.

FUTURE SCOPE OF THE STUDY

Potato & onion are, being shallow-rooted, particularly susceptible to abiotic stresses like drought and nutrient deficiency. Biostimulants can enhance root development, improve nutrient uptake efficiency and strengthen stress tolerance mechanisms. Future research should aim to develop crop-specific biostimulant formulations, establish optimal application protocols, and explore synergistic effects with conventional inputs. Integrating biostimulants into sustainable cultivation practices can contribute to reducing chemical dependency, improving soil health, and increasing resilience to climate variability in underground vegetable production systems.

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CONFLICT OF INTEREST

No conflict of interest were reported by the authors

Table 3: Performance of Potato Under Influence of Biostimulant (Pilatus)

Treatment/ Parameter	Plant height (cm)	Stem thickness (cm)	No. of branches per plant	% dry matter production	No. of tubers per plant	Length of tuber (cm)	Diameter of tuber (cm)	Tuber weight (gm)	tuber yield (kg/plant)	Tuber Yield (t/ha)	TSS (⁰BRIX)
1	58.283	1.742	3.038	18.948	4.508	7.067	4.567	109.167	0.523	21.593	4.430
2	67.333	1.967	3.430	20.722	5.058	8.017	4.833	166.667	0.898	23.997	4.567
3	69.133	2.067	3.712	21.718	5.853	8.850	5.233	195.875	1.285	28.008	4.833
4	70.717	2.077	3.622	21.502	5.667	9.133	5.100	196.500	1.006	26.783	4.772
5	68.450	1.967	3.598	21.505	5.650	8.267	5.000	190.775	0.913	24.450	4.735
6	64.000	1.940	3.302	19.772	4.677	8.283	4.717	141.333	0.677	23.550	4.368
C.D.	4.768	0.186	0.332	0.833	0.322	0.856	0.367	33.647	0.319	1.271	0.258
SE(m)	1.628	0.064	0.113	0.284	0.110	0.292	0.125	11.486	0.109	0.434	0.088
SE(d)	2.302	0.090	0.161	0.402	0.156	0.413	0.177	16.244	0.154	0.614	0.125
C.V.	6.011	7.947	8.058	3.365	5.149	8.655	6.245	16.876	30.163	4.298	4.676

Note: *T1 (Control), T2 (Pilatus 1000 ml/ha), T3 (Pilatus 1250 ml/ha), T4 (Pilatus 1500 ml/ha), T5 (Pilatus 2500 ml/ha) T6 (Competitor product)*

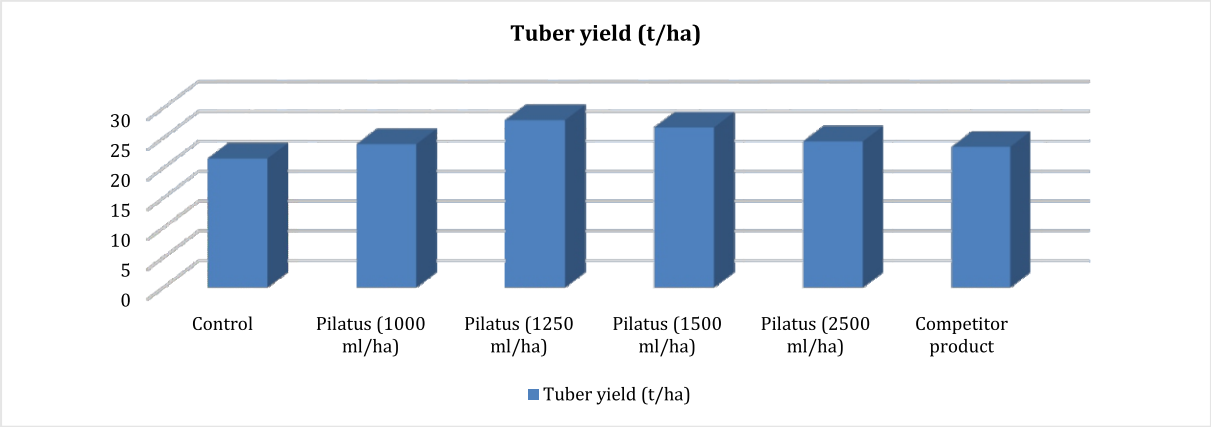

Fig 2: Yield of Potato Tuber Under the Influence of Biostimulant (Pilatus)

