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تأثير التسميد العضوى والمعدنى إما بصورة منفردة أو فى توافيق بمعدلات متباينة مع الرش بمستخلص الأعشاب البحرية على النمو الخضرى وتطور نمو الدرنات والأوزان الجافة ومعدلات النمو لنباتات البطاطس

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الملخص العربى

أجرى هذا البحث بمزرعة كلية الزراعة– جامعة المنوفية بشبين الكوم خلال العروة الصيفية لموسمى الزراعة ٢٠٠٨ / ٢٠٠٩ وذلك بهدف تقييم كفاءة إستخدام الأسمدة العضوية كبدائل أو مكملات للأسمدة الكيماوية لمنع مشاكل التلوث البيئى ولإنتاج غذاء أمن صحيا إلى جانب دراسة تأثيرات التسميد النيتروجينى العضوى ممثلا فى سماد عضوى حيوانى وسماد عضوى نباتى مقارنة بالتسميد النيتروجينى المعدنى وذلك بالمعدل الموصى به وهو ١٢٠ كجم نيتروجين / فدان إما فى صورة منفردة أو فى توافيق بمعدلات متباينة من كل منهما مع إستخدام الرش بمستخلص الأعشاب البحرية وتأثير ذلك على النمو الخضرى و تطور نمو الدرنات و الأوزان الجافة و معدلات نمو النبات ممثلة فى معدل النمو النسبى RGR ، والكفاءة التمثيلية NAR وقد كان التصميم الإحصائى المستخدم هو القطاعات كاملة العشوائية.

ومن الجدير بالذكر أن استخدام التسميد العضوى من أصل حيوانى فى توافيق بمعدلات متباينة مع السماد المعدنى كان الأفضل مقارنة بالسماد العضوى النباتى وأن إستخدام الرش بمستخلص الاعشاب البحرية فى توافيق ثلاثية معهما كان الأكثر فاعلية مقارنة بالمعاملات الأخرى.

وقد أظهرت النتائج أن إستخدام أى من الأسمدة العضوية أو المعدنية مع الرش بمستخلص الاعشاب البحرية كان له تأثيرإيجابيا على كل من النمو الخضرى و تطور نمو الدرنات والأوزان الجافة لاجزاء النبات المختلفة ومعدلات نمو النبات ممثلة فى معدل النمو النسبى RGR ، والكفاءة التمثيلية NAR وأن إستخدام المعاملة ٢٥ % سماد أزوتى معدنى + ٧٥ % سماد عضوى حيوانى + الرش بمستخلص الأعشاب البحرية أعطت أفضل النتائج لكل الصفات التى تم دراستها سابقا تليها المعاملة ٥٠ % سماد أزوتى + ٥٠ % سماد عضوى حيوانى + الرش بمستخلص الأعشاب البحرية ثم المعاملة ٥٠ % سماد أزوتى معدنى + ٥٠ % سماد عضوى نباتى + الرش بمستخلص الاعشاب البحرية.

EFFECT OF ORGANIC COMPOST AND MINERAL N FERTILIZERS APPLIED INDIVIDUALLY OR IN DIFFERENT COMBINATION RATES ALONG WITH SEAWEED EXTRACT ON VEGETATIVE GROWTH, TUBER DEVELOPMENT, DRY WEIGHT AND GROWTH ANALYSIS OF POTATO PLANTS.

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ABSTRACT: ***This investigation was carried out at the Experimental Farm of the Fac. Agric., Minoufiya Univ., Shibin El-Kom, Egypt during the summer seasons of 2008 and 2009 to study the effect of two organic composts e.g. zoological and botanical ones and mineral fertilizers at a rate of 120 kg N/fed., individually or in different combination rates along with or without seaweed extract on vegetative growth, tuber development, dry weight production and growth attributes. A complete randomize block design with 3 replicates was used. It is important to point out that the application of zoological compost in different combination rates with inorganic fertilizer was much better than applying of botanical one and the using of seaweed extract with them in tries combinations were the most effective treatments comparing with other ones. The obtained results indicated that fertilization with any of the used fertilizers either alone or in mixture forms with or without foliar spray with seaweed extract significantly augmented vegetative growth, tuber development, dry weight of different plant organs and plant growth analysis. Whereas the application of fertilizer mixture of 25 % of mineral nitrogen + 75 % zoological compost + foliar spray with seaweed extract was the most effective treatment followed by that of 50 % of mineral nitrogen + 50 % zoological compost + foliar spray with seaweed extract then 50 % of mineral nitrogen + 50 % botanical compost + foliar spray with seaweed extract, respectively.***

Key words: ***Potato, mineral N-fertilizer, zoological-, botanical compost, seaweed extract, plant growth, tuber development, growth attributes, dry weights.***

INTRODUCTION

Potato (*Solanum tuberosum* L.) is considered one of the world major staple food crops as it produces more dry matter and protein per hectare than the major cereal crops (Burton,1989). Potatoes tubers are eaten in more countries than any other crop and in the global economy they are the fourth most important crop after the three cereals namely maize, rice and wheat Vreugdenhil *et al*., 2007. Potato has a high nutritional value because it is a rich source of protein, vitamin C, carbohydrates and iron. In the two past decades, the production of potato increased gradually and still shows an increasing tendency, in all other regions of the world and the increase is rapid in tropic and subtropics regions (Horton and Fano, 1985). Moreover, the production of potato cultivars has widespread extensively and successively in Egypt, especially in the newly reclaimed lands, which are sandy in structure, besides it is infertile. Soil improvement and /or manipulating its nutrient environment would be the most important attempts toward solving this problem. On the other hand, potato plant has high nutrients requirements, especially N- fertilizers, largely due to its shallow root system and short growth duration (Acland, 1980).

Nowadays, production of vegetables with reduction of chemical fertilizers is becoming very important due to increasing their prices also for human

health, environment and exportation, especially to Europe. In the near future, most of exported vegetable will be from the safety production. Organic farming system of vegetable production is in growing now in Egypt to take place to produce safe food for human health and for exportation, especially to European markets, where the consumer is willing to pay higher price for healthy and safe product. There is an increasing interest in the using of organic N sources as fertilizers for production of "organic grown" vegetables.

In recent years, seaweed extract has applied to soil or sprayed on plants as fertilizer, which contain many growth regulators such as cytokinins, auxins, gibberllins and betanins besides most of macro and micro elements that necessary for the development, growth and productivity of plant as well as enhance plant defense against pest and diseases (Durand *et al*., 2003; Strik *et al*., 2004; Khan *et al*., 2009 and Jayaraman *et al*., 2010). Until now, there is not much information available about the application of seaweed extract on growth and yield of potato plants. Thus, the present study is an attempt to examine the effect of foliar spray with seaweed extract on potato plants.

Hence, this work was carried out to studying the effects of organic N-fertilizers namely, zoological and botanical compost comparing to inorganic N-fertilizer at the recommended level of 120 kg N/fed. as soil addition individually or in different combination rates with or without foliar spray of seaweed extract, on vegetative growth, tuber development and its subsequent growth as well as growth attributes.

MATERIALS AND METHODS

The present study was carried out during the two successive summer growing seasons of 2008 and 2009 at the Experimental Farm of the Fac. Agric., Shebin El-Kom, Minoufiya Univ., Egypt. The aim of study was to investigate the potential impact of three kinds of organic fertilizers e.g. zoological and botanical compost as soil addition and aqueous seaweed extract as foliar application on vegetative growth, tuber development and its subsequent growth as well as growth attributes of potato plants cv. Nieta. Randomized samples from the experimental soil were taken at depth of 0 up to 60 cm pre-planting to determine the physical and chemical properties of the soil according to the method described by Chapman and Pratt (1961) and Jakson (1965). The obtained results were listed in Table (1). The experimental design was a complete randomized blocks with 3 replicates. The experimental unit occupied 12m^2 in area and included four rows, each of 5 m long and 0.6 m wide.

The Experiment included 20 treatments as follows:

Unfertilized control (T_1); foliar spray with seaweed extract (T_2); 100 % mineral nitrogen (T_3); 100 % mineral nitrogen + foliar spray with seaweed extract (T_4); 75% mineral nitrogen + 25 % zoological compost (T_5); 75 % mineral nitrogen + 25% zoological compost + foliar spray with seaweed extract (T_6); 50 % mineral nitrogen + 50 % zoological compost (T_7); 50 % mineral nitrogen + 50 % zoological compost + foliar spray with seaweed extract (T_8); 25 % mineral nitrogen + 75 % zoological compost (T_9); 25 % mineral nitrogen + 75 % zoological compost + foliar spray with seaweed extract (T_{10}); 100% zoological compost (T_{11}); 100 % zoological compost + foliar spray with seaweed extract (T_{12}); 75 % mineral nitrogen + 25 % botanical compost (T_{13}); 75 % mineral nitrogen + 25 % botanical compost + foliar spray with seaweed extract (T_{14}); 50 % mineral nitrogen + 50% botanical compost (T_{15}); 50 % mineral nitrogen + 50 % botanical compost + foliar spray with seaweed extract (T_{16}); 25% mineral nitrogen + 75 % botanical compost (T_{17}); 25 % mineral nitrogen + 75% botanical compost + foliar spray with seaweed extract (T_{18}); 100 % botanical compost (T_{19}) and 100 % botanical compost + foliar spray with seaweed extract (T_{20}).

Table 1

The recommended dose of nitrogen fertilizer of 120 kg N/fed was chosen and was applied as N fertilization treatment. This treatment was added either as mineral fertilizer or as zoological and botanical compost one, based on the total nitrogen percentage in each compost beside combination treatments between mineral and both organic fertilizers as replacement rate with or without seaweed extract as foliar application, untreated plants with seaweed extract were sprayed with distilled water. Some chemical properties of the both organic compost and seaweed extract used are shown in Table (2 and 3).

Ammonium sulphate (20.5%) was used as a source of inorganic nitrogen at a rate of 120 kg N/fed. Inorganic-N fertilizer was applied in four equal doses. The first dose was preplanting added + at the time of soil preparation, whereas, the second one was applied after tuber seeds emergence. The remaining two doses were added with 10 day intervals; i.e., 45 and 55 days after sowing. Organic nitrogen; i.e., zoological and botanical compost was preplanting (preridging). Seaweed extract was applied at a concentration of 2-3 cm^3 dissolved in one liter of distilled water, sprayed as a fine mist to all exposed plants till run off. Foliar applications were applied for three times at 10 days intervals beginning at tuberization period; i.e., 6 weeks from sowing.

Seed tubers ranging from 35-55 mm in size with 2-3 sprouts were sown on 2^{nd} of February and 24^{th} of January in 2008 and 2009 growing seasons, respectively. Potato seed pieces were set at 20cm between each other, on rows and in depth of about 15cm in rows. All field plots were fertilized with calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) at rates of 75 kg P_2O_5 and 96 kg K_2O/fed. Superphosphate was added during soil preparation, while potassium sulfate was divided into two equal doses applied during soil preparation and at tuberization stage; i.e., 6 weeks from planting. The harvesting time was done after 120 days from planting for both growing seasons of study, since the cultivated variety is semi late maturated.

A. Vegetative growth:

During the growth period, three plant samples were taken for growth analysis at 10 days intervals started at 70 days from planting; i.e., 5 days after the final spray with seaweed extract. Each sample consisted of 3 plants which were taken randomly from the two outer rows of each experimental unit in both growing seasons of this study. The plants were dissected into different organs and the following growth parameters were recorded: Plant height, number of lateral branches / plant, number of main stems / plant, leaf area / plant, average tubers number / plant, fresh weight of tubers / plant, dry weight of different plant organs; i.e., stems, leaves as well as tubers / plant.

B. Growth analysis attributes:

Based on the above-cited data, the following growth attributes were calculated on single plant basis:

1. Relative growth rate (RGR):

It was determined during the plant growth as assessed at the period of 70-80 and 80-90 day after planting by the following equation reported by Cachorro *et al.* (1994).

$$RGR = \frac{\ln W_2 - \ln W_1}{T_2 - T_1} \quad (mg/g^{-1}/day^{-1})$$

Where:

W_1 and W_2 are the total plant dry weight at times T_1 and T_2, respectively but T_2-T_1 are the period between the two consecutive samples.

2. Net assimilation rate (NAR):

It is important to note that NAR is not an exact measure of photosynthesis but rather a measure of the net dry weight gain by photosynthesis over loss by respiration. The following formula was

Table 2 , 3

used to calculate the NAR as cited after McCollum (1978).

$$NAR = \frac{(W_2-W_1)\ (InL_2 - InL_1)}{(L_2-L_1)\ (T_2-T_1)}\ (mg\ /cm^{-2}/day^{-1})$$

Where:

W_1 and W_2 refer to total dry weight of plants at T_1 and T_2, L_1 and L_2 are leaf area at T_1 and T_2 but T_1 and T_2 are the period between the two consecutive samples.

3. Tuber growth rate (TGR):

It was estimated by the following equation as cited after Mc Collum (1978) as follows:

$$TGR = \frac{dw_{tu}}{dt}\quad (g\ plant^{-1}.\ day^{-1})$$

dw_{tu} = dry weight of tubers (g / plant), dt = days after emergence, which calculated when the 90 percent of the total tuber were emerged to the time of sampling.

Statistical analysis:

All obtained data were statistically analysed according to the procedures outlined of Snedecor and Cochran (1980).

RESULTS AND DISCUSSION:

1. Vegetative growth:

Data presented in Tables (4 and 5) show the effect of organic and inorganic N-fertilizers as N-sources either each alone or in mixture of different replacement rate from both either alone or in combination with foliar spray with seaweed extract on plant growth characters. Firstly, it can be noticed that, generally, the recorded main stem values showed no differences between the three plant samples irrespective the treatments since all main stems of potato plants were grown, generally, at 40 days from emergence, hence the data of the third sample were only shown.