Table 4: Performance of Onion Under Influence of Biostimulant (Pilatus)

T/P	Plant height (cm)	No. of leaves per plant	Weight of roots		Diameter of bulb (cm)	Neck thickness (cm)	Bulb weight (gm)	Bulb yield (t/ha)	TSS content
			Fresh weight (gm)	Dry weight of roots (gm)					
T1	53.000	6.488	7.383	6.350	5.758	0.938	91.667	21.593	10.217
T2	59.167	6.917	8.950	7.500	6.158	1.058	117.500	26.497	10.850
T3	61.333	7.283	9.250	8.042	6.400	1.150	127.250	33.008	10.850
T4	62.617	7.667	9.217	7.883	6.308	1.158	126.583	29.117	11.133
T5	59.833	7.342	9.008	7.842	6.248	1.133	126.750	28.117	11.067
T6	57.517	6.750	7.967	7.033	6.150	1.067	115.833	25.550	9.983
C.D.	4.874	0.372	0.565	0.523	0.217	0.133	19.225	1.722	0.411
SE(m)	1.664	0.127	0.193	0.178	0.074	0.045	6.563	0.588	0.140
SE(d)	2.353	0.180	0.273	0.252	0.105	0.064	9.281	0.832	0.198
C.V.	6.918	4.401	5.475	5.873	2.946	10.272	13.670	5.273	3.214

Note: *T1 (Control), T2 (Pilatus 1000 ml/ha), T3 (Pilatus 1250 ml/ha), T4 (Pilatus 1500 ml/ha), T5 (Pilatus 2500 ml/ha) T6 (Competitor product)*

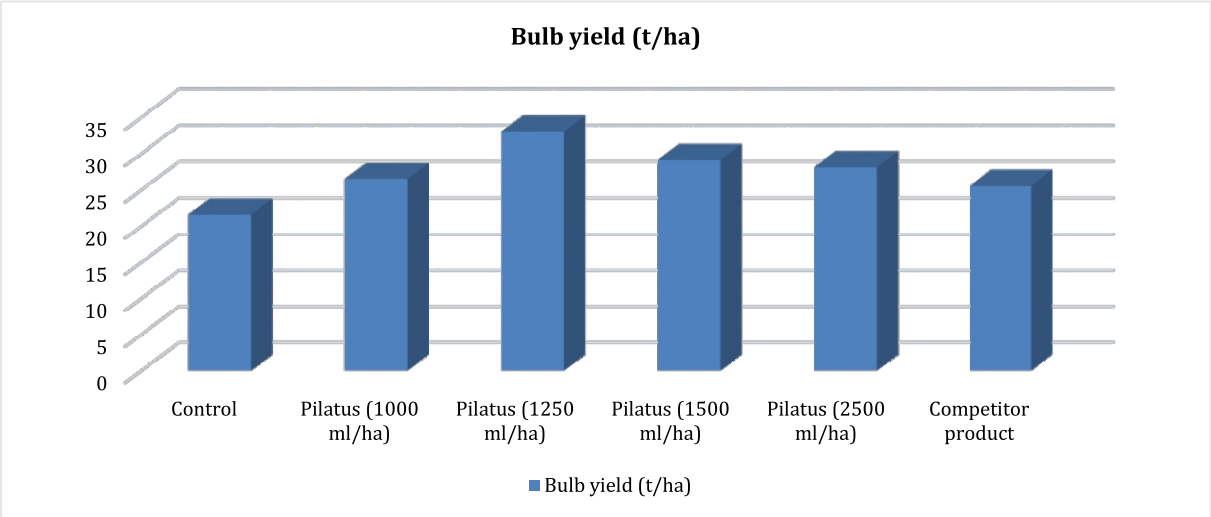

Fig 3 - Yield of Onion Bulb Under the Influence of Biostimulant (Pilatus)

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