It is quite evident from the data in the above-named tables that fertilization with any of used fertilizers either alone or in mixture forms with or without foliar spray with seaweed extract significantly augmented the investigated above-ground potato plant organs. It is noteworthy to note that the application of fertilizer mixture of 25 % MN + 75 % ZC + SE (T_{10}) was the most effective treatment comparing with the other ones followed by that of 50 % MN + 50 % ZC + SE (T_8) and 50 % MN + 50 % BC + SE (T_{16}), respectively. These results were insistently observed at the three sampling dates and in both growing seasons, where the effect was more pronounced in the third sample (taken after 90 days from sowing) rather than the two previous ones.

The obtained growth enhancement owing to the above-mentioned treatments is agreement with that reported by Davis *et al*. (1986); Hensel and Locascio (1987); Malthew *et al*. (1999); Pacha (2003) and Bekhit *et al*. (2005) on potato. Increases in potato growth resulted from N-fertilization, generally may be explained that N element is of extreme importance in plants; where it is a main constituent of protoplasm, nucleic-and amino acid, chlorophyll, protein as well as other important substances. Furthermore, plants with high nitrogen contents had higher levels of endogenous auxins and gibberellins activity, which encourages cell division and elongation as well as initiate meristematic activity, increases leaf number, produce a sufficient assimilation area for maximum photosynthesis, thereby enhancing plant growth (Mengel and Kirkby, 1987).

Regarding the effects of the tested organic N-fertilizers, it can be noticed from the data in Tables (4 and 5) that the effect of zoological compost on plant growth was pronounced rather than botanical compost and that may be attributed primarily to its chemical constituents (see Table 2), where it contain higher macronutrient per cent such as N, P and K as well as micronutrient such as Zn and Cu and subsequently reflected in these nutrients

uptake by plants, where they are considered an essential elements for

Table 4

Table 5

plant growth and have functional roles in enzyme activation, cation transport across membranes, turgid regulation and energy metabolism,...etc. So it may suggest that this superiority in plant growth was depended on the summation of the role of each element involved. Other possibility could be due to the pH of zoological compost, which is about 7.2; i.e., near from neutral pH, so improving soil features (Jones, 1982 as well as Khalaf and Taha, 1988) and thus increasing the availability of soil nutrients (Alvarez *et al*., 1995) in addition the release of N, P and K from organic fertilizer is very much dependent on carbon content of it, that is lower in zoological than in vegetal compost (Table 2) which accelerate the release of these elements Thyboa *et al*. (2006) and in turn, enhancing nutritional status of plants, which necessary for their growth (Mengel and Kirkby, 1987).

The promoting effect of organic composts treatment in increasing all studied growth characters were attributed primarily to absorb more of the available N supplied in it compared with inorganic sources of NO_3^--N (Termorshuizen *et al.,* 2004), that are susceptible to N loss mechanisms such as leaching during the growing period. Therefore, the efficiency with which available fertilizer N is utilized may be marginally improved when organic fertilizer is supplied to vegetable crops such as spinach, lettuce and potato, compared with inorganic forms of N (Smith and Hadley, 1989 on lettuce; Gawish, 1997 on lettuce and spinach; Haase *et al*., 2007 and Gawish *et al*., 2011 on potato).

The superiority effects of foliar application with seaweed liquid extract on growth measurements of potato plants could be explained on the basis that seaweeds extracts are marked as liquid fertilizers and biostimulants since they contain many growth regulators such as cytokinins (Stirk *et al*., 2003), auxins (Stirk *et al*., 2004), gibberellins (Rayorath *et al*., 2008a), betaines (Wu *et al.,*1997), macronutrients such as N, P, K, Ca, Mg and S as well as micronutrients like Mn, Cu, Zn, B, Fe and Mo (Kumari *et al*., 2011), which are in accordance with that cited in Table (3).

The above-named growth regulators as well as macro-and micronutrients are necessary for the development and growth of plant. In view of the findings of Crouch *et al*. (1990) who reported that, foliar spray of lettuce with seaweed extract increase size and vigor of roots, which improve nutrient uptake by them, resulting in root systems with improved water and nutrient efficiency, thereby causing enhanced general plant growth and vigor. Furthermore, positive responses include improved leaf quality, general plant vigor and impart resistance to pathogens and droughts were reported by Khan *et al*. (2009).

2. Tuber development and its subsequent growth:

Data presented in Tables (6 and 7) imply the distinct effect of the different combination rate from organic compost and mineral N-fertilizer with or without foliar spray of seaweed extract on potato tuber development and its subsequent growth e.g. weight and number of tuber / plant, average tuber weight as well as tuber growth rate (TGR), which are recorded at 70, 80 and 90 days after sowing. In this connection, tuber growth rate was calculated as days from emergence, which was 25 days after sowing. Generally, it could be concluded from these results that all investigated treatments significantly increased all the above-mentioned parameters comparing with check treatment (T_1). Whereas, T_{10} (25 % MN + 75 % ZC + SE) achieved the highest values followed by those of 50 % MN + 50 % ZC + SE (T_8) then 50 % MN + 50 % BC+ SE (T_{16}), respectively.

The findings noted in this study revealed that the distinct differences in the number and size of tubers indicate

clearly that, tuber initiation took place much earlier in plants fertilized with any

Table 6

Table 7

combination per cent from inorganic-and organic N plus foliar spray with seaweed extract than unfertilized ones, but the treatment of T_{10} being the most effective. It is interesting to note that tuber initiation itself is only of limited importance. The most important aspect of potato production is the ability of the plant to support tuber growth sink after initiation. This is dependent on the presence of sufficient foliage (source) to provide enough photosynthate, and adequate supplies of water and mineral nutrition (Moorby, 1970). On the other hand, the rate of photosynthesis is regulated by the sink capacity (number of tubers). Tuber growth is achieved by both cell division and cell expansion, although there is some debate as to which is more important, while Plaisted (1957) believed that cell division plays the main role, Ahmed and Sagar (1981) revealed that cell expansion is the main contributor to tuber growth. The highest average tuber weight could be interpreted, in a way, that enhanced early tuber initiation and tuber growth, which caused by the application of the mixture of organic-and inorganic N fertilizers plus foliar spray with seaweed extract, resulting in increased sink activity of the tubers, and the latter in turn improved the rate of assimilation and also the translocation of assimilates to tubers. Such a circumstance arrests top growth and encourages tuber growth, as both compete for assimilates (Krauss and Marschner, 1971).

A promoting effect of the above-cited treatment on parameters of tubers development and it subsequent growth namely, weight and number of tubers / plant, average tuber weight as well as tuber growth rate may be attributed to the increment in vegetative growth, especially leaf area and No. of main stem (Tables 4 and 5). Encouraging leaf area (source) and thereby enhancing metabolites amount in the plant via using the treatment of organic fertilizers + foliar spraying with seaweed extract resulted in increased sinks (tubers) and increased average tuber weight (Krauss, 1985). Moreover he added also that highly significant positive correlation were also found between main stem number vs. each of both stolon formation and number of tubers, which are in agreement with those obtained in our study.

Furthermore, Menzel (1980) reported that shoot and stolon formation is controlled by the level of endogenous hormones, whereby a high level of GA_3 (gibberellins) and IAA (auxin) is essential for stolon formation, while that of cytokinins inhibits it. On the other hand, he mentioned that using inhibitors such as ABA abscisic acid) and CCC (cycocyl) instead of cytokinin, reached similar conclusions, but he was of the view that the site of activity is a stolon tip rather than the base of it. Therefore, the results of this work suggest that the beneficial consequences of organic-N fertilization as zoological-and botanical compost besides foliar application of seaweed extract on tuber development and its subsequent growth are due not only to the promotive effect on plant growth as discussed previously, but also to the alternation in the hormonal balance such as the rise of GA_3 and IAA concentration in leaves (Krauss and Marschner, 1971 as well as Krauss, 1981), which positively affected tuberization. Besides, Krauss (1980) and Marschner *et al*. (1984) indicated that the ratio of ABA to GA_3 at stolon tip play a predominant role in tuberization.

3. Dry matter production of different plant organs:

Dry weight accumulation is commonly used as parameter to characterize growth because it usually has a great economic significance. The total dry matter yield of crops depends on the size of leaf canopy, the rate at which the leaf functions (efficiency), and the length of time the canopy persists (duration). The

production of assimilates by the leaves (source) and the extent to which they can be accumulated in the sink representing the organs that are harvested significantly influences crop yield (Hahn, 1977).

The effect of different combination rate from organic compost and mineral N fertilizer along with foliar application of seaweed extract on dry weight of stems, leaves and tuber for 2008 and 2009 growing seasons is shown in Table (8). The results revealed generally, that different values of dry weight were produced in the above-named plant organs owing to the application of the all tested fertilization treatments, at least partly as a consequence of different duration of growth from emergence to harvest, but these differences were apparent mainly in the treatments receiving adequate amounts of zoological or botanical compost plus foliar application with seaweed extract.

In this regard, it is quite evident from the results in the same table that all the used fertilization treatments significantly augmented potato organs dry weight than those of unfertilized plants. The stimulatory effect of N fertilization in increasing dry weight of leaves and shoots of potato plant would be explained on the base that N is an indispensable elementary constituent of numerous organic compounds of general importance amino acids, proteins, nucleic acids, cytoplasm, chlorophyll and many other important substances.

It is noteworthy to note that the treatment of T_{10} exhibited the highest values of dry matter (DM) production followed by those of T_8 and T_{16} however the lowest values were resulted by the check plants. These results are true at the three plant samples and at both growing seasons. These results are in harmony with those obtained by Abou-Hussein (1995) on potato, Abdel-Ati (1998) on potato and Craigie (2010). The superiority of DM accumulation in different organs of potato plant as a result of the applying organic fertilization e.g. zoological and botanical compost as well as foliar application of seaweed extract may be attributed to their positive effects on vegetative growth (Tables 4 and 5) which was observed and discussed previously in details in section 1.

In the work reported here, the data on total green leaf area (Table 4) indicated the potential of organic N-fertilizers such as zoological and botanical compost to increase substantially the photosynthetic leaf area when provided at equal or above 50 % of the replacement, besides the using of seaweed extract, which made these treatments the most effective ones comparing with the others. Also, higher concentration of chlorophyll were found in leaves of plant grown under conditions of organic fertilizers supply and foliar spray with seaweed extract comparing to check treatment where is considered as an essential compound of the light reaction of photosynthesis. So we suggest that these vigorous potato plants with higher leaf area and chlorophyll content produce more photosynthesis products (e.g. carbohydrates) which in turn translocation to be stored in different parts of plant and hence, increase plant dry weight.

4. Growth attributes:

To obtain further information on the response of potato growth to different combination rate from organic compost and mineral N-fertilizer along with foliar application of seaweed extract, relative growth rate (RGR) and net assimilation rate (NAR) were evaluated and presented in Table (9).

The results indicated that, generally, RGR (mg/g/day) and NAR (mg/cm^2/day) significantly augmented by using the tested organic and inorganic N-fertilizers either each alone or in different replacement rate from both with or without foliar spray with seaweed extract. It is also interesting to note that potato

plants received 25 % MN + 75 % ZC + SE (T_{10}) significantly exhibited the maximum values of these growth attributes

Table 8

Table (9). Relative growth rate (RGR) and net assimilation rate (NAR) as affected by organic compost and mineral N- fertilizers individually or in different combination rates from both along with foliar application with seaweed extract during 2008 and 2009 growing seasons.

Characters / Treatments *	RGR (70-80 days after sowing) (mg /g /day)		NAR (70-80 days after sowing) ($mg/cm^2/day$)		RGR (80-90 days after sowing) (mg /g /day)		NAR (80-90 days after sowing) ($mg/cm^2/day$)	
	2008	2009	2008	2009	2008	2008	2008	2009
T_1	17.6	7.9	6.6	2.7	4.9	3.3	2.5	1.5
T_2	19.2	13.3	6.9	3.6	6.0	4.4	2.9	1.8
T_3	21.9	18.1	9.1	5.6	7.2	6.0	3.8	2.4
T_4	23.1	20.2	9.5	6.2	8.4	6.6	4.4	2.7
T_5	23.1	15.1	9.3	5.0	8.0	6.7	3.3	2.8
T_6	24.5	18.9	9.6	5.5	9.2	7.8	3.5	3.1
T_7	21.0	15.5	9.4	4.8	9.0	6.7	3.6	3.7
T_8	24.9	21.9	9.7	6.7	10.3	8.1	4.6	3.8
T_9	20.8	15.1	8.5	5.5	8.3	8.0	4.4	3.3
T_{10}	25.8	23.4	10.1	7.5	12.3	10.2	4.8	4.1
T_{11}	22.5	15.8	9.2	6.2	7.5	6.6	4.1	2.6
T_{12}	24.0	17.7	9.5	6.7	8.7	7.2	4.4	2.9
T_{13}	23.0	14.5	8.0	4.1	6.7	5.1	3.1	2.4
T_{14}	24.0	17.8	9.6	5.1	9.1	5.9	3.4	2.8
T_{15}	20.2	16.8	8.9	4.2	8.0	6.5	3.2	2.5
T_{16}	24.3	20.2	9.7	6.5	10.1	7.1	3.8	3.1
T_{17}	23.1	17.9	7.5	4.2	7.5	6.4	3.1	2.0
T_{18}	24.0	20.0	9.0	6.0	8.8	7.0	3.3	2.5
T_{19}	19.9	16.9	8.9	5.3	7.1	5.2	3.2	2.4
T_{20}	23.4	18.9	9.4	5.8	8.3	5.8	3.4	3.0
LSD at 5%	0.8	1.1	0.2	0.4	1.0	0.5	0.1	0.2

* T_1 till T_{20}: The same footnote in Table (4).

followed by that of 50 % MN + 50 % ZC + SE (T_8) and 50 % MN + 50 % BC + SE (T_{16}), respectively comparing to unfertilized treatment control. These results conside partially with those of Arthur *et al*. (2003) on pepper, Erhart *et al*. (2005) on potato.

The increase in growth attributes of potato plants; i.e., RGR and NAR resulted from organic N-fertilizer treatments were attributed primarily to absorb more of the available N supplied in zoological-and botanical compost compared with inorganic of NO_3^--N, that are susceptible to N loss mechanisms such as leaching and denitrification, during the growing period. Therefore, the utilization efficiency of available fertilizer N may be marginally improved when both organic fertilizers are supplied to vegetable crops

compared with inorganic form of N (Gawish, 1997).

In addition, increased leaf area owing to the application of organic fertilizers and seaweed extract increase photosynthesis by the plant, thereby encouraging assimilation rate and metabolites amount, thus enhancing rate of growth. Somewhat, similar results were obtained by Jamieson *et al*. (1998) on potato, who stated that improving leaf area expansion particularly at early growth stages increase net assimilation rate because the relative increase in the interception of photosyntheticaly active radiation is large, when leaf area is small. Also, Zaller and Köpke (2004) and Arancon *et al*. (2005) assigned that FYM contains many species of living organisms, which release phytohormones; i.e., GA_3, IAA and CYT that stimulate plant growth, absorption of nutrients and photosynthetic processes. Further, Kumari *et al*. (2011) reported that the enhanced-growth effect is thought to be due to various organic compounds present in the seaweed extract. More specifically it is thought to be due to the presence of phytohormones mainly cytokinins, in the seaweed extracts.

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تأثير التسميد العضوى والمعدنى إما بصورة منفردة أو فى توافيق بمعدلات متباينة مع الرش بمستخلص الأعشاب البحرية على النمو الخضرى وتطور نمو الدرنات والأوزان الجافة ومعدلات النمو لنباتات البطاطس

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الملخص العربى

أجرى هذا البحث بمزرعة كلية الزراعة– جامعة المنوفية بشبين الكوم خلال العروة الصيفية لموسمى الزراعة ٢٠٠٨ / ٢٠٠٩ وذلك بهدف تقييم كفاءة إستخدام الأسمدة العضوية كبدائل أو مكملات للأسمدة الكيماوية لمنع مشاكل التلوث البيئى ولإنتاج غذاء أمن صحيا إلى جانب دراسة تأثيرات التسميد النيتروجينى العضوى ممثلا فى سماد عضوى حيوانى وسماد عضوى نباتى مقارنة بالتسميد النيتروجينى المعدنى وذلك بالمعدل الموصى به وهو ١٢٠ كجم نيتروجين / فدان إما فى صورة منفردة أو فى توافيق بمعدلات متباينة من كل منهما مع إستخدام الرش بمستخلص الأعشاب البحرية وتأثير ذلك على النمو الخضرى و تطور نمو الدرنات و الأوزان الجافة و معدلات نمو النبات ممثلة فى معدل النمو النسبى RGR ، والكفاءة التمثيلية NAR وقد كان التصميم الإحصائى المستخدم هو القطاعات كاملة العشوائية.

ومن الجدير بالذكر أن استخدام التسميد العضوى من أصل حيوانى فى توافيق بمعدلات متباينة مع السماد المعدنى كان الأفضل مقارنة بالسماد العضوى النباتى وأن إستخدام الرش بمستخلص الاعشاب البحرية فى توافيق ثلاثية معهما كان الأكثر فاعلية مقارنة بالمعاملات الأخرى.

وقد أظهرت النتائج أن إستخدام أى من الأسمدة العضوية أو المعدنية مع الرش بمستخلص الاعشاب البحرية كان له تأثيرإيجابيا على كل من النمو الخضرى و تطور نمو الدرنات والأوزان الجافة لاجزاء النبات المختلفة ومعدلات نمو النبات ممثلة فى معدل النمو النسبى RGR ، والكفاءة التمثيلية NAR وأن إستخدام المعاملة ٢٥ % سماد أزوتى معدنى + ٧٥ % سماد عضوى حيوانى + الرش بمستخلص الأعشاب البحرية أعطت أفضل النتائج لكل الصفات التى تم دراستها سابقا تليها المعاملة ٥٠ % سماد أزوتى + ٥٠ % سماد عضوى حيوانى + الرش بمستخلص الأعشاب البحرية ثم المعاملة ٥٠ % سماد أزوتى معدنى + ٥٠ % سماد عضوى نباتى + الرش بمستخلص الاعشاب البحرية.

Table (1). The physical and chemical analysis of experimental soil pre-conducting the experiment (Depth 0-60 cm).

(a) Physical properties

Fraction percentage			Texture class	Organic matter %	Field capacity %	Bulk density gm/cm^3
Sand %	Silt %	Clay %				
31.89	23.93	41.29	Clay	1.73	36.5	1.55

(b) Chemical properties

E.C* m.mhos / cm at 25 °C	PH** 1:2.5 Soil / Water suspension	C.E.C mg / 100 g soil	Total N mg / 1oo g soil	Total P mg / 1oo g soil	Total K mg / 1oo g soil	Soluble ions meq/ 1oo g soil						
						Anions			Cations			
						HCO_3^-	Cl^-	SO_4^{2-}	K^+	Na^+	Ca^{++}	Mg^{++}
0.42	07.55	28.75	50.12	15.27	41.16	0.60	4.35	02.00	0.14	0.30	0.75	0.56

* E.C. Electrical conductivity in 1:5 soil water extract.

** In 1:2.5 Soil / water suspension.

Table (2). Some chemical constituents of zoological and botanical compost.

Compost	Chemical properties											
	Organic C %	Organic matter %	C/N ratio %	E.C ds/m	pH (1:10 Soil / water suspension)	Macro-nutrient %			Micro- nutrient PPm			
						Total-N	Total P	Total K	Fe	Zn	Mn	Cu
Zoological	17.07	29.44	11.15	1.76	7.2	1.5	1.83	0.43	247	150	100	48
Botanical	25	37	20.83	1.33	7.6	1.2	0.81	0.24	250	146	105	50

Table (3). Some chemical constituents of seaweed extract.

Macro-nutrient %						Micro- nutrient Ppm						Some chemical constituents %		Growth regulators					
														%			PPm		
N	P	K	Ca	Mg	S	Mn	Cu	Zn	B	Fe	Mo	Protein	Carbohydrates	Mannitol	Alginic acid	Betaines	Indole acetic acid	Cytokinins	Gabrilic acid
1.5	0.05	1.0	1.0	0.9	9	12	6	100	100	200	5	8	35	7	20	0.04	0.03	100	100

Table (4). Plant height and Leaf area / plant as affected by organic compost and mineral N- fertilizers individually or in different combination rates from both with or without foliar spray of seaweed extract during 2008 and 2009 growing seasons.

Samples	1st sample (70 days after sowing)				2nd sample (80 days after sowing)				3rd sample (90 days after sowing)			
Characters	Plant height cm		Leaf area / plant dm^2		Plant height cm		Leaf area / plant dm^2		Plant height cm		Leaf area / plant dm^2	
Treatments*	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
T_1	38.0	33.6	17.9	17.4	40.3	34.9	18.3	18.2	41.6	36.2	19.0	18.9
T_2	41.9	37.0	22.9	18.9	43.6	39.1	23.7	20.3	46.4	41.1	24.1	22.0
T_3	49.8	41.7	28.8	25.6	52.7	44.2	31.6	28.1	58.3	46.8	33.7	30.1
T_4	52.9	45.4	32.7	29.0	56.9	47.9	36.7	34.9	60.8	49.7	39.2	37.2
T_5	52.5	44.2	41.3	35.5	54.8	45.9	42.9	36.8	58.1	47.3	43.7	39.6
T_6	55.3	47.6	43.5	38.9	59.3	49.8	44.5	41.3	60.7	50.7	46.8	42.8
T_7	54.1	46.8	41.3	37.8	60.0	48.3	42.5	39.0	61.7	49.3	44.4	41.7
T_8	56.7	50.5	43.6	41.5	61.8	53.8	45.3	42.3	64.6	55.8	49.0	44.9
T_9	56.0	46.8	41.0	39.7	59.8	52.1	42.8	39.9	62.2	54.9	45.8	40.6
T_{10}	60.9	53.6	44.5	42.8	64.7	56.7	46.6	43.9	67.9	60.3	51.8	48.0
T_{11}	51.9	45.9	32.3	28.2	54.8	46.8	34.5	31.6	59.1	48.2	39.8	36.2
T_{12}	54.2	49.3	36.4	33.6	58.1	51.4	37.3	35.8	63.3	52.1	43.6	39.4
T_{13}	49.5	40.0	35.9	34.3	51.6	43.7	38.4	35.6	53.4	45.9	41.8	37.9
T_{14}	52.9	43.3	40.1	36.1	55.3	47.3	41.1	38.5	58.2	49.8	44.7	41.0
T_{15}	51.8	44.6	36.5	33.5	58.0	48.1	37.1	35.7	59.8	50.9	39.8	38.3
T_{16}	55.9	47.8	41.2	37.8	61.2	50.8	42.4	39.8	64.3	54.3	45.2	41.6
T_{17}	53.0	43.6	36.3	30.4	57.0	47.4	38.6	31.4	57.8	48.4	40.0	33.9
T_{18}	55.4	47.3	39.2	32.9	59.9	49.5	40.3	34.1	61.1	52.9	43.8	37.8
T_{19}	48.2	40.9	27.3	24.1	51.2	43.1	29.8	27.8	56.7	45.8	32.4	30.1
T_{20}	50.8	44.2	30.2	28.6	53.8	47.6	35.8	31.0	59.1	49.3	37.1	33.9
LSD at 5%	2.1	2.9	0.6	0.7	2.3	1.9	1.0	1.2	2.8	3.3	2.7	3.0

*T_1:Unfertilized cheek; T_2: Foliar spray of seaweed extract (SE); T_3:100% Mineral Nitrogen (MN); T_4:100% MN+ SE; T_5: 75% MN +25% Zoological compost (ZC); T_6: 75% MN+ 25% ZC+ SE; T_7: 50%MN+50% ZC; T_8: 50%MN+ 50% ZC +SE; T_9: 25%MN+ 75% ZC; T_{10}: 25% MN+ 75% ZC +SE; T_{11}: 100% ZC; T_{12}: 100% ZC + SE; T_{13}: 75% MN+ 25% Botanical Compost (BC); T_{14}: 75% MN+25% BC+SE; T_{15}: 50%MN+50%BC; T_{16}: 50%MN+50%BC+SE; T_{17}: 25%MN+ 75% BC; T_{18}: 25%MN+ 75%BC+SE; T_{19}: 100% BC and T_{20}: 100 % BC +SE.

Table (5). Number of lateral branches and main stems / plant as affected by organic compost and mineral N- fertilizers individually or in different combination rates from both with or without foliar spray of seaweed extract during 2008 and 2009 growing seasons.

Characters / Treatments *	1st sample (70 days after sowing)		2nd sample (80 days after sowing)		3rd sample (90 days after sowing)			
	No. of lateral branches/ plant		No. of lateral branches/ plant		No. of lateral branches / plant		No. of main stems /plant	
	2008	2009	2008	2009	2008	2009	2008	2009
T_1	1.1	0.9	1.6	1.2	2.5	1.9	2.1	1.7
T_2	2.0	1.6	2.7	2.3	3.4	2.8	2.9	2.6
T_3	3.0	2.4	3.8	3.6	4.8	4.1	3.9	3.0
T_4	3.9	3.1	4.9	4.7	5.7	4.7	4.8	3.9
T_5	4.0	3.3	5.0	4.7	6.0	5.2	5.4	4.8
T_6	4.9	4.0	6.0	5.8	6.9	5.8	6.2	5.7
T_7	5.0	4.2	5.7	5.1	6.2	5.7	5.6	4.8
T_8	6.0	5.4	6.6	6.3	7.2	6.9	6.8	6.1
T_9	5.3	4.3	5.9	5.3	6.7	6.6	6.2	5.6
T_{10}	6,9	6.1	7.7	7.4	8.2	7.5	7.6	6.8
T_{11}	3.8	2.6	4.1	3.8	5.5	5.0	5.0	4.1
T_{12}	4.7	3.3	5.3	4.9	6.4	5.6	5.9	5.0
T_{13}	3.8	3.0	4.0	3.9	5.9	5.0	5.1	4.3
T_{14}	4.7	3.8	5.1	5.0	6.8	5.7	5.9	5.3
T_{15}	4.2	3.2	4.5	4.1	6.1	5.4	5.3	4.4
T_{16}	5.1	4.7	5.6	5.2	7.0	6.7	6.5	5.8
T_{17}	4.0	3.0	4.0	4.0	6.0	5.6	5.1	4.5
T_{18}	4.9	3.8	5.3	5.1	6.9	6.3	5.9	5.2
T_{19}	2.9	2.3	3.7	3.4	4.3	4.1	3.6	3.2
T_{20}	3.8	3.0	4.7	4.5	5.2	4.9	4.5	4.1
LSD at 5%	0.8	0.6	0.9	1.0	0.8	0.5	0.7	0.7

* T_1 till T_{20}: The same footnote in Table (4).

Table (6). Tuber fresh weight (g/plant) and average tubers number per plant as affected by organic compost and mineral N-fertilizers individually or in different combination rates from both with or without foliar spray of seaweed extract during 2008 and 2009 growing seasons.

Samples	1st sample (70 days after sowing)				2nd sample (80 days after sowing)				3rd sample (90 days after sowing)			
Characters	Fresh weight of tubers g /plant		Average tubers number /plant		Fresh weight of tubers g /plant		Average tubers number /plant		Fresh weight of tubers g /plant		Average tubers number /plant	
Treatments *	2008	2009	2008	2009	2008	2009	2008	2099	2008	2009	2008	2009
T_1	122.2	55.3	2.5	1.7	227.8	144.0	3.4	2.4	329.0	264.8	4.5	3.9
T_2	212.8	119.7	4.0	3.1	383.8	295.7	5.2	4.4	607.4	407.7	7.3	5.6
T_3	311.0	207.0	5.2	4.6	580.8	498.6	7.1	6.5	973.6	643.1	10.1	7.9
T_4	407.7	309.6	6.4	6.0	795.7	703.0	8.9	8.5	1373.9	883.8	12.9	10.1
T_5	432.8	319.6	6.7	6.1	744.0	595.1	8.9	8.6	1289.6	808.5	13.0	9.8
T_6	564.9	438.0	7.9	7.5	1107.5	801.4	10.7	10.6	1763.3	1008.6	15.8	11.5
T_7	467.8	305.5	6.9	6.5	891.0	684.7	9.0	8.7	1427.9	940.2	13.1	11.3
T_8	656.1	482.8	9.0	8.1	1248.1	948.0	10.9	10.7	2064.0	1176.1	16.0	13.2
T_9	575.4	371.9	8.4	7.7	879.1	607.6	9.8	8.2	1595.9	1056.5	15.6	12.9
T_{10}	793.6	652.7	10.2	9.5	1588.5	1217.9	12.8	12.7	2598.2	1418.5	18.8	14.9
T_{11}	338.0	226.5	5.4	4.7	661.7	524.0	7.2	6.6	1111.4	769.0	10.3	8.9
T_{12}	438.2	351.4	6.6	6.1	893.7	743.0	9.0	8.6	1565.5	1007.0	13.1	10.6
T_{13}	372.1	222.4	6.1	5.1	581.5	444.8	7.1	6.4	1223.7	721.6	12.8	9.1
T_{14}	484.0	319.8	7.3	6.5	805.5	641.8	8.9	8.4	1658.3	951.6	15.6	10.9
T_{15}	425.7	239.0	6.6	5.3	627.1	485.1	7.3	6.7	1322.3	851.8	12.9	10.3
T_{16}	539.8	355.1	7.8	6.7	915.5	719.5	9.1	8.7	1764.7	1060.8	15.7	11.8
T_{17}	371.2	223.6	6.5	5.2	625.0	456.1	7.2	6.6	1191.9	757.9	12.3	10.2
T_{18}	473.6	328.7	7.7	6.6	843.3	656.2	9.0	8.6	1603.6	917.6	15.1	11.6
T_{19}	299.5	201.6	5.2	4.5	562.8	471.0	7.0	6.4	933.2	610.0	10.1	7.8
T_{20}	392.3	298.5	6.4	5.9	771.8	669.5	8.8	8.4	1315.8	783.0	12.9	9.4
LSD at 5%	86.5	64.2	1.1	1.3	154.4	148.7	1.7	1.9	277.5	142.0	2.7	1.3

* T_1 till T_{20}: The same footnote in Table (4).

Table (7). Average potato tuber weigh /plant (g) and tuber growth rate as affected by organic compost and mineral N- fertilizers individually or in different combination rates from both with or without foliar spray of seaweed extract during 2008 and 2009 growing seasons.

Samples	1st sample (70 day after sowing)				2nd sample (80 day after sowing)				3rd sample (90 day after sowing)			
Characters / Treatments *	Average tuber weight / plant (g)		Tuber growth rate (g. plant^{-1}. day^{-1})		Average tuber weight / plant (g)		Tuber growth rate (g. plant^{-1}. day^{-1})		Average tuber weight / plant (g)		Tuber growth rate (g. plant^{-1}. day^{-1})	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
T_1	48.9	32.5	2.4	1.7	67.0	60.0	3.8	2.1	73.1	67.9	4.3	2.5
T_2	53.2	38.6	2.5	1.9	73.8	67.2	4.4	2.6	83.2	72.8	5.1	3.1
T_3	59.8	45.0	3.0	2.1	81.8	76.7	5.2	3.3	96.4	81.4	6.2	3.8
T_4	63.7	51.6	3.1	2.2	89.4	82.7	5.6	3.8	106.5	87.5	6.9	4.4
T_5	64.6	52.4	3.3	2.3	83.6	69.2	5.5	3.2	99.2	82.5	6.4	4.1
T_6	71.5	58.4	3.4	2.4	103.5	75.6	6.3	3.8	111.6	87.7	7.1	4.7
T_7	67.8	47.0	3.3	2.4	99.0	78.7	5.0	3.2	109.0	83.2	6.3	4.7
T_8	72.9	59.6	3.8	2.6	114.5	88.6	6.4	4.4	129.0	89.9	7.6	5.4
T_9	68.5	48.3	3.3	2.4	89.7	74.1	5.0	3.3	102.3	81.9	6.8	4.6
T_{10}	77.8	68.7	4.0	2.7	124.1	95.0	6.7	4.9	138.2	96.6	8.3	6.0
T_{11}	62.6	48.2	3.1	2.2	91.9	79.4	5.7	3.4	107.9	86.4	6.7	4.0
T_{12}	66.4	57.6	3.3	2.4	99.3	86.4	6.1	3.9	119.5	95.0	7.4	4.6
T_{13}	61.0	43.6	3.1	2.2	81.9	69.5	5.3	3.0	95.6	79.3	6.1	4.1
T_{14}	66.3	49.2	3.3	2.4	90.5	76.4	6.0	3.6	106.3	87.3	6.7	4.7
T_{15}	64.5	45.1	3.2	2.3	85.9	72.4	4.9	3.2	102.5	82.7	5.8	4.0
T_{16}	69.2	53.0	3.6	2.5	100.6	82.7	6.2	3.8	112.4	89.1	7.1	4.8
T_{17}	57.1	43.0	3.0	2.1	86.8	69.1	5.3	2.9	96.9	74.3	5.7	3.8
T_{18}	61.5	49.8	3.4	2.3	93.7	76.3	6.1	3.5	106.2	79.1	7.0	4.4
T_{19}	57.6	44.8	2.9	2.0	80.4	73.6	4.9	3.1	92.4	78.2	5.6	3.7
T_{20}	61.3	50.6	3.0	2.2	87.7	79.7	5.6	3.6	102.0	83.3	6.3	4.3
LSD at 5%	3.6	5.4	0.1	0.09	6.4	5.8	0.2	0.2	8.8	3.3	0.4	0.5

* T_1 till T_{20}: The same footnote in Table (4).

Table (8). Dry weights of stems, leaves and tubers / plant (g) as affected by organic compost and mineral N- fertilizers individually or in different combination rates from both with or without foliar spray of seaweed extract during 2008 and 2009 growing seasons.

Samples	1st sample (70 days after sowing)						2nd sample (80 days after sowing)						3rd sample (90 days after sowing)					
Characters / Treatments*	Stems dry weight g/ plant		Leaves dry weight g/ plant		Tubers dry weight g/ plant		Stems dry weight g/ plant		Leaves dry weight g/ plant		Tubers dry weight g/ plant		Stems dry weight g/ plant		Leaves dry weight g/ plant		Tubers dry weight g/ plant	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
T_1	2.8	2.3	12.0	10.8	59.5	43.0	3.0	2.6	13.1	12.2	95.3	52.5	3.3	2.9	14.2	12.7	108.5	63.0
T_2	4.2	3.5	14.9	13.7	63.5	46.3	5.1	4.1	18.2	16.6	110.0	65.5	6.4	5.2	20.7	18.9	126.8	77.5
T_3	5.8	5.8	21.3	17.0	74.0	52.5	7.3	7.0	30.6	25.3	129.5	82.0	10.2	9.6	32.8	27.4	155.3	94.0
T_4	7.4	6.9	23.8	20.5	78.0	56.0	9.4	8.8	36.7	29.8	139.8	94.3	13.4	11.7	39.9	32.7	171.8	108.8
T_5	7.3	5.9	22.7	19.8	81.5	57.3	10.4	9.2	39.5	28.4	138.3	80.0	13.3	10.1	45.4	30.7	161.0	102.8
T_6	8.8	7.1	25.4	22.8	85.8	60.3	12.6	10.6	45.7	33.9	156.8	94.8	16.9	12.4	52.4	36.1	178.5	118.3
T_7	7.5	6.8	23.1	21.2	82.0	60.3	11.9	11.5	41.9	35.8	124.3	78.8	13.8	13.0	43.7	36.0	158.5	117.8
T_8	9.1	8.1	29.7	26.7	94.5	64.5	15.1	13.8	54.8	41.2	161.0	109.5	19.7	17.3	56.5	49.8	191.0	134.0
T_9	7.9	6.4	28.0	25.4	83.3	60.8	11.8	12.2	48.6	36.6	125.0	82.3	13.7	13.1	51.7	38.8	169.0	114.5
T_{10}	10.7	9.8	32.9	29.7	99.0	67.8	17.6	15.4	60.3	45.5	167.8	121.5	23.6	19.8	64.7	56.2	208.3	149.8
T_{11}	7.5	5.9	24.1	21.8	76.8	55.8	8.3	9.3	36.0	26.6	142.0	84.3	13.8	11.2	38.9	28.6	166.8	100.8
T_{12}	8.9	7.1	26.3	24.6	81.8	60.8	10.7	10.7	41.3	31.4	151.5	97.0	17.6	13.5	45.6	34.6	185.5	116.0
T_{13}	5.6	5.4	21.0	18.0	77.0	55.3	9.1	8.4	37.9	27.7	133.0	73.8	11.3	9.9	39.2	28.3	151.8	101.5
T_{14}	7.0	6.9	23.5	21.1	81.8	59.0	11.4	9.9	43.0	32.4	149.0	88.8	14.6	12.1	46.4	34.3	168.0	116.3
T_{15}	6.4	5.6	22.9	19.5	78.5	56.5	10.6	10.4	38.6	29.9	122.5	80.0	13.5	12.0	43.1	33.3	144.0	99.5
T_{16}	7.8	6.9	26.8	23.8	89.5	61.3	13.0	12.4	48.7	37.5	155.3	96.0	16.7	16.2	49.6	46.5	176.8	119.0
T_{17}	6.2	4.9	23.0	19.1	75.5	52.8	10.8	10.4	35.5	32.2	131.8	73.5	12.4	11.5	37.3	34.3	142.8	95.5
T_{18}	7.6	6.0	25.6	22.5	84.5	57.3	12.9	11.9	42.9	36.7	153.3	88.0	15.8	13.6	44.0	39.8	174.0	110.0
T_{19}	5.6	4.8	19.6	16.3	71.5	50.0	7.2	5.6	26.0	20.8	123.5	78.5	9.9	7.6	29.6	24.7	139.5	92.8
T_{20}	7.0	5.9	22.7	19.5	75.8	53.8	9.3	7.0	32.2	24.3	139.3	91.0	13.0	9.8	36.8	29.9	156.5	108.3
LSD at 5%	1.3	1.0	2.4	2.7	3.8	3.0	2.0	1.3	5.0	3.2	6.3	10.3	3.0	2.0	6.4	5.0	15.5	13.2

* T_1 till T_{20}: The same footnote in Table (4).

Table (9). Relative growth rate (RGR) and net assimilation rate (NAR) as affected by organic compost and mineral N- fertilizers individually or in different combination rates from both along with foliar application with seaweed extract during 2008 and 2009 growing seasons.

Characters / Treatments*	RGR (70-80 days after sowing) (mg /g /day)		NAR (70-80 days after sowing) ($mg/cm^2/day$)		RGR (80-90 days after sowing) (mg /g /day)		NAR (80-90 days after sowing) ($mg/cm^2/day$)	
	2008	2009	2008	2009	2008	2008	2008	2009
T_1	17.6	7.9	6.6	2.7	4.9	3.3	2.5	1.5
T_2	19.2	13.3	6.9	3.6	6.0	4.4	2.9	1.8
T_3	21.9	18.1	9.1	5.6	7.2	6.0	3.8	2.4
T_4	23.1	20.2	9.5	6.2	8.4	6.6	4.4	2.7
T_5	23.1	15.1	9.3	5.0	8.0	6.7	3.3	2.8
T_6	24.5	18.9	9.6	5.5	9.2	7.8	3.5	3.1
T_7	21.0	15.5	9.4	4.8	9.0	6.7	3.6	3.7
T_8	24.9	21.9	9.7	6.7	10.3	8.1	4.6	3.8
T_9	20.8	15.1	8.5	5.5	8.3	8.0	4.4	3.3
T_{10}	25.8	23.4	10.1	7.5	12.3	10.2	4.8	4.1
T_{11}	22.5	15.8	9.2	6.2	7.5	6.6	4.1	2.6
T_{12}	24.0	17.7	9.5	6.7	8.7	7.2	4.4	2.9

T_{13}	23.0	14.5	8.0	4.1	6.7	5.1	3.1	2.4
T_{14}	24.0	17.8	9.6	5.1	9.1	5.9	3.4	2.8
T_{15}	20.2	16.8	8.9	4.2	8.0	6.5	3.2	2.5
T_{16}	24.3	20.2	9.7	6.5	10.1	7.1	3.8	3.1
T_{17}	23.1	17.9	7.5	4.2	7.5	6.4	3.1	2.0
T_{18}	24.0	20.0	9.0	6.0	8.8	7.0	3.3	2.5
T_{19}	19.9	16.9	8.9	5.3	7.1	5.2	3.2	2.4
T_{20}	23.4	18.9	9.4	5.8	8.3	5.8	3.4	3.0
LSD at 5%	0.8	1.1	0.2	0.4	1.0	0.5	0.1	0.2

* T_1 till T_{20}: The same footnote in Table (4).